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International Agricultural Research

A Contribution to Crisis Prevention

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Book of Abstracts

Preface

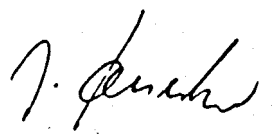
A large part of the world's population still invests the greater part of its energy in cultivating fields and pastures to cover its basic needs, namely acquiring and processing food. In contrast, inhabitants of industrial nations spend the greater part of their life gathering and managing information. Food in these countries is taken for granted with a large selection available 24 hours a day and at all times of the year. Acquiring food, this basic need of mankind, takes only several minutes of daily life. Due to the (mistaken?) assumption that food will also be unlimitedly available in the future, agriculture is loosing its significance in the public eye, both in industrial countries and internationally.

Agriculture, including its affiliated sectors, is the world's biggest employer. At the moment, one billion farmers produce food for six billion people. Although the challenges to produce improved quality food in increasing quantities for an ever growing population without burdening the environment are obvious, the investment into international agricultural and ecological research is decreasing.

Through our activities, we push increasingly at the borders of the load carrying capacity of our planet. Often agrar-ecosystems are over-used due to maladjusted management systems, without the productivity of a particular area being really exhausted. As a result further areas are needed, with consequences in particular for the rain forest, mangrove and coral reef ecosystems. These three systems have a global buffer and regulating function and continually ensure our survival. With continued decimation of these systems a certain point is arrived at where they fall below the necessary critical mass. The systems could be thought of as a sponge which can only absorb a certain capacity. An increasing population competes not only for agricultural production area but also, for example, over habitation area, work places, water and recreation possibilities. This competition for resources will intensify already existent conflicts, so that future military conflicts can be increasingly expected on the grounds of securing resources.

Today the only threat to mankind is mankind itself. A continuously growing population should consider, whether it can procure the necessary resources to feed itself in the long run. Considering the physical supply only, many more people could probably be supported than predicted. But it is also a question of living quality. In industrial countries the term prosperity has gained importance and is connected to a certain living standard which has not much relevance to living quality in an environment worth living in. One thing is certain, the quickly growing population, at the moment about 1.5 % per annum, will continue to have an impact on the environment, probably much quicker and more lasting than it has already done till today.

We should not overlook the fact that our daily well-being is grounded on our ready access to food and water, an access in which we must clearly invest. Every day, every hour where we do not work on the improvement of the diverse agro-ecosystems world wide, rural migration intensifies, the flows of refugees increase, and military conflicts are promoted. Investments in the sustainable development of an international agriculture, which clearly acts as a motor for economic development, are an important contribution to crisis prevention.



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Working Group 1

Research Approaches in Macro-Policy Analysis
Partial versus General Equilibrium Models

Why the Poor Care About Partial Versus General Equilibrium Effects

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The paper compares the impact of macroeconomic structural adjustment and trade liberalization policies on household welfare under partial *versus* general equilibrium frameworks in the Southern African context. The study applies a computable general equilibrium (CGE) model that employs standardized 8-sector social accounting matrices (SAM) for 5 Southern African countries. The analysis decomposes the effects of different trade-related macro shocks into their partial and general equilibrium components, taking into account (a) perfect substitutability *versus* imperfect substitutability; (b) law of one price *versus* domestic price transmission mechanisms; and (c) fixed employment *versus* factor market mobility.

(i) The paper addresses the extensive literature on the role of the agricultural sector in overall economic development in LDCs. Theoretical arguments can be found for both import-substituting industrialization and export-oriented agricultural development, whereas the impact of macroeconomic policy measures directed at these development strategies, like tariff reforms or devaluation of the exchange rate, are always ambiguous and partly driven by macro repercussions and intersectoral linkages.

(ii) The objective of the study is to provide an appropriate framework for isolating partial (direct) effects from economywide repercussions, intersectoral linkages and feedbacks, as well as secondary (indirect) effects in order to determine the deviations in the levels of impact that macroeconomic policies have on household welfare within alternative analytical environments.

(iii) The general question asked in this study is how partial equilibrium results differ from general equilibrium results, especially when looking at household welfare indicators. We explore three issues: (a) general equilibrium effects are typically dampened through repercussions and intersectoral linkages when compared to “plain” partial equilibrium effects; (b) general equilibrium analysis allows for a combination of controlled experiments whose cumulative effects can be isolated into their respective components whereas partial equilibrium analysis typically deals with different isolated scenarios; and (c) complementary policy measures matter and can be handled simultaneously in a general equilibrium framework whereas partial equilibrium analysis has to deal with them separately.

(iv) The methodology applied in this study is an economywide, multisector CGE model. The model accommodates a set of 5 standardized 8-sector SAMs for Malawi, Mozambique, Tanzania, Zambia, and Zimbabwe, hence allowing for comparison of the impact of macro shocks among these countries in the Southern African region.

(v) Results and conclusions will be of relevance for practical policy decision making in order to achieve sustainable economic development. Many African countries are currently seeking eligibility for the HIPC initiative of the World Bank/IMF and have to produce poverty reduction strategy papers (PRSPs) formulating concrete measures to be applied. The measures range from different sectoral policies to economywide macro policies and have to be implemented in packages that combine several measures at the same time. In order to analyze not only the likely economywide effect of a particular policy but also the cumulative effect of a bundle of measures, the CGE approach provides an appropriate framework to meet the demands of current policy work in developing countries.

Key words: Structural adjustment, Southern Africa, CGE models, SAMs

The impact of trade liberalisation on comparative advantage of food crop production in a transformation economy: the case of Vietnam – A Policy Analysis Matrix

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1. Problem addressed

In recent years, Vietnam has undergone a radical transformation process and implemented continuously remarkable changes in economic policies and institutions in general, and in agriculture in particular. The economy responded vigorously during the period 1992-1997: GDP grew at an annual average rate of 8.5%. The agricultural sector grew more moderately, although the achievements in this sector should not be underestimated especially those in rice production. During the last 2 years the statistics even show a somewhat better performance of agriculture than overall economic growth which started to mark a slowing-down. Vietnam became a member of AFTA1 in 1995 and thus it is facing opportunities as well as challenges in the process of fulfilling its commitments. A major question for food crop production in Vietnam is what the possible effects of trade liberalisation and market reform would be on its comparative advantages, and on potentials of production and exports of food crops (especially rice) given the removal of trade restriction, the population and income growths at present and in the 10 years to come. The paper is designed to answer these questions.

2. Objective of the research

The specific objectives of the research are as follows:
- To determine the current level of price distortions in the food crop sector and the major determinants of price distortion.

1 Asian Free Trade Area

- To evaluate the level of protection and competitiveness (comparative advantages) of food (especially rice) production.
- To test the sensitivity of food production and exports to different economic policies and world market (such as world price, exchange rate etc...) scenarios.

3. Research question/hypothesis

- What is the overall trend of food crop production in Vietnam ?
- Although Vietnam is implementing trade liberalisation, the level of protection and price distortion can still be reduced.
- The more liberalised trade is, the more benefits are accruing to farmers (in terms of income opportunities and higher efficiency in domestic production) .
- Government economic policies have a substantial impact on comparative advantages and development of food production in Vietnam.

4. Methodology

The Paper uses the Policy Analysis Matrix (PAM) as the main analytical tool to study the cost structure of rice production, the current level of protection and comparative advantages of rice production by calculating protection indicators (NRP & ERP) and Domestic Resource Costs. In addition, PAM is also used to carry out sensitivity analyses under different trade liberalisation policy options. The model can be considered as a partial equilibrium, single-market, synthetic and policy-oriented simulation model. The advantages as well as limitations of this approach are being highlighted.

5. Results and conclusions

The estimated results show relatively strong comparative advantages for Vietnam in rice production especially when trade barriers and policy distortions are removed. Rice has also a good perspective in the 10 years to come. However, to reap the full benefits, the rice sector in Vietnam needs to become more competitive in a freer trade regime.

Keywords: Food production, comparative advantages, trade liberalisation, Domestic Resource Cost, Policy Analysis Matrix (PAM).

Investigation of Production Opportunities and Resource use Efficiency in Agricultural Production of Armenia

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Problem statement

Since 1990 the transition process (from command economy to free market) started in Armenia. Under the command economy agricultural inputs were highly subsidised and could not serve as objective indicators of production efficiency. Also in the environment of emerging free market relations, where markets are still in the process of transition, actual market prices are likely to reflect market failures and imperfections. In the absence of competitive market prices, reflecting scarcities, and adequate research on real costs of production to determine the comparative advantage in production of agricultural commodities, farmers orient themselves according to private profitability and produce commodities which in the future, once the markets are functioning well, may have no comparative advantage at country level.

Objectives and hypothesis

The main objective of the paper is to study and analyze production and market efficiency of several agricultural commodities in Armenia.
Specific objectives are:

1) to study the formation process of market prices of agricultural inputs, and outputs, to estimate their economic values; to calculate profit-cost ratios of different agricultural alternatives;
2) to investigate the comparative advantage for different production opportunities in agriculture of Armenia.

Hypothesis: Armenia has comparative advantage in vegetable production.

Methodology and Analysis

The theory of comparative advantage implementing the methodology of domestic resource cost (DRC) analysis is applied to investigate the domestic potential of producing six crops: tomato, potato, table grapes, wine grapes, wheat and barley, based on primary and secondary data gathered in three regions of Armenia. Interviews with farmers provided details on quantities and prices of agricultural inputs, outputs, yield levels and production technologies.

To estimate the comparative advantage of commodities in question this research implements the method of DRC estimation described by Monke and Pearson (1989), as a ratio of opportunity costs of domestic factors of production per unit of value added in world prices. The social value of additional domestic output is thus the foreign exchange saved by reducing imports or earned by expanding exports. DRC estimation is done in the following steps :-budget construction; - input/output classification; - social price calculations; - sensitivity analysis conduction.

Conclusions and Recommendations

DRC analysis results conclude whether production of a certain commodity has a comparative advantage for a certain country ,i.e. reveal the efficiency of use of domestic resources. DRC rations and benefit-cost ratios for six crops are calculated. Sensitivity analysis is carried out to examine changes of various factors (e.g. exchange rate, yield level, world reference prices, wages of skilled and unskilled labor) reflecting effects of variations in the economic and political setup on DRC ratios of the selected commodities. The ratios for tomato, potato and wine grapes lie between 0 and 1 (the value of domestic resources used in production of these commodities is less than the value of foreign exchange saved or earned); and for table grapes, wheat and barley are negative (more foreign exchange is used in production of these commodities than they themselves are worth.).**The results of this analysis allow to conclude:** there is a comparative advantage in production of tomato, potato and wine grapes and no comparative advantage in production of table grapes, wheat and barley in Armenia.

Key words: comparative advantage, domestic resource cost.

Frontier urbanization in the Bolivian Amazon: The context of boom and bust in the extractive economy

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Commercial exploitation of non-timber forest products (NTFPs) has been playing a major role in the northern Bolivian Amazon for more than a century. Historically, the region's extractive economy was based on the exploitation of rubber (*Hevea brasiliensis*). A year-round agro-extractive cycle combined subsistence agriculture with the exploitation of rubber and Brazil nut (*Bertholletia excelsa*). This cycle collapsed after the Brazilian government abrogated its rubber subsidies in 1986. Left to the forces of the world market, Bolivian production of wild rubber was no longer viable. Many rubber tappers abandoned their rural livelihoods in search of a new living in one of the region's three urban centers. Riberalta, as the largest among them, received the bulk of rural-urban migrants. Expansion of the labor market and the development of urban infrastructure could barely keep abreast of the unprecedented influx of people. After all, the recent boom in the Brazil nut industry provided specially female immigrants with employment, whereas most of the males continue to rely on the casual labor market, and a notable number leaves each year for the three-month Brazil nut harvest. The majority of newcomers live at the periphery of Riberalta, without access to permanent employment, drinking water and electricity.

The study aimed at elucidating the effect of both boom and crisis in an Amazonian extractive economy on migration, urbanization, and the labor market. It focused on the strategies of ex-forest dwellers to make a living in town compared to those of urban natives and extra-regional migrants. Along with informal interviews of stakeholders from the government and non-government sectors, a household survey was conducted in 1998/99 in four out of a total of 16 peripheral neighborhoods in Riberalta. Semi-structured interviews in 120 peri-urban households selected at random focused on demographic features, migration histories, and sources of

employment and income, both in and out the NTFP industry.
Research was guided by the following questions: 1) what are the underlying reasons for increased urbanization in northern Bolivia, and which role does the rubber crisis and the Brazil nut boom play in this respect; 2) what is the importance of income derived from gathering, processing, or sale of NTFPs as compared to other sources of income of peri-urban households, and to what extent does it differ between ex-forest dwellers, extra-regional migrants, and urban natives?
Obtained results suggest that the rubber crisis was the principal push factor of rural-urban migration over the past fifteen years. But next to the crisis of the rural extractive economy, pull factors such as better health care and schooling, employment in the Brazil nut industry, and the general appeal of urban life influenced rural dwellers' migration to Riberalta. Its recent growth has therefore to be seen in the broader context of frontier urbanization as observed elsewhere in Amazonia. As to income, it is striking that NTFP income is strongly correlated to the educational background of household heads. In both relative and absolute terms, NTFP income rises with decreasing formal education. This trend is reversed with respect to non-NTFP income. NTFP income is specifically crucial to ex-forest dwellers, with 82 % of them deriving income from the participation in the Brazil nut harvest, employment in the related shelling industry and/or other NTFP-related activities. In contrast, little less than half the extra-regional migrants and urban natives generate income from NTFPs. In relative terms, NTFP contribute 46 % to the total household income of ex-forest dwellers and respectively 30 % and 25 % to that of extra-regional migrants and urban natives.
The study shows that the NTFP industry is indispensable for the economic survival of ex-forest dwellers in town. Their high dependence on NTFP-related activities can chiefly be attributed to their lower educational background, as around two thirds of them have primary education or none. About two thirds of extra-regional migrants and three quarters of urban natives, on the other hand, have attended secondary education and, consequently, have more choices on the labor market. They engage less in the strenuous activities offered by the NTFP industry but prefer employment related to petty commerce, services, and administrative

functions.
These findings have several consequences for regional development, especially when focussing on NTFPs. First, rural-urban migration can be ascribed to both the push of a rural extractive economy in crisis and the pull of better facilities and opportunities in town. Second, rural-urban migrants continue to rely on linkages to rural areas, in particular for the gathering of NTFPs. In addition, they depend on lowly remunerated jobs in the urban-based NTFP processing plants, as they generally lack the formal education required for other employment opportunities. Finally, while the prospects of career development are low for ex-forest dwellers, their children will benefit from the move to town where they enjoy better education and health care. It is anticipated that their raised educational levels and the habit of urban lifestyle will result in progressively less participation in NTFP-related activities, which on the other hand will remain essential to all those lacking higher formal education.

Key words: rural-urban migration, non-timber forest products, rubber, Brazil nut, frontier urbanization, Bolivia, Amazon

Working Group 2

Assessment of Poverty and Livelihood Strategies

Poverty Scoring: A Comparison of Effectiveness between Set of Government Poverty Indicators and the Use of Nutritional Status Indicators of Children Under-five Years of Age for Poverty Targeting in East Flores and Sikka District, East Nusa Tenggara Province, Indonesia

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Introduction. The core problem addressed by this paper is to compare the effectiveness of poverty scoring using different types of indicators for the purpose of poverty targeting. As an alternative to the poverty line method based on food consumption survey, The Central Bureau of Statistics (CBS) has been developing a set of indicators to classify whether a household is classified as poor or not. However, this set of poverty indicators does not comprise the nutritional status of children under-five, which is the manifestation of poverty at individual level reflecting either acute or chronic situation. Thus, the objective of the paper is to compare the effectiveness of poverty scoring using the government set of poverty indicators and nutritional status indicators in distinguishing the targeted poor area.

Subject and Methodology. The study was carried out in East Flores and Sikka Districts, East Nusa Tenggara province of Indonesia. 457 randomly selected households with 618 children underfive from East Flores (11 villages) and Sikka (6 villages) were surveyed using a pre-tested open-ended questionnaire. Anthropometric parameters were measured applying standardized method and tools. Children nutritional status is depicted by height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) z scores. Statistical test of Kolmogorov-Smirnov was conducted to analyze the normality of data. Normally distributed parameters were analyzed using Anova and least significant difference.

As Kruskall Wallis test for non-normally distributed parameters. Poverty scoring was applied to differentiate the poor and non-poor. Cluster analysis was also applied to classify target area.

Results. Poverty Scoring A was based on the government's set of indicators and Poverty Scoring B was based on the scoring of anthropometric indices. Poverty Scoring A (Score less than 10 was classified as poor) was able to classify 66.1 % (n=302) of total surveyed households (n=457) to be poor with 58.4 % in East Flores and 41.4% in Sikka. Children under-five (n=618) which have score less than 6 were classified as poor (64.1 %, n=396) with 65.4 % (n=259) in East Flores and 34.6 % (n=137) in Sikka. The findings indicated that there were no significant difference between the two methods of poverty scoring. However, further analysis indicated that there were significant differences between the means of HAZ and WAZ in both of the districts from the poor group of Poverty Scoring B. The results indicated that nutritional status of children under-five in Sikka district was significantly worse compared to East Flores district. Poverty Scoring B was able to indicate, in additional, the severity of the poverty situation eventhough the percentages of the surveyed children in Sikka were lower compared to East Flores district. Results from cluster analysis indicated that classification of poor from the Poverty Scoring B is more robust compared to the results of Poverty Scoring A.

Conclusion. Eventhough not one of both the poverty scoring methods were able to be proven its effectiveness against each other, Poverty Scoring B was able not only to differentiate the poor from the non-poor but also to indicate the severity of the situation of the target area.

Keywords: poverty scoring, stunting, wasting, underweight

Prevalence and Causes of Malnutrition in Urban and Rural Areas of Harari State, Ethiopia

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PROBLEM: Harari National Regional State is a recently established administrative region in east Ethiopia. It was known from clinical records and observations that malnutrition was a problem among children under five in the area, but the exact prevalence of different types of malnutrition was unknown and the specific causes of malnutrition in urban and rural areas had up to the study not yet been identified.

OBJECTIVES AND RESEARCH QUESTIONS: The objectives of this randomised cross-sectional study in HNRS were to establish figures for the prevalence of different types and degrees of malnutrition among children under five in the region; to ascertain specific risk factors for the development of malnutrition in urban and rural areas by assessing the main differences in family background, health status, child-care, child-feeding practices and dietary intake between the children in the two different environments. In order to prevent malnutrition and to improve the nutritional situation of the children in the study area, practical, culturally sensitive recommendations were to be established considering relevant information about the specific causes of malnutrition.

METHODOLOGY AND WORKPLAN: The target group were children under five years of age who had already started eating complementary food at the time of the survey. The sample was selected in a randomised way. At the end of the survey, 411 interviews had been conducted with mothers or caretakers of children under five using a pre-tested questionnaire including a 24-hour-recall form. General data about the child, in-

cluding family background, health status of the child, breastfeeding, complementary feeding, childcare practices and information on the child's diet using the 24-hour-recall format were collected. In addition, the child's weight, length and mid-upper-arm circumference were measured. Further in-depth information was collected through key informant interviews and focus group discussions.

RESULTS AND CONCLUSIONS AND THEIR RELEVANCE FOR DEVELOPMENT: The nutritional status of rural children was with mean weight-for-age-, height-for-age- and weight-for-height-z-scores of -1.7 ± 1.1, -1.6 ± 1.6 and -0.9 ± 0.9 significantly worse ($p \leq 0.000$) than the one of urban children (-1.1 ± 1.2, -1.1 ± 1.4, -0.5 ± 1.0). The severe forms of malnutrition, such as marasmus and kwashiorkor, were identified. 4.8% of the rural children and 2.1% of the urban children suffered from kwashiorkor, the oedematous form of malnutrition. The prevalence of marasmus was similar with 2.1% and 2.4%. A significant difference was noted between rural and urban areas concerning some of the variables assessed, e.g. a higher percentage of rural children receiving pre-lacteal feeding ($p \leq 0.000$) and a higher percentage of rural households suffering from food shortage ($p \leq 0.000$). On average, the children had an insufficient energy intake. Fat intake was on average insufficient and significantly lower for rural children ($p \leq 0.000$). In addition, the children did not meet their needs for certain micronutrients such as calcium, phosphorus, potassium and zinc. These energy and nutrient deficiencies as well as some of the child-rearing and family factors very likely contributed to the insufficient nutritional status of the children.
Most of the above mentioned nutrient deficiencies could be alleviated by two strategies: increasing the use oilseeds in the children's diet and adding more fruits and vegetables particularly to the diet of younger children. Traditional knowledge and practices should be incorporated in any health and nutrition related activities.

Keywords: Malnutrition, children < 5 years, Ethiopia, diet, anthropometry

Livelihood Strategies and Rural Changes in Indonesia: Studies on Small Farm Communities

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The concept of livelihood has received an increasing attention from the socio-economic scientists and has been one of the major important research topics in the theme of sustainable development of the marginal rural agricultural communities since last decade. This growing concern arises as a response to the fact showing that in the effort of securing livelihood the rural small farmers may adopt different strategic actions that are not necessarily ecologically soundly. However, some studies showed that the application of diverse livelihood strategies could have either positive or negative socio-economic and ecological implications that influence to the performance of sustainability in the respecting region. Each community develops its own strategy for survival and build specific form of resistance necessary for protecting the whole social system from any devastating socio-economic threat. Thus, the livelihood strategies are location specific in the sense that different region provides its community with different possibility of taking survival actions.

In this paper, the concept of livelihood strategy is understood as 'diverse economic actions oriented towards meeting desirable needs that are complex and interrelated, and are ranging from natural resources manipulations using specific techniques up to constructing institutional regulating mechanisms at different levels of social system of the community'. The livelihood strategies the small traditional farm community adopted could also cause rural changes in the form of functional shifts and the transformation of social structure that are more adapted to the emergence of new orientation in the survival strategy.

This paper tries to observe and to find the patterns of livelihood strategies the traditional farm communities developed and the related consequences resulting from performing survival actions in two villages of Indonesia. The data and information used in this paper are largely based on the evidence found from the fieldwork done during 1997-1998 in West Java and West Kalimantan Provinces, where the ecological and socio-

economic characteristics of both regions are definitely different. The study tries to sketch the patterns of livelihood strategies based on the observation of two level of analysis – the household and the community – of these regions.

Based on the findings of the study, the most essential difference of survival actions performed by the two communities are centered on the following facts:

West Java showed a more individual household defined livelihood strategy where income sources diversification could be the most important economic action.

West Kalimantan showed a very strong agricultural-centered collective based livelihood strategies implying that communal-based social protection security is still of great importance for the region.

The study identified stages of strategic-related economic actions ranging from survival actions up to accumulating processes that are generally structured by the traditional small-farm communities in the regions. Some structural changes relating to the adoption of some strategies are also identified. These changes cover some following aspects:

Farm household labor organizational changes resulting from the labor allocation in the non-farm activities.

The increasing intensity of spatial mobilization of the rural labor resulting from undertaking out-migration based livelihood strategy.

The emergence of rural socio-economical polarization arising from the process of loss and gain of asset resulting from the consequences of exchange process.

The study believes that in the coming years, the livelihood strategies of rural communities could become even more complex as people found new opportunities and niches in various filed of activities. As people found new preferences, the role of farm would become less important source of livelihood for many rural household economy of developing regions.

Determination of Poverty Level of Rural Households Antropoligical or Quantitative Approach?

Nestor Ahoyo Adjovi and Patrice Igué Adegbola

Introduction and problem

At the beginning of the third millennium, all the national and international institutions multiply the organization of conferences on the fight against poverty in the developing world: an essential condition to boost growth and ensure development and growth.

Unfortunately in Benin, the fight against poverty has not yet shown any significant result despite the tremendous efforts made by the government, NGOs, the civil society and donors. Every body seems to agree that to accelerate poverty reduction, one has to take concrete actions on target issues. Determination of factors that can influence the welfare of rural farmers should be given high priority in any strategy towards reduction of poverty (Sadoulet and de Janvry, 1995). Analysis of the structure and the functioning structure of the rural households as well as their typology is therefore necessary.

The classification by level of prosperity (level of poverty) of households allows to have two kinds of groups: those who have “access to” and those who “control” economic important resources (Gandin, 1988). In fact, farmers with different level of prosperity would have different levels of needs or problems and behavior toward the adoption of proposed technologies.

The functioning of farms is determined by global decisions made by the unit, which depend on factors endowment at farm level (economic resources, climatic condition, their objectives and constraints, etc.). It is the analysis of these decisions, which form the basis of understanding of the functioning of the farming system.

To identify efficient development policies, knowing a good typology is essential. Most of the times, when development partners decide to intervene in a particular region, they either have very little time to produce a good typology, or the means they have at their disposal do not permit them to undertake diagnostics studies that are expensive and at the same to time finance the projects. The question is whether expensive

feasibility studies that can lead to know farm typology are really unconditional to obtain a good classification of farms in the beninese context. In other words is it possible to obtain the same result more rapidly by using the anthropological approach, to examine the importance of prosperity (or poverty) indicators?

Objective of the research

The objectives of this paper are to determine the different categories of farms and to compare the results of an anthropological survey of classification of rural households based on prosperity level with that of quantitative analysis.

Methodology used

Two kinds of classification were carried out:

- Classification by level of prosperity carried out by qualified people (men and women). This classification shed light on the types of agricultural production systems and their characteristics defined by farmers themselves. The level of prosperity indicators will be deduced from this.
- Classification based on quantitative analysis based on parametrical tests and on multivaried analysis, which lead to a classic classification.

The required data for this analysis was collected by a survey in a village of South-Benin (interviews to some identified qualified people and structured questionnaire to farmers).

Findings of the research

Analysis of data and information collected from this village gave us the following findings:

- Anthropological survey allowed us to identify the principal criteria of different farming systems according to the farmers themselves. The researchers or economists outside the community do not always perceive all of these criterion. The reality of poverty is best perceived on the basis of differentiation criteria proposed by those who are facing the reality of poverty (farmers themselves) rather than the imagination

of the researcher.

- the number of classes of farmers in the community according to their poverty or prosperity levels obtained by the anthropological method is close to that determined by quantitative analysis. Classification obtained by the first method is more accurate and allows to avoiding errors of appreciation. This is therefore recommended.

the characteristics of classes dictated by anthropological approach contains some very important realities on which development approaches should be based to better address questions of poverty to find appropriate solutions.

Conclusion

The results obtained confirm that from the view point of time and finance, classification of households by prosperity levels with anthropological approach is more indicated than quantitative analysis which is by far expensive and does not necessarily bring more useful information.

Working Group 3

Technologies, Institutions and Policies for Natural Resource Conservation

„Economics of Pesticide Policy Reform in Developing Countries" – selected results of a multi-country project

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The objective of pesticide policy at the international and national level is to bring social costs in line with social benefits. The available policy remedies include regulation and economic instruments. Regulations, including bans on individual chemicals or classes of chemicals, are an effective means of stopping the introduction of hazardous compounds into the environment. Economic instruments, for example taxes, registration fees and import duties, work to redistribute the costs of pesticide use from the public to pesticide producers and consumers and adjust the private costs to the total social costs occurring for pesticide use.

Securing changes in pesticide policies consistent with the basic tenets of welfare theory requires a strategy designed to achieve gradual reductions in economic distortions and recasting of inappropriate procedures. The procedure starts with a country study on pesticide policy and leads to the formulation of an optimal mix of policy instruments subject to a defined objective in its final stage. The first step is to establish a well-structured overview of the crop protection situation in the country. The second step is to venture into an in-depth case study that investigates the socio-economic impact of proposed policy changes.

Such approach was followed in a pesticide policy applied research project of the GTZ and the University of Hannover in several developing countries. In this paper, the results of one country, Costa Rica are presented. Costa Rica provides a good case in which despite an expressed policy emphasising sustainable development, negative externalities caused by chemical pesticide use are in evidence. The method included a stakeholder analysis and an econometric analysis of pesticide demand in the coffee sector of Costa Rica. For the stakeholder analysis some twenty experts from national ministries, research institutes, the private sector and international organisations participated in a specially designed seminar-workshop Costa Rica. To facilitate the discussion, experts were asked to

identify the factors determining levels of pesticide use and rate these factors on a scale of -5 to +5. indicating discouraging and encouraging pesticide use respectively. Results showed that the majority of factors encourage pesticide use. Among these, institutional arrangements and information constraints were the most important. Tax exemptions for pesticides were also considered key by the experts attending the meeting.
The latter aspect was then picked up in a case study of the coffee sector in order to assess the impact of a pesticide tax on pesticide use and the income coffee producers. Here, an extensive survey in two major coffee growing areas was used as the empirical base for this analysis.
Results showed first of all that the use of agrochemicals and of labor in coffee production have increased significantly from 1993 to 1995, most likely related to the increase in world market coffee prices during this period. Also, yields and the use of external inputs also differed significantly between the two regions and between the different farm sizes. Pesticide demand was estimated using a profit function approach following three flexible functional forms to estimate the aggregated pesticide demand in a fixed-effects panel model. The functional forms were derived from the Quadratic, the Normalized Quadratic and the Generalized Leontief profit functions. The demand function derived from the Quadratic model provided both significant and plausible results. The own-price elasticity at means of aggregated pesticide demand was estimated at -0.99, and the cross-price elasticity between pesticide demand and the wage at 0.79, suggesting that labor is an important substitute for pesticides in coffee. The demand functions derived from the Normalized Quadratic and the Generalized Leontief profit functions did not generate meaningful results. In addition cross-price effects of the different types of pesticides was conducted using a system of simultaneous demand equations. Using the computed elasticities, the impact of three pesticide tax scenarios was investigated. Results showed that the impact of a pesticide tax on income from coffee production is not substantial while the reduction in pesticide use was found to be highly depended on the tax scenarios used.
Overall, results of the country study, combined with an in-depth case study, showed that there may be more scope for economic instruments in pesticide policy in developing countries than previously assumed.

Productivity increasing investments versus resource saving technologies
A case study of Black Thai farming systems in the uplands of Vietnam

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Problem

In the mountainous regions of northern Vietnam suitable agricultural land is scarce and farmers often use marginal land for agricultural production. Areas on steep slopes are cultivated and often maladjusted farming methods are applied. Agricultural productivity therefore is low. Additionally, soil erosion and natural resource degradation are of major concern.

Research objectives

Productivity improving innovations can be counterproductive to longer term resource conservation measures, particularly when short term yield increases conceal the long term soil fertility decline caused by erosion. This paper analyses the different reactions of farmers towards productivity improving innovations and resource conservation measures and the interaction between these two approaches in the mountainous regions of Northern Vietnam.

Methodology

The study is based on a farm household survey in 1998, covering 100 smallholder households. Supplementary to standardised questioning participatory tools were used to picture the changes in yields and areas of important crops over the last 50 years. In group discussions a historical transect of the village was made and the structure of upland cultivation over the last 50 years was recorded. A main focus was laid on farmers' strategies in the past and today cultivating their upland fields.

Results

The most important crops on upland fields in Son La Province are upland rice and maize. In upland rice production, improved varieties were not strongly promoted and not applied by the farmers. Farmers did notice over the years the continuous decline of rice yields and associated this to decreasing soil fertility and erosion. Soil studies support these observations of the farmers. Since around 5 years, improved varieties for maize are highly promoted and widely applied by farmers. Since this time, maize yields on upland fields are significantly increasing. The consequences of decreasing soil fertility is overlaid by the increasing maize yields. Although resource saving technological progress in form of hedgerows, covercrops and microterraces are officially promoted in the study area. The adoption at the moment is low. These technologies are very labour intensive and the economic benefit is not visible to the farmers.

Conclusion

At present, farmers do not see the necessity for the application of resource saving technological progress in their fields. Better information and extension is therefore necessary. At present, productivity increasing technological progress is compensating the losses through erosion and declining soil fertility. In the long run, without a change in cropping pattern and cultivation methods yields will decline. This will have a negative influence on the income of farmers.

On the other side, problem consciousness alone will not improve the adoption behaviour towards resource saving technological progress, unless erosion control measures at hand are more attractive to farmers. Resource saving new technologies are still very labour intensive and land consuming without any short term economic benefit for the farmer. Here is still a big need for research to adapt the existing technologies to farmers needs.

Keywords: Black Thai, farming systems, new technologies, sustainable land use, Vietnam

Beyond Privatised Land Tenure Per se for Sustainable Management of Agricultural Land in a Semi-arid Environment in Kenya

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This paper is based on a study performed in semi-arid Ghazi and Ndome areas in Taita-Taveta, Coast Province in Kenya between 1997 and 1999 to determine the root causes of persistent physical degradation of agricultural land. As a result of escalating land degradation, the agriculturally depended community livelihoods continue to be threatened through loss of top fertile soil and loss of available farmland through water erosion and sand deposition; increased agricultural labour demands especially on women farmers, whose subsistence must be met from land with increasingly diminishing productivity, and extensive damage to local infrastructure especially roads and hence disruption of trade and other essential social activities and services. From a global perspective, unchecked land degradation, particularly in developing countries would contribute to global change among others through encouragement of economic and ecological refugees and hence potentially expensive socio-economic and political consequences.

That land degradation remains a serious problem despite advances in amelioration technologies in such places, indicates that other factors hitherto ignored or unknown are equally critical in conservation planning. In the preceding research, it was hypothesised that these factors encompass the whole fabric of the human dimension (i.e. socio-economic, cultural, institutional and political factors). Therefore attainment of sustainable land management would largely depend on increasing focus on this dimension, without ignoring the technical dimension. In this endeavour, this paper addresses the role of privatised land rights within the Kenya context.

Questionnaire surveys, interviews and topical participatory rural appraisals (PRAs) were employed to gather primary data from households randomly selected from village development committee (VDC) records. Additional data was obtained from secondary sources, notably from World Neighbours-Kenya documentation.

Although private property rights were people driven and possession of title deeds was the main determinant of security of land tenure, there was no evidence that directly linked land titling per-se to land improvement. Compared to structural conservation technologies, indigenous land and water management (ILWM) technologies were independent of land titling. Their relative popularity was principally an economic risk management strategy against poor household financial capital endowment.

Therefore although land titling is a critical initial requirement for sustainable land management in Kenya, its effectiveness would depend on it being attuned to other factors on a long term basis, notably improvements in the productive value of land and improvements in the quality and quantity of social and human capitals. This link forms a crucial part of this paper and is discussed in the context of land tenure reforms towards poverty eradication and improved environmental management.

Key words: Privatised land tenure, sustainable land management, Kenya

Saving of Firewood and Improvement of Smallholder's Income through Combined use of Solar and Biomass Energy in Crop Drying

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Sun drying is still the most common drying method for cocoa beans used by smallholders in Indonesia causing the low quality of the Indonesian cocoa. On large plantations mechanical dryers are used requiring 3.0 kg of firewood per kg of cocoa beans. To overcome this energy and quality problems, a Solar Processing Centre was developed. The thermal energy for drying is provided by a roof integrated solar air heater and a newly developed high efficient biomass furnace. This reduces the firewood consumption from 3.0 to 0.3 kg/kg dry beans. A simple temperature control allows automated temperature control of the drying air.

Key words: solar energy, biomass, energy, drying, cocoa

Working Group 4

International Agricultural Research: Methods, Strategies and Institutions

Participatory Research in the CGIAR

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The CGIAR and its associated centers have often been criticized for producing results that are useful mostly for resource-rich and better-off farmers and that were more often than not detrimental to small farmers and to a sustainable use of natural resources. One of the reasons often stated is the neglect of small farmers' reality in CGIAR-research.

Participatory research approaches and the involvement of farmers into formal research have gained more importance over recent years. Nowadays, that their formal acceptance has reached a point that many donors are now demanding more farmer participation it is useful to take a closer look at the state of the art of participatory research in the CGIAR.

The paper is based on an analysis of more recent literature, of recent CGIAR and TAC reports, as well as on personal communication with resource persons. The first part of the paper gives an overview over participatory research activities in the CGIAR from the 80s until today. The second part highlights the state of the art of the discussion about participatory research within the CGIAR. The last part pinpoints problems and deficiencies in the CGIAR regarding participatory research and offers suggestions as to how participatory approaches can better be integrated in the system in order to exploit their potential more effectively.

Three broad phases are identified and explained in the paper:
the development of innovative and quite famous approaches to farmer participation in research in the early 80s at some centers
the dispersal, neglect, and rejection of participatory approaches to research by CGIAR-mainstream through the 90s
a revived interest for participatory approaches in the CGIAR during recent years.

However, until today the number of CG-researchers who are knowledgeable about participatory research approaches and methodologies varies between centers, but is generally not very high. The majority of researchers associate farmer participation only with adaptive research, if at all. For quite a number of researcher this should be the task of NARS and not of CG-centers. Proponents of more farmer participation in CGIAR-research see a much larger potential: farmer involvement should not be restricted to downstream research, farmers should also play a role in strategic issues like priority setting, evaluation of processes and results and the development of new methodologies. Management has largely abandoned its negative attitude towards participatory research, however, pro-active support and necessary structural and organizational changes are still limited.

The main challenge for the CGIAR is to view participatory approaches to research as the central strategy to ground its work much better in the reality of its intended users. As yet, there seems to be a limited understanding of the potentials of participatory research in upper management and with senior staff, exceptions notwithstanding. Experiences from the system-wide program on participatory approaches and gender analysis and other CG-activities with participatory research need to be translated into a clear concept, new strategies for its institutionalization, new structures, adaptable research methodologies and to modified staff profiles. Priority setting needs socio-eco-regional grounding, starting from people's livelihoods and not from commodities or other pre-conceived disciplinary agendas.

All of these issues are being discussed within the CGIAR and the need for change is increasingly being recognized, however, as it seems, a lot of awareness-raising and support is still needed before changes can be seen on the ground and work is shifted towards reaching CGIAR's new mandate of poverty alleviation.

Key words: participatory research, CGIAR, institutionalisation

Alternatives for Funding Agricultural Research in Developing Countries: The Potential of Foundations and Funds

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Investing in agricultural research for development of the rural sector in developing countries has been considered to be useful and important. During the last 40 years agricultural research has proven again and again to boost development of the agricultural sector through increased production and the rapid growth in productivity of some agricultural products led to the so called green revolution. In the post green-revolution period agricultural research is being more and more criticized for not producing enough and for not producing relevant research results (Byerlee and Alex, 1998; Plucknett, 1995; Blatz and Dresrüsse, 2000). In view of those problems the issue of funding arises and it is being discussed whether agricultural research for development warrants public funding as in the past. The result of such donor fatigue was that funding of agricultural research has been cut substantially.

At the same time, however, challenges in the agricultural and rural sector in many developing countries are increasing. For example, as populations growth and new means of communication develop it is a new challenge not only to surpass the yield and productivity gains already achieved for the major staples, but customizing agricultural technologies to optimize income and employment generation in the rural sector, addressing issues of food quality and safety, and developing integrated approaches to natural resources management (CGIAR, 2000). It is evident that challenges involving long term solutions can be met only if the right policies for development are implemented on issues such as land rights, providing to resources and credit. The mix of policies will have to include

agricultural research because with food production being the limiting factor in development knowledge and technical innovation provided by agricultural research determine growth in productivity on limited land resources. In a democratic setting, policies should be framed according to the articulated needs of those involved. If farmers are encouraged to actively participate in research and with the help of specially trained information and knowledge brokers to express their needs, this will generate the articulation of policy requirements and of technical innovations relevant to move agricultural and rural development.

The paper starts from the problem that public funding of agricultural research for development in Germany and that the lack of public funds implies a challenge to find creative solutions to complement public funding by other sources. The objective of the paper is to identify and discuss alternatives for funding agricultural research. It is assumed, that such alternative mechanisms must involve private sources at all levels, i.e. farmers in developing countries and private individuals in developing countries. The paper in particular addresses two sources of funding for agricultural research largely have been neglected in the past: The first source is the large amount of private investors in developing countries who, in the search of profitable investment, also happen to be interested in ethical appealing investment solutions. This opens up the window of the “Ethic-Funds” which, e.g. already known as Eco-funds. Second, there is a considerable number of wealthy sponsors who, following philanthropic ideas, may be interested to donate considerable funds into a foundation which supports relevant and useful agricultural research activities.

The paper deals with the research question of the potential for private and philanthropic funding mechanisms in developed countries to complement deteriorating public funds for agricultural research and at the same time complementing farmers efforts on adaptive research. For that purpose reviews of the present landscape of funds available with private investors and priorities of investment will be presented. Also reference to experiments in farmers fields in West Africa will be made.

It is shown that latest developments on the market for ethical funds open a huge potential to tap private investors’ aims “to also do something

good" while investing their money. Tax rebates recently allowed against contributions to foundations add to the argument of investing in those funds. However the market for ethic fund is competitive with a large range of health, food, and environment, and nature funds already in existence. The potential for philanthropic donors contributing to funding of agricultural research for development is evident. A growing number of successful businessmen and entrepreneurs find it appealing to sponsor innovative research, and particularly to invest parts of their assets in setting up a permanent foundation.

The two types of sponsors, private investors and philanthropic donors, are likely to easily be convinced by the concept of carrying out agricultural research in corporation with farmers. Farmers can get involved in research by paying and/or contributing won time and land to experiment. Special techniques of analysis of such experiments in large numbers allow not only researches to draw conclusion and recommendations of innovations but also policy makers to infer and articulate policy arguments for appropriate institutional back up of such innovations. It can be shown that the money invested or sponsored will empower farmers in developing countries. First experiments undertaken in the context of research programs in West Africa indicate the potential of this approach based on the concept of the knowledge broker.

A Profile of Migrants and Analysis of Remittances In Smallholder Households in the Village of Molalatau - Botswana

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The paper is based on empirical research on smallholder[2] households' livelihood strategies in the village of Molalatau in Eastern Botswana[3]. In that drought prone region, agriculture is risky and unreliable. Therefore, diversification and adoption of different livelihood strategies is the logical response by rural households to ensure a smooth stream of income throughout the year. Investment in the education of children, with the aspect for them in the future to find employment in the formal sector is a common strategy. The paper provides a profile of the members of the study households who live outside the village. This includes their socio-economic characteristics, e.g. age, gender, education and employment. That will serve as an introduction to the main focus of the paper that will be the analysis of remittances to the study households. Only regular private cash transfers to the household, and not small gifts or benefits from village level reciprocal relationships, will be regarded. That is due to the cross-sectional character of the data. The amounts and share of remittances in the overall income portfolio of the different income groups among the households will be presented. The paper distinguishes between absent members of the household and other relatives sending remittances. Through cross tabulation both, the share and importance of these new migrants' remittances to the livelihood of their households is highlighted. A typology of households that are receiving remittances is developed and stands in centre of scrutiny.

The contribution of the paper in the context of Botswana consists in pro-

[2] In Botswana, the proxy for poverty is cattle holding. Those households with less than 40 heads of cattle are considered to be poor. In the village, the random sample was taken from these HHs. However, among these 48 HHs I have drawn an income poverty matrix (very poor to better off).

[3] The study was conducted over a six months period, during which a random sample of 48 households was interviewed and studied in-depth. Unit of study is the household. However, in Botswana this alone would be inadequate to capture the diverse possibilities available to the households to make the ends meet. Therefore, data on absentees have also been collected.

viding a better empirical understanding of the role of migrant labour for rural households. In addition, the country is suffering under the Aids scorch and the sharply rising rates of criminality and road accidents. Youth migration and mobility, from both sexes, is one of the main causes behind this bleak situation. From the socio-economic point of view, and as that one of a middle-income country, the government has many options open for it to redistribute the highly skewed national income. Decisions on more balanced development policies for more investments in rural areas, education policies, and financial policies (e.g. to tax migrant labourers, or cattle owners to provide for the rural poor) might well benefit from indicators like those presented in the paper.

The theoretical discourse on the motivations to remit reaches from pure altruism to pure self-interest on the side of the senders of remittances. Using evidence form the study village, the paper seeks to explain these motivations. According to the characteristics of their households (e.g. livestock ownership, placement on the sample's income poverty matrix, gender of the head, number of rooms and other assets, etc.) the rationale of migrants' behaviour is examined. Thus different reasons for remitting are identified. They include the aspiration to inherit, the wish to invest in assets in the home area, the intent to return home some time in the future, the mere human urge to care for the own family, as well as combinations of the above.

The paper concludes that in spite of high rates of unemployment in the urban areas of Botswana, private investments by the rural households in secondary and higher education for their children can be considered as rational. For the poorest group in the study village, income from remittances is ten times higher as that from arable farming under drought conditions like the season of 1999. For the society as a whole, options of vocational training and job creation in the rural areas could be far better than the present policies.

A global strategy for cassava research and development in the 21st century

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A number of national and international organisations have been actively collaborating over the past years in the formulation of a global cassava research and development strategy. The need for such a strategy was discussed several years ago during a meeting convened by IFAD at it's Rome headquarters. The meeting, attended by representatives of donor agencies, international and regional organisations and selected NAR's from Africa, Asia and Latin America, recognised cassava as a food security and commercial crop that lends itself to a commodity approach for poverty alleviation. The meeting also recognised the important role of cassava in income generation and in reducing the risk of food shortage in developing countries where poverty is widespread.

Based on these considerations, a global cassava research and development strategy was considered necessary to identify opportunities for private investments, for public intervention in response to situations of market failure and for food security purposes. The strategy should also define constraints as a basis for determining and prioritising a research agenda and to define more cost-effective institutional mechanisms to help rationalise the allocation of public and private resources for research. Furthermore, the development of a framework for technical cooperation in research and technology transfer at international level that would reflect regional/national specificity and institutional comparative advantages was thought to be important if cassava was to make a future impact on global food and income security. Finally, the scene should be set for future debates on global issues that may affect cassava development.

A global cassava development strategy requires a correlation of stakeholders including cassava producers and their organisations, govern-

ments, donors, technical and research institutions and their networks, NGOs and their networks, and the private sector, in order to achieve the objectives listed above.

This strategy is now being developed from a number of country case studies and regional reviews as well as from thematic contributions. Country case studies for Benin, Brazil, Colombia, Ghana, Nigeria, Tanzania, Thailand and Uganda, highlight the importance of the crop as a source of income for farmers and its traditional role as a staple food crop in the case of Africa, as well as its potential as an industrial crop. The case studies have demonstrated the importance of private sector involvement and macro-economic policy support in the development of the cassava sector particularly in Brazil, Nigeria and Thailand. Regional reviews for Africa, Asia and Latin America as well as theme-oriented global considerations focus on important aspects of cassava's sub-sectors such as markets, environmental issues and gender implications.

A further review organised by IFAD in June 1997 established a schedule for completion of the strategy. The plans covered the preparation of a draft strategy document that would be distributed to regional and international bodies and individuals for comments and modification. In addition, a series of regional consultation meetings were organised bringing forth ideas and suggestions to strengthen the strategy and to agree on the approach proposed in the draft strategy document. The regional consultations also provided an opportunity to ascertain the role and contribution of cassava for food security and poverty alleviation and the opportunities for cassava development. The consultation meetings for specific regions and groups were held during 1998: for eastern and southern Africa in March 1998, for Latin America and the Caribbean in April 1998, for Africa as a whole in October 1998, for Asia in December 1998 and again for West- and Central Africa in June 1999.

With these preparatory activities completed a definite global cassava research and development strategy is now being developed and made available to all global stakeholders.

Poster/Tools Section 1

Poverty, Land Degradation and Food Insecurity: The Challenges for Sustainable Livelihood of Rural Households in Ethiopia

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The twin relationships between food production, degradation of the physical environment and poverty are gaining interest in food security policy formulation. Despite severe investment constraints most developing countries have given official recognition to the fact that natural resource degradation has a great effect on their economies and threatening their food security to which Ethiopia is not an exception. This is mainly owing to the fact that most of these countries depend heavily on agriculture which is dominated by subsistence production and widespread poverty. The challenge of achieving sustainable livelihood in rural areas is so formidable mainly due to the inherent interdependence between the impoverishment of the resource users and land degradation.

With multitude of conservation interventions introduced over the last five decades, it could be expected that agricultural land degradation would no longer be excessive. Yet the Ethiopian highlands (area over 1500 masl), comprising some 46% of the national territory which accommodate more than 85 % of the population, are threatened by accelerated land degradation. There, fifty to sixty percent of the rainfall is lost as runoff, carrying an estimated 2-3 billion tons of topsoil away annually.

Land degradation in Ethiopia has been variously attributed to farmers' ignorance of proper land management practices or even to their sheer laziness. However, a closer investigation reveals that there are a number of indigenous water and soil conservation techniques successfully employed by poor land users, given conducive institutional, political and socio-economic circumstances. Farm households and their livelihood strategies are at the core of the decision making process in adopting non-degrading practices.

This study mainly aims at investigating the rationale of resource poor

farmers to exercise resource degrading practices, the incidence of poverty in perspective of per capita calorie consumption in rural areas. The empirical data are collected in different regions of Ethiopia, which are selected purposively to represent most of the major farming systems in Ethiopia, where as households are selected within each site randomly. Merhabete district (Northern Shoa) is prone to recurrent drought and represents degraded area. Alemaya district (Eastern Hararghe) has diversified rural livelihood systems based on cash crop production. Hitosa district (Arsi zone) comes from grain surplus producing area and there land degradation seems not to be an immediate problem.

A total of 180 rural households has been selected and each has been interviewed three times within the one cropping season of 1999/2000. Farming and conservation activities on 540 plots covered with variety of crops has been monitored and registered within the same cropping season. Gini coefficients and group decomposable Theil entropy measures were calculated to examine income inequality and incidence of poverty. A binary Logit model is used to establish the relative role of different factors in the poverty profile of the households under consideration and to isolate their individual effects.

The preliminary results shed light on how the problem is perceived by resource-poor farmers which constitute the poorest segment of the population. Farmers capacity to make conservation investment or intensify production on the land they have, are conditioned by cash cropping and asset endowment of the household. Dependent ratio, education of the household head, gender, land per adult equivalent, number of oxen held, and location have shown statistically significant effect on household poverty. Striking disparities in income and consumption among the three research locations has been observed. This demands for region-specific alternative remedies to mitigate the overriding problem of poverty and food insecurity in Ethiopia.

What is a variety: investigating farmers‘ concepts as a base for participatory breeding in Rajasthan, India

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In western Rajasthan, it is commonly reported by farmers that on an average, out of ten years there will be two to three severe drought years, one or two good rainfall years whereas the rest of years can be more or less good or bad years. Given this situation, crisis prevention is an integrated part of life for rural people and finds expression in all main activities including farming. The staple crop in Rajasthan is pearl millet (*Pennisetum glaucum* [L.] R.Br.), which is grown on 4-6 million ha annually. Conventional plant breeding has so far failed to develop successful varieties for such marginal conditions.

The research objective was therefore to investigate farmers’ concept of pearl millet varieties as a base for developing new participatory approaches for pearl millet breeding. The way how farmers describe pearl millet varieties, and particularly which traits they consider to be relevant and why was the main focus of this study.

For this purpose, farmers grouped and classified 81 accessions of pearl millet during a workshops in the growing season of 1997. The methods applied to facilitate the expression of farmers’ knowledge were semi-formal interviews in combination with PRA exercises such as classification and ranking. The same pearl millet populations that were de-

scribed by farmers during the workshops were also evaluated in formal field trials at three locations across two years.

Farmers used botanical traits as indicators for environmental adaptation, which was the main criteria for farmers‘ classification of pearl millet plants. Field trial data confirmed a strong association between the traits used by farmers and performance of populations in different environments.

Therefore, farmer participation in plant selection and variety evaluation is an effective approach to identify suitable varietal options and increase food and seed security for poor farmers in risk-prone areas such as Rajasthan.

Key words: pearl millet, farmers’ knowledge, participatory plant breeding

Small-scale food processing enterprises in Indonesia: Which elements influence employment capacity?

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Problem

Developing countries whose economies are mainly dominated by agriculture have problems as a result of continually increasing populations and shortage of land for agricultural production. The rural population which in the past found employment in the agriculture sector now has to look for employment alternatives because the absorption in this sector is limited. Missing alternatives, especially in rural areas, can result in impoverishment and migration to urban areas.
The rural small-scale industry can play a key role in the preparation of employment and income alternatives for the rural population (MANIG, 1985), and impoverishment and migration streams to urban areas can be restricted.

Research objectives

This presentation is based on a study which examines the various employment dimensions in rural food-processing small-scale enterprises. Empirically the demographic, spatial, temporal and economic dimensions of employment in small-scale enterprises will be revealed. Factors which influence the employment situation in the enterprise-household system will be analysed and conclusions will be drawn respecting the stability and role of rural small-scale industries in the development process.

Methodology

The **scope of this research** is the enterprise-household system with its three partial systems “household”, “enterprise” and the “external system area”. The partial system household is the co-ordination centre for distributing resources which are at household’s disposal for the three partial systems. The enterprise is the level of production in which free resources are joined together. Organisation and production are influenced by

household decisions. Decisions in both systems are influenced on their part by an external system based on social and regional relations.
The **research region** was located in West-Java, in the District Bogor, 60 km south of the Indonesian capital Jakarta, in six Sub-Districts (Bojonggede, Cibinong, Citeureup, Megamendung, Ciawi and Caringin). These Sub-Districts have a semi-rural character with an average population density of 4177 inhabitants per km^2. Agriculture, as well as middle and large size industries, are located in these areas. The infrastructure, access to markets and the public transportation system are well-developed. The average distance from these Sub-Districts to the city Bogor (300,000 inhabitants) is 17 km. Busses and trains shuttle regularly during the whole day in various directions, including the capital Jakarta.
The **data and information** furnished in this presentation are largely based on facts and research findings drawn from fieldwork activities conducted during a six month period in the research regions (from November 1998 to May 1999). Before the main survey, a basic survey was carried out in which 125 entrepreneur-households in eight different branches were interviewed. 79 entrepreneur-households were selected for the main study. The criteria used for the selection were the number of employees (max. 19 employees) and the main income source of which income from the enterprise had to make up at least 50 % of the total household income.

Results

An average of 4.28 persons were employed in the selected enterprises: 2.51 family members and 1.77 hired workers. Before the economic crisis in Indonesia, the average percentage of hired workers was 2.78 per enterprise. The percentage of family members was nearly constant. It shows that the institution “family” is one of the most important resources for employees in small-scale enterprises and a relative stable entity during an economic crisis.
The percentage of family members and hired workers as employees depends on the labour-intensity of the branch of industry and demographic factors respecting the entrepreneur family. Demographic factors which influence the composition of the employees are the size of the household

and the average age of the children.
The working conditions, such as working days per week and working hours per day depend on the total number of employees and percentage of family and hired employees. In general, hired employees work more than family members (more days per week and hours per day).
From an economic point of view, the income from the enterprise is the main income source of the entrepreneur household. Additional income sources are derived mainly from agriculture, but this income percentage is very minimal in the total household income. The average profit per enterprise is sufficient, but there is usually not enough for investments. The number of employees is independent of the profit level. Enterprises with a larger profits have the same number of employees as enterprises with a lower profit and vice versa. Differences are mainly based on the kind of product derived in the specific branch.
Machines can be found in six branches, but mainly in larger enterprises with more employees. The machines are mainly used in these branches in order to relieve the work. In two branches, the work was largely manual. The level of profit has no influence on the use of machines.
Marketing is another area which influences the employment level and the profit situation in the enterprises. There are differences between the marketing institution (self-marketing and trader) and the marketing area (urban and rural).

Conclusion

The influencing factors, which are inherent in the enterprise-household system have a great variety for the employment sector. The entrepreneurs, their families and hired workers find employment in and derive their income mainly from small-scale enterprises. Furthermore, small-scale enterprises are a relative secure institution for family members and non-family members in crisis situations. Income derived from the enterprises could possibly stimulate economic and rural development.

Improvement of the supply of micro nutrients with the production of mango-fruit leather in the Philippines

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In the rural areas of the Philippines exists an insufficient provision of the population with micro nutrients, especially with vitamin A. This scarcity of vitamin A leads on the one hand to a higher susceptibility to infections, on the other hand it increases the mortality rate of mothers and children. Furthermore it is the major cause for blindness of children. In the past few years approaches have been made to erase or reduce this scarcity by the distribution of vitamin A capsules or the enrichment of the basic food with vitamin A. Sustainable approaches aim at the sufficient supply of the population with vitamin A by influencing the eating habits and securing an offer of products which are rich of vitamin A or β-carotene throughout the year. Sweets that are rich of vitamins and are based on natural raw materials shall facilitate the direct access to children. The advantage of fruit leather compared to traditionally produced fruit slices is that also small fruits can be used and the amount of fruit flesh wasted is very small.

Mangoes have the highest β-carotene content of all tropical fruits. But a sufficient supply of vitamin A by the consumption of fresh mango can only be assured for a short period of time, because of their seasonal availability. Mangoes are being produced in large quantities in the Philippines. During the harvest period only part of the yield can be marketed as fresh fruit due to the large offer of this product. Aside of the consumption of fresh fruit the production of dried mango has gained local importance. Due to a lack of information about the optimal drying conditions, the commonly practised drying process with warm air leads to a reduction of the β-carotene and vitamin content.
The main topic focused in this research is to determine the conditions for the production of fruit leather from mango puree without the decrease of

its high amount of micro nutrients.

A procedure for the production of the mango puree was developed. The production process includes the peeling and the blending of the fruits. Afterwards the puree has to be blanched. For the drying the puree is spread out in thin layers on metal trays. Experiments concerning the basic drying behaviour of mango leather under different drying conditions have been conducted with a laboratory over flow dryer. The temperature of the drying air was varied between 50 and 80°C, which can be considered a relevant range for solar drying systems. Furthermore, the influence of the drying parameters on the quality characteristics such as colour, texture and content of micro nutrients were analysed. Based on the results of the laboratory experiments, the drying process has been tested under the local conditions with a solar tunnel dryer at the State College for Agriculture of the Visayas, Philippines. Additionally, different types of trays will be tested under the aspect of the regularity of the drying process within the product.

The drying temperature has the strongest influence on the drying time and thus on the product. Drying temperatures below 50°C make the product go bad. The blanching of the puree does not effect the content of β-carotene. In order to ensure a regular drying of the puree layer, the thickness of the layer should not exceed 0,75 g/cm². For removing the fruit leather from the base after the drying process, metal trays are more convenient than cotton cloth or wax paper which attach to much to the product.

Key words: mango, fruit leather, β-carotene, solar drying

NGO-based participatory impact monitoring of a rural development project in Karnataka State, India

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Implementers of development projects are more and more under pressure to justify what they are doing. Especially NGO feel the need to document not only the activities they are carrying out but also the short- and long-term impact of their work.

The paper presents both a general methodology of participatory impact monitoring (PIM) derived from a study in a project in south India and its application in an assessment of selected impacts. The rural development project Holalkere is a co-operation between the Indian NGO MYRADA and the German Deutsche Welthungerhilfe. Some concrete results are presented in regard to the self-help group and resource management approaches used in that particular project.

The integration of PIM in the existing monitoring system of the project aimed at enabling project staff to monitor the impacts of their project in a cost-effective and participatory way on an on-going basis, so that relevant information are derived for possible plan adjustments and redefining project strategies. Apart from the direct use for the project management a second objective was to serve as a tool for leaning and to form a basis to justify the project investments. Hence it is directed to other implementing, financing and supporting organisations, like other NGO, financiers, governments, donors) as well as to the interested public.

Impact monitoring is a complex task and often neglected in favour of pure activity and result monitoring. Since there is a dearth of effective, timely and practical methodology, They are rarely assessed. On the other hand, funds for development assistance are decreasing and development agencies worldwide are questioned to justify how and to what

extent the expenditures benefited the rural poor and to what degree the efforts have affected development processes. Sustainability aspects of the project and in the project's effect on poverty alleviation are major concerns.

The PIM-methodology is based on the following definitions: 'Participatory' means that directly involved actors (NGO/ SHG) monitor project impacts self-responsibly and exchanging their results in a regular dialogue. 'Impact' comprises all effects and changes that are caused by a project; they may be intended (planned), unintended (unplanned but imaginable) or occur even unexpectedly. 'Monitoring' is a continuous and systematic process of observation, documentation and critical reflection.

The methodological guidelines for NGO-based PIM consists of five phases:
Preparation phase. The output here is a meaningful and manageable set of impacts decided upon all actors involved and a common understanding of the meaning of expected or feared impacts.
Reflection phase. Awareness about the background of the selected impacts is created by the formulation of hypotheses on the relationship between project activities and impacts and about the likely influence of external factors on these impacts.
Indicator development phase. Indicator formulation is the core element of PIM. It includes the elaboration of methods and choosing of tools for the data collection and is guided by the principles of participation, cost-effectiveness, appropriate precision and user-friendliness.
Measurement phase. Here the data are collected and processed.
Analysis phase. In the final step the processed data are interpreted in order to arrive at appropriate conclusions. Representatives of the target group are involved in this process, judging the results jointly with staff and expressing their views. This is also a forum to discuss causes for observed changes, needed reactions of the project and to evaluate the data collection methods for improvements in future monitoring.

Conclusions of the practical experience: The adoption of PIM as a man-

agement tool requires to take the needs, capabilities and constraints of the users into consideration. On the other hand it needs favourable framework conditions. The experience from Holalkere shows that for a successful adoption of PIM the staff must feel a need for it. Since PIM involves extra work the project staff have to have a motivation for the application, i.e. PIM should not be viewed only as a donor or head office concern. Additional inputs especially in terms of finances and time are needed. Their amount should be realistically assessed before PIM is introduced. The indicator measurement should be simple and harmonised with regular routine work. Good communication channels and appropriate systems for feedback between different project levels as well as between staff and the target group are required. A close co-operation between planners, implementers and the monitoring staff is very important. PIM should not be executed in a isolated unit, the integration in the project structure may require organisational changes within the project. The introduction of PIM is much easier if some kind of monitoring and evaluation system already exists in a project.

Key words: India, Impact, Monitoring, Participation, Rural development

Sustainable Plantation Programmes through Rural Cooperatives: Issues of Community Participation and Monitoring

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During the past five decades various changes have taken place in political, economic and social institutions. Worldwide trends indicate that economic reforms, changes in national policies, and global concerns have contributed to redefine the roles of these institutions. In India, this paradigm shift helped to evolve an institutional mechanism from state controlled towards community participation in the area of natural resource management. This paper examines the evidence from the activities of Tree Growers Cooperative Societies (TGCS) that were established to support economic, environmental and social upliftment of rural people. Fuelwood, fodder, pulp and timber wood species are planted in the TGCS site and the benefits are shared among the shareholders. The feasibility of these programmes can be evaluated in terms of economic benefits to the stakeholders and sustainability through optimal rotation of trees as well as continuous annual income to the stakeholders from such rotations. These wood plantations not only provide fuelwood and fodder but also mitigate CO_2 emissions by removing carbon from the atmosphere and sequestering it. The results indicated that the Internal Rate of Return for a 20-year plantation cycle for various TGCS vary between 12 and 20%. Thus, the plantation activities brought prosperity to the local people and equity among various strata of the society. The data, obtained from six TGCS in India suggest that self-help and the involvement of local people, mainly women, is necessary for the survival of cooperative institutions even in a market driven economy. The analysis also helps to appreciate the economic trade-offs involved in the monitoring the natural resources that helps in sustaining the community involvement. Results show that these types of institutions where the local communities play an important role in monitoring plantation programmes is essential for sustainable development.

Increase in agricultural productivity – resource-based in contrast to commodity-based

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Assuming we call significant yield increase in single crops 'green revolution', then the first green revolution took place about 10 to 12 thousand years ago when man started to cultivate land. It was also the beginning of civilisation. Since then, man has increasingly transformed the land and natural vegetation and rose to be main creator of the biogeosphere. Today, there is hardly any ecosystem around the globe which has not been influenced by man.

It was only in 1930 that the world population reached 2 billion and, since, has increased to 6 billion in the year 2000. Because of this rapid increase the demand for food, feed and industrial crops has grown enormously. Half of the 1.5 billion hectares of arable land – 18 per cent of the biologically productive land area of the earth – was started to be cultivated only in the 20th century and mostly forest was sacrificed to meet this requirement.

The second green revolution started only in the late 1960s when high yielding varieties of wheat and rice were designed to overcome the predicted hunger crisis. Great achievements were made, especially related to irrigated agriculture, while rain-fed farming was hardly influenced by this revolution.

World agriculture today faces two major constraints which not enough attention is paid to by science and decision makers. First, we increasingly restrict our food basis towards a limited number of plant species. Today, 65 per cent of the world arable land is reserved for only 21 annual crops. Even more worrying is the fact that 60 per cent of our food energy and protein comes from only three cereals – wheat, rice, and corn. Designing functional food by using genetechnology in order to improve food quality, e.g. of rice, again will speed up this process of constriction since diversified ingestion is no longer necessary to meet the daily required balanced food. Secondly, arable land resources are under-utilised because of poor

management. Yields of rice, for example, range below the world average of 3.8 t • ha^{-1} (1998) in 70 countries. Assuming those countries only reached the average level of their continent, e.g. Africa (2.2 t • ha^{-1}), the world rice production could be increased by 17 per cent. There is a need to invest in better management of arable land to prevent further loss in productivity and simultaneously to investigate so far under-explored plants to broaden our future food basis.

BAMFOOD - Increasing the productivity of Bambara Groundnut (*Vigna subterranea* L. Verdc) by appropriate utilisation and management of genetic resources

Werner Schenkel, Klaus Fleissner und Ewald Sticksel

(i) Problem

Agricultural research has traditionally focused on a few staple crops, while relatively little attention has been given to minor crops. Many of these neglected species are well adapted to marginal growing conditions like arid areas and low fertility soils. Furthermore, some of these crops contribute considerably to food supply on a regional level. There is a growing awareness of the potential of neglected crops to contribute to increased food production and of the need to improve these crops. In addition, sustainability of agroecosystems is considered to be depending on biological diversity.

One example for a neglected crop is the Bambara Groundnut (*Vigna subterranea* L. Verdc), a indigenous crop in Africa. Increasing the productivity of Bambara Groundnut will help to maintain genetic diversity while simultaneously enhancing the food supply in marginal areas in Africa. For this purpose an EU funded project is starting in 2000. This paper will focus on the part of the project dealing with breeding efforts.

(ii) Objective of research

Bambara Groundnut has been grown by subsistence farmers in Africa for centuries. Over this period, farmers have accumulated a wealth of knowledge on the crop and have cultivated an array of landraces that have become well adapted to the vagaries of local climates and soils. In order to improve this species local expertise and landraces have to be systematically utilised and exchanged between different growing regions in Africa. Over the past decade, scientists in Africa and elsewhere have begun to accumulate agronomic and physiological knowledge about the crop and to link this with the indigenous knowledge and perceptions of farmers and their families. This expanding knowledge base needs to be co-ordinated and further progress needs to be directed by an understanding of the genetic diversity of the species and the mechanisms by which existing landraces can be improved through selection and breed-

ing. Developing proper breeding strategies will help strengthening the role of Bambara Groundnut in agriculture thus conserving its genetic diversity.

(iii) Research hypothesis

To attain the potential of Bambara Groundnut and to conserve its genetic diversity, breeding efforts and the release of improved varieties are strongly recommended. The following hypothesis are defined:

available genetic diversity can be conserved and utilised by a breeding system which uses local landraces for the development of improved cultivars.

Development of improved cultivars raises and stabilises yield of Bambara Groundnut

systematic characterisation of genebank accessions will help to attain the agronomical potential

the use of modern molecular techniques is an efficient tool to support conventional methods in evaluating genebank accessions

a participatory approach will ensure that breeding goals and methods are adapted to local conditions

adapted techniques for seed exchange, seed storage and seed quality management will ensure the dissemination of research results in farmer's practise

developing operational crossbreeding techniques suitable for Bambara Groundnut is essential to achieve long term breeding progress.

(iv) Methodology and workplan

A farmers surveys will be conducted to identify local demands and breeding goals. Agronomical characterisation of important land races and genebank material in multilocation replicated fieldtrials, glasshouse tests and on-farm trials will be performed. A core collection of the IITA Bambara Groundnut genebank accessions is defined based on passport and evaluation data. Multiplication of promising accessions of the core collection allows further characterisation and dissemination. Molecular analysis based on RFLP, AFLP and RAPD markers to estimate the extent of available genetic diversity, strategic planning of breeding efforts

and monitoring of genetic diversity during further breeding process is performed. Adapted Marker techniques are developed and established with partners in Africa.
A very important step is the development of crossbreeding methods that enable middle- and long-term progress.

(v) Results, conclusions and their relevance for development
The project uses a bottom up approach with direct participation of the final users. Farmers using new varieties as well as researchers using new molecular tools are involved in their development. Prompt implementation of result and feedback during the project is thus assured. Problems of Bambara Groundnut production in subsistence farming systems are addressed to improve the nutritional and economic status of the rural population in marginal areas of southern Africa.
Since the project is starting in June 2000 only preliminary results are presented. A survey conducted in Northern Namibia revealed that the Bambara Groundnut is the third most important crop, cultivated by 82 % of farming households. The target region is characterised by marginal agricultural conditions and a high percentage of households solely depends on agriculture as income. The survey exhibited that availability of proper seeds is difficult and the yields are unstable due to low uniformity. Up till now, single plant selection is the only breeding tool and breeding progress is slow. Nevertheless, this approach led to the release of the first Bambara Groundnut variety for Namibia. Cultivating a range of diverse genotypes is considered by farmers to be the key to tackle with adverse growing conditions (drought spells). Farmers were successfully involved in the evaluation and selection process of breeding lines during ongoing research.

Rural Development, Household Welfare and Poverty in Indonesia (Case Study of Lombok-Indonesia)

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Poverty continues to pervade rural areas in developing countries such as Indonesia. The incidence of poverty in Indonesia declined from 40% in the mid-1970s to 11% in 1992, however, due to the economic crisis in the mid-1997s, around 80 million people (39% of population) fall below the poverty line by 1998. To deal with this problem, Indonesia government becoming increasing aware of need to combine the macroeconomic and rural development policies, since more than 65% of population lives in rural areas.

In this paper we estimated empirically the impact of rural development programs on household welfare and poverty in Lombok-Indonesia. The main question to be addressed: whether rural development programs that have been implemented have had impacts on household welfare and poverty, in the sense that indeed it helps the rural poor escape from poverty.

We address this question by using two-stages of Heckman model to overcome the problems of *selection bias*, given to the non-experimental nature of the study design. In the first stage, we estimated the probability of participates in rural development programs by probit maximum likelihood method and then the results of predicted values used to obtain the estimate of household welfare and poverty impacts on the participating households.

Descriptive and direct ordinary least square (OLS) analyses show that participates in rural development programs have positive and significant impacts on poverty and households‘ welfare. However, when the case of selection bias take into consideration, the impact of rural development

programs was not significant, even though the coefficient is still positive. Hence, the conclusions on the impacts of rural development programs on household welfare and poverty depend on which econometrics specification one consider to be more valid.

Oral Presentations Section 2

Diversity in Tropical Land Use Systems- Culturally, Economically and Ecologically

Working Group 1

Interactions in Agroecosystems

Einfluss der Landnutzungsintensität auf Blütenbesucher am Kaffee und Arthropoden am Kakao in Agroforstsystemen in Zentral-Sulawesi

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Zusammenfassung

Die fortschreitende Zerstörung der artenreichen tropischen Regenwälder und ihr Ersatz durch Landnutzungssysteme gilt als eine Hauptursache für den weltweiten Diversitätsverlust. Daher ist eine Bewertung der Agroforstsysteme im Hinblick auf ihre Biodiversität von aktueller Bedeutung. Am Beispiel von blütenbesuchenden Bienen an Tieflandkaffeesträuchern und von Arthropoden an Kakaobäumen wurden verschieden intensiv genutzte Agroforstsysteme in einem Landnutzungsgradienten miteinander verglichen. Die Nutzungsintensität wurde durch abiotische und biotische Habitatparameter charakterisiert. Die Tiere wurden standardisiert durch Beobachtungen und Kescherungen per Dipterennetz am Kaffee und am Kakao quantifiziert. Die Abundanz und Diversität der Bienen nahm mit zunehmender Nutzung nur wenig ab. Bei näherer Betrachtung zeigte sich jedoch, dass mit zunehmender Nutzungsintensität die solitären Bienen häufiger und die sozialen Bienen seltener wurden. Die Arthropoden an Kakaobäumen wurden in phytophage und entomophage Arten unterteilt. Die Abundanz der phytophagen Tiere nahm mit der Nutzungsintensität zu, die der entomophagen ab, womit eine signifikante Abnahme des Räuber/Beute-Verhältnisses verbunden war. Die Ergebnisse zeigen, dass die Nutzungsintensität der untersuchten tropischen Agroforstsysteme Auswirkungen auf die Struktur der Lebensgemeinschaften hatten. Diese resultierten weniger in Veränderungen im Artenreichtum als vielmehr in den Interaktionen und Ökosystemfunktionen. Die Ergebnisse erlauben die Formulierung von zwei Hypothesen. Zum einen sollte die Bestäubung durch soziale Bienen in traditionellen Agroforstsystemen eine größere Rolle spielen als in intensiv genutzten Systemen und dies könnte sich auf die Kaffeeerträge auswirken. Zum anderen sollte mit zu-

nehmender Nutzungsintensität die Kontrolle der Kakao-Schädlinge durch ihre Gegenspieler geringer werden.

Kennwörter
Indonesien, Agrarökosysteme, Bienen, Räuber/Beute-Verhältnis

Soil fertility and crop production along toposequences on upland maize and cassava fields of north-west Vietnam

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Three-quarters of the land area of Vietnam is dominated by mountainous topography, the north-western part of the country is even almost exclusively highland. Agriculture is increasingly practised on the steep slopes of the mountains, as population of Vietnam's northern mountainous enormously increased in the last years and agricultural land is scarce. Agriculture in mountainous areas of Southeast Asia is often generally blamed for not being sustainable because of deforestation and creation of heavy soil erosion on sloping fields. This wanted to be studied in north-west Vietnam by assessing soil erosion, analysing soil fertility changes and related yield differences at different slope positions.

Soil parameters were surveyed on 19 maize fields of four villages and on 25 cassava fields of five villages of Yen Chau District in north-west Vietnam in 1998. Soil investigations were carried out along toposequences on fields with up to 43° inclination. Six slope positions were used in this study: two basal slope positions (bottom, concave), two mid slope positions (lower, upper) and two top slope positions (convex, ridge). At the respective slope positions, two soil profiles were analysed. Soil samples from 0-10 cm depth for each profile were sampled and analysed for pH, organic matter, total nitrogen, available phosphorous, available potassium, cation exchange capacity and soil texture. Depth, colour and erodibility of topsoil horizon as well as inclination of slope positions were also investigated. In addition to the soil investigations, maize and cassava yields were analysed. Maize grain yield was determined at different slope positions of six fields. Two plots, each spacing 3 m x 3 m, were harvested at the different slope positions. Cassava was harvested at upper and lower mid slope positions of three fields. Root tubers of three cassava plants were harvested at two plots per slope position, each

spacing 2 m x 2 m.

Total nitrogen, available phosphorous and CEC was higher at upper positions of maize fields compared to lower positions. Also higher values at upper positions were found for organic matter content and pH in the mean of all villages but with differences between the villages. Contrary to the other soil parameters, average available potassium was higher at lower positions. Greatest depth of topsoil horizon was expected under secondary forest, but was found at the upper mid slope. Topsoil depth decreased downwards. Differences of soil parameters between upper and lower positions on cassava fields were similar in trends as on maize fields. Organic matter, nitrogen, phosphorous and depth of topsoil horizon was higher at the upper positions. Contrary to the maize fields, pH and potassium were decreased as well as CEC increased at lower positions. At top of most maize and cassava fields, yields were higher compared to positions more downward on the slope. It seems that especially the higher organic matter, nitrogen, and phosphorous content at the upper position led to 27 % higher yields for maize and 31 % for cassava compared to lower positions.

Erosion features on soil surface were found in only few upland maize and cassava fields of Yen Chau District. But, lower soil fertility and decreased yields at lower positions of the steep fields clearly indicate that soil erosion processes already take place in all fields and thus represent an important production constraint for the farmers. The primary stage of soil degradation and erosion found in the study region may soon lead to heavy soil erosion problems already existent in other regions of northwest Vietnam. Soil conservation measures are applied by the farmers, but they are only found sporadically on few fields. Greater efforts should be made to develop conservation strategies in accordance with the local people's needs and constraints to achieve stabilization of upland agroecosystems in Vietnam.

Keywords: erosion, highlands, slope, soil conservation

Diversity of traditional coffee production systems in Ethiopia: contribution to sustainable yield and conservation of coffee genetic diversity

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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 Ethiopian farmers, which maintained different landraces in different parts of the country. Coffee production systems in Ethiopia are quite unique when compared with most of the coffee growing countries in the world. 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 practices developed by farmers, and varies from one coffee producing region to another depending on respective agricultural history. This paper presents the three traditional systems and their respective contribution to the national economy and conservation of coffee genetic resources. This is based on surveys done though out the country to estimate the distribution of each production system and coffee land races grown in different parts of the country. The survey involved structured interviews with coffee farmers, field visits and secondary data from local development agents and agricultural development offices.

In the *forest coffee production system*, coffee is harvested directly from wild plantations of understorey coffee plants growing in Afromontane rainforests of west and southwest Ethiopia by subsistent farmers. Currently, forest coffee represents 9% of the total land covered by coffee, and contributes about 5-6% of the total coffee production in the country. *Semi-forest coffee* represents the production system in which forest coffee is manipulated through thinning of overstorey trees, removal of ground vegetation and enrichment of empty spaces in the forests by transplanting naturally regenerated or raised coffee seedlings. This system represents about

24% of the total land covered by coffee, and contributes about 20% of the total coffee production in the country. *Garden coffee system* is coffee farm, established in open, medium or heavy shade, with an area of less than 3 ha. In some places, coffee farms form agroforestry system in which 15-16 species of trees are used as shade. Garden coffee is estimated to represent 62% of the total land area covered by coffee and contributes 68-69% of the coffee production in the Ethiopia. All in all, the traditional, production systems cover 95% of the total area covered by coffee and 94% of the total coffee produced in the country. Coffee is the single most important export commodity crop, and accounts for well over 60% of foreign currency earnings. It contributes 4-5% to the national GDP, 20% of the government revenue and a job opportunity to more than 25% the total populations.

Equally important is the contribution of traditional coffee production system to the maintenance of the genetic diversity of coffee germ plasm. From survey in different part of the country, it was found that over 120 coffee land races are cultivated by farmers. Accordingly, 45 are from coffee growing regions in south and southeast parts of the country east of rift valley while 76 are from the coffee growing regions found on the Western part of the rift valley. The traditional system, which was maintained for ages farmers is now threatened by increased population, which is forcing farmers to intensify their production system since their land holding is getting smaller and smaller. There is no assurance for *in situ* conservation coffee genetic pool on farmlands. The fate of coffee genetic resources conservation in such system depends on a mechanism which will allow the continued traditional system of production on farm lands and also which enhances productivity of such system. Further research on the functioning mechanisms of the system and possible ways of enhancing agricultural production efficiency is without losing the genetic resources of the crop is recommended.

Key words: *Coffea arabica,* agroecosystem, genetic pool, Ethiopia

Sustainability of intensive rice cropping systems in the tropics from a soil biogeochemical perspective

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Declining rice yields following the “green revolution” were reported from highly intensive, irrigated rice cropping systems in tropical Asia. This has raised concern, given the need to meet future demand for this staple food by raising current yield plateaus even further. In keeping pace with plant breeding, soil quality research has to focus on sustainable management of the most productive agricultural wetlands across S and SE Asia. Apparent knowledge gaps in our mechanistic understanding of nutrient supply and soil health triggered our search for soil biogeochemical determinants of sustainability. A first attempt was made to monitor potential determinants and indicators of soil fertility in the organic phase. A standard set of soil biochemical and microbiological assays is implemented in field experiments at IRRI and at collaborating NARS partners in S and SE Asia.

Our approach followed the conception that nutrient supply in flooded rice soils is channelled through labile soil organic matter pools that include soil protein and microbial biomass acting as both sink and source of plant nutrients. In a sequence of ten consecutive crops, these pools switched their functions from wet season sink to dry season source. Coefficients of variance within cropping seasons showed a positive correlation with grain yields. Negative correlations between respiratory mineralization and soluble phenolic compounds suggested a role of phenols in regulating the remineralization of labile organic nutrient pools. Particular clues to sustainability were obtained from comparing the extremes of intensification: the ancient Ifugao rice terraces vs. the oldest intensive rice cropping field experiment in the tropics at IRRI. Soil microbial communities of the intensive cropping system were turned over more rapidly and

showed enhanced levels of cyclopropane fatty acids, an indicator of metabolic stress, probably due to limited supply of suitable organic energy carriers. Signature lipid compound (SLC) analyses indicated more diverse microbial “guild” profiles for a wide range of biogeochemical pathways in the rice terraces as compared with narrower, viz., stronger prokaryote-dominated “guild” profiles in the intensive system. This could put an intensive rice cropping system at a higher risk of being affected by limited energy supply (lacking crop residue return), and by accumulating potentially ecotoxic metabolites such as phenolic compounds. - Certain of the monitored parameters may eventually emerge as diagnostic tools in managing long-term yield stability and soil health of tropical rice systems.

Key words: sustainability; rice soils; biogeochemistry; soil microbiota

Working Group 2

Land use Planning

Luftbildgestützte Erfassung aktueller und historischer Desertifikationsprozesse bei Chikal im Sahel Nigers / Westafrika

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I. Problematik

In der Sahelzone herrschen durch die Besonderheiten von Klima, Relief, Böden, Vegetation und anthropogenem Einfluss äußerst labile Agrarökosysteme vor. Ein seit längerem anhaltender Trend zur Aridifizierung, sowie ein starkes Bevölkerungswachstum üben einen immer stärker werdenden Nutzungsdruck aus. An die Stelle von traditionellen ressourcenschonenden Bewirtschaftungsarten treten immer häufiger die landwirtschaftliche Nutzung marginaler Flächen, Verkürzung der Brachezeiten, Überweidung, übermäßige Holzentnahme usw. Die Folge davon sind vielfältige Degradationsprozesse. Dies zeigt sich besonders deutlich an der ackerbaulichen Trockengrenze.

II. Zielsetzung

Ziel dieser Arbeit ist die Erfassung von historischen und aktuellen Desertifikationsprozessen. Vor diesem Hintergrund wurde versucht, die Interdependenzen von Nutzung, Vegetationsbedeckung, Böden, Relief und Niederschlag, sowie deren Beziehungen zu Erosions- und Akkumulationsvorgängen im Detail an einem ackerbaulichen Grenzstandort im Sahel Nigers zu erfassen und zu bewerten.

III. Fragestellung

Detaillierte Untersuchungen über räumliche und zeitliche Dynamik und Intensität von Desertifikationsprozessen sind rar. Zu untersuchen war daher, in welchem räumlichen und zeitlichen Umfang und mit welcher Intensität die Prozesse ablaufen und welche Faktoren sie steuern.

III. Methodik

Die Fragestellung wurde mit einem multifaktoriellem Ansatz bearbeitet, wobei neben Geländemethoden eine multitemporale Luftbildinterpretation von drei Befliegungen (1956, 1975 und 1997) zur Nutzung und Vegetationsbedeckung den Schwerpunkt bildet. Im Gelände wurde eine Transektkartierung durchgeführt, bei der Nutzung und Vegetationsbedeckung, Reliefsituation, Oberflächenbeschaffenheit und Bodenmerkmale erfasst. Es wurden 16 Profilgruben angelegt, beschrieben und für die Durchführung von Standardanalysen und Cs137– Analysen beprobt. Hinzu kamen Mikroreliefmessungen, räumlich und zeitlich aufgelöste Niederschlagsmessungen und eine Befragung von Bauern zur aktuellen und historischen Nutzung.

V. Ergebnisse und Schlussfolgerungen

Die Luftbilder dokumentieren eine deutliche Ausweitung der ackerbaulichen Flächen in bisher vorwiegend weidewirtschaftlich genutzte Gebiete und damit eine Zerstörung der natürlichen Buschvegetation. Vor allem die Plateaus mit ihren flach geneigten Fußflächen, den Glacis, sind seit den 70er Jahren einem zunehmendem Nutzungsdruck ausgesetzt. Als verbleibende, durch die Anlage von Gärten und Feldern immer kleiner werdende Rückzugsgebiete für die Beweidung, wird die Busch- und Grasschicht dort besonders stark durch Überweidung und Holzentnahme degradiert. Dies wird zudem durch den anhaltenden Trend zur Aridifizierung verstärkt. Innerhalb der landwirtschaftlich genutzten Flächen zeichnet sich neben der Zunahme von Feldern auf Kosten der Brachen ein deutlicher Trend zu kürzeren Brachezeiten ab, wobei größere zusammenhängende Brachen zerfallen und für den Hirseanbau genutzt werden. Die Ergebnisse belegen, dass die Vegetationszerstörung eine zunehmende Dynamik von Erosions- und Akkumulations-Prozessen, sowie eine stärkere Oberflächenverkrustung verursacht und eine dauerhafte Verschlechterung der Standortseigenschaften nach sich zieht. Sofern in dieser Hinsicht keine Veränderung durch eine angepaßte Landnutzung eingeleitet wird, ist mit einer raschen Intensivierung dieser Prozessdynamik in der Region Chikal zu rechnen.

The identification and application of communication tools for participatory land use planning at sub-district level in the highlands of northern Thailand

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The problem background

The remote mountainous areas of northern Thailand, inhabited by the now over 800,000 hilltribes people (only 200,000 in 1960) who traditionally practice various forms of shifting cultivation, have gradually been integrated into the Thai administrative system with a "carrot and stick approach" of development support and repression. After an initial focus on the elimination of opium cultivation in the 1970s, and as a consequence of development ethics changing towards more participation of target groups in the 1980s, there are changes even at policy level like a Community Forest Act debated since 1991 and a government initiative of decentralisation since 1996 (Tambon Act in Thai, sub-district level). With these new planning initiatives, accurate maps showing village boundaries and land use will become even more important for land use negotiations with government departments around several critical issues:

- The forest cover in Thailand has decreased from 53% to less than 20% in the last 40 years, and there are no more primary forests;
- The policy of forest preservation, while at the same time emphasising permanent hilltribe settlements and farming in a few tolerated pockets of land, has not reverted the overall problem of forest degradation;
- Shifting cultivation evolved over a long time and cannot suddenly be changed to permanent farming without adverse effects on the land.

Research objective

Against the controversial background, this research tried to develop:

- Durable and easily transportable maps recognised by all parties;
- Aggregated information at sub-district level for regional planning;
- A tool that allows regular updating of land use data for the rapidly changing land use in the highlands.

Hypothesis

After years of exposure to project driven land use mapping and planning, hilltribe farmers are aware and want to decide their own future land use.

Methodology

The research was conducted in the project area of the GTZ Thai-German Highland Development Programme (TG-HDP) in Mae Hong Son province, where in 1990 the Community Based Land Use Planning and Local Watershed Management (CLM) was initiated. Three-dimensional topographic models became the main tool for hilltribe farmers and government representatives in a joint planning process to demarcate:

- Village areas including outer user boundaries and permanent cultivation areas;
- Community forest areas and conservation/watershed forest areas.

Hand-drawn village land use maps of all 10 target villages of Huai Poo Ling sub-district were digitised using ArcInfo, counter-checked with aerial photographs, aggregated and printed using ArcView3. Topographic data was supplied by the Remote Sensing Centre of Chiang Mai University. Printouts (A1 size) were distributed to village leaders, government agencies and the new Tambon Administrative Organisations (TAO).

Results

There is a high degree of accuracy of farmers mapping their land use, and there are only few overlapping forest areas when aggregating data. The maps are very well received by village representatives as they can take these to TAO meetings, yet less well received by government agencies who still try to limit the cultivated area. There is even a danger of backfiring in the sense that the now revealed extent of land use may lead to land confiscation by authorities in the absence of land titles, still not given by the government for the highlands. In this conflict, the International Centre for Research in Agroforestry (ICRAF) in Chiang Mai, which collects such data for the whole north of Thailand, may acquire the role of neutral mediator between the government and farmers in future. It remains to be seen whether this participatory approach can help to solve the dichotomy between forest protection and agricultural subsistence.

Traditionen lokaler Wirtschaft als Grundlage für Ernährungssicherheit und ressourcenschonende Landnutzung in einer bolivianischen Andenregion - Perspektiven im Rahmen politischer Dezentralisierung

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In this paper agricultural production and local economies of an andean region are analyzed, their importance to global development processes is evaluated. Biodiversity, apropriate agricultural technology and local forms of distribution were found that help to maintain a basic food supply. But these local resources are judged as backwardness and tend to disappear. The local subsistance economy includes a favorable relation to the surrounding system of market economy. This is why the strengthening of the subsistance structures is possible without isolation from the market processes. In Bolivia, politics of decentralization and peoples participation have made possible the mobilization of the local ressources. Agricultural investigation should support this focus on local empowerment.

Key words: Andean agriculture, local empowerment, Bolivia

Model-based planning and decision making in tropical forest management (Revised Abstract)

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Problem:

The history of mankind is closely related to the history of forests and their use and misuse. For more than 1,5 Mio years, forests provided man with wood for energy, construction, and various other non-timber forest products like food, medicine and household articles. Today, additional forest benefits like environmental values and carbon sequestation are recognised equally important.

The loss of forest area in the tropics is estimated at about 13,7 Mio ha annually (FAO, 1999). Despite the loss of forest cover, there is also a deterioration in forest health and structure in the remaining forests. Both aspects restrict the natural capacity of forests to continuously produce their specific goods and services. Among the major causes for forest degradation are air-pollution, illegal encroachment, and overharvesting. Since only the latter can be solved at the operational level, the determination of suitable harvesting levels is one of the major tasks of sound forest management planning. Especially in tropical forest management, the derivation of the sustainable annual allowable cut (AAC) is of superior importance since long-term experiences are generally lacking. Currently, forest management in the tropics is mostly done without proper planning.

Research Objective:

Models for simulating the growth of forests have been developed since more than 200 years. Yield tables, developed on the basis of empirical field data, are among the earliest approaches. Today, advanced computer-based models simulate the growth of forests on the basis of ecophysiological processes. Only recently, these models were tested for the use in tropical forest management. The objective of our research is to

utilise the potential of these forest growth simulation models for forest planning and decision making. We chose the growth model FORMIX3-Q, which has been developed and calibrated for Sabah, Malaysia.

Research Questions/ Hypotheses:
Can we use the model for the determination of key forest planning parameters?
How can varying site and stand conditions be integrated?
Are the results reliable and operational to support sustainable forest management?

Methods
To answer our questions, we decided to test our hypotheses in a degraded forest in Southeast Asia at the forest management unit level. The ecophysilogical model parameters were derived locally to allow accurate growth simulations. Truthful data on regeneration and mortality rates, photosynthesis and species grouping are indispensable for modelling long-term growth behaviour. To allow spatial modelling, the model was linked to a GIS system. Spatial data layer in the GIS are site and stand specific, like slope, structure, plant-available water and soil nutrients. For simulation purposes, the combination of above inputs results in 48 site-specific stand-types (SSST). For each SSST, tree diameter distributions were derived, based on 490 terrestrial inventory plots.

Results and Conclusions:
Field research was carried out in the 55,000 hectares Deramakot Forest Reserve (Sabah, Malaysia), consisting of heavily logged over and partly degraded lowland dipterocarp forest.

The underlying principle for calculating the AAC is to rehabilitate the forest conditions by increasing the present growing stock to its optimum, where maximum increment of commercial species can be obtained (called "domestication" by LAMPRECHT). The management concept comprises a modest, gradually increasing timber harvest under strict control of environmental and silvicultural standards (incl. application of

"Reduced Impact Logging" techniques). By doing this, rehabilitation and utilisation of the forest potential can be obtained at the same time.

The model simulates forest growth with and without timber harvesting under different sets of standards (scenarios), in which number of harvested trees, damage rates etc. are modified. The aim is to determine the level of harvestable timber that allows for the realisation of a) a continuous timber flow to satisfy the local economy and local needs for raw material, and b) the rehabilitation of an ecosystem with all environmental services and products. By selecting areas to be harvested in 10 years intervals (i.e. area control) and defining a preliminary working cycle of 40 years, this approach leads iteratively to a realistic, site-and-stand-specific and area-related calculation of stand improving sustainable harvesting-levels. According to the different scenarios, the results of the calculated AAC's show a wide range with a maximum possible harvest rate of 10.000 m³ per annum. This is only 10% of the regionally applied harvesting level under uncontrolled conditions.

The results obtained clearly show, that the forest growth model FORMIX 3Q has the potential to emerge to a planning and decision making tool in tropical forest management. It can be adopted to local conditions by incorporating results from field inventories, site quality assessments and by linkage to a GIS system. Especially the calculation of the harvestable volume and the determination of silvicultural standards are of major importance for all further forestry decisions and has direct economic implications. Implementing this new planning tool into tropical forest management will help to manage forests sustainably and to rehabilitate and simultaneously utilise the economic and ecological potential of already degraded forests.

Working Group 3

Management and Utilization of Natural Ecosystems

The Miombo Woodlands – A Resource Base for the Woodcraft Industry in Southern Zimbabwe

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Forests and trees provide a wide variety of commodities for the daily use and welfare of rural dwellers in tropical countries. In Zimbabwe, wood carvings have become important handicraft articles which are sold to tourists along the roads to major excursion attractions. The principal tree species preferred for carvings are pod mahogany (*Afzelia quanzensis*), bloodwood (*Pterocarpus angolensis*), Zimbabwe teak (*Baikiaea plurijuga*) and to a lessor extent, leadwood (*Combretum imberbe*) and African blackwood (*Dalbergia melanoxylon*). Since the late 1980s, the number of roadside handicraft markets has increased steadily, rising the demand for carving wood. This has caused considerable pressure on the resource base in areas surrounding craft markets.

This study is part of a forestry research project on sustainable forest management concepts for the miombo woodlands of Zimbabwe. To this end, information on the distribution and the structure of the local forests is indispensable. Thus a forest inventory, applying a stratified sample plot design, was carried out in southern Zimbabwe. Five classes of wood cover, on three land use types, were identified in an area comprising 52.700 ha. In total 80 sample plots were selected randomly in relation to the size of each stratum (PPS sampling: probability proportional to size). In circular plots (d = 30 m), all trees of dbh ≥10 cm were measured. Within these plots a square subplot (20 x 20 m) was established and all trees ≥1.3 m of height were recorded. In another sub-square (10 x 10 m), all tree seedlings below 1.3 m were noted. The objectives were: (1) to determine abundance, frequency and absolute dominance of the tree species preferred for woodcarvings and (2) to assess whether the location of craft market stands influence the occurrence of tree species. Results show that the ten tree species preferably used for wood carvings account for 19% wood volume of all 78 tree species recorded during the survey. The species most frequently found in the research area are

dominating trees of the miombo woodlands, *Julbernardia globiflora* and *Brachystegia spiciformis.* The tree species used for wood carvings showed an abundance of 3.35/ha of 77/ha (all species) (or 2.9 m^3/ha^{-1} of 11.19 m^3 ha^{-1}). High variability was found between the different strata. No significant correlation could be identified concerning the location of wood carving markets and the occurrence of tree species. Further findings indicate that indigenous forests in the region are unlikely to be able to sustain the current harvesting rate, considering the present regeneration capability. This results in two problems: First, the carveable species will become locally scarce and wood more expensive. Second, the reduction of wood availability can have negative effects on the welfare of craftsmen. Members of the craft industry are likely to switch to different tree species in order to maintain their production levels. In communal areas, where most craft markets in Zimbabwe are located, the selective use of certain tree species for carving is likely to drive the species to local extinction.
The research was funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) as part of a long term comparative study being undertaken by the Center for International Forestry Research (CIFOR).

Key words: Forest inventory, tree species frequency, wood carvings, population structure, miombo woodlands.

Agroecological comparison of „rainforestation“ farming sites on Leyte, Philippines

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Abstract

Since 1990 an innovative approach has been started in the Philippines to combine rehabilitation of degraded former rainforest areas with the necessities for subsistence income and biodiversity conservation. On more than 20 sites on the island of Leyte in the Central Visayas of the Philippine archipelago the technology of „rainforestation farming“ is continued ever since this method of using mainly indigenous trees for the reforestation of grassland areas or unproductive coconut plantations has been introduced.

Due to the rigid landscape of this island with mainly soils of volcanic or uplifted marine origin the conditions of the sites of the respective „rainforestation farms“ vary considerably. While the climatic conditions in this perhumid area of the tropics is rather uniform, the geomorphology, geology , soil conditions and nutritional input possibilities for the plants are varying on a wide scale. In addition, singularities like typhoons have a major influence on the ecosystems, both natural and anthropogenic ones.

On three sites located in different geomorphologic, geological and altitudinal places the growth behaviour of two indigenous trees (*Dracontomelon dao* and *Dipterocarpus validus*) and two exotic tropical tree species (*Pterocarpus indicus* and *Swietenia macrophylla)* were investigated. These trees are used by local farmers as part of their efforts to generate a sustainable income by using the „rainforestation“ technologies. The investigations included soil analysis, leave nutrient determination and tree growth behaviour on three different sites located at altitudes of 420 m a.s.l., 90 m a.s.l. and 52 m a.s.l. The parental material at two

sites consists of basaltic/andesitic rocks while on the third site uplifted and well drained limestone forms the parental material. pH and exchangeable bases vary, so does the availability of phosphorus and potassium. The results concerning the micronutrients analysed per site and per tree revealed a very great similarity between sites and trees. The study of the vegetation structure, as expressed by the height of the tree stands of the same growth age revealed the different performance of the used reforestation trees on the various sites.

The presented data will be discussed under the aspect of optimising the efforts to rehabilitate degraded sites, re-establishment of ecological functions of erosion prone areas and generation of income for subsistence farmers on Leyte.

Key words: Reforestation, Rainforest, Rainforestation Farming, Philippines

Community-Based Management for Coral Reef Conservation In the Gilis Island of Lombok Indonesia

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The coral reefs of the Gili Islands of Lombok Indonesia have experienced a substantial deterioration and destruction within the last decade. Human activities are the main factors of reef degradation and are related to marine exploitation such as dynamiting (blast fishing), the use of weighted lines to break coral in fish-driving operations (muro-ami), poison (cyanide) fishing and over-fishing/collecting. To overcome this situation, government and non-government organizations have implemented a community-based management strategy for coral reef conservation since 1998.

This study is aimed to investigate and analyze the activities of these newly established local institutions and community-based management forces dealing with coral reef conservation and their implications for the various groups of local and indigenous communities.
Research was conducted by interviewing stakeholders and observation participation in order to figure out and to experience the situation and condition of the research object.

The project has been successful in achieving the participation of local community as well as in creating many activities. The project offers something that satisfies the need of local community especially regarding the economic activities. However, the local institution established to take care of the coral reef ecosystem has nothing to do because of inadequate resources and understanding of its role. The local institution established in the area is a new institution created to support the project so that it has no root in the community. Moreover, the knowledge of local people about the law is poor due to the low intensity of program socialization so that they break the law without feeling guilty. The Paper suggests that the genuine participation can be achieved by respecting local

wisdom and indigenous knowledge, and all activities should be rested on the local properties. In addition, without enough knowledge, it is difficult to change the perception and the behavior of the people so that the people education and empowerment is a prerequisite to succeed in the natural resources conservation efforts.

Key words: Gili Islands, reef degradation, community-based management, local institution, participation.

Working Group 4

Ecosystem Functions

Integrating Biodiversity and Ecosystem Functions

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Problem

The crisis of biodiversity, which was identified during the last decades of the 20th century (Wilson 1985, Wilson 1989, Soulé 1991, Eldrige 1992, Western 1992, Grehan 1993, Platnick 1997), is mainly due to the loss of species tropical regions. More than this, we can also observe a decline in the diversity of biotopes, habitats, communities and ecosystems.

The UNCED "earth summit" at Rio de Janeiro concentrated in 1992 on sustainability and biodiversity. This brought the problem of the loss of natural diversity into the minds of politics and economists. Today the most countries of the world have signed the Convention on Biological Diversity and are obliged to identify .

This convention contains one of many unsatisfying definitions of biodiversity, which addresses more than species diversity but is, nevertheless, quite obviously nor consistent nor complete (Wilson 1992, Bisby 1995, Heywoood & Baste 1995, Gaston 1996, Lovejoy 1997, Tilman 1999).

Objective

Since the works of the Greek philosophers Aristoteles and Theophrastos mankind is trying to describe and understand natural diversity. Natural scientists of the 20th century concentrated exclusively on species diversity. Species-area-relationships (e.g. island biogeography) and Shannon's entropy are traditional approaches to this field. But, during the last decades the limitations of this point of view became obvious. The similarity or dissimilarity of objects (e.g. species) and thereby the heterogeneity of communities, ecosystems or landscapes may be more important for ecosystem functions.

This paper aims at the construction of a new concept for biodiversity, which can be applied at different levels of biological and ecological organisation. It has to consider different scales in space and time.

More than this it is necessary to include functional aspects as well. Ecological complexity is a central aspect of biodiversity. It is propable, that the loss of species diversity will go together with a loss of functional diversity of ecosystems. This can lead to a destabilization of ecological systems or result in a loss of natural services.

Research Question

Biodiversity is more than the number of objects or of certain types within a given area or time. It includes also the variability between them and the variety of their interactions. Is it possible to measure, describe and analyse these different aspects of biodiversity?

Results and Conclusions

Based on theoretical considerations a new concept of biodiversity is introduced. It can be applied to different forms of biological and ecological diversity. Nevertheless, it is necessary to identify which form of diversity at which level is of major importance within an ecological system.

Key words: biodiversity, ecological complexity, ecosystem functions, ecological concepts, heterogeneity

Managing Agrobiodiversity in Disaster Situations

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Natural disasters and armed conflicts cause severe loss of genetic diversity in crop plants and farm animals. The Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture adopted in 1996 in Leipzig (Germany) stipulates that assisting farmers in disaster situations to restore agricultural systems is a priority activity of in-situ conservation.

GTZ's Sector Project "Managing Agrobiodiversity in Rural Areas" provides support on the sustainable use of plant and animal genetic resources, in particular, to poorer rural people in marginal areas. The Project further provides consultancy services to political decision-makers in developing countries and in Germany. A study prepared on behalf of the Project identifies, using a desk review of the literature and examination of case studies, those determinants of emergencies which are important when assessing specific disaster situations with respect to plant and animal genetic resources. The study summarizes the current state of international debate and delivers recommendations for improved consideration of the relevant issues in both the preventive sphere before and remedial sphere after crises.

Disasters destroy plant and animal genetic resources both directly and through indirect consequences such as humanitarian emergencies and accelerated processes of impoverishment. The cause-and-effect complexes associated with armed conflict are responsible for a broad array of specific impacts upon the management of genetic resources. Efforts to rehabilitate and restock genetic resources within the context of emergency aid measures harbour a potential for further loss of farmers' varie-

ties and indigenous landraces if local varieties and breeds are not taken adequately into consideration or are further reduced by substitution crossings associated with these efforts.

In the follow-up to the Global Plan of Action, the conferences held under FAO auspices in 1997 and 1998 produced a series of proposals and measures aimed at promoting seed security as a precondition of sustainable food security, and assisting farmers to restore agricultural systems and seed security activities. In the area of animal genetic resources, no measures relating to the specific problems of loss in disaster situations have yet been taken, although there is a high level of awareness of the problems.

Disaster-related loss of agricultural biodiversity can only be prevented by combining, in an appropriate manner, preventive in-situ and ex-situ conservation measures with improved intervention mechanisms of the organizations which provide emergency aid and rehabilitation in disaster situations. Concentrating and networking in research and development activities are important conditions for the development of successful approaches and strategies: too little is currently known about the informal management of genetic resources, about indigenous prevention strategies and about the way genetic resources are managed in the event of crisis. Scarcely any research has been carried out into the management of local farm animal breeds in disaster situations – corresponding development cooperation activities are similarly absent.

Key words: plant genetic resources, animal genetic resources, agrobiodiversity, crisis prevention

Assessing water supplies for irrigation - availability of natural resources and productivity indices

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The competition between water uses for the agricultural sector on the one hand and demands for drinking water supplies, industrial uses and the tourist sector on the other hand requires political or market oriented regulation in many subtropical countries. In order to implement such regulations transparent and objective methods for the estimation of water resources are needed. In addition, useful indices are required allowing to compare water consumption and productivity at regional scales.

Concept

Simple concepts are reviewed for the evaluation of the water resources availability at regional scales. Based on the availability of water resources indices are introduced that measure the productivity of water as a resource in agricultural or other systems. The concepts involve two steps:
Estimation of natural recharge using data that is usually available from basic soil physical studies or that can be easily collected in the field.
Building consumption indices in terms per capita use and of water supply areas or water supply periods required for the replenishment of water resources by natural or artificial recharge.
This concept is applied along a hydroclimatic profile through the Eastern Mediterranean.

Methodology

Two simple, well established and robust methods for the estimation of groundwater recharge were used: an implementation of the water balance approach (MODBIL – a modular balance model) and the chloride method. These methods are based on the principles of water movement

in soils and concomitant solute transport. The combination of these methods is straightforward and offers the additional advantage of cross-validation. The water balance model uses daily meteorological variables (rainfall, temperature and relative humidity), soil and vegetation parameters for the prediction of fluxes within the soil. It calculates runoff, actual evaporation and groundwater recharge. The actual evaporation concentrates chloride the soil water. This effect can be used as a second indicator of groundwater recharge. Using irrigation and water consumption data, recharge is transformed into indices.

A *water supply area* corresponds to an area that can sustain the water consumed in a production unit by natural runoff and recharge generation. A *water supply period* corresponds to the time that is needed to replenish the water resources consumed by a production unit without allowing for lateral water import. The *water supply period* immediately indicates the water dept or the time that is needed to replenish water resources by natural recharge or runoff generation without import of water from other areas. The *cumulated* water supply period directly gives the time in years needed to restore the natural conditions.

Results and Conclusions

The estimation of groundwater recharge in several study areas in Greece, Cyprus, Israel and Jordan showed a strong temporal and spatial variability of recharge rates between 150 litre/y*m² in some areas of Greece with favourable recharge conditions to just about 1 litre/y*m² in dry areas of Jordan. By integrating these naturally available resources of water over recharge intake areas, the total natural replenishment could be determined and compared to the actual use as indicators for the sustainability of water supplies. A comparison of estimated present day recharge rates to the actual consumption in these areas highlighted the urgent need to improve water productivity, to increase the re-use of water and to optimise the use of treated water for irrigation in order to prevent severe water crises.

Poster/Tools Section 2

Alle Kühe sind gleich!? Zur Bedeutung der Beziehungen von Menschen und Tieren in Systemen der Landnutzung - eine interdisziplinäre Aufgabe -

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Landwirtschaftliche Nutztiere haben einen großen Anteil an der Diversität tropischer Landnutzungssysteme und leisten einen wesentlichen Beitrag zur Nahrungssicherung der Menschheit; an marginalen Standorten sind sie oft die einzige nachhaltige Nutzungsmöglichkeit der natürlichen Ressourcen. Die globale wirtschaftliche Bedeutung der Tierhaltung kann daran verdeutlicht werden, daß 12% der Weltbevölkerung ihren Lebensunterhalt ausschließlich aus der Tierhaltung bestreiten und tierische Produkte 40% des Wertes der landwirtschaftlichen Produktion weltweit ausmachen. Ein Bedarfsanstieg für Nahrungsmittel tierischer Herkunft ist zu erwarten. In Gebieten jenseits der agronomischen Trockengrenze, z.B. der Sahelzone, die einen Feldbau mit nur schwer kalkulierbaren Erträgen erlauben, ermöglicht die Tierhaltung eine wesentliche Stabilisierung der Lebenssicherung durch Risikostreuung und Krisenprävention. Systeme der Nutzung tierischer Ressourcen können nicht allein unter wirtschaftlichen Gesichtspunkten analysiert werden, vielmehr müssen die Beziehungen der Tierhalter zu ihren Tieren einbezogen werden. Schließlich sind Menschen und Tieren aktive Teile so unterschiedlicher Systeme, wie Ökologie, Wirtschaft oder Kultur.
In einer interdisziplinären Arbeit werden verschiedene Einflußfaktoren, Produktionstechnik, naturräumliche Gegebenheiten, Kultur oder Ethik, berücksichtigt, um die Kommunikation verschiedener Fachrichtungen in Theorie und Praxis zu ermöglichen. Längere Aufenthalte bei Rinderhaltern in Westafrika (Fulbe) und Europa führten zu einer intensiven Auseinandersetzung mit partizipativen Erhebungsmethoden. Während der Arbeit mit den Fulbe bestätigte sich die Erkenntnis, daß Beziehungen von Tierhaltern zu bestimmten Tierrassen nicht idealisiert werden dürfen. Auch in Westafrika erfahren verschiedene Tiere unterschiedliche Wer-

tung und Achtung seitens der Menschen.
Der ‘Brückenschlag’ zwischen verschiedenen Disziplinen und Lebensformen ist im ‘Zeitalter’ der Globalisierung unumgänglich. Eine effektive Nachhaltigkeit der Zusammenarbeit erfordert nicht nur Fachleute, sondern auch Generalisten. Die unvoreingenommene, auf gegenseitige Hilfe abzielende Kommunikation muß in diesem Zusammenhang wesentlich verbessert werden. Die Berufsethik beginnt nicht erst im fremden - sondern im eigenen Lande.
Die physischen und psychischen Ansprüche der Menschen bestimmen Funktion und Wert der Tiere in einer Kultur: ökologische, ökonomische, religiöse und soziale Komponenten sind prägend. Rein rechnerische Gesichtspunkte berücksichtigen selten die Beziehungen von Menschen und Tieren, deren wirtschaftliche Nutzung die emotionalen Einstellungen nicht prinzipiell ausschließen muß. Sowohl traditionelle als auch moderne, außereuropäische und europäische Tierhaltungssysteme zeigen, daß sich ökonomische Produktionstechnik, artgerechte Haltung und Tierethik verbinden lassen. Um der Tierhaltung an marginalen Standorten auch künftig die Bedeutung zukommen zu lassen, die ihr zusteht, ist die Zusammenarbeit aller Beteiligten unumgänglich. Die Verbesserung der Produktionstechnik eines Tierhaltungssystem darf nicht lösgelöst von anderen Aspekten der Beziehungen der Tierhalter zu ihren Tieren betrachtet werden.

Sustainable management of natural resources in Kenya and Tanzania: A gender approach

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Background

In the face of the depletion of natural resources through processes of degradation and destruction caused by humankind and a constantly increasing demand for land in the East-African countries Kenya and Tanzania at the same time strategies have to be worked out and operationalized to solve this urgent problem. Within this context, gender aspects play a significant role: The decrease of natural resources shows dramatic consequences mainly for female smallholders, as it is predominantly them being in charge of the production of subsistence crops, whereas the male small-scale farmers are mainly engaged in cash crop cultivation. The participation of female farmers renders more difficult in view of the fact that they almost do not dispose of capital and time as well as they only have limited or no access to land. Moreover, they are often subject to socio-cultural restrictions.

Still, these gender-related aspects are often overlooked resp. not addressed appropriately within project approaches. Their neglection is one of the bottlenecks for a sustainable resource management on the local level. Over and above that, not taking the above named aspects into consideration causes far-reaching consequences - in the end for the well-being of the whole global community and natural environment.

Methods and objectives

In the frame of the research reciprocal effects between the encouragement of gender issues and measures for a sustainable management of natural resources in four projects in Tanzania and Kenya shall be examined by means of in total 24 rural (female-headed) smallholdings (selection criteria per project are location in two different agro-ecological zones and implementation of measures with distinct positive ecological and economical effects). Data shall be obtained through applying the method

of **action research/participating observation** during a stay of 4-7 days on each farm. Furthermore, basic data shall be collected through making **drafts** from each farm.
The aim is to list, compare and rate the diverse techniques being propagated through the projects selected with regard to **potentials and problems**, to evaluate the **effects of the conservation activities** on the socio-economical living conditions of the smallholder families (and their environment), to investigate the **'spin-off'/'trickle-down-effects**' of the 'successful' female farmers on their socio-cultural and ecological environment, to **contribute to new ways of field-research** and to contribute to **knowledge exchange and -dissemination**.

Results

As one result of the first field research (investigations in 12 rural smallholdings in two project areas in Kenya and Tanzania) the analysis shows that the ecological conditions as well as economical aspects like food security, fuelwood- and water supply have been stabilized and improved through different techniques. Furthermore, ‚successful' female smallholders are functioning as important **knowledge careers** and **motors** through various activities.

Conclusions and outlook

*It is to be expected that an **intensified encouragement of ‚successful' female smallholders** leads to an enhanced implementation of project measures and thus to an improvement of the environment and the living conditions not only of the respective families but through ‚multiplicator-effects' (e.g. group activities) of the whole community. The same effects are to be expected through an **intensified encouragement and integration of ‚open-minded' men** (e.g. in gender trainings).*
Additionally, their participation will support the empowerment of women through creating gender awareness and a basis for gender equality.

Key words: Gender; sustainability; natural resources; East-Africa

Indigenous knowledge assessment of wild and cultivated legume germplasm in Bac Kan Province: An on-going research in North Vietnam

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Fast growth of both population and demand for resources are increasingly leading to the transformation and degradation of ecosystems in North Vietnam. Deforestation, overgrazing, soil erosion, even national policies and technical innovations – all contribute to the destruction of natural habitats followed by the consequent loss of genetic diversity. Since Vietnam is largely a subsistence-based economy, the main risk of progressing genetic erosion lies in the loss of landraces or wild plants that are adapted to local conditions, and in the interdependent loss of local knowledge concerning this genetic diversity. Specific adaptation to marginal local conditions contributes to the stabilisation of local food security.

Legumes are a source of protein, oil and starch; in that way they contribute to human and animal nutrition providing multi-functionality. Their value in sustaining the productivity of tropical soils and providing animal feed at the same time might be equally important as their contribution to human food resources. Given their importance for food security and natural resources management, the conservation of legume germplasm is of high priority, especially in Southeast Asia which is an important centre of legume genetic diversity. Furthermore, in order to contribute to the conservation and sustainable use of a resource which represents the raw material for future breeding demands, the assessment of indigenous knowledge concerning genetic resources of legumes can be considered as an essential part of conservation. Without continuous access to a broad gene pool in connection with the corresponding knowledge it is hardly possible to respond to an escalating population growth in combination with fast changing environments.

The objectives of the project are (1) to explore the role of legumes in the prevailing production systems, and (2) to investigate the traditional use of legumes with a view to revive or strengthen this use by enhancing cultural awareness of legume genetic resources to improve productivity and sustainability of farming systems.

The indigenous knowledge assessment was carried out in 7 villages of Na Ri district, Bac Kan province from June to August 2000. In order to select villages for the survey secondary data were reviewed. A herbarium voucher containing a pre-selection of legumes was shown to a range of village informants to understand local botanical classification systems. Complementarily, a guided field tour was conducted in order to complete the voucher collection, and to observe and identify different ways in which legumes are used. The cultural and biological aspects of local knowledge were documented including photographs and the drawing of seasonal calendars to highlight opportunities and limitations of the agroecosystem where legumes were found. All interviews were conducted in a semi-structured way involving questionnaires and short field notes. Individual and group interviews were combined in a sequence to avoid biases caused by group dynamics, gender issues, age or leadership.

It was found that less than 50 % of the presented wild growing legumes were identified by the farmers and assigned to medicinal, forage and/or technical purposes. Generally, grain legumes are integrated into the production systems only to a minor extent. Among participating ethnic groups significant differences in the importance of grain legumes in rotation and intercropping were observed.

Key words: highlands, genetic diversity, genetic resources, natural resources management, ethnobotany

GIS-gestützte Zuordnung von Landnutzungs- und Bodenmustern als Grundlage für die Regionalplanung im Nordosten Brasiliens

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Problemdefinition und Zielstellung

Der Nordosten Brasiliens ist gekennzeichnet durch eine hohe räumliche und zeitliche Klimavariabilität, die in Verbindung mit den vorherrschenden sozioökonomischen Rahmenbedingungen zu wiederkehrenden Engpässen in der Trinkwasserversorgung und zu Hungersnöten führen. Für die regionale Planung der Trinkwasserversorgung, die in weiten Teilen der Region aus Oberflächenwässern gedeckt wird, sowie für präventive Maßnahmen zur Sicherung der Lebensmittelversorgung, ist die Kenntnis der räumlichen Verteilung der Böden und der damit verbundenen Landnutzung von großer Bedeutung. Ziel der Untersuchungen war es daher, in einer Beispielregion, mit Hilfe von Fernerkundungsdaten für die dort auftretenden Bodenklassen den ackerbaulich genutzten Flächenanteil zu bestimmen.

Material und Methoden

Das Untersuchungsgebiet liegt im Bundesstaat von Piauí und umfasst eine Fläche von ca. 6000 km^2. Grundlage für die Bestimmung des Anteils der einzelnen Bodenklassen an der ackerbaulich genutzten Fläche war zum einen eine mittelmaßstäbige Konzeptkarte der Bodengesellschaften sowie eine Landnutzungskarte für das Jahr 1996. Die Landnutzungsklassifikation wurde aus einer Landsat TM5 Satelitenbildszene abgeleitet. Sowohl die Bodenkarte als auch die Landnutzungskarte wurden durch mehrmalige Geländebefahrungen qualitativ überprüft.

Ergebnisse und Schlußfolgerungen

Mit Hilfe der satellitenbildgestützten Landnutzungsklassifikation konnte die ackerbaulich genutzte Fläche einzelnen Bodenklassen zugeordnet werden. Ein Vergleich der so geschätzten Anteile der Bodenklassen an der ackerbaulich genutzten Fläche mit ihrem Anteil an der Gesamtfläche zeigte deutliche Unterschiede. Durch die Verwendung der Landnutzungskarte konnte gezeigt werden, daß bestimmte Bodenklassen, insbesondere solche mit hoher Wasserspeicherfähigkeit, bevorzugt ackerbaulich genutzt werden. Im Vergleich zu ihrem Anteil an der Gesamtfläche, war der Anteil dieser Bodenklassen an der ackerbaulich genutzten Fläche um über 200% höher.

Die Ergebnisse belegen die Bedeutung der satellitenbildgestützten Landnutzungsklassifikation für die Zuordnung von Landnutzungs- und Bodenmustern und die flächenmäßige Quantifizierung von Standortskomplexen. Diese bilden wiederum die Basis für eine fundierte Planung der Regionalentwicklung in Nordostbrasilien.

Key words: Landnutzung, Boden, Fernerkundung

Traditional use of and reliance on the forest among the Luhya people with special regard to the traditional medical system and the use of medicinal plants in Kakamega Forest, Western Kenya

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The Convention on Biological Diversity, which was passed at the Conference on Environment and Development (UNCED) 1992 in Rio seeks to promote the conservation of biological diversity and its sustainable utilisation. Local communities, known for their environmental knowledge and sustainable economic strategies, are recognised in the Convention as a preserver of the world-wide endangered biological diversity.
Inspite of the great importance of biological diversity, many countries do not have sufficient data on what biological resources they have, where they are to be found and how they may be utilised. The great biological diversity of rain forests, in particular, have hardly been explored. Because of the reduction of forest areas many species are already extinct.
The Kakamega Forest Reserve is located in the Western Province of Kenya and covers an area of about 21.000 hectare. As a tropical rainforest it receives an annual rainfall of at least 2.000 mm and is therefore evergreen and humid. The forest is described as the easternmost relic of the Guineo-Congolian type of rain forest, that stretched in the Pleistocene period from West Africa across Uganda and Kenya. Due to climatic changes in the beginning of the Holocene, the vegetation has been isolated. Contact with the montane forest of the rift escarpment has led to an intermix with afromontane species. Therefore the forest contains a unique plant diversity.
Today, very little of its original forest cover is intact. High population pressure and intensive land use around Kakamega Forest is a danger to the very existence of the biological diversity of the area. Many plants which once could be found easily, are becoming scarce and may soon vanish unless strong conservation measures are taken.
From April to June 1999 a study was performed together with the Luhya

people -the tribe that lives adjacent to the Kakamega Forest- focusing on the use of forest products in general, the use of medicinal plants among the traditional herbalists and other members of the community in particular. Ecology, biological diversity and endangerment of the forest were central aspects of the study.
The main part of research involved interviews with traditional herbalists practising in the area, as well as members of local communities and foresters in charge. Traditionally used plants, in particular medicinal plants, were recorded.
Due to many ways of using the forest -firewood, timber, food, medicine, raw material- the forest is a source of indispensable supply for the needs of the Luhya. In addition, local people see the forest as a grazing area for their livestock and as a potential land reserve for agriculture.
Traditions and cultural knowledge are still very important to the Luhya, and their culture is closely connected with the forest. Even today there is still an abundance of indigenous knowledge held amongst the communities and a strong reliance on the use of plants, especially for medicinal purposes.
Therefore with the destruction of the forest the Luhya endanger their own traditions and livelihood.
Even the protection of parts of the forest as *Nature and National Reserves* did not change the situation of the forest. Despite the prohibition of certain kinds of encroachment, the vast majority of households still continues to use the forest at least for basic needs. The relationship between forest guards, rangers and the local people is generally poor and the situation around the forest is tense, since the people resent their loss of rights concerning use of the forest.
Therefore, it is important to find strategies for forest protection together with the Luhya people. The protection of forest should, due to the Convention on Biological Diversity, include the preservation of the local culture. Strategies have to be found for Kakamega Forest, which are ecologically as well as economically efficacious.
One strategy could be the management of the forest environment through a zoning concept. Therefore to ensure on the one hand as much indigenous forest cover as possible and to permit on the other hand op-

timal use of forest resources on a sustainable basis, the forest could be divided into functional units.
Further alternative economic strategies are the extraction of non-timber forest products for sale in local markets, the introduction of agro-forestry or tourism.
Local participation is a major tool in environmental planning. To reach the goal of sustainable use of the forest, the strengthening of local and traditional institutions plays a major role in this process. Due to the importance of community education, especially on the environment, the major aim of local institutions is the education in general and about the conservation value of Kakamega Forest. One of the existing local institution is the *Kakamega Environmental Education Programme (KEEP),* founded by the chief tourist guide of the forest. This programme focuses on school children, who are taught by the tourist guides about the ecological and biological importance of the forest, about different plants and animals in the forest and about edible fruits, mushrooms, honey and natural medicines. Further they are instructed in alternative income possibilities.
Other community organisations of Kakamega that do not primarily have educational purposes are e.g. the *Kenya All Traditional Herbalists and Practitioners Organisation (KATHPO)*, the *Beekeepers Association*, a tour-operator association and diverse family-planning and women's groups. These groups mainly concentrate on solving major problems of people and the environment. Therefore these local and traditional institutions play a major role in finding conservation strategies.
One outcome of the study was, that strategies like the management of environment through forest zoning and other strategies, which tackle the problem at the core like family planning, introduction of fuel saving stoves etc., can find the acceptance of the local people (when these strategies are established together with them and organised by them). Since the forest is highly threatened in its continuing existence, efforts have to be made and implemented immediately.

Key words: Rain forest, Western Kenya, medicinal plants, forest protection, environmental education

The Internet atlas of natural and agronomic resources in Niger and Benin

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The lack of available data for planning purposes in developing countries is an often discussed problem. This is not only due to missing data but to limited access. Often, data are existing but dispersed in different institutions including NGOs. Consequently, a data collection and communication tool is needed. New information technologies like the Internet ease this approach.

The “Internet Atlas of Natural and Agronomic Resources” was developed within the Special Research Programme 308 “Adapted Farming in West Africa” as a tool of data collection, communication and for the presentation of research results. The content of the atlas reaches from climate and soil resources to economic data. The atlas is commented. This means, it presents not only maps but also short scientific comments and interpretations. Additionally, the data underlying the maps and the map geometry can be downloaded from the web-server. This eases direct use and further development of map contents.

An argument against the use of the Internet is, that it is not widely accessible in developing countries. However, once prepared for the Internet, the content can also easily be printed. The experiences made so far show, that national institutions in Niger and Benin are keen to build upon the Internet atlas in order to develop a national atlas which is lacking so far.

Key words: land use planning, data base, maps, national atlas

Management, Conservation and Utilization of the Pacific Chongón-Colonche Mountains in Ecuador: Project Methodologies and First Experiences

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Problem Addressed

The Chongón-Colonche mountains at the Pacific Coast of Ecuador are situated in an ancient inhabited area. The population of mainly red Indian origin live at the borders of the mountains that serve important functions as a watershed for the dry coastal area, as a conservation area of endemic species and to provide the people with wood and many non-wood products. The constant fogs formed by the contact of tropical air with the relatively cold ocean water, are caught by the tree crowns. This mechanism of virtually "milking the clouds" is the most important water providing mechanism for the mountain rivers. In the last decades the forest area has been reduced drastically due to a constant growth of the farmer population, immigration of cattle breeders from the Manabí area and destructive exploitation. In 1994, with the help of the NGO Fundación Natura and some of the local villages an area of 78.000 ha has been declared as a "Protected Forest". This is a low conservation category of the National Forestry Law, that excludes forest logging but permits a non destructive use of the forests. In 1998 an Ecuadorian-German development project managed by Fundación Natura & GFA Terra Systems started with an overall budget of DM 18,5 Million over a period of 10 years to promote the local people in their efforts to reforest, protect and utilize the Chongón-Colonche forest.

Objectives of Research

In order to reach its development goals, many questions have to be investigated by project accompanying research efforts, e.g. to
Find an effective mechanism of financial or other incentives to get local farmers involved in restoring and conserving their forests
Find land use systems (Afforestation, Agroforestry, Natural Forest Management) that conserve the environment and that are profitable and sus-

tainable
Find techniques to establish land use rights on the ground.

Research hypothesis

Direct economic benefits are an effective way to get local farmers to participate in environmentally oriented projects
Land use systems that are adopted by farmers have to fulfil a couple of well selected criteria
It is possible to apply a natural forest management system that is attractive for the local people and conserves their forests.

Methodology and Work Plan

Since its start in October 1998, the project has elaborated forestry and agroforestry systems in a participatory process with the local people. A financial incentive system is in place. In the two years ahead the currently rudimentary project data base will be developed and integrated in an overall Monitoring & Evaluation (M & E) System. Additionally a natural forest management system will be designed and incorporated. With the use of GIS and GPS the community land limits will be established on maps and, at the same time in the field.

Preliminary Results and Perspective

First results of the project show the process of species and agroforestry systems selection, the financial incentive scheme, yield predictions deduced from actual growth of other plantations in the area, and suggestions for the M & E System and the Natural Forest Management. This highly complex project requires a constant effort of adaptation and accompanying research. Its results will be exposed and published periodically in the future.

Key words

Forest Conservation Management, Agroforestry, Incentive Systems, Social Forestry, *Prosopis juliflora*

Miombo woodland utilisation by smallholders in Handeni / Tanzania: Strategies for income generation

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(i) Problem addressed: Within African dry lands the increasing destruction of Miombo woodlands is a special problem. The yield of traditional management of these ecosystems is not longer sufficient to cover the needs for food supply and cash crop of the growing rural population.

(ii) Research question/hypothesis: The study is based on the assumption that the know-how about the multiple use of Miombo woodlands is a base for further development of proper resource utilisation systems. A consequently integrated management using agro-forestry systems considering timber and non timber products of trees and shrubs should influence the economic and social situation of people in this area in a positive way. Non wood forest products (NWFP) which on the one hand contribute to the subsistence of single families, on the other hand can be marketed and serve as a source of income, should rise the prestige of that forest type in the awareness of the local users.

(iii) Objective of research: Based on these presumptions the main objective of a study in Handeni District, North Eastern Tanzania was to improve a better understanding about the situation of Miombo utilisation in the research area through descriptive analyses. Derived objective was to describe the potential development of the region in case of fulfilment the subsistence needs, income generating, and ergonomic aspects such as labour organisation and qualification.

The investigation was focused on the inhabitants of four villages from two different ecological zones of the Miombo woodlands from the small scale farming Zigua / Nguu and a semi-nomadic cattle rearing Maasai tribe. Information related to the utilisation of forest-resources based on

the knowledge and experiences of local people and local experts, was collected through individual interviews, group discussions, field observations and key interviews within and outside the research area.

(iv) Methodology and workplan: To get access to the traditional knowledge about woodland utilisation, tools of PRA were used to record the actually used NWFP and also the way of harvesting and use of these products, their contribution to subsistence and their economic means. The following research steps serve to reach the main objective: 1. Assessment of the role of forest utilisation, especially of NWFP, for the predominantly agrarian subsistence livelihood. 2. Identification of the present role of selected NWFP of Miombo woodlands, taking into account ecological, economical and socio-cultural aspects of land use. 3. Description and evaluation of possibilities and constraints of diversification of the product range, and an increase in direct utilisation of trees and shrubs, based on the carrying capacity of the ecosystem.

(v) Results and conclusions and their relevance for development: The three tribes consider woodlands first of all as a resource for agriculture and cattle grazing. Honey, mushrooms, other wild food and barks were identified as most promising NWFP in the region for subsistence households and income generation. In the research area the marketing of woodland products can be considered as an incentive for the conservation of the woodlands. The acceptance levels for accelerating propagation of utilisation and marketing of NWFP vary between and within communities. For subsistence economies an intensified use of NWFP can be recommended in most cases, while strengthening commercialisation is only recommended with caution because of the high risks. An establishment of collaborative processing and marketing can improve the marketing possibilities of all product samples.

Key words: Miombo, NWFP / NTFP, Social Forestry, Tanzania.

Furthering the Domestication of African Pear (*Dacryodes Edulis* (G.Don) HJ Lam)

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The African pear (*Dacryodes edulis* (G. Don) HJ Lam), is one of the numerous indigenous African tropical fruit tree species (TFTS) that had in the past, received very little research attention. The horticultural, nutritional, pharmaceutical and industrial potentials of this species had in recent times however, attracted the attention of the outside world. The domestication process of the African pear is still at its infant stage. For a better exploitation of the already known potentials of this species, it is essential to: (i) identify the intra-specific variations in both the pomological and horticultural characters within the available germplasm and (ii) develop a more efficient vegetative propagation technique for this tree crop species. This study was therefore undertaken with the above objectives in mind.

Two series of experiments were conducted at Imo State University in Nigeria involving both extensive field and nursery germination/vegetative propagation studies. Morphological observations were made on 418 different trees both from within and outside the farming zones where the species naturally occurs. Fruit samples of the identified variants collected from the field study were germinated in the nursery and used for the pomological and vegetative propagation studies. Fifteen pomological characters were examined.

The treatments in the vegetative propagation studies were made up of three levels each (0.2%, 0.4% and 0.8%) of indole-butyric acid (IBA) and naphthalene acetic acid (NAA) all dissolved in methylated spirit and four different rooting media (top soil, river washed sand, sawdust and river washed sand + sawdust). Cuttings were propagated both during the dry season in the month of November and during the rainy season in the month of May. Modified low-technology non-mist vegetative propagation systems (Leakey *et al*., 1990) were used. The number of green leaflets

retained by cuttings in each treatment after each week was recorded. Statistical methods used for data analysis were randomised complete block design (RCBD) and regression and correlation.

Of all the pomological and vegetative characters of the African pear examined in both the field and nursery, only fruit size, fruit length/breadth (L/B) ratio and fruit pulp thickness were found reliable in the categorisation of the species into large, medium and small fruit types. The L/B ratios for the large fruit types ranged from 1.46 to 1.82, and varied only slightly for the medium fruit types ranging from 1.32 to 1.36. The L/B ratios for the small fruit types ranged from 1.12 to 1.28 and unlike the above two, generally have very thin pulps (2 - 3mm.); a feature which lowers their horticultural appeal (Okorie *et al*., 2000). The leaflet number in a rachis was significantly ($p=0.01$) correlated with the rachis length in a linear fashion with R^2-value of 75%.

Treatment of the cuttings with either IBA or NAA at 0.2%, 0.4% and 0.8% respectively, showed no significant improvement over the control on the rooting of African pear cuttings. Out of a total of 680 cuttings, only 3.4% actually developed root primordia in the rainy season trials and neither hormonal treatment nor rooting media had any significant effect. In terms of cutting leaflet retention, top soil and river washed sand however proved superior over sawdust. The percentage of green leaflets retained after one week were 59.7%, 59.6% and 15.9%, respectively.

A great deal of intra-specific variations of taxonomic interest and horticultural value exists in the African pear to warrant the initiation of a selection and improvement programme. There is the need for further studies on this important species, especially the development of more efficient techniques for rapidly multiplying the tree species vegetatively. Studies on the micro-propagation of African pear is recommended as this is already being used on a few ´TFTS` presently considered important in international trade like kola, cacao, oil and date palms. The tropical food tree crops like the African pear are very efficient in tackling the twin problems of hunger and environmental degradation, especially in Africa and therefore deserve increased research funding and priority.

Key words: African pear, domestication, propagation, improvement.

Die Zahlungsbereitschaft als Nutzenmaß für die Bewertung des Umweltgutes (Eine Bewertung von Gunung Gede Pangrango Nationalpark in Indonesien)

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Einige von der Bewertung der Umweltveränderung beim direkten Ansatz erfolgt über die Ermittlung der maximalen Zahlungsbereitschaft. Bei der kontingenten Bewertungsmethode wird der Wert der Umweltgüter nicht aus Informationen über real existierende Märkte abgeleitet. Man fragt die befragten Personen in einer hypothetischen Bewertungssituation nach ihrer Zahlungsbereitschaft für die Durchführung einer umweltrelevanten politischen Handlung (Marggraf und Streb, 1997; Enneking, 1998;Wronka, 1998).

Man versteht hierunter, daß die individuellen Präferenzen für Umweltgüter auf dem Wege direkter Befragungen in monetäre Größen übersetzt werden. Durch eine Frage der Form : “Was wären Sie maximal bereit für eine Qualitätsverbesserung zu zahlen ?“ kann direkt die kompensierende Variation und somit die theoretisch korrekte individuelle Wertschätzung ermittelt werden (Hackl, 1997).

Mit Hilfe von Zahlungsbereitschaften wird der ökonomische Wert natürlichen Ressourcen ermittelt. Im vorliegenden Forschungsvorhaben ist die Nutzenmaßnahme den Gunung Gede Pangrango Nationalpark eingewendet worden. Der Gunung Gede Pangrango Nationalpark hat insbesondere zwei Funktionen, und zwar Erholungs- und Schutzfunktion. Die unterschiedliche Biodiversität des Gunung Gede Pangrango Nationalparks bildet die Grundlage der Erholungsaktivitäten der Touristen und er ist seit vielen Jahrzehnten ein bekanntes Tourismusziel. Bei Ankunft in diesem Park muß man die Eintrittskarte kaufen. Die Eintrittskarte bildet die Finanzierungsquelle des Parks. Über eine Variation des Eintrittspreises werden die Zahlungsbereitschaft der Touristen ermittelt.

Der Park hat auch eine Schutzfunktion in Form der Sicherung der Was-

serversorgung für die lokale Bevölkerung. Im Nationalparksgebiet beziehungsweise in der Randzone befinden sich die Wohnsitze der einheimischen Bevölkerung, die seit mehrere Jahrzehnten lang von der lokalen kleinbäuerlichen Familien bewohnt werden. Die meisten von Ihnen leben in Armut. Um den Nutzen des Nationalparks für die einheimische Bevölkerung zu bestimmen, wurde der Wert der Wasserversorgung durch die "Cileutik" Wasserquelle ermittelt. Die Wasserquelle hat eine große Bedeutung. Das Wasser wird von der einheimischen Bevölkerung zum Trinken, Waschen, Kochen, und Baden benutzt. Entsprechend groß ist der ökonomische Wert des Wassers für die Menschen und die gesamte Umwelt/Region.

Wenn die Wasserversorgungsprojekte aufbauen wöllte, würde die lokalle Regierung und der GGPNP realisieren. Durch der Zusammenhalt sind die lokale Regierung der einheimische Bevölkerung eingeladen worden, an der Realisierung der "Wasserversorgungprojekte" teilzunehmen. In diesem Fall zeigt sich das, daß die monatliche Wasserbeitrag als Zahlungsbereitschaft von der betroffenen Bevölkerung angesichts der Wasserversorgungsprojekte aufbauen wöllte.

Key words: Umweltsbewertungsanalyse, Umweltschutzgebiet, Umweltgüter, Zahlungsbereitschaft

Germplasm characterisation of the tropical multipurpose legume shrub *Flemingia macrophylla*: A research project in Colombia and Germany

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Flemingia macrophylla (Willd.) Kuntze ex Merr. is a perennial, leafy legume shrub particularly suited for low-input smallholder production systems in the subhumid and humid tropics. It is used for a range of purposes such as soil cover, mulch and fuel wood, as shade-providing plant in young coffee, cocoa etc. plantations, and as erosion barrier hedge. The particular advantages of *F. macrophylla* – based on experiences with a commercial variety – are vigour, leafiness, adaptation to acid, low-fertility soils, drought resistance, excellent coppicing capacity and regrowth after cutting, and slow leaf decomposition. Its main limitation is low nutritive value because of high tannin content combined with very low palatability to cattle.

The species' centre of diversity is Southeast Asia where germplasm has been collected in south China, Indonesia, Malaysia, Papua New Guinea, Thailand, and Vietnam. The presently available collection, which is maintained at the CIAT Genetic Resources Unit, comprises about 80 wild-plant accessions whose genetic diversity is, as yet, unknown.

An ongoing project is presented by which the variation in the collection is described on the basis of:

- Accession characterisation and preliminary evaluation based on measurements and observations in space-planted, single-row plots at the CIAT-Quilichao Experiment Station, near Cali, Colombia. This will be done during two rainy and one dry season using a range of conventional morphological and phenological descriptors (such as growth

habit, branching and regrowth capacity, plant height and width, relative leafiness, leaf, fruit and seed morphology, length of vegetative phase), production parameters (such as establishment and regrowth vigour, seasonal dry-matter production, drought tolerance, seed production, incidence and severity of diseases and insect pests), and analysis of both forage and mulch quality (contents of crude protein and tannins, tannin astringency, *in vitro* dry-matter digestibility, and litter degradability, respectively).

- Genetic analysis with DNA markers at the University of Hohenheim, Germany (Random Amplified Polymorphic DNA – RAPD).

Expected results will be used to:

- Identify a core collection representative of the entire collection's genetic diversity for eventual multilocational testing;
- identify particularly promising accessions for livestock nutrition (forage value) and soil improvement (litter quality of mulch material);
- identify origin subregions in Southeast Asia, with particularly high diversity of *F. macrophylla*, that might warrant further germplasm collection missions (also in view of increasing genetic erosion in the region); and
- to contribute to the development of an improved core collection concept, applicable to wild-species legume germplasm in general, based on the comparison of genetic diversity assessed via analysis of (a) origin information, (b) characterisation at the field plot level, and (c) DNA markers.

Key words: Legume diversity, tropical forages, nutritive value, litter quality, core collections

Enset clones of the Sidama, southern Ethiopia: diversity and distribution

Bizuayehu Tesfaye & Peter Ludders

Ethiopia has long been recognised as the centre of origin and diversity for a large number of crop plants (Vavilov, 1951; Harlan, 1969). Of these, enset, Ensete venticosum Welw., is one of the little known Ethiopian domesticates which has made a significant impact on the local agriculture.

The genus Ensete is a member of the family Musaceae which also includes the edible bananas. About 8 species are recognised within the genus, but only one species, E. ventricosum, is economically the most important. The cultivation and use of E. ventricosum is restricted to Ethiopia. It is the dominant plant in the gardens and backyards of southern Ethiopia at elevations ranging from 1500 to 3100 m asl, although its wild relatives are found at much lower elevations (Cheesman, 1947; Baker, et al, 1953).

The major areas of enset cultivation are concentrated in the south and south-western Ethiopia, where it serves as a staple and co-staple food for an estimated 10 million people. Enset has been cultivated in this part of the country for many centuries and has evolved as one of the most stable and sustainable agaricultural systems. The entire enset production is for subsistence and is still under traditional method of cultivation using unimproved local land races, which are maintained as true to type clones through vegetative propagation (Bezuneh,1966; Smeds, 1955).

Centuries of human selection and local adaptation have resulted in great clonal wealth of enset in Ethiopia (Smeds, 1955; Bezuneh, 1966; Alemu, 1994; Brandt, etal., 1997). However, hitherto clone diversity has been considered in a broad context, and quantitative data on the distribution range, spatial patterns and relative importance of the various clones do not appear in the literature. The selective significance of particular clones and their contribution to overall diversity is also unknown. Moreover, it is not clear whether previous counts of clones represent just names or existing clones that are still in use. There are thus major gaps in our knowledge of the extent of the number, distribution and abundance patterns of

enset clones as well as the spatial dynamics of enset clone diversity in Ethiopia.

The objective of the present study was to provide a clear overall picture of enset clone diversity and dynamics in the Sidama region of Ethiopia. The individual goals were to i) draw up an exhaustive inventory of existing clones in the region; ii) analyse the distribution and abundance pattern of clones, and iii) establish empirical relationships between clone diversity and site factors such as elevation and distance that serve to predict diversity patterns in the region.

Diversity and spatial distribution of clones were investigated in farms of 300 randomly selected peasant households at ten different locations using presence-or-absence data. Diversity in this context is definefd as the number and abundance of clones at each site. Distribution refers to the number of surveyed sites in which a clone was found. Three diversity and one similarity indices were constructed and used to analyse diversity patterns at different spatial and elevational scales.

A total of 86 named enset clones was recorded. Small scale distribution characterizes the spatial structure of most clones. Regional distribution of clones was positively correlated with local abundance such that more widespread clones were also typically more abundant ($r = 0.78$, $p < .01$). On average, 52% of the clones in each location were shared with the other sites, with the number of overlapping clones decreasing as the distance between sites increased ($r = -0.24$, $p < .05$).

There exists a predictable pattern of clone diversity along elevational gradient ($r = 0.71$, $p < .05$). Clone diversity (measured by clone richness, Simpson (1949) and Shannon and Weaver (1949) diversity indices) was low at low altitude areas, reached a maximum at 2400m asl and declined silghtly afterwards. This increase in clone diversity parallels closely the variation in cropping pattern, farmers' reliance on enset and other environmental factors along elevation. Implications for collection and conservation of enset diversity are discussed.

Key words: distribution, diversity, enset, Ethiopia, land race

Ökonomische Bewertung alternativer Ökotourismusprojekte und umweltethische Einstellungen der Besucher im Naturschutzgebiet der vierten Region in Chile: Eine kontingente Bewertungsstudie

Pablo Villalobos

1. Problemstellung

Naturschutzgebiete für Erholungsaktivitäten offnen zu halten, hat eine lange Tradition. Die ersten Erfahrungen damit wurden in den Vereinigten Staaten gemacht. In Nationalparks wodem bestimmte Gebiete für Camping und Fischen ausgewiesen und Wanderlehrwege u.a. angelegt. Auch die Vergabe von Konzessionen im Tourismussektor ist keine neue Praxis auf dem Gebiet des Managements von Naturschutzgebieten. In Chile gibt es bereits seit 20 Jahren Naturschutzgebiete, für die Konzessionen vergeben werden. In besondere hat diese Art der Verwaltung in den letzten 10 Jahren an Bedeutung gewonnen. Die touristischen Dienstleistungen und die Infrastruktur, die in den Naturschutzgebieten angeboten wird, können negative Umweltwirkungen erzeugen. Andereseits sind die touristischen Dienstleistungen wichtig für die Finanzierung und damit für die Existenz der Naturschutzgebiete. Es gilt deshalb eine Ausgestaltung der touristischen Angeboten zu entwickeln, die auf den Interessen der Besucher basiert und den ökonomischen Notwendigkeiten Rechnung trägt, ohne die ökologische Konsequenzen zu vernachlässigen. Die kontingente Bewertungsstudie, die im Nationalpark “Fray Jorge” durchgeführt wurde, trägt zu diesem Ziele bei.

2. Ziele der Forschung

2.1 Allgemeines Forschungsziel

Das allgemeine Ziel der Forschung war die ökonomische Bewertung der Nachfrage nach Tourismusdienstleitungen für alternative zu Ökotourismusprojekte im Nationalpark Fray Jorge.

2.2 Spezifische Ziele

Die spezifischen Ziele der Forschung waren:

- Ermittlung der Zahlungsbereitschaft der Besucher für eine Verbesserung der Infrastruktur und Dienstleitungen mittels einer kontingenten

Bewertungsstudie.
- Erfassung der umweltethischen Einstellungen der Besucher
- Bereitstellung einer Entscheidungshilfe für die nationale Forstbehörde in Bezug auf zu tätigende Investitionen

3. Forschungshypothesen

Die Forschungshypothesen werden durch folgenden Postulate zusammengefasst:
- Die Besucher sind in der Mehrheit bereit, mehr für ihre Eintrittskarte in den Park zu bezahlen, wenn durch Projekte die Ausstattung im Inneren des Parks verbessert wird.
- Die vorgeschlagenen Projekte werden von den Besuchern positiv bewertet, da sie den vorrangigen Aktivitäten der Besucher während ihres Aufenthaltes im Park entsprechen.
- Es besteht eine positive Korrelation zwischen der Zahlungsbereitschaft und den umweltethischen Einstellungen der befragten Besucher.
- Es besteht eine positive Korrelation zwischen der Zahlungsbereitschaft der Besucher und deren Einkommens-, Bildungs- und Beschäftigungsniveau sowie dem Alter der Befragten.

4. Methodologie und Arbeitsplan

Zwischen November 1998 und Januar 1999 wurde eine kontingente Bewertungsstudie im Nationalpark Fray Jorge, IV Region Chiles, durchgeführt. Es wurden zur Sicherung der Repräsentativität 442 Personen befragt, von denen 9 Prozent Ausländer waren. Die Stichprobe wurde in Besucher, die sich lediglich einige Stunden (Tagesbesucher) im Park aufhalten und solche, die im Park übernachten (Campingsbesucher) aufgeteilt. Diese Differenzierung ist von Bedeutung sowohl für die Bewertung der zu schaffenden Szenarien als auch für die statistische Analyse. Es wurden entsprechend der Merkmale der beiden oben genannten Besuchergruppen zwei hypothetische Szenarien entworfen. Beide Szenarien beinhalteten ähnliche Projekte in Bezug auf die Qualität der angebotenen Leistungen. Mit Informationen über Projekte und unter Verwendung von photographischem Material wurden zwei Plakate entworfen (eines pro Besuchergruppe), auf denen die vorgeschlagenen Projekte detailliert erklärt werden. Der Fragebogen setzt sich aus drei Teilen

zusammen: Einstellung zu den natürlichen Ressourcen des Nationalparks Fray Jorge, Erfassung der Zahlungsbereitschaft der Besucher in Zusammenhang mit den auszuführenden Projekten und die sozioökonomische Charakterisierung der Befragten. Für die statistische Auswertung der Variablen wurde das Statistik-Programm SPSS Version 8.0 eingesetzt. Um die ökonometrische Schätzung der Zahlungsbereitschaft sowie die wichtigsten berücksichtigten Variablen in der Analyse zu bestimmen, wurde ein logistisches Regressionsmodell angewandt.

5. Ergebnisse und Schlussfolgerungen

Ergebnisse

- Zwischen dem Einkommen und der Zahlungsbereitschaft der Besucher wurde eine signifikante Beziehung festgestellt.
- Die von den Befragten geäußerte positive Bewertung des Projekts stimmte mit den Erholungsprioritäten der Besucher während ihres Aufenthaltes im Park überein.
- Gleichermaßen konnte festgestellt werden, dass die von den Befragten ausgedrückten Mittelwerte der Geldbeiträge (Preis der Eintrittskarte) höher sind als der aktuelle Preis.
- In Bezug auf die umweltethische Einstellungen konnte festgestellt werden, dass die befragten Besucher ein hohes Bewusstseinsniveau gegenüber den natürlichen Ressourcen des Nationalparks besitzen.

Schlussfolgerungen

- Die vorgeschlagene Methodik und im besonderen die kontingente Methode haben die vorgegebenen Ziele erreicht und die zu Beginn der Forschungsarbeit aufgestellte Hypothese bestätigt.
- Die durchgeführte Studie vermittelt präzise Informationen bezüglich der Nachfrage nach Erholungsangeboten seitens der Besucher sowie über die Wirkungen der Besuche auf die natürlichen Ressourcen des Nationalparks. Dies ist die Grundlage, um ein nachhaltiges Management im Nationalpark Fray Jorge zu realisieren
- Die kontingente Bewertungsmethode eignet sich als neue und interessante Methode der Bürgerbeteiligung bei der Entscheidung über Investitionsprojekte.

Implications for vegetation studies from inter-annual variation of species composition in semi-arid environments

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The climate of semi-arid environments is characterised by a high inter-annual and intra-annual variability of the precipitation. For vegetation studies this can be crucial because species composition of a herbaceous flora dominated by annuals is often determined by the pattern of the first rains and the total amount of rainfall. This was demonstrated on permanent plots on three different fallow sites in Niger, West Africa. Fallow vegetation was surveyed from 1994 to 1998 using the Braun-Blanquet method. Two sites, a protected fallow and grazed fallow, were located on deep sandy soils. The third site, which was grazed, was situated on a shallow soil.

The number of different species observed per plot varied between the years, with some species being absent in one year but present in the next. Likewise, the frequency of occurrence of individual species varied between years. On all sites, certain species occurred in all years, but their abundance changed enormously from year to year. Species of a second group were all absent in 1998 because they were buried by sand from heavy storms, or when germinating again, were eaten by small grasshoppers.

The inter-annual fluctuation of abundance and/or dominance of various species signifies a considerable problem for vegetation studies. For phyto-sociological approaches many species which are abundant in some years, but absent in others, cannot be used as character or differential species. Still, these species can be of certain value: If species fluc-

tuations are known from permanent plot analysis, they can indicate certain site characteristics in years of presence. But it would be preferable to identify a group of species with similar fluctuation trends for specific precipitation patterns and site conditions, so that at least some of them will germinate and develop each year.

Key words: fallow, Niger, rainfall variability, West Africa

Optimizing automated fingerprinting of maize germplasm using SSR Markers

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The Applied Biotechnology Center of the International Maize and Wheat Improvement Center (CIMMYT) has undertaken molecular marker fingerprinting of maize germplasm in order to better understand the diversity present in breeding lines and populations, and to better classify them into heterotic groups. Fingerprinting of heterogeneous pools and populations such as CIMMYT's open pollinated varieties is more difficult than line fingerprinting, and we have tested methods to accurately but efficiently characterize these populations. We have begun a collaborative study with the University of Hohenheim to optimize high-throughput fingerprinting techniques and analysis using SSR markers multiplexed by size and fluorescent dye color and run on an ABI Prism™ 377 automated DNA sequencer. A pilot study was run where 57 inbred lines and 7 populations of CIMMYT maize were fingerprinted using 38 primers, and data was converted to binary matrices and allele frequencies were calculated for each population. Analyzed data showed that the inbreds clustered according to pedigree and selection history, as expected, and that populations could be uniquely characterized based on allele frequency. Furthermore, when the populations were characterized using simply the presence or absence of the alleles, similar results were found as with analysis using allele frequency. This indicates the possibility of bulking DNA from several individuals in a population to save considerable time and reagents. We will continue to fingerprint additional germplasm using these optimized techniques.

Key words: SSR, maize, fingerprinting

Rice Varieties Identification Through Integration of Physical and Chemical Properties

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This study was conducted to identify 8 *indica* type rice (*Oryza sativa*) varieties namely; Kaodokmali105 (KDML105), Hom Kongluong (HKL), Hom Suphanburi (HSP), Suphanburi1 (SPB1), Suphanburi2 (SPB2), Suphanburi60 (SPB60), Suphanburi90 (SPB90), Chainard1 (CD1), by using integrated results of seed coat character, amount of amylose and alkali digestion property of seeds.

The treatments were assigned in a Randomized Complete Block Design (RCBD) at the Department of Agronomy, Faculty of Agriculture, Chiang Mai University, Chiang Mai, THAILAND.

The results showed that the amount of amylose could be used to separate the rice varieties into 3 groups. Group1: low amylose, consisted of KDML105, HKL and HSP (13.75, 15.75 and 17.75 % amylose). Group2: medium amylose, consisted of SPB2, and SPB60 (22.00 and 23.75 % amylose). The last group: high amylose, consisted of SPB1, SPB90, CD1 (28.50, 28.25 and 28.25 % amylose). The amount of amylose in KDML105, HKL, HSP, SPB2, SPB60 were significantly different.

This method could be used to easily separate and identify KDML105, Hom Kongluong and Hom Suphanburi from the other varieties. SPB2 and SPB60 could be separated by using alkali digestion property (alkali digestion level 3 and 7). While SPB90 could be specified from SPB1 and CD1 by alkali digestion property (alkali digestion level 7, 4.25 and 4.00). SPB1 could be separated from the other varieties by the physical property of the seed coat. Seed coat of SPB1 has an awn while the others do

not. Different amounts of amylose were caused by the ratios of the linear chain and branched chain structures of glucose in the seed endosperm. High amylose was due to the high linear chain glucose. The lowest in alkali digestion level could be explained by the straight adherent glucose molecular structure.

Key words: Rice varieties, physical properties, chemical properties.

Oral Presentations Section 3

Pressure on Ecosystems
Problems and Possible Solutions

Working Group 1

Impact of Climate on Crop Production

The impact of climate variability on crop production in Central-Benin

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One of the major factors determining crop production, and therefore food supply and security, is the physical resource endowment of a given area. Crops differ in their adaptability and productivity with respect to soil and climatic conditions.

The suitability of the climatic conditions of Central-Benin for six selected crops (maize, sorghum, cowpea, groundnuts, cotton and cassava) was evaluated in terms of minimal length of growing period, precipitation, temperature, air humidity, radiation and other particular climatic requirements. Current land evaluation systems, e.g. those inspired by FAO´s land suitability classification approach, attach great importance to the climatic potential of the land and to the growing period characteristics for determining suitability ratings. The use of monthly data for the evaluation of growing period is a common practice and has the advantage that it can rely on easy available climatic information. The evaluation of climate is based on the parametric method. The climate characteristics are regrouped into 4 groups (characteristics related to rainfall, temperature regime, relative air humidity and radiation). In the parametric method a numerical rating is attributed to each characteristic. An index (I) is calculated by multiplication of the individual ratings:

$$I = A \times \frac{B}{100} \times \frac{C}{100} \times \frac{D}{100} \times \cdots$$

(*I [c,s]* = climate or landscape and soil index; A, B, C, D...= ratings)

For the total land evaluation the climate index is transferred into a climatic rating according to the following relations:

$$Ic < 25.0 \Rightarrow I \times 1.6$$

$$25 \leq Ic \leq 92.5 \Rightarrow I \times 0.9 + 16.67$$

(Ic = climate index)

The comparison of the climatic ratings for March and April as sowing date

in the study area showed that the best month is beginning of April for all crops except for cotton, which must be sown in june, when long-term mean climate data is considered.

The climate ratings are based on long-term rainfall data of twelve climate stations in the area. It can be seen that the main crop maize is far from being the most adapted to the area. On the other hand, it generally has a high yielding potential and is thus of interest for the local food production. However, crops such as groundnuts, sorghum and cowpea are more suitable.

Low rainfall during the second and last month of the growing period are most often limiting followed by total rainfall of the growing period. The calculated climatic ratings show the following rating sequences: groundnuts > sorghum > cowpea > cassava > cotton > maize. However, it must be pointed out again that these indices are means with considerable differences between the climate stations.

The climate evaluation for maize production based on annual rainfall data shows that the climate rating is higher (55) than the long-term value (48) in four out of 30 years for the Save station and five out of 30 years for the Bohicon station. Lower values (22) compared to the long-term value are obtained in 15 out of 30 years in the Save and 11 years in Bohicon. From 1985 to 1993 it was observed a constant climate rating of 22 in the Save station. The climate evaluation per year for cowpea production exhibits that lower values as the long-term mean are obtained in four out of 30 years in the Save station. On the other hand, in Bohicon station lower ratings are obtained only in two out of 30 years. Compared to the long-term value, the higher climate rating (82) are obtained in seven out of 30 years only in Save station.

The total land index were calculated from the soil and terrain indices and climate rating of the nearest climate station. The temporal variability of the climate rating has an impact on the land suitability of different crops. In years with high climatic rating the land index is higher and vice versa. Due to the variability of the climate rating, the variability of land indices for maize production is more marked than those of the cowpea production. This is attributed to the higher water demand of maize compared to cowpea.

Climatic Warming and Soil Respiration in Horticulture

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Global climate change as predicted by climatologists is expected to influence ecosystems as well as horticulture. Apart from the increase of atmospheric CO_2-concentration, temperature is probably the most important factor. Soil respiration, the process by which CO_2 produced from soil organisms and plant roots is released at the soil surface, shows a clear temperature dependency. Root respiration generally accounts for approximately 30% to 84% of total soil respiration with the balance being largely microbial respiration. As soil respiration provides some of the CO_2 essential for photosynthesis, it also contributes to the CO_2 balance of the orchard ecosystem.

It was the objective of the present research to predict some effects of climatic warming by comparing soil respiration under deciduous trees grown in South Africa (Stellenbosch) and Germany (Ahrweiler). Moreover, the effect of pear stem girdling was studied to quantify the contribution of recently fixed photoassimilates to soil respiration. Finally, differences in soil respiration between deciduous (pear) and evergreen (citrus) trees growing in adjacent orchards were investigated to work out principal differences between these tree types and assess possible effects of climatic warming.

In 1997/98 soil respiration rates of an Oakleaf soil under 7-year-old ‘Rosemarie’ pear (*Pyrus communis* L.) trees on ‘BP3’ rootstock and ‘Miho Wase Satsuma’ citrus (*Citrus unshiu* Marc.) trees on ‘Troyer citrange’ rootstock and also of a fluviatile soil type under 25-year-old ‘Granny Smith’ apple (*Malus domestica* Borkh.) trees on seedling rootstock grown in Stellenbosch were compared with soil respiration rates of 8-year old ‘Cox Orange’ apple trees on M9 rootstock grown on a sandy loam in Ahrweiler. Measurements were conducted at irregular intervals below the crown of the trees, about 10-40 cm from the trunk, on days

without irrigation or rainfall in the prior 24 hours. A CPY-2 canopy assimilation chamber covered with cardboard or a SRS soil respiration system connected to the CIRAS-1 or EGM portable infrared CO_2 analyser from PP Systems were used. One set of pear trees was girdled in spring using a pruning saw and a 6 mm strip of bark around the trunk was removed.

Soil respiration in South Africa under the evergreen citrus was stable at about 240 mg CO_2 m^{-2} h^{-1} from spring (September) to autumn (February). On the contrary, for the deciduous species pear and apple, soil respiration rates varied considerably during the growing season with a broad summer peak lasting for three months in pear (South Africa) and five months in apple (Germany). In spring and autumn, soil respiration in the pear rows was only slightly higher than that in citrus rows, but reached maximum values of up to 800 mg CO_2 m^{-2} h^{-1} in summer. Girdling reduced soil respiration by about 40%, indicating that up to 300 mg CO_2 lost m^{-2} h^{-1} in the controls derived from carbohydrates which were recently transported to the root system. Soil respiration under 25-year-old ‘Granny Smith’ apple accounted for 230 mg CO_2 m^{-2} h^{-1} in the South African spring, which was comparable to citrus, but less than in pear (300-320 mg CO_2 m^{-2} h^{-1}). In Germany, soil respiration in spring was somewhat larger and accounted for 350 mg CO_2 m^{-2} h^{-1} under apple trees. Maximum rates (ca. 1000 mg CO_2 m^{-2} h^{-1}) were reached in late spring and early summer.

Based on the present results, it can be concluded that soil respiration under deciduous trees in Germany and South Africa is comparable. The slight differences are well within a range that could be attributed to the different soil types, tree ages and cultivars. The results indicate that climatic warming will not necessarily increase soil respiration, although increases of root respiration are well established for increasing root temperature. The over the year stable root respiration of citrus clearly indicates that this evergreen species adapts to different soil temperatures and maintains a stable root respiration level.

Key words: apple, pear, citrus, deciduous, evergreen

Influence of shade management on gas exchange and transpiration of coffee plants (*Coffea arabica L.*)

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The influence of permanent shading, exposure to full sun light, and cutting the shade tree on stomatal conductance, leaf temperature, and transpiration rate was investigated with coffee leaves. Those from shade adapted plants showed higher stomatal conductance compared to sun-exposed ones. Temperatures of top and canopy leaves where lower on shaded plants, whereas higher temperatures of exposed top leaves were found in the fully exposed ones. An impaired stomatal movement of the latter lead to peak temperatures up to 41° C. Stomata of coffee leaves still remained closed 10 days after pruning the shade tree. $\Delta^{13}C$ values differed between continuously shaded and unshaded plants and were lower after cutting the shade tree, too.

Key words: *Coffea arabica* L., shade, photosynthesis, transpiration, leaf temperature

Working Group 2

Water Resources Management

Land and Water Resources Management in Ethiopia: What did we learn, where do we go?

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The problem: Progressive land degradation threatens the agro-ecology, crop and pasture land of the Ethiopian highlands. The situation is aggravated due to deforestation, overgrazing and land mismanagement. Indigenous land and water management technologies turned out to be less and less efficient. External interventions to compensate for the inefficiency of traditional methods were not sustainable. However, the success and failure of the indigenous techniques and intervention programmes are not well documented. The current status of the problem and future trends are not investigated yet. This study aims to: 1. Examine and review experiences in soil and water conservation activities; 2. Compare and contrast traditional versus modern land and water management methods with respect to their sustainability, social acceptance, integration into agricultural practices and possible future trends; 3. Critically review land and water management policies and/or strategies and assess their failures as well as possible future directions.

Research questions: The questions posed are: Have we obtained lessons, what is the current situation and how are the future trends? Are there conducive socio-economic as well as policy frameworks to mitigate the problems?

Methods: This paper focuses on land and water management in the central highlands of Ethiopia. Intensive archive research and literature review, exploratory social survey, field investigations and interviews with authorities as well as experts were used for the study.

Results and conclusions: Ethiopia has rich experience in indigenous as well as modern land and water management technologies which encompass a range of mechanical, biological and integrated measures. Traditional methods became less effective with increasing livestock and population pressure, land fragmentation and extreme degradation. Modern intervention measures were inefficient, environmentally not sustainable and socially unacceptable. The main reasons are: Inappropriate planning, use of unpopular implementation policies and strategies as well as lack of property right. Due to their past experiences, farmers today tend to prefer the indigenous techniques which they perceive as part of traditional agricultural practices. Despite increased awareness of the problem, farmers have become suspicious about external interventions. Contrary to the previous policies, current soil and water management strategies focus on sustainability. However, the question of changing farmers' attitude towards introduced programmes is yet to be resolved. Transparent action plans at regional as well as community level are lacking. At the same time, pressure on the ecosystem is increasing at an alarming rate. Hence, land degradation, amplified by climate variability, remains the major environmental and socio-economic challenge.

In order to improve the situation, indigenous technologies should be encouraged and promoted. To make land and water management sustainable and socially acceptable, the socio-economic priorities of the potential target people need to be considered prior to the launching of any intervention actions. Participatory approach should be encouraged and clear property rights defined. This study is expected to contribute to the knowledge of problem identification, project planning and management, conscious policy and decision making in land and water resource management. Community-centred and sustainability oriented projects will capitalise on these findings. Multidisciplinary research should be made to improve the indigenous techniques and adapt the modern ones to the environment and socio-economic realities.

Key words: erosion, indigenous, intervention, soil, sustainability

Optimizing crop water use by deficit irrigation : A case study in South Brazil using Corn

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Introduction

Irrigated agriculture is a major factor in determining the food security of mankind. As population growth increases, efficient use of water resources becomes critical in maintaining crop production. Experiences in more developed countries have shown that irrigation scheduling is the most important factor affecting the efficiency of irrigated crop production. Provided that crop water requirements can be correctly estimated and be matched by frequent irrigation applications, deficit irrigation is a way to further optimize the use of water for production.

The study focuses on the question, how irrigation scheduling must be adapted to facilitate irrigation management aimed at conserving water. It was carried out under the production conditions of the Brazilian State of Rio Grande do Sul taking maize an example.

Material and Methods

The field study was carried out at the experimental farm of the Federal University of Rio Grande do Sul (Eldorado do Sul - $30^0$05' S, $51^0$39'W, 40m) covering four seasons (1993-1997) using a line source sprinkler design to induce different levels of water stress. Crop sampling and eco-physiological measurements were carried out at frequent intervals. An automatic weather station (Campbell, Logan, UT, USA) was installed in an adjacent area to collect data of solar radiation, air temperature, relative humidity, precipitation, wind speed and direction

Results and Discussion

Average measured grain yield was 10 t/ha and 6 t/ha under conditions of none-limiting and limiting soil moisture supply, respectively. The effect of water stress was more pronounced in dry years than in wet years. Highest irrigation efficiency was reached when water deficits occurred during the tasseling and silking stages of the crop.

Using various sets of yield responses to soil water yielded a relation which can be used to match irrigation with targeted production. Maximum water use efficiency was reached at the particular site of Eldorado do Sul when soil water content was kept at 74 percent field capacity.

Evapotranspiration is often determined by models. Their predictive quality is very much influenced by accurate informations on the state of crop water stress. We compared several indicators of water stress and found that leaf temperature is most suitable for practical purposes. It can be effectively determined by infrared thermography. Other methods like porometry, pressure-bomb readings or monitoring soil moisture were either too costly or produced inconsistent results.

Extending current scheduling methods to include decision support for deficit irrigation requires informations on yield and stress responses to water. Our results show, that such informations can be easily gathered using standard agronomic data and none-sophisticated instrumentation.

Limited literature on the topic shows that there is a growing need for studies of crop responses to water deficit aimed at conserving water.

Keywords: Deficit Irrigation, Water Use Efficiency, Modeling, Corn

Growth and leaf gas exchange of well-watered and water-stressed tamarind seedlings under NaCl salinity

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Abstract

In many countries tamarind (*Tamarindus indica* L.) is often considered as a minor fruit, yet it has a potential to contribute to commercial horticulture not only in warm tropical climate, but also in subtropical regions. Its adaptability to variable climatic and edaphic conditions and the high nutritive value of the fruit enhance its potential as a new crop, if proper production techniques are available.

Drought and salinity are major agricultural problems in arid and semiarid areas, where tamarind is commonly grown. In these areas, low soil moisture affects plant growth through an interaction between a lowered matric component of the soil water and an increased salt concentration in the soil solution. Tamarind is generally known as being drought and salt-tolerant, but there is still a lack of knowledge as to the physiological responses to water and salt stresses. This paper described changes in growth and leaf gas exchange of well-watered and water-stressed tamarind seedlings subjected to different levels of NaCl salinity.

Four-month-old tamarind (*Tamarindus indica* L.) seedlings were divided into three groups of 12 plants each. Plants of each group were irrigated with nutrient solution to which either 0, 60 or 120 mM NaCl was added. Each group was further subdivided into two sets. One set was watered daily to near field capacity (-0.03 MPa) by application of 150 ml of solution per pot (well-watered, WW). In the other set, water was withheld until plants had symptoms of drought stress (-0.70 MPa) and then rewatered with 150 ml per pot (water-stressed, WS).

Leaf gas exchange was measured three times during the course of the experiment (10 weeks). At the end, seedlings were harvested and sepa-

rated into individual parts and their dry weights determined. Leaf area was determined by using LI-COR Model L13000 area meter. Data were analysed by analysis of variance, and differences among treatment means were determined by least significance difference (LSD).

Results have shown that WW seedlings grew rapidly during the course of the experiment; their height, leaf number and leaf area increased about 2 times from the initial values. On the other hand, growth of WS seedlings was greatly inhibited during the span of the experiment; their height, leaf number and leaf area were only 70%, 71% and 65%, respectively, of the WW plants. Growth of WW seedlings was only slightly affected by low salt, but was greatly reduced by high salt treatment. Any inhibiting effect of salt stress on growth of WS plants could well be outweighed by inhibiting effects of water deficit.

For WW unsalinized seedlings, leaf stomatal conductance (g_s) was maximum and remained unaffected during the span of the experiment. Expectedly, time courses of leaf transpiration rate (E) and leaf net assimilation rate (A) were very similar to that of g_s. Addition of low salt caused a slight decrease in A. However, in plants receiving high salt, A decreased sharply, then stabilised with no further reduction. In leaves subjected to water stress alone or to simultaneous water and salt stresses, A and E decreased as a function of time. This coincided with significant declines in g_s, suggesting that stomatal closure played a significant role in limitation of A in those leaves.

In conclusion, we found that water stress reduced growth of tamarind seedling much more severely than salt stress. Growth and leaf gas exchange of WW plants were only inhibited when high salt level (120 mM NaCl) was imposed, while plant growth continued at 60 mM.

Key words: Tamarind, salinity, water stress, growth, gas exchange

Potential of EPIC/ALMANAC for Crop Growth Simulation in Semiarid Environments of NE Brazil

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Crop models can be applied as research tools for providing interactive responses to *"what if"* questions related to an improved understanding of the influence of season, location and management on growth processes of plants, for deriving recommendations concerning crop management and for investigating environmental and sustainability issues. Models can also be used as a policy tool for yield and area forecasting and land use planning. Finally, they are important tools for gaining a better understanding of how ecosystems interact with a rapid changing environment as they can synthesize existing knowledge in a common framework and explore the consequences of known or hypothetical mechanism at higher levels of integration. The objective of the research presented here was to test the applicability of the *Environmental Policy Integrated Climate* (EPIC) model and its follow-up version the *Agricultural Land Management Alternatives with Numerical Assessment Criteria* (ALMANAC) model for NE Brazil. Major constraints of crop production in Northeast Brazil are erratic rainfall distribution, limited availability of plant nutrients, restricted field capacity, low pH, toxic levels of aluminium, and salinity. Crop production in NE Brazil is often handicapped by erratic rainfall distribution and a low fertility level of the predominant soils, leading to a strong rural exodus with a strong impact on the Brazilian society. Among 13 crop models, EPIC and ALMANAC were selected for simulating the crop production within the interdisciplinary Brazilian-German research program *Water Availability*

program *Water Availability and Vulnerability of Ecosystems and Society* (WAVES) in semi-arid regions of Northeast Brazil. The reason for selecting both models were (i) the crop files of both models allow to simulate the growth and yield performance of about 80 crops, half of them can be grown in the tropics; (ii) both models consider Al toxicity and the availability of nitrogen and phosphorus in the soil; (iii) ALMANAC is able to consider up to ten plants in a single simulation run and, thus, it reflects both competition by weeds and mixed cropping. For model calibration, on-farm field trials were established at representative sites in the Brazilian federal states of Piauí and Ceará. The daily rainfall distribution has been well simulated by the EPIC/ALMANAC weather generator from recorded monthly data. The occurrence of dry spells within the rainy season was also well predicted by the weather generator of the models. With regard to solar radiation, a good correlation between simulated and measured data was found for the rainy season only whereas solar radiation during the dry season was under-estimated, leading to reduced yields in the simulation runs of both models. In 1996, the harvested area of crops represented by EPIC/ALMANAC crop files were 20% for the *Litoral*, 74% for the *Sertão*, 76% for the *Meio-Norte,* and 83% for the *Cerrado* in the states of Piauí and Ceará. Simulation runs with rice, maize, lettuce, and cowpea in various environments by using traditional and improved crop varieties showed promising results, particularly when traditional crop management was used. However, improved crop management was only well estimated on the more fertile test sites. Both models partly failed to simulate crop growth and yield performance with regard to burning, mulching, increased planting density and fertilizer applications on less favourable sites which represent about 40% of the agricultural area cultivated in Piauí. In conclusion, the structure of both models is appropriate for simulating crop production in Northeast Brazil but model calibration is urgently recommended and in progress.

Keywords: crop modelling, Al toxicity, erratic rainfall distribution, mixed cropping

Working Group 3

Overcoming Stresses in Crop Production
1. Weeds and Insects

Efficacy and Shelf-life of Mycoherbicides for the Management of Parasitic Weeds of the Genus *Striga* and *Orobanche*

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Parasitic weeds of the genus *Striga* and *Orobanche* are causing considerable yield losses in cropping systems south of the Sahara and in the WANA-region. Their management is unsatisfactory solved since present control methods are still not efficient enough to control already the underground development stages of the parasites. Hence, most of the control methods do not lead to a yield increase in the first years of application.

Fungal antagonists of the genus *Fusarium*, especially *F. oxysporum*, which have been isolated from diseased plants of *Striga hermonthica* (Del.) Bent. and *Orobanche cumana* Wallr., have been proved to be highly pathogenic to all developmental stages of the parasites including seeds. In addition, they are highly host specific and non-pathogenic to a wide range of crops tested (e.g., cotton (*Gossypium* spp), sunflower (*Helianthus annuus* L.), soybean (*Glycine max* (L.) Merr.), tomato (*Lycopersicon esculentum* Mill.), meeting two important criteria to be used as mycoherbicides. Applied as solid medium in field trials these fungi showed to be highly effective. However, the inoculum amount has to be reduced to a practicable level, which is aimed by the development of formulations.

Different granular formulations with fungal propagules were produced using chlamydospore-rich biomass of the fungal isolates as inoculum. Sodium-alginate granules were prepared by ionotrophic gelation of a mixture of a sodium alginate solution, inoculum of the biocontrol organism as well as different nutrient amendments. To produce wheat flour-kaolin granules (‘Pesta’) of the fungi, the inoculum was mixed with durum

wheat-flour, sugar, a filler, and water. The efficacy of the formulations to control the parasitic weeds was tested in greenhouse experiments by incorporating the granules pre-planting into the soil. Furthermore, studies on the shelf life of the preparations under ambient conditions were conducted.

Compared to the untreated control, ‘Pesta’ granules applied in dosages of 0.5 g per kg soil reduced the emergence of *Striga* and *Orobanche* shoots by 70 to 80 % and caused disease as well as the death of emerged parasite shoots.

Formulations on the basis of alginates have been advantageous to maintain the viability of *F. oxysporum* over a period of time of at least 12 months. However, our recent findings proved that viability of *F. oxysporum* encapsulated in ‘Pesta’ granules is strongly influenced by the storage temperature as well as the type of incorporated inoculum. The conducted investigations showed that chlamydospore-rich biomass is the most suitable inoculum for long term viable and storable ‘Pesta’ granules, especially when stored at low temperatures. Up to 100 % of the initial Colony Forming Units (CFU) were found after 12 months of storage at 4 °C.

Current experiments are carried out in order to better understand the factors limiting the efficacy of the formulations and to overcome this limitations by improving fermentation and formulation techniques.

Key words: parasitic weeds, biological control, *Fusarium oxysporum*, encapsulation

Breeding strategies to overcome sorghum grain yield losses caused by the parasitic weed *Striga hermonthica*

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Striga hermonthica (Del.) Benth. is a major biotic constraint to sorghum [*Sorghum bicolor* (L.) Moench] production in semi-arid tropical Africa. Development of adapted, productive cultivars has been limited partly due to the difficulty of evaluating resistance in the field and lack of alternative reliable screening assays. Hence, this research focussed on the utility of laboratory and pot *versus* field measures of striga resistance in sorghum.

Two recombinant inbred populations (RIPs) were used. Each comprised 226 $F_{3:5}$ families, derived from the crosses: (1) IS 9830 (low-stimulant striga-resistant) × E 36-1 (high-stimulant striga-susceptible); and (2) N 13 ("mechanically" resistant) × E 36-1. Each RIP was divided into Sets 1 and 2, respectively evaluated in 1997 and 1998. RIP 1 was assessed in an *in vitro* agar-gel assay using striga seeds from Kenya, Mali, and Niger. Both RIPs were screened in pot trials with striga from the respective three countries, and in field experiments at several sites in Kenya and Mali. In all tests, the $F_{3:5}$ families of each RIP were evaluated together with their parental lines and checks in an 11×11 *hexa*-lattice.

Traits discussed are: mean maximal germination distance [mm] of striga seeds in the agar-gel assay; emerged striga plants pot^{-1} or m^{-2} (in fields) around 88 days after planting (S88); area under striga number or severity progress curves (ASNPC and ASVPC, respectively) in pot and field trials; and sorghum grain yield [g m^{-2}] in the fields.

Agar-gel assays with RIP 1 showed highest germination distances with striga from Kenya. Analysis of variance revealed a high level of variation among the $F_{3:5}$ families and significant $F_{3:5}$ family by striga population in-

teractions for this trait. Repeatabilities for the three sources of striga ranged from 87 to 95 %. Striga populations from Mali and Niger were more closely correlated to each other than either was to the striga population from Kenya.

In pot trials, genetic variation was significant for striga traits at individual locations. But combined across pot trial locations within years, the variance component due to $F_{3:5}$ families was not significant and genotype by environment interactions were high. Consequently, heritability was low for striga traits in pot trials.

In the field studies, $F_{3:5}$ families differed significantly both at single sites and across locations for striga traits and grain yield. Genotype by environment interactions were highly significant. Heritability ranged from 0.56 to 0.82 for S88, ASNPC, and ASVPC, and from 0.37 to 0.80 for yield. Moderate to tight genetic correlations were observed in RIP 1 between germination distance *in vitro* and field resistance in Mali. In contrast, non-significant or weak associations existed between *in vitro* germination distance and field resistance in Kenya. Reduced striga emergence in the pot trials was inconsistently associated with *in vitro* germination distance and striga resistance in the field. Higher grain yield was genetically associated with less striga infestation in fields.

The agar-gel assay provides a useful indirect aid for identifying sorghum lines which stimulate high or low levels of striga seed germination. Significant genotype by striga population interactions and the specific reaction of the striga from Kenya indicated existence of parasitic variability in *Striga hermonthica* which should be further investigated. Pot screening is negated because of the inconsistent correlation to striga traits in field trials. Significant genotype by environment interactions in the field trials stress the importance of multilocational resistance trials to achieve stable resistance to *Striga hermonthica*. Use of ASNPC, ASVPC with appropriate field design offered improved direct screening tools for striga resistance in sorghum.

Key words: sorghum, striga, resistance, screening techniques

Cover legumes increase productivity of upland rice under intensified land use in east Africa

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Most upland rice in West Africa (about 2.5 million hectares) is produced by subsistence-oriented farm families in bush-fallow systems with slash-and-burn practices. Population pressure has forced upland rice farmers to drastically reduce fallow periods or expand cultivation onto marginal soils. These processes have denuded large areas of natural vegetation, increased erosion, mined soil fertility, provoked the build-up of weeds, and reduced production potential. Improved fallow technologies were hypothesized to contribute to the stabilization of upland rice-based systems. Particularly legume-based technologies may provide opportunities to contribute to the conservation of the natural resource base while maintaining inter-annual yield and generating increased output. A summary of six years of research conducted in collaboration with the West Africa Rice Research Association is presented.

Diagnostic trials in > 500 farmers' fields in four representative rice-growing environments across Côte d'Ivoire compared extensive long fallow (6-30 years) with intensive short fallow (1-5 years) fields regarding soil parameters, weed infestation, rice yield and labor productivity between 1994 and 1996. In the same four environments, 12 annual legume species were compared with the traditional weedy fallow in replicated field experiments regarding weed suppression, N accumulation, biological N-fixation ($\delta\ ^{15}N$), and yield effects on rice in 1997 and 1998. Finally, agronomic and economic performance of best legume selections was evaluated in participatory on-farm trials in 1999.

Declining fallow length was associated with a 20-30% yield reduction. Weeds were the dominant factor responsible for land use intensification-related yield loss in the forest, while the reduction in soil organic matter and N supplying capacity were the main culprits in the savanna. In all environments, increasing demand for hand weeding reduced labor productivity. Alternative technologies such as legume fallow must control weeds in addition to adding N and organic matter. N accumulation by legumes varied between 10 and 270 kg N ha^{-1}, with 30-90% of that derived from BNF. Grain yield of rice that had been preceeded by a legume fallow were on average 0.2 t ha^{-1} (about 30%) greater than that preceded by the ”weedy” fallow. Biomass of the fallow was in most instances significantly greater with legumes than with natural vegetation and several legume species suppressed weed growth.

Over 60% of 129 farmers involved in various participatory technology evaluations expressed interest in using fallow legumes in their own upland rice-based systems. Farmers selected legumes largely on the basis of labor considerations such as ease of land clearing (male) and weed suppression (female), but also on the basis of yield effects (male and female). Frequently selected fallow legumes included *Tephrosia villosa* and *Indigofera hirsuta* in the savanna, and *Crotalaria micans* and *Cajanus cajan* in the forest. At one of the forest sites, use of farmer-selected *C. micans* in the off-season increased productivity, while decreasing labor requirements in comparison with a 3-year natural fallow.

Since 1999, several legumes are grown by farmers. For the promising legumes, agro-ecological and farming systems niches have been determined and extrapolation domains visualized (GIS maps) as a basis for systems development research and technology transfer strategy. Preliminary results show that for every well-managed hectare of improved fallow, several hectares of land can be taken out of slash-and-burn production, with obvious benefits for natural vegetation, biodiversity and the environment.

New approaches in the assessment of desert locust management in Africa

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Desert locusts are considered to be an important threat to crop production in the semi-arid areas extending from Western and Northern Africa over the Arab peninsula to Pakistan and India. Owing to their migratory activity, desert locusts are a trans-boundary public bad, which in the past made the governments of affected countries intervene with emergency control operations mostly using heavy loads of chemical pesticides. Expenditures for desert locust control were estimated to exceed US$ 500 million for the last ten years on a global level. Donor contributions to preventive and reactive control with pesticides have exceeded US$ 300 million in the 1986-1989 campaign alone. In spite of the considerable investments, in-depth economic evaluations of control campaigns are rarely done. A more recent FAO-study based on a bio-economic simulation model developed from historical and expert data the likelihood of positive net benefits from the conventional control were found to be only 10 to 20 percent. External costs of the control campaigns like health costs, production losses in livestock and environmental damage were not included in this analysis. Notwithstanding these results, the view that desert locust control tallies up with improving food security prevails among decision-makers in affected countries. As a consequence, governments, international organizations and bilateral donors stick to a state-run control strategy.

This paper reviews and identifies advanced economic concepts capable of integrating the dimensions of the desert locust problem that go beyond control philosophy of previous approaches. An outline of a framework for an economic evaluation of desert locust management is developed that makes the decision process more transparent.

The research is based on the hypothesis that previous analyses are built on a problematic reference system that tend to lead to an overestimation of the benefits of preventive control by neglecting on-farm adaptation, alternative intervention measures and the external cost component of pes-

ticide use.
As a first step, the main economic features of the phenomenon are analyzed. The theories of public goods and external effects as well as risk-analytical approaches were found to be helpful in this context. On the one hand, "preventive" control is considered a public good to the farmers in the affected area. Analogously, it is also a public good to the affected countries in the context of an internationally organized and financed control strategy. Therefore the proposed framework is based on the basic tenets of benefit cost analysis taking including game-theoretic in order to determine the amount and the direction of side payments. Also, different methods for non-market valuation are examined with regard to their suitability for measuring the value of non-marketed goods with a special emphasis on the contingent valuation method.
On the other hand, the erratic nature of desert locust population dynamics and their migratory activity call for a formal consideration of risk aspects, especially in view of the risk averse attitude of the decision-maker. Basic risk containment strategies are considered and the decision of farmers is conceptualized with the help of decision matrices. Risky outcomes on aggregated levels are incorporated via stochastic simulation and stochastic dominance criteria. Methods for obtaining the necessary information on probability distributions of the parameters are compiled.
In the light of these considerations, a framework for an economic evaluation of different desert locust management strategies is developed. As a reference system, a scenario without public intervention but with on-farm adaptation is defined. The contribution of alternative projects is measured as the incremental welfare improvement against this scenario.
Three alternative intervention strategies are discussed in more detail, starting with the prevailing "preventive" control strategy. Here, going beyond the procedure of the conventional approach, instead of using models on population dynamics and building benefit estimates on weak assumptions on the relationship of desert locust populations and damage inflicted, benefits are measured as a willingness to pay for the service among farmers in regions where preventive control was implemented versus in those without such interventions. Similarly, it is proposed to obtain the amount of external costs by using contingent valuation surveys

among affected stakeholders like pastoralists and beekeepers. As a new alternative, a subsidized insurance scheme is discussed. A contingent valuation study is proposed to measure the benefit farmers receive from such insurance. Concurrently, a probability distribution of the insured losses can be obtained from farmers using visual survey techniques to elicit data for determining the actuarial premium and the effects on market supply. A system of subsidized self-protection is taken into account as a third alternative. This arrangement emphasizes the responsibility of the private sector and could be implemented as a mechanical protection of high-value crops.

The presented methodology is capable of incorporating a broad range of effects into the economic evaluation and is applicable to different loss abatement strategies. Using the proposed framework allows the selection of the economically most efficient abatement strategies based on multiple criteria. This should contribute to a transparent decision making process less susceptible to psychological pitfalls and misguided political bargaining.

Working Group 4

Overcoming Stresses in Crop Production
2. Pests and Abiotic Stresses

Development of integrated crop and pest management for vegetable production in North Africa and West Asia - strategies to reduce disease stress through biological system approaches.

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Intensive vegetable production in North Africa and West Asia can be described as a high input system that relies heavily on pesticides, fertilizer and irrigation. The lack of classical rotations, limited sources of resistance coupled with optimum conditions for pest and disease development e.g sandy soils, warm temperature and optimum moisture promote pest and disease epidemics.

The use of pesticides, in particular the soil fumigant Methyl Bromide, has been a highly successful method of limiting pest and disease impact with the agro-ecosystem in the past. The loss of Methyl Bromide, a highly effective but dangerous pesticide, as well as the lack of good alternatives, has led to severe problems with soil-borne pests and diseases on many horticultural crops.

New and acceptable pesticides for soil-borne pest and disease control will require research input on the side of industry. At the present time good alternatives are not available to the farmer to combat these serious economic problems. Therefore, basic and applied research is urgently needed to develop acceptable alternatives such as: 1) practical rotations 2) trap cropping systems 3) physical methods of control 4) new sources of resistance 5) organic amendments to stimulate the antagonistic potential and 5) the use of biological control agents.

To improve crop health, biological management of the pests, using both new and established technologies, designed to manipulate the pest to below threshold densities are urgently required. Attempts are being made in ongoing projects in North Africa and West Asia to solve these problems with new innovative approaches.

The strategies being used to integrate physical and agronomic methods will be outlined and discussed. The advantages and disadvantages as well as the probable level of acceptance of such systems by growers will be evaluated.

Integrated Pest Management in Subsistence Banana Production Systems in East Africa

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Banana is one of the major food staples and an important food security crop in developing countries. Highest per capita consumption of banana in the world is found in the East African Highlands where it is an integral part of people's culture and diet. In addition to being a food staple, banana are an important source of income, complementing cash crops such as coffee. Bananas are mainly produced by subsistence farmers. Banana, once established, enters a phase of continuous growth and banana gardens can remain productive for more than 50 years. Permanent cultivation of the crop, as is the case in East Africa, however, makes the control of pests and diseases especially difficult. Farmers have identified pests and reduced soil nutrient status as the leading causes of banana decline in the East African Highlands. The roots and rhizomes of banana are damaged by a complex of nematodes (*Radopholus similis*, *Pratylenchus* spp.) and the banana weevil (*Cosmopolites sordidus*) impeding the plant's ability to take up water and nutrients. Affected plants show slow growth, reduced fruit filling and susceptibility to toppling or snapping. The outbreak of new diseases in the area such as black Sigatoka (*Mycosphaerella fijiensis*) and viruses (banana streak virus, bunchy top virus) accelerated the decline of banana yield and plantation life.

Research results suggest that no single control strategy will provide complete control of any of those pests. Therefore, a broad integrated pest management (IPM) approach might provide the best chance for success. Such a program would include cultural and biological control, host plant resistance, and in rare cases chemical control.

Cultural methods can contribute to the control of banana weevil and nematodes, although material and labour requirements often limit farmer adoption. The use of clean planting material is the most promising method to

reduce initial weevil and nematode levels. Clean planting material may be obtained from tissue culture or careful selection and treatment (paring, hot water) of field collected suckers. Crop sanitation and weevil trapping may provide partial control, although adoption is limited by high labour demand. Due to high costs, rotation may not be feasible and is particularly difficult in areas of high land pressure. Attempts at classical biological control of the banana weevil already started in the 1930s but did not succeed. Today, research results suggest that microbial control using endophytic and entomopathogenic fungi may provide an effective means of controlling banana weevil and nematodes. Host plant resistance offers a safe and long-term intervention strategy for banana weevil and nematode control for resource-limited farmers in Africa. Plantain hybrids resistant to black sigatoka have already been successfully bred but resistance to weevils and nematode is not yet available in highland cooking banana. Moreover, banana breeding is a slow process affected by low seed set and the long duration of the crop. Chemical control is often prohibitively expensive to small scale subsistence farmers and, in many cases, products available on the market have not undergone proper evaluation tests. For these reasons, as well as environmental concerns, chemical control is being discouraged.

To date, demonstration plots, on-farm research and farmer participatory research (FPR) at benchmark sites have addressed the use of clean planting material, weevil trapping, mulching, crop sanitation, weevil pheromones, herbicides, cultivar screening, soil banding, organic fertilisers, and dissemination of banana. Research on developing technologies, e.g. enhanced weevil trapping with pheromones, entomopathogenic fungi, and mutualistic fungal endophytes, is needed to face new and ever changing pest and disease problems. New technologies then need to be incorporated into existing IPM packages and evaluated at the farmers level

Contribution of N uptake and morphological root characteristics to N efficiency in tropical maize cultivars

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Nitrogen is the most limiting nutrient in maize (*Zea mays* L.) production in the humid and subhumid tropics. The flush of nitrate mineralised at the beginning of the rainy season is easily leached into deeper soil layers and thus lost for the crop that is usually planted when the rains become more reliable. In this situation, especially where no additional fertiliser is available, maize cultivars that rapidly develop a deep root system should be very efficient to take up the leached nitrate and have higher potential for grain yield. The objectives of this study were to determine genetic variation in N efficiency (defined as grain yield at low N supply) in tropical germplasm, to clarify whether early N uptake and morphological root characteristics contribute to N efficiency, and to select cultivars based on seedling root characteristics in the screenhouse and evaluate them for N efficiency in the field.

Different sets of cultivars were grown in Ikenne (forest zone, eutric nitisol) in 1993 and in Mokwa (savanna zone, luvisol with high sand content), Nigeria, in 1994 and 1995 at different levels of N fertilisation (Ikenne 0, 30, 90; Mokwa 1994 0, 60, 120; Mokwa 1995 20, 120 kg N/ha). Grain yield, N uptake, N utilisation efficiency (*i.e*. grain yield/N uptake at maturity), root-length densities (root auger sampling) and rooting depth of cultivars as well as nitrate availability at different soil depths and net mineralisation were determined. The same sets of cultivars were grown in tubes (20 cm high, 5.7 cm inner diameter) at different soil bulk densities and evaluated for different root characteristics at the seedling stage.

Maize cultivars differed in N efficiency, N uptake at the beginning of stem elongation, at silking and at maturity. The importance of N uptake for N efficiency was demonstrated: N taken up at stem elongation was related to N efficiency in 1993, and N uptake at silking was correlated with N efficiency in all years. At low N supply, grain yield was more closely related to N uptake at maturity than to N utilisation efficiency. N taken up at the beginning of stem elongation was about 10-20 % of N uptake at silking which was approximately 100 % of total N uptake. This indicates that about 80 % of N uptake occurred in a period of 4-5 weeks before silking. The requirement of high nitrate concentrations in the rooting zone and a powerfull uptake system during that period is obvious.

In 1993 and 1994, root-length densities increased approximately by 100 % from stem elongation until silking with exploration of deeper soil layers at the same time. Although great variation in root-length density existed, differences between cultivars were not significant and a consistent relationship between root-length density at any depth and N accumulated by the plants at the respective sampling time or level of N supply was not found.

Cultivars grown in compacted soil in tubes differed in seedling-root growth characteristics including root length, number of seminal and adventitous roots, vertical growth rate, and penetration rate. The correlation between these root parameters in the pot and in the field were not consistent, however.

In conclusion, differences in N efficiency in tropical maize germplasm do exist and can be exploited for the development of N-efficient cultivars. N uptake efficiency rather than utilisation efficiency appears to be a major factor contributing to overall N efficiency. Although of major importance, root characteristics (in the field or at seedling stage under semi-controlled conditions) can not unequivocally be recommended as selection criteria for breeding N-efficient maize cultivars due to their high variability and labor-intensive methods of assessment.

Screening maize for adaptation to acid aluminium-toxic soils of Colombia*

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In most acid soils throughout the world Al is the most growth and yield limiting factor, affecting up to 30% of the ice-free land surface potentially usable for food and biomass production. Acid soils represent a large pool of potential land for future agricultural development. An economically and environmentally acceptable alternative to overcome subsoil acidity by deep liming is to develop plants tolerant of the conditions typical in these soils. Aluminium-induced callose formation has been proposed as a sensitive marker of Al sensitivity. This was reported to be even more sensitive than inhibition of root elongation, the first visible symptom of Al toxicity, frequently used in earlier studies. The aim of the project was to evaluate the prospects of Al-induced callose formation as a tool for screening maize (*Zea mays* L.) cultivars on acid Al-toxic soil in Colombia. The experiments were aimed at answering the following questions:

- Can Al-sensitivity be determined in nutrient solution on a single plant level non-destructively using Al-induced callose formation and the individual plants thereafter be transferred to the field to assess grain yielding capacity?
- Is Al-induced callose formation of cultivars related to plant performance on an acid Al-toxic soil on a single plant level?

A system was developed using paper beakers sealed with a wax layer allowing screening for Al-resistance of plants in nutrient solution as well as later transfer to the field. Roots penetrating the wax layer of the paper beaker entered a nutrient solution with 0 or 25 µM Al supply at pH = 4.3. After 12 h of treatment 0.5 cm root tips were analysed for Al-induced callose formation. Thereafter, plants exposed to 25 µM Al were trans-

planted to an Al-toxic soil, those not treated with Al to an Al non-toxic soil at different sites in Colombia in order to evaluate further plant development. For each individual transplanted shoot height was recorded every two weeks as well as the onset of flowering. Additionally, ear height and grain yield were determined at harvest.

Transplanting was successful at both sites. Plant growth as well as yield was significantly reduced on the acid Al-toxic site compared to the non-toxic site. Grain yield showed a highly significant negative correlation with anthesis-silking interval (ASI; r = -0.77**) and positive correlations with plant height (r = 0.83***) and ear height (r = 0.69***) in acid soil environment.
Cultivars showed a large variation in Al-induced callose formation in nutrient solution. Al-induced callose formation did not correspond to relative plant height during the course of experiment. However, Al-induced callose formation could be significantly correlated to relative yield (r = -0.79*), relative above-ground dry matter (r = -0.79*) and showed a negative relationship to relative ear height (r = -0.57) at harvest.

In conclusion, the method applied in this study allowed the subsequent assessment of Al-sensitivity of maize in nutrient solution culture and adaptation to acid Al-toxic soils. It could be confirmed that Al-induced callose formation is a sensitive marker to confirm stability of Al-resistance when new hybrids are developed.

key words: aluminium, callose, maize, resistance, screening,

Poster/Tools Section 3

Effect of plant material quality of secondary forest vegetation on phosphate dynamics in soil

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The role of the resource quality as a driving factor for the decomposition of organic matter has been recognized since long time. Many decomposition studies have been conducted to predict the rates of decomposition and nutrient release from empirical indices of resource quality such as the C-to-N-ratio. However, information about P dynamics during decomposition is still scarce in the humid tropics. An improved understanding will contribute to sustain the availability of P in soil. Our objective was to examine how the amendment of plant material derived from secondary forest which had contrasting resource quality affects the mineralization and immobilization of P in soil.

Ground plant material (< 1 mm) from five species, namely: *Albizia lebeck, Trichospermum* ssp *, Macaranga hispida*, *Chromolaena odorata,* and *Ficus subulata* was mixed (3% g/g soil) with an Oxisol which had a very low content in available P (0.8 ppm Bray-1; pH $_{(CaCl_2)}$ 5.68). The amendment of *Albizia lebeck, Trichospermum* ssp *, Macaranga hispida*, *Chromolaena odorata,* and *Ficus subulata* contributed to the addition of P at 17, 17, 13, 36 and 21 µg P/g respectively.
Upon mixing, the substrates and a pure-soil-control were aerobically incubated in plastic bags at 28 °C. Distilled water was added as necessary to replace evaporation losses. After 4, 8, 32, 72, and 125 days of incubation, available P (Bray-1), microbial biomass P, and labile inorganic P_i (0.5 M $NaHCO_3$ at pH 8.5) were determined on three replicates per sampling date and treatment.
C. odorata had the highest resource quality as compared to other species as indicated by the lowest C-to-N-to-P-ratios and contents in lignin,

ADF and cellulose. On the other hand, *M. hispida* had the highest C-to-N-to-P-ratios and lignin contents. *F. subulata*, *A. lebeck* and *T.* ssp. had a moderate resource quality.
Amendment of plant material significantly (P<0.01) affected the dynamics of labile P_i and plant available P (Bray). After 8 days of incubation the both parameters were depleted from the soil which was amended with *F. subulata* as compared to *M. hispida, A. lebeck, T.* ssp. and *C. odorata* in decreasing order. At the end of incubation, the labile P_i increased to 1.8, 2, 3.5, 1.2 and 1µg P g^{-1}, and the available P increased to 0.9, 0.6, 1.7, 0.4, and 0.7 µg P g^{-1} for *F. subulata*, *A. lebeck, C. odorata M. hispida* and *T.* ssp, respectively.

The microbial biomass P content peaked after 8 days in all treatments. This corresponded to the period when the labile P_i and available P were at minimum. However, amended soils had greater levels of microbial biomass P during incubation as compared to the control. At peak of microbial biomass P, the difference to the control were 2.5, 4.1, 6.8, 3.3 and 4.6 µg P g^{-1} for *F. subulata, A. lebeck, C. odorata, M. hispida* and *T. ssp.*, respectively. The Chromolaena-amended soil produced more available P as compared with control only after 32 days.

The quality of plant material affected significantly (p<0.01) the dynamics of P mineralization and immobilization in the soil. Chromolaena showed had the best performance in improving the availability of soil P. Amendment of Chromolaena improved P-mineralization to about 15% (p<0.01) and 6% (p<0.05) by 72 days and 125 days of incubation period, respectively.

Key words: plant material quality, available P, labile inorganic P, biomass P

Effect of Chilling on Growth and Dry Matter Production of Sweetpotato

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Sweetpotato *Ipomoea batatas* L. (Lam) belongs to the family Convolvulaceae. Its origin is in the tropical America, from where it was spread over most of the world's tropical, sub-tropical and warmer temperate regions. The optimum temperature for growth and tuber production is at about 24°C. When temperatures is below 10°C, growth is severely retarded. Its frost sensitivity restricts sweetpotato cultivation in temperate regions to areas with a minimum frost-free period of 4-6 months and relatively high temperatures during the cold period. The optimum temperature for tuber production is about 25°C. Cultivation of sweetpotato in temperate region and/or at high altitudes is limited by temperature and hence research is necessary to improve chilling tolerance of this important crop. It is the objective of the present investigation to evaluate the chilling sensitivity of the Indonesian cultivars and clones 'Dayak', 'CIP-1', 'AB94078.1', 'AB94001.8', and 'AB95001.4' and to determine the effect of low temperature on growth and dry matter production.

In August 1998, one-month old, rooted cuttings of 'Dayak', 'CIP-1', 'AB94078.1', 'AB94001.8', and 'AB95001.4' were planted in 20 l pots in a sand-soil mixture and grown in the greenhouse of the experimental station Marhof of the University Bonn. Average temperatures at day and night were 24°C/19°C in August, 20°C/16°C in September, and 15°C/11°C in October. The corresponding minimum temperatures over night were 15°C, 14°C, and 6°C, respectively. From September to November five plants of each cultivar were harvested at the 1st of each month. Fresh mass and dry mass of roots, tubers (if present), stems and leafs as well as leaf number and leaf area were recorded. In addition, the

freezing point of 2 mm - leaf discs of plants grown in the greenhouse in June 2000 was determined with the 'Kryoscan' Multichannel-Exothermic-Measurement-System to correlate these results with those of the growth analysis. Temperature was reduced at a rate of 5 °C per minute.

With regard to dry mass production, 'AB95001.4' and 'AB94078.1' grew until November. Nevertheless, in 'CIP-1', 'AB94001.8', and 'Dayak' dry mass significantly increased only in August and September, but remained similar during the rest of the experiment. For these cultivars, the temperature reduction with regard to the mean values from 16°C to 11°C over night and with regard to the minimum values from 14°C to 6°C impaired growth significantly. This result is well in accordance with earlier reports giving a threshold value of about 10°C for chilling sensitivity in sweetpotato.

Determination of the freezing point of leaf discs did not reveal any significant differences between the sweetpotato clones. The mean values varied between -9.6°C and -11.0°C and are well within the range usually recorded for leaves (Blaich, written communication, 2000).

Based on the present results, clones 'AB95001.4 and 'AB94078.1' are more tolerant to chilling and may be regarded as promising clones. Further experiments under practical conditions will show, whether these clones can successfully be grown in high altitudes and temperate regions, where sweetpotato cultivation is yet limited by low temperatures.

Key words: chilling, sweetpotato, Kryoscan

Variation in *Fusarium graminearum* isolates and their response to a susceptible and resistant winter wheat.

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Fusarium graminearum (Schwabe) causes fusarium head blight (scab) in wheat and it is of economic importance as it is responsible for serious yield loses and production of mycotoxins which make the grain unfit for human consumption or animal feed. Control of the fusarium head blight disease relies on the use tolerant or resistant cultivars available as chemical control is still limited. However, at present there is no durable resistance to the disease available. Breeding for resistance is expensive and time consuming because it involves screening of a large scale of genotypes. Today with the knowledge of the variability of the fungus makes the screening even more complicated. Hence information on the variability of *Fusarium graminearum* assists in formulating cost effective strategies of breeding for scab resistance in wheat cultivars.

Fifteen isolates of *F. graminearum* originating from Germany and the United States of America were examined for their cultural characteristics in the laboratory and their aggressiveness on the resistant cultivar Arina and on the susceptible cultivar Agent after a single spikelet inoculation in outdoor pot experiments.

The variation in cultural characteristics was mainly on the pigmentation on potato dextrose agar (PDA). Sub-culturing the fungus on SNA media for six generations or more decreased the ability of the fungus to sporulate. In the outdoor pot experiments, all the isolates used were pathogenic on both the tested wheat cultivars but varied in their ability to cause scab. The time required for symptoms to appear varied for various isolates but on average it was longer on resistant cultivar Arina (5-11 days) than in the susceptible cultivar Agent (4-9) days. The same trend was found in the movement of symptoms from the inoculated spikelet to the non-inoculated spikelet (10-18 days in Arina and 8-15 days in agent).

However for the trichothecene non producing mutant (isolate GZT40), symptoms never moved to the next spikelet. The sudden brightening of the top half of the spike also varied within the isolates and the cultivar. Isolates that were slow in inducing symptoms showed low virulence and vice versa.

Head blight rating appeared to be a more stable and reliable parameter of measuring aggressiveness of *Fusarium graminearum* as compared to thousand corn weight. The experiments demonstrated that scab symptoms move down the rachis and then spread to the corresponding spikelets.

Key words: *Fusarium graminearum,* aggressiveness, wheat (*Triticum aestivum*)

Oral Presentations Section 4

Farming Systems and Technologies for Crop and Livestock Production

Working Group 1

Farming Systems and Resource Use

Desusmo: A Holistic Approach for the Management of Natural Resources under Subtropical Conditions

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Problem Addressed

The 'Mata Atlântica' region in Brazil, stretching along the coast between 8° to about 28° southern latitude, was once an immense forest of about 1 million km² extension. Nowadays approx. 70 % of the Brazilian population live in this region, many of them in the big metropolitan areas like Rio de Janeiro and São Paulo. Only approx. 6 % of the "original" Mata Atlântica have not yet been eliminated by human activities.
After deforestation and its use for the production of sugarcane and coffee, the majority of the land had lost much of its soil cover and fertility. Their present use as low input - low output pastures contrasts with the need to supply the nearby "Mega-Cities" with food and fibre. In some locations, unregulated high-input farming systems with horticultural or other commercial crops, grown for 1-3 years on pasture land, have developed, accelerating soil erosion and environmental contamination.

Objective of Research

The international and multidisciplinary research project "Development of Sustainable Farming Systems on Mountainous, Low Fertility Grazing Land in South America", (DESUSMO) which has been carried out between 1994 and 1998, linked institutions from Germany, Spain, Brazil, Bolivia and Chile. The project was financed by the European Commission and the Brazilian Government.
One significant goal was to increase the supply of uncontaminated agricultural produce to the urban markets while at the same time environmental pollution can be halted, soil erosion be diminished and forest remnants be protected. Furthermore special attention was given to improve the socio-economic situation of the rural population in order to guarantee the long-term impact of the proposed measures.

Research Questions/Hypothesis

(1) Sustainable farming systems can be developed which are economically viable, socially acceptable and environmentally sound .
(2) Agricultural intensification can be achieved in harmony with forest protection.

Methodology and Workplan

In order to achieve the above mentioned objectives and goals a holistic and interdisciplinary approach was applied, taking into account the complexity of the system and the diversity of influencing factors. Special emphasis was given to (1) Socio-economic factors as they were regarded to be of equal importance to the biophysical factors; (2) Regarding farming systems as part of the local community, the region and the nation; (3) Farmer's participation in on-station, on-farm and in-household research as well as in extension activities.
The research activities in the State of Rio de Janeiro were accompanied by (1) Dissemination to the municipal community on the objectives, action lines, goals, ongoing activities and of the results obtained by the DESUSMO project. (2) the organization of courses, seminars, lectures, field-days meetings and debates on alternative technologies, sustainable development and environmental problems with the rural population; and (3) Elaboration of articles in newspapers and magazines about management and conservation of natural resources.

Results and Conclusions and their Relevance for Development

The project achieved the testing and implementation of (hopefully) sustainable cropping and pasture systems for the Mata Atlântica Region. It could clearly be shown, that already the introduction of slight changes in the common cropping systems alleviated the pressure on the environment significantly].

- Production methods have been developed, which need considerably less agrochemicals (pesticides, fertilizers) without reduction in financial terms and therefore contribute to the sustainable protection of the water resources. The chemical contamination of farmers, agricultural products, soils and water has been analyzed and recommendations for the reduc-

tion of the use of agrochemicals elaborated.

- Soil conservation methods have been found, which diminish soil erosion to the tolerable soil loss limits without reducing production efficiency. Recuperation of degraded pasture by using appropriate fodder plant species has been successful.
- Agroforestry trials, integrating numerous tree species into different pasture setups, showed a good soil stabilization, better infiltration rates, the incorporation of organic matter through biological activities and a better availability of nutrients.
- The profits of the farmers involved in the programme could be increased by using improved production systems and by cultivation of perennial fruits and a greater variety of crops (crop diversification).
- As larger quantities of unpolluted fruits and vegetables of a greater variety were produced, the consumers could be supplied with healthier produce.
- The consciousness of farmers, farmers organizations, local politicians, etc. to adopt sustainable farming systems in order to protect the natural resources and to safe their basis of livelihood was raised.

The relevance for large-scale development has to be regarded with cautiousness.

Comparative Analysis of the Diversity and its Implications for the Development Potential of Small Farming Systems in the Savannah of Brazil

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Problem addressed

In reaction to the rapidly shrinking agricultural frontier in most areas of the tropics, decision-makers are looking for the potential contribution that less-favoured agricultural lands can make to avoid increasing scarcities of resources as causes of tensions endangering peace and stability.

Objective of research

The purpose of this research is to explore the role of family income sources diversification in the development of sustainable farming systems in agro-ecologically and economically marginal areas.

Research question/hypothesis

The following questions are addressed: Does the concentration of family income sources reduce or increase the living standard of the family? Does the combination of certain income sources promote or inhibit a sustainable development of farming systems? Does the concentration of family income sources reduce or increase technology use? These hypotheses are tested empirically using data drawn from different study areas in the savannah region of Brazil.

Methodology

Different income sources are classified and the mix of income sources is quantified. Farms are put into categories according to their income sources diversification level using cluster analysis. These categories are the base for examining the factors influencing the use of modern inputs. Univariate analysis are used to explore the relation among variables related to the scale of operation, the farm area, the income diversification

level and the use of modern technologies measured as the expenditures on modern inputs.

Results and conclusions and their relevance for development
The study contains a brief description of the study areas in the Savannah of Brazil. The diversified nature of agricultural production is highlighted. An overview of the resulting farm types is provided. The detailed analysis shows that family income sources mix vary substantially across farms. The very differentiated income sources mix of a substantial number of farms suggests that ecological factors play a limited role in determining income sources mix, even in this ecologically more or less homogeneous region. Off-farm employment is an important source of family income in many farming systems and there are evidences that its importance may even increase substantially in the future. When income sources concentrations are used to construct a series of farm types and to test for differences in the factors influencing modern input use, Univariate analyses fail to show significant links. The differences or lack of differences revealed by the Univariate analyses are important to policymakers and individuals as well as institutions concerned with the adoption of new agricultural technologies.

Key words: Agricultural Economics, Small Farming Systems, Income Diversification, Savannah, Brazil

Small farms in transition economy: do they have chances to survive?: Case of Armenia

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Problem Statement

Armenia was the first of former Soviet republics to privatise the farmland in 1991. The transition period from the authoritarian planned economy to new market type of economic relations started since then and continues until now. In what environment are they farming now? Is it at all possible to tribe sustainable farms having a country average 1,4 ha land (those in the main agricultural zone, Ararat Valley have even less land barely reaching 1 ha)?

Study Objective

Though there are numerous studies conducted aimed at general evaluation and possible reorganisation of the sector, this is the first attempt as a holistic analysis of the situation of more than 320,000 small family farms, their problems at farm-household level, their perceptions of the presence and their perspectives and plans for the future. The purpose of this study is to fill this gap through the consideration of the farmers' decision making process by thoroughly analysing external and, of particular importance, internal factors that have impact on the decisions about land use, environment, procurement, marketing, education, health, etc.

Methodology

The study utilised the FSA (Farming Systems Approach) together with comparative descriptive statistics to arrive at recommendations and suggestions hopefully bringing useful insights to policy makers, specialists, and to farmers themselves. SWOT analysis is integrated as a tool to discuss internal strengths and external treats of an average family farm in

two study regions (64 small family farms altogether). The study areas differ geographically (agro-climatic conditions) and in terms of market access.

Discussion Issues , Results and Perspectives

The paper covers salient aspects of farm-household systems such as land use pattern, farm and family income, credit and cash availability, etc. These characteristics underline the extent and the diversity of the problems faced by family farms in Armenia. The small sizes of land plots (they are also scattered on relatively large distances) do not allow farmers to apply necessary mechanisation. High prices or no availability of agricultural inputs further sharpen the situation. Age, education, health aspects are not of less importance. Credit and cash availability are still other problems.

The results of analysis revealed that small family farms are largely of subsistent character however having good opportunities to expand into commercial operations. It is difficult for Armenian farmers to get credits. There has to be a programme established which would help farmers who do not meet conventional agricultural credit criteria. This would allow to increase small family lending. The farmers' responses indicate, however, that they are not much optimistic about the future of their farms. Farm income nosedives as input prices, transportation and marketing costs continuously increase. The creation of wholesale market is still another big issue to tackle. The creation of these markets in remote areas would allow local farmers to save on freight costs and help them to compete with producers in other regions for sales. We recommend to develop constructive engagement between interested parties such as public and private organisations and farmers as soon as possible as these can foster rural development, relieve social tension, mitigate the costs from market and policy change.

Key words: transition, small farming, land market, sustainability

Identifizierung pastoraler Systeme mit partizipativen Methoden im Mittleren Atlas Marokkos

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Die Arbeit fand im Rahmens des INRA-Programmes Viandes Rouges statt. Ziel der Studie war es, die Schafhaltungssysteme im Mittleren Atlas zu identifizieren, um Subsysteme gezielt erforschen und Verbesserungsvorschläge ableiten zu können.
Zur Identifikation der Systeme wurde die MARP (Méthode Accélérée de Recherche Participative) angewendet. Partizipative Erhebungs- und Planungsmethoden sind im mittleren Atlas und im nordafrikanischen Kontext ziemlich neu. Ein weiteres Ziel der Studie war daher, MARP-Methoden zu testen und lokal anzupassen.
Nach einer Vorbereitungsphase wurden insgesamt 10 Workshops mit jeweils 5 bis 8 Tierhaltern und Hirten pro Workshop durchgeführt. Dabei wurden zunächst folgende MARP Werkzeuge angewandt: Ressourcennutzungskarten, Futter- und Reproduktionskalender, Rankings von Futterressourcen, Entwicklungshemmnisse und -prioritäten.
Die Ergebnisse zeigen, daß 11 Clans des Stammes der Ireklaouen die zur Verfügung stehenden pastoralen Ressourcen nutzen. Die räumliche und zeitliche Nutzung wurde durch traditionelle Zugangsrechte geregelt, die noch heute in abgeschwächter Form gelten. Bezüglich der räumlichen Nutzung besteht für Tierhalter oder Hirten, die keine traditionellen Zugangsrechte haben, die Möglichkeit, über bestimmte Verträge mit Inhabern von Zugangsrechten zeitlich befristeten Zugang zu erhalten. Diese Verträge sind wichtig, um die Stabilität und Flexibilität der pasto-ralen Systeme zu erhalten und ermöglichen ärmeren Mitgliedern der Gemeinschaft, an Tierbesitz zu kommen.

Die zeitliche Nutzungsregelung über die Ausweisung von Reserveweiden wird heute nicht mehr praktiziert. Daher tragen die Verträge zur

Übernutzung der pastoralen Ressourcen bei, weil Personen, die keine Clanmitglieder sind, die Möglichkeit erhalten, ihr Einkommen in Schafherden zu investieren, indem sie einen Vertrag mit einem Mitglied des Stammes schließen.
Die Futter- und Reproduktionskalender ermöglichen die Einordnung der Tierhalter in drei Schafhaltungssysteme, die sich im Ausmaß der Mobilität und im Nutzungsgrad der Futterressourcen (kollektive Weiden, Wald, Brache und Getreidenebenprodukte) unterscheiden.
Diese Systeme werden in dem Vortrag beschrieben. Mehrjährige Vegetationserhebungen in den kollektiven Weiden führten zu einer Ergänzung der zu Beginn der Untersuchungen von den Tierhaltern angefertigten Ressourcennnutzungskarten. Mit Hilfe der neuen Karten entwickelten die Tierhalter neue Ideen zum gemeinsamen Ressourcen-management, die eine Regelung des Zugangs zu Wasser berücksichtigen.
Die Untersuchung der pastoralen Systeme mittels MARP war möglich nachdem die Methoden an die soziokulturellen Bedingungen angepasst wurden.

Key words: MARP, Schafhaltungssysteme, Mittlerer Atlas, Marokko

Working Group 2

Farming Systems and Resource Use

Developing a framework for participatory research approaches in risk prone diverse environments

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The mission of the CGIAR is to contribute, through its research, to promoting sustainable agriculture for food security in developing countries. The focus is on increasing agricultural productivity, safeguarding natural resources, and contributing to people-centered policies for environmentally sustainable development. In addition to continuing its work on high potential areas, the CGIAR is increasingly committed to addressing the natural resource management problems of the poor in less-endowed and risk-prone areas (CGIAR 1995).

Nowadays, it is widely agreed upon that local people have to be put at the center of the perspective, and that they must become actively involved in the (formal) process of innovation development through participatory research approaches. Over the last decades, a great diversity of participatory research approaches has evolved, however, it is not yet well understood which types of participatory approaches are useful for different kinds of research questions, goals and contexts. ‘Participation’ is still a rather diffuse and fashionable term, which is strategically included in almost every research proposal.

The objective of this paper is to shed some light on the multiplicity of participatory approaches used in International Agricultural Research and to structure and classify this diversity by providing a *typology of approaches*. The purpose of offering such a typology is to establish a more differentiated language and a conceptual framework, that can help research managers to make better choices and more informed decisions when designing their research approach.
Findings are based on a review of literature and internet sites, discussions with key informants, and a questionnaire-based study of 53 re-

search projects carried out during 1999 by the *CGIAR Systemwide Program on Participatory Research and Gender Analysis* (PRGA Program). This information was analyzed in order to single out a set of prototypical approaches and to assess the state of the art of participatory research in the CGIAR.

Four prototypical approaches were identified and described along key characteristics, such as the underlying objectives, types of participation, actors involved, their roles, the procedures and the research methods used. These are the transfer of technology approach, farmer first, learning and action research, and farmer-controlled research. Most participatory research activities in the CGIAR are downstream applications at the level of applied and adaptive research. Participatory research is frequently seen as a better way of technology transfer, which is rather considered to be the task of NARS, extension services and NGOs. Examples of participatory learning and action research approaches, where scientists facilitate and support peoples' efforts in seeking solutions for constraints they have identified at local level, are still scarce in the CGIAR. Those who are advocating participatory research as a means of empowerment, equity, and capacity building are looked upon as mixing development-driven agendas with research-driven ones. In view of the complex challenges in natural resource management, which are a function of technical skills and know-how as well as social negotiation, organization and rules, the CGIAR needs to broaden and reconsider its natural resource management research strategies. Participatory learning and action research approaches at the grassroots combined with strategic research through comparative case studies are indispensable if International Agricultural Research is to achieve an impact in risk prone and diverse environments.

Key words: participatory research approaches, CGIAR, natural resource management

Induced Changes in Land-Use and Property Rights Under the Influence of Market Access and Demographic Change: The Borana Pastoralists in Southern Ethiopia

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The Borana Plateau is a semiarid area in Southern Ethiopia with rainfall that averages between 353 mm to 873 mm and exhibits high variability, with a coefficient of variation that ranges between 0.21 to 0.68. The area is dominated by extensive livestock production or pastoralism carried out mainly by the Borana ethnic group. Despite the semiarid nature of the Borana rangelands, the past decade has witnessed a pervasive adoption of crops and rangelands privatisation by either individuals or small groups of individuals. Although the region is identified as having a high ecological potential vis-à-vis livestock production, the area is still in a crisis today mostly due to pressure on the rangelands and associated changes in land-use. In some areas stocking rates are high, whereas the actual stock densities in other areas fall below the potential carrying capacities. This trend is hypothetically attributed to various factors, among which changes in property institutions, induced by increasing population and improving market opportunities are frequently cited. The semi-arid nature of the area creates a concern as to whether the area may form a stable basis that support a fully privatised system.

The primary objective is to assess how the level and variability of rainfall, market conditions (access and prices) and population pressure affect resource use, property rights change and livestock development in the area. Specifically, the study attempts to show how different framework conditions lead to the formation of different pathways to livestock development, and seeks to recommend appropriate property institutions sustainable use of rangeland resources in the area. In addressing the above issue, we derive an empirical model of stocking densities and land use (% cropped) and property rights (% of private grazing land), which is then

used to estimate the effects of exogenous parameters on stocking densities, land allocated to crops, and land allocated to private pastures. The study hypothesises that the dynamics of stock densities, land use and property rights are determined by an interplay of environmental variables, market variables and demographic shifts. It is further hypothesised that social capital variables such as resource use rules and regulations could be also important in explaining the process, while the role of national level policy variables should not be neglected as facilitators of the observed changes.

A community level data was generated over a one year period through intensive interviews, supplemented by participatory appraisals of land-use and property rights using GIS-techniques. This data set forms a basis for testing the hypotheses developed in the conceptual model. Since one of the key variables in explaining stocking densities is the degree of cooperation realised by a community, an initial analysis is performed relating an index of cooperation to exogenous variables hypothesised to affect the ability of the community to cooperate. This variable is then used as an explanatory variable in a simultaneous equation model of stocking densities, land allocated to crops, and land allocated to private pasture. The results obtained so far indicate the following: a) regions with high coefficients of variation in rainfall have lower livestock densities, and lower levels of land allocated to crops and private pasture, b) heterogeneity within a community, measured in terms of a *gini*- coefficient for the distribution of wealth levels, is related to low levels of cooperation, stocking densities, land allocated to crops and private pasture, c) higher relative prices of livestock and shorter distances to market are associated with greater stock densities, as well as less land allocated to crops, d) the proportion of members engaged in wage work outside has a significantly negative effect on the ability of the community to cooperate, e) the greater the cooperation, the lower the stock densities and the lower is the land allocated to crops and to private pasture, f) land allocation to crops is significantly influenced by population, market access and social capital variables, but not land allocation to private grazing.

Like other pastoral systems, the dynamics of land use and property rights in the area is explained by an intricate interaction of socio-

economic and environmental factors. The adoption of crops is partially driven by accessibility to market centres under the influence of in-coming crop producing ethnic groups, and in some areas by suitable rainfall conditions. In other areas however, cultivation is merely a pretext for acquiring grazing land that would otherwise have been impossible to alienate. The desire for private range is not significantly explained by demographic variables, market variables or changing social relations. However, it is positively and significantly related to land allocation to crops. While this may partly suggest that land allocation to private grazing is a concomitant of the pervasive adoption of crop cultivation in the area, it may also suggest the existence of other factors driving changes in property rights over grazing land. To this end, national level policies regarding land-use and resettlement of pastoralists are crucial factors.
In conclusion, it appears that current changes in land use patterns are, at least in part, a function of the desire of individuals to diminish the negative externalities associated with overstocking on the commons. One of the key driving forces seems to be increased population and increased heterogeneity among community members; increased privatization of land is also more likely in areas with lower coefficients of rainfall variation and where non-community members more frequently migrate into the community. On one hand, the Boran are becoming more settled and some land use change is a function of relative prices favoring crops as well as the availability of subsidized inputs from the Ministry of Agriculture. However, cooperation can mitigate negative externalities on the commons, and thus the impetus for over-allocating land to crops and private pastures. One of the key elements in fostering cooperation will be methods for handling the increased heterogeneity among community members, and mitigating the negative effects of increased wage work on cooperation. Whereas currently members primarily dedicate time to community activities, money allocations based on wealth levels may help to alleviate the negative effects of both heterogeneity and increased wage work.

Key words: property rights; land-use change; livestock development

The level of risk aversion among African farmers – results of a gambling approach

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The development of appropriate technologies for small scale farmers has to take into consideration a variety of criteria for technology selection, among which the profitability and the riskiness are most important. Very often both criteria stand in competition, i.e. modern, more profitable technologies (vegetable crops, higher input levels, specialisation of cropping systems, capital investments) are riskier than traditional, low input, diversified technologies and systems. More farmers are risk averse, more they will refuse to accept risky innovations. If economics want to support technologies or policies on risk-averse farmers, an attempt should be made to quantify risk aversion.

In a research project on agricultural price policy in Benin the question arose what would be the effect of cotton price stabilisation on farmers production response, compared with other measures of an integrated cotton policy such as input or credit supply. Linkages between price stabilisation and technology adoption were to be shown.

There are a few ways to assess risk aversion but all have serious limitations, particularly in developing countries. An innovative alternative was developed in the 1980s by Binswanger in India, which consists of letting people gamble under controlled risk conditions with high payoffs, i.e. realistic risk comparable to normal decision situations for medium-size investments. This approach avoids most weaknesses of the other methods and allows direct measurement of risk aversion.

The research that is presented in this article is basically a replication of Binswanger's tests with West African farmers which was not done until that time. The research methodology basically consisted in the following: 75 farmers of different ethnic groups and agro-ecological situations of whom detailed socio-cultural and economic data had been collected during the previous 18 months were made a gift in cash that they could keep or use in a lottery. The principle of the lottery was to bet on the result of

throwing a coin. In case the person rightly guessed the result, he was paid a prime, on the contrary he lost a part of the sum bedded. The pay-offs are chosen in such a way that the expected outcome can only be increased by accepting a higher variability of outcome. From the choice of the risk level risk aversion can be deduced. Risk aversion scores were then regressed on a variety of personal characteristics in order to find explaining variables for risk aversion.

The main result is that farmers were found to be severely risk averse: if risk is measured as Z-score (which is the trade-off between expected returns and standard deviation accepted by farmers) the risk aversion was 0.7-1. This means that farmers depreciate risk passionately or, synonymously, strongly prefer risk reducing strategies. For instance, in risk programming models which simulated farmers response to cotton price stabilisation it was found that severely risk-averse farmers reduce their incomes by about 30% (and even more) when the (present) cotton price stabilisation is abandoned in favour of a price regime which transfers the world market price variability to farmers unbuffered.

In contrast, there are hardly any personal characteristics which could explain the risk aversion level, a result in line with Binswangers results. It seems that risk aversion is rather an independent general (cultural?) than a personal or situation-specific quality. This insinuates that risk reduction is equally appreciated by farmers of different wealth levels.

For the research question, results make a strong argument for price policy stabilisation in developing countries when strong price variability exists, even if the stabilisation instruments (in the case of Benin a stabilisation fund) bear high costs: the aggregated losses due to risk-avoiding strategies (diversification, strong subsistence orientation, lack of investment, sub-optimal doses of input use, etc.) which farmers would adopt in the absence of price stabilisation often more than outweigh the public expenditures.

Key words: Africa, price policy, risk, technology adoption, supply response

The Land Evaluation System for Family Agriculture Suitability (SIATe), developed for the Brazilian agrarian reform.

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The Brazilian Federal Constitution attributes the Union to expropriate land that does not fulfill its social functions for Agrarian Reform (AR). In the period of 1995 to 1999 the AR settled 372,866 families. Among the social functions of land it is stated that land has to be adequately explored. The land evaluation procedures to verify the unproductive status and the feasibility for family agriculture were not specifically designed to support AR surveys. The none consideration of important variables known to be directly linked to the development of the settlement projects is a strong indicator for the unsuitability of current procedures. This paper describes SIATe (Land Evaluation System for Family Agriculture Suitability) an expert system developed for land evaluation for the Brazilian AR. SIATe is a regional system based on land suitability concepts with internal modules related to land qualities, regional conditions, land use types and analytical modules.

Key words: Agrarian Reform, Land Evaluation, Expert System, Brazil.

Working Group 3

Technologies for Crop Production

Analyzing the Adoption of productivity-enhancing, resource-conserving (PERC) technologies in Central America using a Logit and a Structural Equation Model

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Despite many efforts to foster the use of soil conserving technologies by small farmers in Central America, their overall adoption is low. This seems to result mainly from a technology and policy design process that does not account sufficiently for the differences between commercial and environmental innovations. Consequently, many promoted practices do not fit small farmers circumstances in the region.
A case study conducted in the Polochic Valley in northeastern Guatemala on the adoption of the herbaceous legume Velvetbean (*Mucuna spec*.) as a cover crop in maize cropping systems is described. A logit model is used to identify factors that influence the adoption of this productivity-enhancing, resource-conserving (PERC) technology. A Structural Equation Model (SEM) is also built to model links between food security needs of farmers, institutional factors, the intention of farmers behind their choice of technologies, and the adoption of soil conservation technologies.
Results show that soil conserving technologies that do not have additional substantial short-term effects on increasing productivity will always need strong external incentives for their adoption, while technologies combing both effects seem to be better suited for a rapid diffusion among small farmers in CA.

Key words: Technology adoption, Logit Model, Structural Equation Model, Velvetbean, Guatemala

Soil nitrogen use efficiency by lowland rice as function of slope management

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Most food crops in the humid zone of West Africa are produced in the undulating landscape of the inland valleys. On the predominantly sandy Alfi- and Ultisols of the region, traditional rainfed lowland rice dominates the valley bottoms, while valley slopes are increasingly being cleared from natural forest or bush-savanna vegetation for producing upland crops. In light of the near complete absence of mineral fertilizer use, native soil nitrogen tends to be the most limiting nutrient. And, this cropping system might increase nutrients leaching (losses) from the slope to the lowland.

Understanding and managing the dynamics of native soil N is seen to be a precondition for sustainable lowland rice based cropping systems in West Africa.

Previous work has illustrated the seasonality of native N dynamics. We could show that relatively large amounts of nitrate-N (23-68 kg N ha^{-1}) could be translocated during the 3-month-long dry-to-wet season transition period (March-May) from upland soils into the lowlands via subsurface flow. There, nitrate encountered saturated soil conditions and disappeared rapidly. *In situ* N_2O flux measurements in lowland soils peaked at the end of the transition season, indicating that native soil N that was lost from uplands via nitrate leaching, may be lost from lowlands via denitrification. The present work studied the role of land use management on the use efficiency of native soil N by lowland rice.

A two-year field experiment (three-times replicated strip-plot design) was

conducted on a hydrologically isolated toposequence in an inland valley of the experimental farm of the West Africa Rice Development Association (WARDA) near Bouaké in Côte d'Ivoire in 1998 and 1999. It compared three variants of slope use, representing extreme cases of subsurface interflow management to the adjacent lowland. These main plot treatments included (1) a tilled bare soil (maximal N leaching and subsurface flow contribution), (2) a dense pigeon pea [*Cajanus cajan (L.) Millspaugh.*] fallow (miming the natural vegetation-scenario of N retention in the upland) and (3) a complete interception of any subsurface flow through three dense rows of banana plants in the hydromorphic valley fringe. Subplot treatments, laid out in the bunded rainfed lowland below the main-plot slope management treatments, included presence vs. absence of vegetation in the pre-rice niche during the dry-to-wet transition season (bare fallow vs. flood-tolerant *Aeschynomene afraspera* in 1998 or *Brachiaria* spp in1999). N accumulation in the biomass of the pre-rice lowland fallow vegetation and in the biomass of rice at harvest was complemented by weekly determination of soil N_{min} (0-20 cm) during the dry-to-wet season transition.

Results from two years of differential slope management on lowland soil fertility showed a peak of soil N_{min} about 2 weeks after the onset of the rainy season. The largest share of this N_{min} was in the form of nitrate and appeared to have originated from upland slopes. Nitrate-N input into the lowland was up to 47kg/ha higher when adjacent slope was left bare of vegetation as compared to complete interception of subsurface flow via banana plants. The presence of a deep-rooting and supposedly N-retaining slope vegetation (*Cajanus cajan*) reduce N input into the lowland by over 20%, compared to bare fallow, to 37 kg/ha. This suggests that slope management is likely to affect N translocation along an inland valley toposequence. Differential lowland vegetation management indicated that the presence of a vegetative cover during the dry-to-wet season transition period can act as a "nitrate sink", thus possibly reducing native soil N losses by denitrification. Following a "nitrate catch crop", lowland rice-yields increased significantly ($p<0.04$) by 0.9-1.1 t/ha^{-1} compare to the bare-fallow lowland plot.

It may be concluded that lowland fertility and crop yields in inland valleys appear to benefit from nutrient import from the slope. Improved management of both the slope and lowland vegetation has been shown to increase productivity of the lowland. However, the potential contribution of a fertility that is ”stolen” from adjacent uplands is likely to diminish with time and has to be seen critically in light of a rapidly increasing pressure on uplands for subsistence food crop production. This highlights the need for new strategies to manage soil fertility at landscape level. Studies are currently under way to model seasonal soil N dynamics at watershed level and to develop land use planning tools for improved native soil N management.

Key words: *Soil, nitrogen, Cajanus cajan, Pigeon pea, West Africa.*

Drying lychee-fruits (Litchi chinensis) for preserving quality and vitamin C

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The post harvesting losses of tropical fruits, according to investigations of FAO, range between 40-60 %, depending on product and region. Reasons for these extremely high losses are often seasonal overproduction, insufficient access of farmers to municipal and international markets due to lacking marketing structures, as well as poor product quality. As alternative to fresh marketing of fruits, the processing on the spot to storable and transportable products is provided. Here, drying is of great interest for local farmers. Dried lychee-fruits, known as lychee-nuts in China, but recently gain increasing importance also in Southeast Asia and South Africa. There might be also an interesting market in western industrialised countries as well due to the intensive exotic flavour, their high Vitamin C content and multifarious possibilities of uses.

In spite of increasing significance of tropical dried fruit, hitherto only insufficient knowledge about their drying behaviour and particularly the quality changes occurring while drying, is available, yet. Therefore these functional correlation have been examined by an interdisciplinary approach, in co-operation with Chiang Mai University (Thailand). For that reason drying experiments with emphasis of the influence of different mechanical, chemical and physical pre-treatments of the fruit have been determined. The dried products were valued with regard to their quality changes. Moreover, the drying behaviour of lychee-fruits was determined to qualify the possibility of using a solar tunnel dryer or to optimise the layout of a tray dryer.

Lychee-fruits (*Litchi chinensis*), like many other tropical fruits, even by cool storage keep only well as fresh fruits for a few days. An essential post-

harvesting problem is the pericarp browning immediately by heat effects and water losses. This browning reaction that already makes the fresh marketing much more difficult also causes special difficulties while drying. To suppress the rapid growing of mould and bacteria a quick drying is absolutely necessary (*Nip* 1988, *Coates* 1994), the colour change though highly depends on the drying temperature (*Underhill* 1994). To prevent colour changes, microbiological activity, an occurring of bitterness (*Ross* 1969) and high Vitamin C-losses comparative drying experiments of un-treated, chemically (by sulphiting, acidulating), mechanically (by peeling, stoning) and physically (by blanching, sugaring) pre-treated lychee-fruits should show the optimal drying regime with the best quality preservation, without any deterioration in taste of the fruits. These numerous influencing factors on a quality guided processing though are hardly known, and there is still a high demand of research.

All drying experiments concerning the influence of air temperature, relative humidity and air velocity were carried out with the institute's own high precision laboratory-overflow-dryer. For chemical pre-treatment a liquid sulphiting process (*Häuser* 1995) and citric acid were used. Blanching the fruits in water of 90 °C should inactivate enzymes causing browning reactions of pericarp and arillus without any additives. For mechanically pre-treated fruits the drying behaviour of whole, stoned and peeled and stoned fruits was determinated. For analysing the quality of fresh and dried fruits the water content was determinated by using the Karl Fischer Method (*Scholz* 1984), the colour was measured by a Minolta chromameter using the L*a*b* system. The retained sulphite content of the dried fruits was determined enzymatically by using the enzymes sulphite oxidase (SO_2-OD) and NADH-peroxidase (NADH-POD) and measuring the absorption of NADH photo-metrically at 340 nm. An HPLC method was used to determine the total Vitamin C content (*Hutasingh* 2000) of fresh and dried fruits. A sensory evaluation of the dried fruits was done by a sensorial panel examining the samples with the help of an hedonic scale.

The sensibility of lychee-fruits concerning high temperatures and long drying times requires a gently but effective method to receive the needed

water activity of a_W<0.6. With the given pre-treatments the quality of dried lychee-fruits can be clearly influenced. The optimised drying conditions determined for a tray dryer results in dried lychee-fruits of excellent quality. The high vitamin C content and a pleasant colour could be mainly preserved. The use of a solar tunnel dryer is limited by the given climatic conditions while harvesting period. Drying lychee-fruits and improving their quality helps to find a solution for the high post harvest losses and offers an additional income to Southeast Asian farmers by open markets for a re-discovered quality-improved product of an high nutritional value with multifarious possibilities of uses.

Key words: lychee, dried fruits, quality

Working Group 4

Technologies for Livestock Production and Aquaculture

Twelve years of co-operative research on milkfish to increase aquaculture production for local markets in the Philippines

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In Southeast Asia, fish is the major source of animal protein for the majority of the population. For centuries, aquaculture has contributed significantly to the supply with fish. In the Philippines, milkfish (*Chanos chanos* Forsskal) is the predominant fish species for brackish water aquaculture, it has been cultivated there at least for 400 years. In addition to the production of valuable protein-rich food, milkfish culture provides (partly seasonal) employment and income at various stages of the culture process from collection of fry in coastal waters to harvest and marketing and processing of the food fish. It is estimated that about 1 million people in the Philippines are engaged in this business. However, milkfish culture has not been static over the centuries, but has been influenced by technical progress and economic developments, as can be clearly demonstrated by the changes in the last decades.

In the beginning of the century, production was exclusively extensive, relying only on the low natural productivity of the ponds, which are typically located in former mangrove stands with highly acidic soil. Fish yield at this time was reported to be in the order of 250 – 500 kg ha^{-1} y^{-1}. Starting in the fifties of the last century, semi-intensive production systems have been developed, in which the growth of natural food is enhanced by liming of the ponds, application of organic and inorganic fertilisers and supplemental feeding. Using these techniques, the yield can reach 1000 – 2500 kg ha^{-1} y^{-1}. Intensification, expansion of pond area and introduction of freshwater culture of milkfish in Laguna de Bay allowed for an in-

crease in total milkfish production in the Philippines from 36 000 t in 1955 to more than 235 000 t in the eighties. However, pond area dedicated to milkfish culture has been decreasing since the 1985, as the technologies for the culture of shrimps and valuable finfish species became available and were economically attractive to the fish farmers. These cultures require more capital and inputs but less labour, the products are marketed mostly in urban and international markets (Manila, Singapore, Hongkong, Japan) and do not contribute to protein supply for the local population, apart from having negative impact on the environment.

In 1989, SEAFDEC Aquaculture Department and the Department of Animal Nutrition and Aquaculture in the Tropics and Subtropics, Hohenheim University, started a series of research projects on milkfish aquaculture in order to create the scientific base for improved aquaculture techniques to increase the profitability of milkfish culture compared to other aquaculture activities and thereby help to maintain this aquaculture for local markets. The first project, funded under the programme for scientific cooperation with developing countries of the “Deutsche Forschungsgemeinschaft” (German Science Foundation) dealt with basics of energy requirement of milkfish of different sizes and at different temperature and salinity levels. Later projects were on the digestibility of different protein sources, metabolisability of natural food and supplemental feeds and on the quantification of feed intake by milkfish in pond and pen culture. The results from these research projects indicated that current pond preparation and feeding practices do not match with the physiological nutrient requirements of the fish, leaving scope for technical improvements and possibly higher profitability of a sustainalble production system. Recommendations for milkfish culture have been developed or modified based on these findings.

Key words: Aquaculture, Philippines, Milkfish (*Chanos chanos*)

Partial Replacement of Fish Meal with Some Alternative Protein Sources in the Diet of Tilapia *Oreochromis niloticus*

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With the ever increasing need for cheap sources of protein to meet the world's over-population problem, more attention is focused on fish farming. In the developing countries where the problem is acute, tilapia culture is believed to offer one of the solutions, especially in view of the depletion of the existing fisheries. The relative ease of culture of tilapia and its rapid growth rate under tropical and semi-topical climates have led to its widespread distribution. Such advantages have given tilapia an important edge over other species. The successful intensification of culture methods for tilapias may be achieved if accurate diets satisfying all of the nutrient requirements are formulated. However, one of the major problems confronting the fish farming industry is the increasing cost and short supply of fish meal (an important ingredient in fish feed), and other animal protein sources. Fish nutritionists have tried to use less expensive plant protein sources to partially or totally replace fish meal. This is necessary in order to reduce the cost of fish production. The amino acid composition of alternative protein sources for fish have been assessed. Results from such studies have shown that no single feed stuff can provide an alternative to fish meal. However, by combining several alternative sources, researchers have obtained the required essential amino acid profile for fish. The objective of this study is to assess the suitability of soybean meal, groundnut cake, wheat bran, and blood meal to substitute fish meal in diets of *Oreochromis niloticus* (L.).
15 test diets were compounded to yield 33.32% dietary protein, dry weight (by calculation). They were formulated by mixing the above mentioned, alternative protein sources with fish meal at varied proportions. From our earlier experiments, the protein requirement of this species was estimated as 33.32% dietary protein. Fifteen fingerlings (initial mean

weight; 3.23g) were introduced to each of the experimental tanks containing forty litres of water. Each diet was assigned to three tanks. The fish were fed for 8 weeks at 5% body weight per day in 3 portions. All fish groups were weighed every two weeks and the quantity of food was adjusted accordingly. Temperature was maintained at 27±1ºC throughout the experiment. At the end of each experimental phase the fish were finally weighed. Twenty fish from each feeding group were taken, their intestine removed and the carcass homogenised. Freeze dried samples of fish at the beginning and end of the experiments as well as the samples of the test diets were analysed for proximate composition. Protein (N × 6.25) was determined by the Kjeltec System (Tecator); crude fat by Soxtec System HT (Tecator) using petroleum ether, and ash by burning in a muffle furnace at 750°C for 4 hours. Oxygen bomb calorimeter (Framo-MK 200) was used for energy determination at two replications per sample. High Performance Liquid Chromatography (HPLC) (Merck Hitachi) was used for amino acid analysis of feed and fish samples.
Fish fed diet 1, containing 43% fish meal recorded the highest weight gain, highest specific growth rate (SGR) 3.46, and the lowest food conversion ratio (FCR) 1.11. In diet 8, the proportion of fish meal was reduced to 26% inclusion level. Part of the fish meal was substituted with 18% soybean meal and 5% blood meal. An improved fish performance was evident. SGR and FCR of the fish group fed diet 8 were 3.02 and 1.34, respectively. These were not significantly different from diet 1 at 0.05 probability. It was observed that blood meal above 6%, groundnut cake above 10% and wheat bran beyond 10% inclusion level in the feed, retarded growth in this study. However, considering the performance of the best fish groups, it appears that a proper combination of soybean meal, blood meal, groundnut cake and wheat bran can provide between 42 and 45% of the protein needed by *Oreochromis niloticus* (L.). In such a combination soybean meal alone, is capable of replacing up to 25% of fish meal in the diet, in terms of dietary protein contribution.

Key words: Tilapia, Fishmeal, Alternative protein sources.

Genetic and economic evaluation of alternative breeding objectives and schemes using deterministic simulation in Kenya

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Nucleus breeding programme can be a good strategy for genetic improvement in non-industrialized countries, which lack the money, expertise and structure required for operating an efficient improvement programme based on AI and milk recording in the whole population. However, there are no effective dairy breeding programmes in Kenya. It has been shown that a young bull system (YBS) has lower costs and gives more profit than the conventional old bull system and that it has an advantage when the time horizon considered is short, the resources are limited and interest rates are high. The latter two are the common problems that characterize most of the non-industrialized countries.

Using deterministic simulation, a two-tier open nucleus breeding scheme and the YBS were assumed to genetically and economically evaluate various breeding objectives and breeding schemes. ZPLAN computer programme was used for this purpose. Four breeding objectives were defined and included three dual purpose objectives, which represented the present, smallholder and future production situations, and one beef objective and differed from one another by the traits included and their economic values. The traits were milk yield, fat yield (FY), lactation length, preweaning daily gain, age at first calving, calving interval, postweaning daily gain, mature weight, herdlife, preweaning survival rate (SR) and postweaning survival rate (PSR). The breeding schemes differed in the records available for use as selection criteria and therefore in the costs

and investments parameters. 100% artificial insemination (AI) was assumed in the nucleus and 35% in the commercial population. Selection of cows was restricted to the nucleus but the best cows in the commercial sector, which join the nucleus after their first lactation are selected subjectively. The annual monetary genetic gain and profit per cow in the population were used as evaluation criteria.

Apart from one breeding scheme in the beef objective, all breeding objectives and schemes realized profits. The objectives and schemes that ranked highly for annual monetary genetic response and total return per cow did not rank the same in profit per cow in all cases. In the breeding objective that assumed the future production situation, the difference in profit per cow between the scheme that assumed records on FY were available for use as selection criteria and that, which assumed no records on FY were available, was small. In all the objectives, the availability of additional selection criteria had no effect on the annual genetic response in SR and PSR. The lack of genetic response in SR is expected because this trait is more under environmental than genetic influence.

There is evidence that a well-organised breeding programme based on dual-purpose breeding objectives and utilizing the two-tier open nucleus and the YBS could sustain itself. A scheme that requires records on FY seems not to be justified from an economic point of view. Before the breeding programme is established on a large scale, pilot selection schemes should be developed first and shown to work. During all the establishment stages, the needs and interests of the producers as well as the ecological conditions should seriously be taken into consideration. There is therefore the need for further studies on how this can be realized and improved genetics delivered to cattle owners, especially to smallholder producers.

Key words: Breeding objectives; Dairy cattle; Selection; Tropics

Effect of calf rearing management on milk yield and live weight performance of crossbred dairy cattle in Thailand

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Since 1982 the Thai government implements a program to increase self sufficiency in milk production and restricted importing of fresh milk and milk products. Eventhough the dairy cattle population and annual milk production have increased, it meets only about 30 % of the domestic demand. Milk production in Thailand based on crossbred dairy cattle using methods developed in industrialized countries. Yield per cow is low amounting to 8-10 litres/day. Furthermore, the performances of calves are low and mortality rates are above 25% in small scale farms. Therefore, dairy enterprises in Thailand require an appropriate production system with regard to calf rearing and milking methods which are suited to farming system.

This investigation was aimed to evaluate the effect of milking method and calf rearing management on milk production and calf rearing efficiency with hypothesis that milking methods and calf rearing management affect dairy efficiency.

Forty Holstein Friesian crossbred (75-87.5 %)cows and their calves were used. The experiment was a 2 x 2 x 2 factorial experiment with three factors. Sixteen primiparous (PP) cows and 24 multiparous (MP) cows were distributed into the following treatment. Milking treatments were (1) HM : hand milking and (2) MM : machine milking. Calf rearing treatments were (1) AR (artificial rearing) : bucket feeding of whole milk (average bucket milk feeding during 4-84 days was 2.91 kg/calf/day) and (2) RS : restricted suckling twice daily for 15 minutes after milking until 84 days of lactation. During 85-252 days of lactation, the cows were continually milked without calf suckling.

The average saleable milk yield, average total milk yield, cow live weight, average daily gain of calves, average milk consumption by calves and heart-girth measurement were analyzed as dependent variables using least squares analysis of variance according to the general linear model (GLM) procedure in the Statistical Analysis System (SAS, 1998).

Average total milk yield of MM cows were significantly higher (P<0.01) than HM in all periods (4-84 days : 12.07 vs. 10.80 kg/day; 4-168 days : 10.16 vs.9.40 kg/day and 4-252 days : 8.58 vs.7.97 kg/day). It was found that MM cows produced significantly (P<0.01) more saleable milk yield than HM cows in period 4-84 days (8.78 vs.7.76 kg/day) but no significant different in saleable milk yield in other periods. Throughout the study period the RS cows produced significantly (P<0.001) more saleable milk yield than the AR cows (4-84days: 9.83 vs. 6.71 kg/day; 4-168 days: 9.23 vs. 7.15 kg/day and 4-252 days: 7.97 vs. 6.47 kg/day); and the different between RS and AR cows for total milk yield also significant (P<0.001) throughout the study period (4-84days: 13.21 vs. 9.66 kg/day; 4-168 days: 10.90 vs. 8.66 kg/day and 4-252 days: 9.08 vs. 7.47 kg/day). The MP cows produced significantly (P<0.01) more saleable milk yield than PP in periods 4-84 days (8.89 vs. 7.65 kg/day), 4-168 days (8.73 vs. 7.65 kg/day) and 4-252 days (7.70 vs. 6.74 kg/day). It was also found that MP cows produced significantly (P<0.01) more total milk yield than PP in all periods of study (4-84 days: 12.00 vs. 10.86 kg/day; 4-168 days: 10.31 vs. 9.24 kg/day and 4-252 days: 8.75 vs. 7.79 kg/day). Cow body weight was not affected either by milking or calf rearing treatments. There were no significant interactions between milking methods and calf rearing management, between milking methods and parity number of the cows, and between calf rearing management and parity number of the cows on milk production and cow body weight in any period of the study.

Calves reared by RS consumed significantly (P<0.01) more milk per day in the period 4-84 days than did AR calves (3.35 vs. 2.88 kg/day). The average daily gain of calves under RS treatment was significantly higher (P<0.01) than AR calves (690 vs. 500 g/day). The heart-girth measurement of the calves was not significantly different at birth, 28 days of age

and 56 days of age, but RS calves had significantly ($P<0.05$) greater heart-girth measurement than AR calves at weaning (94.87 vs. 90.04 cm).

The results of this experiment indicated that for 75-87.5 % HF crossbred cows machine milking achieves a higher milk output. Restricted suckling of calves increase saleable and total milk yield as well as calf growth performance.

Key words : Restricted suckling, Artificial rearing, Saleable milk yield, Total milk yield, Live weight , Crossbred

Poster/Tools Section 4

Macro nutrient balances of two *Mucuna* varieties in *Mucuna*/maize systems in the forest savannah transitional zone of Ghana

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Reduced fallow periods in many parts of West Africa's transitional zone between Semi deciduous Forest and Guinea Savannah due to an increasing population leads to a decline of soil fertility and, hence, to reduced agricultural productivity. The removal of subsidies on mineral fertilizers in Ghana in 1994 has led to a decline in fertilizer consumption from 65000 mt in 1989 to 11600 in 1994. Hence, mineral fertilizers are beyond the financial reach of many small-scale farmers.

Leguminous cover crops grown as improved short fallows have shown to have high agronomic potential in Ghana. The adoption of *Mucuna* cover crop systems in Benin has received considerable attention and has been the subject of numerous research activities. Only recently, *Mucuna* cover crop systems are also attaining attention by farmers in Ghana. Despite tremendous yield increases even under on-farm conditions there is a need to analyse the potential sustainability of such systems.

One tool to assess and monitor land quality and its change over time and the dynamics of soil fertility is the nutrient balance. Whilst the soil is considered as a black box, the quantity of nutrients entering and leaving a field are analysed, and the balance is estimated. The model assumes that over time soil fertility is determined mainly by the degree to which nutrient exports are balanced by nutrient imports. Internal fluxes between nutrient pools are considered to be more or less in equilibrium.

Macro nutrient (N, P, K, Ca, Mg) balances at field level for maize/*Mucuna* rotations were calculated for two different *Mucuna* varieties: the late maturing *M. pruriens* var. *utilis* which is relay interplanted into major season maize at tasseling or cob forming stage and an early maturing local *Mucuna* variety which is planted after maize harvest in pure stand. Nutrient

flows quantified included N derived from symbiotic and non-symbiotic fixation, wet and dry deposition (inputs), and harvested products, removed residues, leaching, denitrification and volatilization (outputs). Measurements of maize yield components were recorded on 18 farmers' fields in 1999, whilst N fixation, *Mucuna* biomass and seed yield components were assessed on 27 farmers' fields during the 1999/2000 minor season.

On-farm data showed that all macro nutrients including N had a negative balance for the local *Mucuna* variety with -15.7 kg N, -11.5 kg P, -32.7 kg K, -34.4 kg Ca and -18.5 kg Mg per hectare even without consideration of losses through erosion. The relay cropping system with *M. pruriens* contributed 31.8 kg N per hectare to the system while the budget of the other nutrients was negative with -8.7 kg P, -28.3 kg K, -28.6 kg Ca and -15.7 kg Mg per hectare. Removal of maize and *Mucuna* seeds was the major negative nutrient flow in the short natural fallow system. Harvesting the local *Mucuna* seeds led to an even higher removal of N than through the removal of maize grain while *M. pruriens* seeds removed only 77% the amount of nitrogen compared to that in maize seeds.

The data suggest that late maturing *Mucuna* varieties with lower seed yield contribute more to soil fertility maintenance than early maturing types with high seed yields. Recent attempts in utilization of the seeds for human and animal consumption have to be viewed more critically from this point of view. However, even a rotation of *M.pruriens* with maize is not sustainable if not elements other than N are added to the soil in the form of mineral fertilizers or organic amendments.

Key words: *Mucuna*, nutrient balance, West Africa

Haymaking Technology to Improve Dry Season Feed Availability in the Adamawa Plateau of Cameroon

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1.STATEMENT OF THE PROBLEM.

The quality of any conserved feed for ruminants during the dry season (winter) is dependent on the method of its preparation. Grass hay is mainly used by livestock farmers of the Adamawa plateau located in the sub humid zone of Cameroon. Its quality is bad and is affected by the type of pasture, pasture management and hay making know how.

2. OBJECTIVE

To test the effect of different lengths of grazing deferment and storage on the yield and quality of hay from natural and improved pastures.

3. RESEARCH HYPOTHESIS

Length of grazing deferment influences the yield and quality of *Brachiaria* and native pastures.

Storage length under indoor conditions does not effect hay quality.

4. METHODOLOGY

An experiment was carried out between April 1995 and April 1997at the Wakwa Institute of Agricultural Research for Development (IRAD) centre, Cameroon. Two sets of pasture, one of mostly *Hyparrhenia*-predominant native grass species and the other a cultivated introduced grass species, *Brachiaria ruziziensis* cv. Germain and Evrard, were used. After grazing during the early rainy season, six 40m x 40m subplots in two replications per deferment length were fenced off within each of the 3 paddocks of each pasture type. The plots were zero timed to give 3 deferment lengths

(12, 10 and 8 weeks) before cutting on November 6 of 1995 and 1996 respectively. Field curing length was 4 days. Hay was baled and stored in a shed. Samples were collected at week 0 (November 20), week 12, (February 20) and at week 20 (April 20) of each year. Pasture yield was determined prior to cutting. Quality measures were obtained from proximate and detergent analyses, nylon bag, and the pepsin cellulase digestibility methods. Data entry was done using Dbase IV+. The general linear models (GLM) procedure of SAS (SAS 6.03 , 1991) was used for determining least squares of treatment means and Type III type of sums of squares were used for means separation.

5. RESULTS, CONCLUSIONS AND RECOMMENDATIONS

The dry matter yields (DMY) of the *Brachiaria* and native pastures were 2108 and 1926 kg/ha , ($P < 0.05$) at cutting, and 1846 and 1701 kg/ha ($P < 0.05$) respectively after 4 days of curing. Least squares DMY declined from 2017 $\pm$ 87.8 kg/ha at cutting to 1774 $\pm$ 80kg/ha after curing ($P < 0.05$). Dry matter content(%) of the hay after curing and at week 0 of storage was 86.7 and 88.9%, respectively ($P > 0.05$). Within pastures and deferment length, the 12 week deferred plots had the highest yields ($P < 0.05$) followed by the 10 week and lastly by the 8 week plots for each of the above periods. *Brachiaria* pasture always had higher yields ($P < 0.05$).There was a significant reduction in DM % within deferments and between pastures from week 0 to week 20 of storage.

Crude protein (CP), 24 hour nylon bag disappearance rate, and the organic matter solubility rate in a pepsin–cellulase solution (ELOS %), were 6.6, 50.8 and 45.9 % for the 8 week; 5.8, 44.6 and 44.7% for the 10 week, 5.2, 38.3 and 44.8 % for the 12 week *Brachiaria* samples at cutting. The corresponding values for the native pastures were, 5.2, 48.2 and 32.7%; 4.9, 39.5 and 32.1%; 4.2, 39.3 and 30.4%, ($P < 0.05$). For both pasture types, lower values ($P < 0.05$) were obtained for these parameters at week 0 of storage. They further declined from week 0 to week 20 of storage for all samples. The crude fibre content was higher in native pasture samples ($P < 0.05$) and increased in both pasture types during storage. ELOS yield, the digestible DM and CP yield based on

the 24 hour nylon bag disappearance value were highest for the 10 week deferment plots for each pasture type. This reflected the intermediate DM yield and relatively higher CP and ELOS values of the 10 week deferments. *Brachiaria* samples had the higher values ($P < 0.05$). From this study, it can be seen that *Brachiaria* hay from pastures deferred for 10 weeks attained the best quality.
The hypothesis on the effect of deferment length on hay yield was confirmed, while the hypothesis on the effect of hay storage length was rejected.

KEY WORDS: Pastures, deferment, hay, storage, Cameroon

Participatory bread wheat breeding in Ethiopia: A socio-economic assessment

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Increasing the production of foodstuffs in developing countries against the background of rapid population growth, widespread food shortage, malnutrition and the destruction of the natural resource base still remains important for the future. This is of special concern to Ethiopia because the country often faces food shortages. The cereal crop productivity indices in Ethiopia have not shown significant increasing trends both over time and space in Ethiopia. The reversal of these phenomena would require continual innovation, adaptation and the ability to create and exploit resources both internal and external to the farm. Specifically, the country needs to intensify crop production through application of relevant innovations including better crop varieties adapted to varying agroecological conditions and socio-economic set-ups. The capacity to innovate and adapt is thus essential. However, there is an observed weakness in the area of technology adaptation and adoption in Ethiopia. Ethiopia's natural and socio-economic environments are characterised by complexity, diversity and risk proneness, necessitating the need for a different technology (variety) development paradigm.

Based on the experiences of participatory and multidisciplinary bread wheat breeding project being implemented in Ethiopia since 1996, this poster addresses the following research questions:

- What are the elements that explain the differential bread wheat variety reception (cognitive adoption decisions) of farmers?
- How researchers react to these identified reception variables in the actual variety selection processes?
- How do farmers' selection criteria differ from breeder's selection crite-

ria?

One of the objectives of the socio-economic research in the context of this project was to understand the differential varietal reception behaviour of wheat farmers and how these feeds into the actual breeding process. To realise this both qualitative (participatory action research during breeding and test phase) and quantitative research tools were utilised.

This study revealed a set of important issues. First, the project objectives as originally conceived by breeders or pathologists were too restrictive. The objectives were later made more comprehensive with the participation of farmers and socio-economists in the project. Second, participatory crop breeding should be conceptualised as a two-way flow of information between farmers and breeders/pathologists to enable optimal decision in variety selection process. Third, the responsiveness of breeders to the information emanating from farmers depends on many factors related to the researchers socio-economic attributes as well as farmers' biophysical and socio-economic circumstances. Finally there is substantial divergence between the two groups in variety selection process. Farmers' selection criteria or indices are multidimensional and varietal choice decisions are made sequentially. At earlier growing seasons, they make tentative choices mainly based on indicators related to yield potential. The farmers often make no mention of yield in their varietal choice exercise at this stage. They make use of indirect indicators of yield potential like number of tillers, circumference and colour of leaves, etc. As more and more information is gathered about the varieties the original choice decisions may be revised or maintained.

Therefore, the efficiency of Ethiopian wheat breeding program can be substantially enhanced through adopting participatory action research methodologies.

Key words: Participatory, interdisciplinary, Innovation, variety

Improving profitability of traditional rice farming by introducing alternate rice-fish culture in Kerala state, India

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Rice is the staple food in Kerala and used to occupy 24 per cent of the net cropped area in the state. The area utilised for rice cultivation and rice production has declined from 1 million ha and over 1.5 million tonnes in 1970 to 0.353 million ha and 0.728 m tonnes during 1998-99. The current domestic production is hardly sufficient to meet even a third of the state's annual requirement. The decline of paddy fields has had a considerable impact on the socio-economic texture of Kerala. The increasing cost of cultivation and disproportionate increase in prices of inputs such as fertiliser, pesticides and labour without any commensurate increase in output price are the major factors that contributed to the persistent pressure for the increased preference of other, more remunerative crops. The wrong policies imposed on the agricultural sector over the past years have resulted in the inability of the farmers to identify the appropriate technology to sustain the profitability of their agricultural operations.

In an attempt to remedy the situation, the State Government has set up the 'Fish Farming Development Agency' (FFDA) to implement a project promoting rice-fish integrated farming. The project has been started in the low lying Kuttanad area, which used to be a major rice cultivation region in the state. The programme envisages one crop of paddy followed by another crop of fish during the year. Since an overwhelming majority of holdings are small, investments and resources are sought to be pooled under this set up. Polyculture of fish and prawns under an extensive farming regime is being given thrust. During the initial phase, which is already underway fish like catla, rohu, Chinese carps especially grass carp etc., have been widely grown. With limited feeding, a fish yield of up to 2.5 tonnes per ha. has been realised under this system. During the fol-

lowing season an increase of rice yields of up to 15 per cent has been recorded even with decreased use of fertiliser. In addition there has also been substantial saving on weeding expenses. At present, 1,873 ha have been brought under integrated farming in upper Kuttanand region. The farmers earn Rs. 5,000 to Rs. 6,000 per acre (DM 1 = Rs. 22) from fish farming. FFDA is currently giving Rs. 4,000 per ha. as input subsidy to farmers. Financial support is provided to the local self-governments to set up infrastructure facilities for fish farming. The government is assisting in providing fish seed, marketing of the fish produced, and is also establishing a comprehensive legislation to regulate all aspects of this new farming system.

The scientific input for the project has come from the Kerala Agricultural University. For the project to prosper and be sustainable there is a need for continuous research investments into the various aspects of this new production system in this area. Information needs to be accumulated and developed regarding the most ideal fish species that could be used, the entire nutrient cycling pattern in the fields, the amount and type of feeds that might be required for the fish culture part, and support for the continuous improvement of the system. An information sharing partnership with institutions that have experience in managing such systems in other parts of the world could come in handy at this stage.

Key words: Rice-fish culture, profitability, Kerala state

The influence of fermented Putak (*Corypha elata robx*) on growth performance of weaner pigs

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The major carbohydrate source for pig-fattening in Indonesia is based on maize meal. However, due to the rising demand for maize meal as a staple and the continued increase in its price, alternative energy sources for pig production are continually being sought. Putak, the inner stalk of the palm tree (*Corypha elata robx*), has been widely used in Indonesia as a source of energy in pig rations. However, no studies on its optimum inclusion level or handling requirements have been carried out. On average Putak contains 2-2.23 % crude protein (CP), 50-55 % starch and 5.6-12.23 % crude fibre (CF). The objective of this study was to evaluate the use of Putak in place of maize meal in diets for fattening pigs on pig growth performance and economic viability of the enterprise.

Thirty-two weaner pigs (8.2 kg at the beginning of the experiment) were divided into four groups of eight animals each and used in a completely randomised design experiment. The animals were randomly allocated to four diets varying in Putak inclusion. The and four rations were 1. the control ration, 2. unfermented putak included at 10 % of the maize meal (UFP), 3. low fermented putak inclusion at 10 % of the maize meal (LFP) and 4. high level of fermented putak at 20 % of the maize meal (HFP). The diets were isonitrogenous and isoenergetic at 200 g/kg crude protein and 4 500 kcal/g gross energy contents. Fermentation of the Putak was effected by boiling the Putak for 40 minutes first, cooling it and then fermenting it with *Saccharomyces cerevisae* (750 000 cell units/kg fresh Putak) for two weeks. This was meant to increase starch availability and to raise the CP content of the Putak. Other dietary ingredients were maize meal, fishmeal, rice bran, coconut meal and pig mix mineral mix.

Except for maize meal, these were the same across diets.

The pigs were offered the diets *ad libitum* for 90 days. Live body weight (LW) and feed intake data were collected weekly and food conversion efficiency over the whole period was calculated. Data were analysed in SAS® using the GLM procedures, while economic benefits were assessed using the partial budget approach.

There were no differences in initial LW, but significant ($P<0.001$) final LW, weight change and daily gains. There were no differences between the control and the LFP dietary treatments on these variables. Performance was least on the UFP treatment. Food intake per day was inhibited significantly ($P<0.001$) on the UFP and HFP treatments but actually enhanced on the LFP compared to the control. As a result, efficiency of food conversion for LW was lowest on the UFP followed by the HFP, LFP and the control diet. Unfermented Putak inclusion severely inhibited intake, possibly through a depression in digestibility and/or some anti-nutrients in raw Putak. Gross margin was maximised on LFP followed by the control ration and then the HFP, while the least values were experienced on the UFP treatment.

It is concluded that fermented Putak can be included in pig diets at 10 % level in place of maize meal with no deleterious effects on animal performance and it actually improves the economic viability of the pig-fattening enterprise. While farmers would find it profitable to harvest and use Putak in pig rations in place of maize, a programme involving planting of Putak trees possibly as a plantation, should be an integral part of the extension message to the farmers.

Key words: Putak (*corypha elata robx*), *Saccharomyces cerevisae*, fermentation, pig diets

Blood and Milk Urea Nitrogen as a Tool to Monitor the Protein Nutrition of Cattle under Tropical Conditions

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Tropical grasslands are particularly important for production of milk and meat from ruminants by small holders. In these systems quality and quantity of forage are often limiting factors for animal performance. This results in a low consumption of digestible nutrients and, consequently, in low animal production and productivity. Nevertheless, productivity could be increased by supplementation with limiting nutrients. In the last two decades extensive work has been done to find reliable indicators of the nutritional status of cattle as a tool for strategic supplementation. The levels of blood urea nitrogen (BUN) and milk urea nitrogen (MUN) have proven to be useful for monitoring protein and energy nutrition of beef and dairy cattle under temperate conditions. However, up to date relatively little information is available on the relationship between these variables and the nutritional status of cattle feed with tropical forages. The objectives of the present work were (1) to evaluate the effect of different nutritional and animal factors on rumen ammonia nitrogen, blood urea nitrogen and milk urea nitrogen and (2) to establish relationships between these variables and the protein nutrition of cattle under tropical conditions. The knowledge of these relationships would allow the use of BUN and MUN as metabolic indicators of the protein and energy status of cattle and could be helpful in making nutritional management decisions.

In two experiments carried out in the eastern plains of Colombia the level of rumen ammonia nitrogen and of blood urea nitrogen of steers receiving diets with different crude protein contents was measured. In the first experiment the level of dietary crude protein, rumen ammonia and BUN was followed in eight esophagus and rumen fistulated steers grazing two pure grass pastures and two grass-legume pastures in a 4x4 crossover design. The pastures had been selected to present contrasting levels of

dietary crude protein contents (5.7 to 11.8% in dry matter (DM)). One grass-legume pasture contained a legume with a high tannin content. In the second experiment four rumen fistulated steers were assigned to four levels of protein supplementation, using a 4x4 Latin square design. The basal diet consisted of low quality hay supplemented with four levels of urea. Dietary crude protein in this trial varied between 7.3 and 15.8 % in DM. The third experiment consisted of a field study on nine commercial dual purpose cattle farms located in the northern cost region of Colombia. Samples and information were collected during two seasons of the year (dry and rainy season). On each farm, 12 healthy cows were selected, covering different phases of lactation. Results were used to quantify the effect of different nutritional and animal factors on urea levels in blood and milk.

In general, rumen ammonia nitrogen concentration was linearly correlated with the level of dietary crude protein ($P<0.0001$, $r^2= 0.77$-0.92) in experiment 1 and 2. However, in diets containing elevated proportions of tannins variation in content of dietary protein did not affect rumen ammonia levels. Independent of the type of forage, a high correlation between BUN and rumen ammonia nitrogen was observed ($P<0.0001$, $r^2= 0.74$-0.88). Experiment 3 showed that in dual purpose cows, MUN level was highly correlated with BUN ($P<0.0001$, $r^2= 0.93$). From the nutritional and animal factors analyzed, the dietary protein:energy ratio was closest related to variations in BUN and MUN.

This study confirms that BUN and MUN may be useful tools for monitoring rumen ammonia nitrogen level and protein intake of ruminants and may serve to adjust protein and energy supply of cattle grazing tropical pastures. The results further indicated that the minimum MUN level for cows in dual purpose systems is approximately 10 mg/100 ml. Values below this level are usually associated with dietary protein deficiency, and cows at these levels will probably respond to protein supplementation.

Key words: dual purpose cattle, milk urea nitrogen, protein nutrition, tropical grasslands

Soil conservation by vegetative barriers in a maize cover crop system in northern Thailand

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Problem

In the mountainous areas of northern Thailand, soil losses from agricultural fields averaged 67 t ha^{-1} yr^{-1} during the past decade. Farmers, however, have been reluctant to adopt soil conservation measures due to insufficient profitability and the need for large initial investments.

Objective

To assess the sustainability and profitability of food crop production with soil conservation practices and fertilisation on steep slopes in the subhumid zone of Thailand.

Hypotheses

Relay cropping of lablab guarantees soil losses in maize below the tolerance threshold

Additional nutrient and water conservation by vegetative barriers can be economically profitable, particularly with hedgerow species that produce direct benefits such as fruit trees or fodder crops

Methodology

A 2-year field experiment was started in March 1997 on the research station of the Department of Land Development (DLD) at Huai Luk, 100 km north of Chiang Mai (19 N, 99 E), located in a tropical savannah climate (Köppen $A_{W;}$ avg. temperature = 25°C; annual rainfall = 1,354 mm in 1997 and 927 mm in 1998). The soil was an Alfisol with a clay to clay loam texture, a pH-H_2O of 5.6 and low total N, available P and cation exchange capacity. Erosion plots (10 x 36 m) on slope inclinations between 21 and 36% comprised (i) two fertiliser levels (none and 61 kg ha^{-1} N plus 13.9 kg ha^{-1} P) and (ii) five maize cropping systems with a relay crop

of *Lablab purpureus* (L.) Sweet and a maize straw mulch. Three systems had vegetative barriers planted to (i) *Leucaena leucocephala* (Lam.) De Wit, (ii) mango and grass (*Paspalum notatum* Flügge*) and (iii)* pure grass (*Brachiaria ruziziensis* Germain et Evrard*).* Two treatments were without barriers: (i) farmer practice and (ii) agroforestry with mango tree rows. All tree or grass rows were 1 m wide and spaced 6 m apart. Soil loss and runoff were measured after each erosive rain (>10 mm).

Results and conclusions

Averaged across years, the three hedgerow systems reduced the runoff to 12 mm and the soil loss to 0.4 t ha^{-1} yr^{-1} as compared to 63 mm and 10 t ha^{-1} yr^{-1} in the farmer practice. Losses in agroforestry of 27 mm run-off and 3 t ha^{-1} yr^{-1} soil were closer to the barrier systems than to the farmer practice. In spite of sacrificing 25% of the maize area for trees or grasses, the average maize grain yield of the four erosion control treatments of about 3 t ha^{-1} was equal to the farmer practice. Fertilisation increased maize grain yields significantly from 2.3 to 3.9 t ha^{-1} and total dry matter from 7.1 to 11.6 t ha^{-1} in the farmer practice.

The N losses by erosion were reduced from 32 kg ha^{-1} yr^{-1} in the farmer practice to 3.5 kg ha^{-1} yr^{-1} in the mean of the three hedgerow systems which also had negligibly low losses of other nutrients: 0.01 kg ha^{-1} P, 1.3 kg ha^{-1} K, 0.7 kg ha^{-1} Ca and 0.3 kg ha^{-1} Mg.

The economic evaluation (ignoring establishment costs for hedgerows) demonstrated that barriers with species that are purely grown for barrier and mulching purposes can not compete with directly marketable species such as fruit trees.

To conclude, the use of *Leucaena* and grass prunings for fodder seems to be more profitable than mulch application, which was not essential for soil conservation. The total value of nutrient conservation in the mean of the three fertilised hedgerow treatments as compared to the farmer practice amounted to 31 US$ ha^{-1} yr^{-1}.

Key words: erosion, relay cropping, fruit trees

Survey on the use of natural food and supplemental feed in commercial milkfish farms on Panay, Philippines

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The milkfish (*Chanos chanos* Forsskål) is the most important cultured fish species in the Philippines. In 1998, more than 156,000 t were produced here, mainly in brackishwater ponds. A significant part of this production is done semi-intensively in commercial fish farms of 1-30 ha total pond area. A culturing system is defined as semi-intensive if the natural food from the pond is enhanced by fertilization and/or supplemental feed is given. Local researchers from the Philippines suggest daily rates of supplemental feeding of up to 4% BME (body mass equivalent). However, investigations on the intake of supplemental feed and natural food by milkfish in experimental ponds showed that only a part of the supplemental feed was taken in directly by the fish. The present study aimed to find out the utilization of natural food and supplemental feed in commercial milkfish ponds.

Several pond monitorings were conducted on Panay Island, Philippines, in commercial milkfish farms using different culture methods, between 1996 and 1998. The individual size of the ponds ranged between 1.0 ha and 9.0 ha. Pond depth varied between 0.3 m and 0.7 m. Pelleted feeds were given only on a small-scale fish farm in Dumangas (1 ha pond area), where it was given in three equal rations at a total daily rate of 3.75% BME. No fertilizer was applied here. The other farm in Banate used a method involving regular transfer of fish (every 8 weeks) to larger ponds with well-developed natural food, as well as stocking of fish of different sizes (total pond area 30 ha). This farm used fertilizer for the

ponds prior to stocking the fish to enhance the growth of natural food. About 2,000 kg ha^{-1} chicken manure and 2,000 kg ha^{-1} pig manure were applied per production cycle (two cycles per year). The estimated production figures ranged from 1.2 t/ha/y in the small scale farm to 1.5 t/ha/y in the semi-intensively managed milkfish farm. Milkfish typically reach commercial size after 120 days.

To evaluate the actual feed intake, fish samples of up to five fish per hour were collected at regular intervals with a cast net over two to five days, after which period all hours of the day had been covered. The daily feed intake was estimated by microscopic and gravimetric analyses of stomach contents followed by non-linear regressions with the aid of the fish feeding model MAXIMS.
The MAXIMS analysis suggested that in the case of the small, intensive farm only around 22% of the feed given was taken in directly by the fish (0.82% BME), leading to a wastage of high quality fish feed and an apparently poor food conversion ratio of the compound feed (FCR=6.8 assuming 100% ingestion). Furthermore, the growth rate reached only 1.73 g/d. Faster growth of fish can be achieved even without supplemental feed; in the fertilized system, a growth rate of 2.36 g/d was calculated for fish feeding mainly on *lablab*, a cyanobacterial mat also containing diatoms and invertebrates.

In conclusion, these results may suggest a heavy reduction in or even the abandonment of the use of supplemental feed for milkfish, since growth rates of milkfish in ponds without any feeding are comparable to those of fed fish. Semi-intensive systems may achieve this aim; they are most likely also more economically efficient. Nevertheless, systems involving the shifting of stocks between ponds in the grow-out phase in order to use natural food more efficiently require greater land area and management skills and are therefore unsuitable for small-scale farmers.

Key words: milkfish, semi-intensive aquaculture, commercial fish ponds, feed intake

Effects of supplementation of sole or mixtures of selected multipurpose trees (MPTs) on feed intake, live weight and scrotum circumference changes in Menz sheep fed a basal diet of tef (*Eragrostis tef*) straw.

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Inadequacy and inconsistency of feed supply is a major bottleneck to efficient animal production in tropical farming systems. Tropical feeds are usually fibrous in nature and deficient in nitrogen, sulfur and phosphorus. They support low levels of animal production and reproductive performance through most of the year. To this end, there is a strong need to identify and use locally available resources that can correct the nutrient deficiencies of animals in a sustainable way. In this regard, multipurpose trees (MPTs) offer an attractive alternative in animal feeding by virtue of their high nitrogen content as well as their integration in the tropical farming systems. However, some MPTs contain anti- nutritional factors (ANFs) in concentrations that are detrimental to animals. Browsing animals dilute deleterious effects of ANFs by feeding on mixtures of plant species. Such a strategy may also improve the efficiency of nutrients utilization. Therefore, this experiment was conducted with the objective of evaluating the effects of supplementation with sole or mixtures of the MPTs on feed intake, nutrient utilization, daily live weight and scrotum circumference gains of Menz rams offered a basal feed of tef (*Eragrostis tef*) straw.

Hypothesis

Supplementation with mixtures than sole MPTs have beneficiary effects in improving the performance of sheep fed on straw, as a result of improved feed and nutrient intakes, dilution of anti- nutritional principles and improved rumen function.

Materials and methods

Fifty four yearling Menz rams were blocked on initial weight. They were offered tef straw *ad libitum* and supplemented with *Sesbania sesban* (1198); *Sesbania sesban* (15019); *Leucaena pallida* (14203); *Acacia angustissima* (15132); *S. sesban* (1198) + *L. pallida* (14203) (2: 1); *S. sesban* (15019) + *L. pallida* (14203) (2:1); *S. sesban* (1198) + *A. angustissima* (15132) (2:1); *S. sesban* (15019) + *A. angustissima* (15132) (2:1) and wheat bran (control) at a daily rate of 0.9 % of live weight. Water and mineral licks were offered *ad libitum*. Daily feed offer and refusals were measured. Body weights were taken every 15 days. Scrotum circumference measurements were taken monthly. Offered and refused feeds were sampled for chemical analysis.

Results

The MPTs and their mixtures contained crude protein and fiber ranging between 21.6 - 27.8 % and 20.4 - 33.8 % respectively. Significant differences were observed between treatments in straw DM ($P< 0.05$), supplement and total DM, OM and N ($P< 0.001$), and ADF($P< 0.01$) intakes. Rams supplemented with sole and mixtures of MPTs had significantly higher daily intakes of straw DM, total DM and ADF ($P< 0.01$), OM ($P<0.05$), and N ($P<0.001$) than those supplemented with wheat bran. Significantly higher daily intakes of supplement and total DM, and ADF($P< 0.05$) OM ($P<0.01$), and N ($P<0.001$) were observed in rams supplemented with mixtures than sole MPTs. Significant treatment differences were observed in daily live weight gain ($P<0.001$), final live weight achieved and daily scrotum circumference gain ($P<0.01$). Supplementing MPTs as mixtures than as sole resulted in significantly higher daily gains of live weight ($P<0.001$), scrotum circumference ($P<0.05$) and final live weight ($P<0.01$). Mixtures of MPTs also resulted in significantly higher ($P< 0.05$) final live weight, daily live weight and scrotum circumference gains.

The results indicated that MPTs can improve basal feed and nutrient intakes better than agro- industrial by- products like wheat bran. Supplementation with mixtures of MPTs proved to be more useful than sole

MPTs in daily feed, OM and nitrogen intakes. The significant differences observed between treatments in daily live weight and scrotum circumference gains reflect inherent differences between the MPTs in their content of nutritional and ANFs.

From the results, it could be concluded that supplementation with MPTs promote better utilization of fibrous feeds than supplementation with agro-industrial byproducts like wheat bran. Moreover, supplementation with MPTs as mixtures could alleviate limitations imposed by content of anti - nutritional factors in wider utilization of sole MPTs like *A. angustissima*.

Key words: MPT, tef straw, feed intake, live weight, scrotum circumference.

Influence of Land Rights on Resource Allocation and Resource Productivity in Northern Thailand

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Problem

In Thailand, several organizations give different types of land rights documents, but most of them provide only the right to use land. This does not help to improve farm productivity and income of farmers (FEDER et al.,1988 cited by ONCHAN, 1993). As a consequence, there are two groups of farmers : farmers with full land rights and farmers without full land rights. The farmers' difference concerning the land rights may lead to different ways of access to land, using land as well as other agricultural resources and their productivity. This study was conducted in Phayao Province in Northern Thailand, where there are still some persistent problems of forest clearing for agriculture and firewood in the upland areas with different land rights availability. These problems may strongly relate to resource allocation and productivity. In this way the analytical procedure focuses on two main questions: what are the degree of differences of resources productivity's among two groups of farmers? And do factors' productivity and resources allocation vary significantly among these farmers?

Objectives

- to understand development land tenure system in Thailand.
- to analyse how limited land rights affect resource allocation and productivity of resources.

Hypothesis

Determining land tenure impact on resource allocation and productivity, the hypothesis of the study is those farmers with land title deed (having full land rights) allocate their resources better than those having no full land rights.

Methodology

A sample of 92 farmers Phayao province, Northern Thailand, is used and structured questionnaire is utilized for data collection. Three functional

forms (Linear function, Semi-Log function and Cobb-Douglas function)are applied to analyse the effects of land rights on resources allocation and their productivity. The production function model is used to examine the differentials of resources allocation and factors' productivity among land title deed owners (with full land rights) and no-land title deed owners (without full land rights). There are 8 factors to analyse in production function ; 1).Value of rice production (Baht per Rai), 2). Farmers' age (in years) 3). Education year (years) 4). Fertiliser cost (Baht/Rai) 5). Herbicide cost (Baht/Rai) 6). Insecticide cost (Baht/Rai) 7). Total labour (man-days/Rai) and 8). Rice revenue (Baht/Rai).

Conclusion and discussion

Land tenure system influences farming system through resource allocation pattern. Farmers having land title deed used labour, pesticide and herbicide more intensively than those having no full land rights.. Consequently the productivity in value of rice of the farmers having land title deed is higher than those having no land title deed. The cost of pesticide used and the output of rice are the two factors affecting rice productivity in value. The Cobb-Douglas function provided the higher value of R square adjusted and an appropriateness of significance of coefficients. It has been found out a diminishing marginal productivity to individual factors for all farmers. Additionally, some previous results showed that ownership security affected both investment incentives and the availability of resources to finance investment (CHALAMWONG (1988) and PRANEETVATAKUL (1996) summarised that those with land titles and land rights, tend to be more willing to invest, in terms of labour and cash to enhance the soil fertility than those without. Conclusion, land rights evidently influences resource allocation and land use and land management based by farmers and rural actors. As a result, this issue can guide agricultural policy maker for foreseeing that land right is very vital for farming system and sustainable land use as well as other resource allocation.

Key words: Land rights, Regression analyses, Agricultural Economics, Northern Thailand.

Cultivation of Lentinus edodes and Pleurotus ostreatus on lignocellulose substrates for fruiting bodies and animal feed production

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Introduction

Wood degrading fungi such as Pleurotus ostreatus and Lentinus edodes have the ability to convert lignocellulose containing wastes into edible mushroom and digestible material. Therefore, cultivation of wood degrading fungi has beneficial not only for human food but also for animal feed production. In this study, the use of wheat straw and sugarcane bagasse as substrates with a supplementation of wheat bran for animal feed and mushroom production was examined.

Materials and Methods

Two Indonesian strains of P. ostreatus and L. edodes were used in the present study. Fifty g of agricultural wastes (wheat straw and sugarcane bagasse) with particle size of 1 mm was placed in 1500-ml jars. The substrates were supplemented with 5, 10 and 15% of wheat bran. Substrate without supplementation was used as control. Deionized water (150 ml) was added to the jars, which were then sterilized at 121^{o}C for 30 min. Four replicates were inoculated with 3 agar plugs (diam. 7 mm) per jar, sealed with polypropylene and incubated in the dark at temperature 25^{o}C for 45 days. After the colonization period, the cultures were transferred to a light incubator (temperature $\pm$ 18^{o}C and RH 75 - 90%). The fruiting bodies were collected until 150 days. The yield of fruiting bodies was determined after drying at 105^{o}C, and was calculated as percent dry matter mass at the original substrate. During the colonization period, loss of organic matter, loss of lignin and in vitro digestibility were also determined.

Results

The L. edodes grew well on wheat straw and produced the fruiting bodies. The first fruiting bodies were formed after 86 days, but L. edodes did not produce fruiting bodies on sugarcane bagasse. The first fruiting bodies of P. ostreatus on sugarcane bagasse were formed after 57 days and 103 days on wheat straw. The time which was necessary for the first fructification decreased by the supplementation with wheat bran. The supplementation with wheat bran increased the yield of fruiting bodies of P. ostreatus and L. edodes. The yield of L. edodes growing on wheat straw supplemented with 15% wheat bran was 8.7%, as compared with not supplemented substrates (1.5%). The lowest yield of P. ostreatus (0.3%) was obtained using sugarcane bagasse and increased to 5.6% after supplementation with 15% wheat bran. The yield of P. ostreatus growing on wheat straw with supplementation of 15% wheat bran was higher (8.3%).

After 60 days incubation by L. edodes and P. ostreatus, the loss of organic matter were 23.7% and 28.4% respectively. The highest lignin decomposition occurred in substrates after fermentation with P. ostreatus (58.3%). The in vitro digestibility increased after fermentation with both fungi. The change of in vitro digestibility was higher after incubation with L. edodes (24.6%) than with P. ostreatus (11.8%).

Conclusion

The use of wheat straw and sugarcane bagasse with supplementation of rich nutrient as substrates for mushroom production is possible. The optimal level of supplementation should be examined.

Key words: lignin, in vitro digestibility, wheat straw, sugarcane bagasse

Einsatz photovoltaischer Pumpsysteme zur ressourcenschonenden Bewässerung in Ägypten

St. Rollinger, A. Hegazi, S. Algohary und J. Müller

Die Kombination photovoltaischer Pumpsysteme mit optimierten Mikrobewässerungs-anlagen stellt vor allem in ariden Regionen mit unterentwickelter Infrastruktur eine Möglichkeit zur energiesparenden Wasserförderung und verlustarmen Wasserausbringung dar. Diese Systeme konkurrieren jedoch mit dem weit verbreiteten Pumpenantrieb durch Verbrennungsmotoren. Eine in mehreren Ländern durchgeführte Studie der GTZ ergab dagegen Kostenvorteile bei PV-Pumpsystemen gegenüber Dieselpumpen bei kleineren Bewässerungsanlagen, wobei die Obergrenze je nach Projektstandort bei 2 bis 4 kW_p lag.

Im Rahmen eines bilateralen Forschungsprojektes wurde 1997 am Projektstandort in Ägypten eine Versuchsplantage mit einer photovoltaisch betriebenen Tropfbewässerungsanlage ausgerüstet, wobei das Wasser direkt, d.h. ohne Einsatz eines Hochbehälters eingespeist wird. Das Forschungsziel war vor allem die Reduzierung des Energiebedarfs durch Realisierung eines hohen Gesamtwirkungsgrads, sowie die Vermeidung von Wasserverlusten durch eine möglichst gleichmäßige und störungsfreie Verteilung. Hierzu sind zum einen die Einzelkomponenten der PV-Bewässerungsanlage selbst zu optimieren, zum anderen das System insgesamt, d.h. die Abstimmung der Komponenten aufeinander.

Bei der Wasserverteilung stehen mehrere Bewässerungsverfahren zur Auswahl. Unter der Prämisse der Wasser- und Energieeinsparung wurde ein Tropfbewässerungssystem für niedrige Betriebsdrücke konzipiert und an die spezifischen Anforderungen des PV-Pump-systems angepaßt. Vor allem in der Zeit der geringeren Einstrahlung, in der ein niedriger Förderdruck herrscht, gewinnt eine sichere Funktion des Wasserverteilsystems an Bedeutung. Auf einem Teil der Plantage wurde deshalb ein spezielles Steigrohrsystem installiert, um das Rohrnetz ständig mit Wasser gefüllt zu halten, womit das tägliche Fluten der Anlage mit der damit verbundenen ungleichmäßigen Wasserverteilung entfällt.

In einem mehrjährigen Langzeitversuch wurde die Anlage kontinuierlich vermessen und optimiert. Dabei wurden nachfolgende Arbeitsschritte durchgeführt:

- Anpassung der Solargeneratorkennlinie an die Lastkennlinie der Pumpe.
- Optimierung des Solargeneratorneigungswinkels.
- Untersuchung des Einflusses von Staubablagerungen auf die Transmissionsminderung der Solarmodule.

Bei der Wasserverteilungsmessung wurde deutlich, daß sich der Variationskoeffizient für die Tagesdurchflußmenge bei der Steigrohrseite mit 12 % und bei der konventionellen Anlagenseite mit 14 % kaum unterscheiden. Dem Vorteil der geringfügig besseren Wasserverteilung zu Betriebsbeginn stehen einige schwerwiegendere Nachteile gegenüber. Die Versuchsdurchführung am Projektstandort hat gezeigt, daß es schwierig ist, die Steigrohrkonstruktion über längere Zeit funktionsfähig zu halten, um eine gleichmäßigere Wasserverteilung zu erreichen. Durch Unachtsamkeit bei der Feldarbeit, fehlendes Verständnis für die Steigrohrkonstruktion und ungenügende Qualität des lokal erhältlichen Materials entstanden immer neue Leckagen, die für das Entweichen des Wassers aus dem Rohrsystem verantwortlich sind.

Als Bewertungsparameter für ein abgestimmtes PV-Pumpsystem wurde das Verhältnis des hydraulischen Energieäquivalents, d.h. das Produkt aus Förderstrom und Förderhöhe, zur installierten Solargeneratorleistung herangezogen. Systeme mit Werten um 0,7 m^4/W_p werden derzeit als gut eingestuft. Während dieser Bewertungsparameter zu Projektbeginn noch bei 0,49 m^4/W_p lag, konnte er auf 0,72 m^4/W_p erhöht werden. Diese Steigerung beruht vor allem auf der besseren Anpassung der Solargeneratorkennlinie an die Lastkennlinie der PV-Pumpe und der ständigen Reinigung des Solargenerators.

Das Problem der Staubablagerung auf die Transmissionsminderung der Solarmodule wurde bei den durchgeführten Messungen am Projekt-

standort verdeutlicht. Bei einer Expositions-dauer von 38 Tagen am Versuchsstandort reduzierte sich die Transmission der Solarmodule von 93,7 % auf 75,9 %. Durch die Reinigung der Generatoroberfläche konnte der mittlere Gesamtwirkungsgrad von 2,1 % auf 3,1 % erhöht werden, was einer Steigerung von 48 % entspricht.

Die durchgeführten Messungen haben gezeigt, wie sich die Optimierung der einzelnen Systemkomponenten eines PV-Pumpsystems und ihre Abstimmung aufeinander auswirken kann. Nur durch eine Wirkungsgraderhöhung des Gesamtsystems kann die Reduzierung des Energiebedarfs gewährleistet werden, die bei den PV-Pumpsystemen die Grundvoraussetzung für eine wirtschaftliche Alternative zu anderen Pumpenantrieben ist. Neben der Optimierung der Wasserförderung muß auch bei der Wasserverteilung auf eine energiesparende Lösung geachtet werden. Dabei haben die Erfahrungen und Messungen in Ägypten gezeigt, daß ein angepaßtes Tropfbewässerungssystem diese Vorgaben mit direkter Wassereinspeisung, d.h. unter Verzicht auf einen Hochbehälter erfüllen kann.

Das silvopastorale System im Norden Costa Ricas

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Ein silvopastorales System ist eine spezifische Form der Agroforstsysteme, in welchem die traditionellen Komponenten von Tierproduktionssystemen mit dem Vorhandensein von Bäumen kombiniert wird. In Costa Rica besitzen mehr als 90% der viehwirtschaftlichen Betriebe Weidebäume, die dem Vieh als Schatten dienen und z.B. Verkauf von Holz. Mehr als 75% der viehwirtschaftlichen Betriebe besitzen lebende Zäune zur Abgrenzung von Weideflächen. Obwohl mehrere Autoren die Anwesenheit von einzelnen Bäumen und von lebenden Zäunen auf Viehweiden kommentierten, bestehen derzeit nur wenige systematische Studien über die Weidebäume und über ihre ökonomische und ökologische Bedeutung in den viehwirtschaftlichen Betrieben. Ziel dieser Studie ist es, die forstliche Komponente in den viehwirtschaftlichen Betrieben in der feuchttropischen Zone im Norden von Costa Rica, zu analysieren. Die Analyse ist ein Bestandteil einer umfassender Studie über die ökonomische Bedeutung der Weidebäume in der viehwirtschaftlichen Produktion der Region.

Im Mai 1999 wurden 35 per Zufallsstichprobe gewählte Viehzüchter in 9 Zonen des Bezirks La Fortuna de San Carlos über die viehwirtschaftlichen Produktionssysteme befragt. Mit dieser Information wurde eine diskriminierende kanonische Analyse durchgeführt, wonach drei unterschiedliche viehwirtschaftliche Produktionssysteme unterschieden werden konnten: 1) gemischtes System (Milchproduktion und Landwirtschaft); 2) in Milchproduktion spezialisiertes System; und 3) Systeme der Haltung von Zweinutzungsrindern (Milch- und Fleischproduktion). Im September 1999 wurden 10 Betriebe ausgesucht, um danach detailliert die Weidebäume und die lebenden Zäune auf den Viehweiden zu unter-

suchen. Dadurch sollten die anwesenden Baumarten identifiziert und ihre Häufigkeit, Herkunft und räumliche Verteilung untersucht werden.

Basierend auf der biophysischen Analyse konnte ermittelt werden, daß die durchschnittliche Prozentsatz der Fläche mit Weiden und Bäumen signifikant größer ($p < 0.001$) in den Betrieben mit Zweinutzungsrindern (74%) war als in den Betrieben mit einem gemischten Produktionssystem (16%) und mit einer exklusiven Milchproduktion (27%). Im Durchschnitt war die Milchproduktion pro Flächeneinheit größer in den Systemen mit exklusiver Milchproduktion (14.2) und in der gemischten Produktion (12.6) als im Zweinutzungsrindsystem (4.3) ($p <0.05$). Laurel (*Cordia alliodora* (R & P) Oken) ist die vorherrschende Art in den Betrieben mit Zweinutzungsrindern. Das in Milchproduktion spezialisierte System besitzt im Vergleich zu den anderen zwei Systemen eine höhere Anzahl von nicht kommerziellen Baumarten, die aber eine größere Schattenfläche als Laurel anbieten. 85% der Betriebe besitzen lebende Zäune, wo die Baumart Poró (*Erythrina* spp.) vorherrscht. Die Prozentsatz der Zaunlänge pro Flächeneinheit von Weide variierte nur sehr wenig zwischen den unterschiedlichen Produktionssystemen.

Die in den viehwirtschaftlichen Betrieben integrierte forstliche Komponente in La Fortuna de San Carlos variiert nach dem benutzten Produktionssystem. Sie herrscht vor allem in den Systemen mit Zweinutzungsrindern vor. Die Informationen über die auf den Weiden vorherrschenden Baumarten, deren räumliche Verteilung und deren Funktion innerhalb der verschiedenen Produktionssysteme ist entscheidend zur Beurteilung der aktuellen und potentiellen Bedeutung der Bäume in der ökonomischen und ökologischen Nachhaltigkeit der viehwirtschaftlichen Betriebe.

Key words: cattle, live fences, trees in pastures, silvopastoral system

Reuse of Water in Tropical Agriculture

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(i) Waste Water from Agricultural Production

By definition, water changed in its quality by human use, is thus becoming waste water. In the tropics water is the limiting factor to crop and livestock production outside the rainy season. Intensive forms of crop production, where irrigation and draining pipes serve for the applicability of the technical definition for waste water, result often in a non point pollution impact to surface waters.
The liquid effluents from livestock production are less considered waste water but instant manure. Its handling often results in a point pollution impact to the recipients, whereas its intensive fertilizing use is contributing to both types of water pollution.
In order to reuse such waste waters, a treatment is inevitable. Here, the capacity of constructed wetlands (CW) to treat polluted surface waters will be discoursed with special reference to crop production.

(ii) Constructed Wetlands for Treatment and Production

The biotechnological method to apply CWs for water treatment is by now quite known and accepted as far as the treatment of domestic or municipal sewage is concerned. Less investigated had been the application of CWs for the treatment of other polluted waters.
The research project, which is presented here, had been short titled, ”Reuse of Water”. The work had been funded by the EU under the scheme of INCO-DC. Participants came from Austria and Germany in Europe and from the Chinese provinces of Hubei, Zhejiang, located in central China in the Yangtzi river basin, and from Shenzhen, the

neighbour region to Hongkong in the province Guangzhou, coordinated by Prof. W. Grosse, Institute of Botany, University of Cologne, Germany.

(iii) Optimizing Wetlands for Various Pollution Sources

Investigated had been the purification of polluted waters in CWs according to the elimination of carbon compounds (TOC/CSB), nutrients (N and P), microbes and biotoxins. Since quite a number crops, can grow in natural and constructed wetlands, a variety of species had been tested.

(iv) Applied Wetland System and Investigated Species

For the research work, a constructed wetland system had been optimised that makes use of flow and stagnation periods by a combination of vertical and inverse vertical flow compartments. In difference to vertical or horizontal flow reed beds, known for the treatment of domestic sewage, the CWs were layed out for a much higher hydraulic load.
In the trial stage more than 100 species had been tested for the plants suitability to grow under CW conditions, and for the wetland performance vegetated by these species.

(v) Reuse of Polluted Waters Treated in Wetlands and Crop Production

The chief impact on surface water pollution is derived from two sources. The direct discharge of untreated or insufficient treated municipal sewage and the impact of fertilizers and eroded soil particles.
Thus, water pollution of surface waters often resembles diluted sewage accompanied by high nutrient values. In turn the hydraulic load in CWs can be raised to 1,000 mm and more. The carbon compound decomposition to levels ensuring environmental standards proved feasible even with higher carbon loads. The more complex elimination of nutrients follows elimination patterns similar to those in reed beds.
With bigger waters the DOC pollution is peripheral to eutrophication, a process that provokes algal blossoms producing biotoxins harmful to fish and humans. Here, CWs have to be modified to eliminate nutrients and bio-toxins. This can be gained by enlarging the inverse flow compartments to enhance denitrification and to increase general retention time.

Different vegetation had no significant direct influence on the efficiency of treatment, which is understandable looking at the huge amount of carbon and nutrient compounds passing a constructed wetland. Nonetheless, the vegetation carries a wide range of positive effects making it essential for the function of a constructed wetland.
The investigation carried out proved CWs to be an useful tool to improve water quality of polluted surface waters to any given standard. The main application is in the field of long time water quality improvement of polluted surface waters such as ponds and lakes.
The application for crop and biomass production is best feasible in concepts integrating crop and livestock production.

Sustainable breeding methods for smallholder dairy production under unfavourable conditions in the tropics

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Problem

Population growth and changing of food patterns in developing countries lead to an increasing demand for animal products. Breeding strategies overtaken from developed countries for improving milk performance in most cases cannot be applied at smallholder level because the prerequisites (e.g. breeding organisation, information system, herd structure) often do not exist. Upgrading local breeds with exotic cattle is very common and seems to promise a quick solution. Uncontrolled crossbreeding however can lead to problems like lack of adaptation to tropical stresses of poor nutrition, disease challenge and heat stress (KAHI et al., 2000; WOLLNY et al., 1998) or genetic erosion, e.g. loss of breeds (SARMIENTO et al., 1998). Therefore sustainable breeding methods for genetic improvement of local breeds and existing crossbred cattle as well as sustainable crossbreeding strategies are warranted.

Objective of Research

The objective of this study is to develop a methodology for genetic improvement of dairy cattle at smallholder or village level, taking into account biodiversity and social aspects, and make proposals for sustainable breeding strategies for different situations.

Research question

The prerequisite for animal breeding is a basic attitude of farmers to be interested in genetic improvement of their animals and to be willing to collaborate actively for this aim. On the other side, an organisation is needed for coordination and provision of basic services. The first step for improvement is to screen and analyse local activities at farmers' and or-

ganisational level. The second step is to develop sustainable breeding organisations, the formulation of adapted breeding plans and their implementation.

Methodology and workplan

The general tasks that have to be undertaken are the following:

1. Assessment of existing activities and breeders' perception (animal recording, selection activities, exchange of breeding animals, etc.)
2. Analysis of breeding organisations, structures and tasks
3. Assessment of task efficiency
4. Analysis of breeding tasks and their efficiency
5. Derivation of appropriate breeding methods for

-Formulation of breeding programs
-Implementable breeding tasks

In this study special emphasis is given to the analysis of breeding tasks and their efficiency and the derivation of appropriate breeding methods. Given some basic parameters as breeding goal, number of base animals, herd structure, genetic parameters, different scenarios in different modules are examined:

Module 1: Bull selection (number of bulls needed when AI (deep frozen / fresh sperm) or natural mating, consequences for selection intensities):
Module 2: Performance test (proportion of cows tested, test period, accuracy, etc.)
Module 3: Breeding value estimation (use of different degrees of pedigree information a. o.)

Relevance for development

The results of these theoretical considerations will be the base lines for the derivation and implementation of breeding programs for a wide range of smallholder production systems.

Key words: Breeding methods, sustainability, smallholder dairy production

Poster/Tools
Miscellaneous Topics

Utilisation of heat for tropical stored product protection

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The application of heat is an ancient method for drying and disinfesting durable stored products. At temperatures above the optimum, mobile insect stages actively search for cooler spots, above 40°C most insects will fall into heat stupor and die sooner or later. While in some Central African countries, maize, grains and pulses are stored above the fire place, solar drying is used in many Asian, African and Latin American countries. As a physical disinfestation technique, the use of heat has the advantages of being fast in action, reliable, available, non-toxic and thus residue-free. The mode of action is simple and poses little risk to uneducated users. The risk for the development of pests resistant to heat is low. In addition, solar heat may be used at low costs.

It was reported that grain may tolerate a Chinese method of heat treatment with temperatures of 45°C for up to 5 days without significant losses in germination power or baking quality. Laboratory experiments with a variety of stored product pest insects revealed that temperatures above 50°C are lethal to stored product arthropods in even much shorter times. When insects were exposed to heat in an experimental chamber, complete mortality was achieved after 10 min treatment at 55°C for adult saw-toothed grain beetle *Oryzaephilus surinamensis* (L.), red flour beetle *Tribolium castaneum* (Herbst), as well as eggs, larvae and pupae of both the dried fig moth *Ephestia cautella* (Walker) and the Mediterranean flour moth *Ephestia kuehniella* Zeller. At 50°C, 14 min proved sufficient for complete control of adult *O. surinamensis* and *T. castaneum*.

Empty storage structures can be treated with heat, as well. A number of smaller flour mills in Germany, previously treated with methyl bromide, a fumigant that will be internationally banned due to its ozone depleting potential in the world's stratosphere, are now treated with heat, produced by electric or fossil fuel driven generators. In experimental treatments,

most critical points were found close to windows, in the external walls and in the vicinity of water pipes.

In tropical countries, solar heat generators could be used to disinfest products, storage facilities and other premises with heated air. The construction of such generators is fairly simple but could be optimised by a joint project focussing on the future production of such units by small local craftsmen, in this way helping to develop small enterprise.

Key words: disinfestation, solar heat, heat generator.

The Biochemistry of Post-Harvest Deterioration of Cassava (*Manihot esculenta* Crantz) Root Tubers

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Cassava (*Manihot esculenta* Crantz, Euphorbiaceae) is one of the most important roots crops in the world. With a production of over 150 million tons per year it is the staple food for more than 500 million people especially in the lowland tropics. Its high yield in carbohydrate, low susceptibility to pathogens and its low demands on water supply and soil quality make it very attractive to farmers, processors and consumers. But these benefits are impeded by its short shelf life after harvest. The cassava root rapidly shows signs of a physiological deterioration process that occurs within one to three days of harvest at the latest. These changes, known as post-harvest physiological deterioration (PPD), render the tuberous roots unpalatable and unmarketable. The visible coloration (black-blue colour of the vascular tissue) of the root tissue indicates a loss of its nutritional value and taste and makes the crop difficult to sell. Because of this smallholding farmers are limited in their choice of markets and have a vital interest in the improvement of the crop. A better storability of cassava may as well result in a better supply of the population in developing countries.

For the improvement of the crop it is essential to understand the histological and biochemical processes in order to identify potential means by which PPD may be controlled. Comparative evaluation of the visual symptoms of PPD in various cultivars of cassava revealed that there are differences in susceptibility to deterioration. These differences can provide breeders and biologists with the opportunity to use the genetic variability of cassava to improve the crop.

To understand the process of deterioration of cassava tubers a multidisciplinary approach is necessary. This must combine histological, biochemical, chemical and molecular investigations. Nine cassava cultivars with different susceptibility to post-harvest deterioration were analysed. Different microscopic techniques were used to investigate the processes at the wound surface of cassava roots as well to localise specific chemical compounds. Biochemical and chemical analysis were used to get information on the biosynthetic pathways involved in the process as well as to quantify compounds of interest.
Previous work on post-harvest deterioration showed that the processes involved are very similar to wound reactions described for other plant systems. But whereas in other plants (e.g. potato) these reaction may lead to wound healing the wound reactions in cassava, however, are incomplete.
A very common feature in plant defence and wound response is the synthesis of so called ”reactive oxygen species (ROS)”, like superoxide or hydrogenperoxide. This investigated showed that in all cassava cultivars hydrogenperoxide accumulated during the first 24 hours in significant amounts. The accumulation of secondary metabolites is another feature described for plant systems as a reaction to pathogen attack or wounding. For cassava many authors described increasing concentrations of diterpenes and polyphenols after harvest. The accumulation of terpenoids was not found in this investigation but an increase in favan-3-ols and hydroxycoumarins. Especially the increase in scopoletin and hydrogenperoxide together with increasing activities of a scopoletin specific peroxidase could be shown to have a great impact on post-harvest physiological deterioration. The blue-black (and still unknown) product of this reaction is the reason for the first visible signs of PPD (vascular streaking).

Key words: Cassava, Manihot esculenta, post-harvest deterioration, abiotic stress.

Integrierter Umweltschutz in der Palmölproduktion Indonesiens

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Problemstellung

Der weltweite Verbrauch an Ölen, zu denen neben den Pflanzenölen auch tierische Fette gehören, wird im Jahre 2020 mit etwa 175 Millionen Tonnen annährend doppelt so hoch sein wie heute mit etwa 100 Millionen Tonnen. In Indien und China alleine werden in 20 Jahren mit circa 50 Millionen Tonnen etwa 30% der Welterzeugung verbraucht. Dabei nimmt die Ölpalme eine unter den Ölpflanzen eine außerordentliche Stellung ein. Hauptanbauländer sind mit etwa 80 Prozent der derzeitigen Weltproduktion an Palmöl Malaysia und Indonesien, während die afrikanischen, südamerikanischen und sonstigen Anbauer hier nur eine vergleichsweise unbedeutende Rolle spielen. Für die indonesische Wirtschaft hat der Ölpalmenanbau eine erhebliche Bedeutung. So wurden beispielweise 1997 etwa 1,4 Millionen Dollar durch den Verkauf von 2,9 Millionen Tonnen Palmöl auf internationalen Märkten eingenommen, wobei Deutschland nach den Niederlanden zu den wichtigsten Importländern für indonesisches Palmöl gehört. Während in Malaysia (wegen der nur noch in begrenztem Umfang verfügbaren Flächen) eine Ausweitung des Ölpalmenanbaus kaum möglich erscheint, ist eine ständige Erweiterung der Plantagenflächen in Indonesien sehr wahrscheinlich. 1997 erreichte die gesamte Anbaufläche fast 2,5 Millionen ha. Im Mittel wurden zwischen 1993 und 1999 jährlich etwa 200.000 ha Ölpalmen – mit steigender Tendenz – neu gepflanzt.

Forschungsschwerpunkt

Ausgehend von den Überlegungen, daß Deutschland ein wichtiger Importeur von indonesischem Palmöl und damit in gewisser Weise mit verantwortlich über den Rückgang der tropischen Regenwälder und die damit verbundenen Klimawirkungen direkt betroffen sein könnte, wurde vom Bundesministerium für Bildung und Forschung über den Projektträ-

ger BEO im Sommer 1999 ein Verbundvorhaben initiiert, mit dem Thema: “Integrierter Umweltschutz in der Palmölindustrie”. Diese Herausforderung führte zu der Projektbezeichnung Ecological and Economic Challenges in Palm Oil Production (EcoPOP).
Das Ziel des Verbundprojekt definiert sich wie folgt:
Die Forschungsprojekte von EcoPOP sollen zu ressourcenschonenden, umweltgerechten und sozial verträglichen Produktionsverfahren bei der Palmölgewinnung führen, die heutigen ökologischen und ökonomischen Standards entsprechen und anhand betriebswirtschaftlicher, produkt- und verbraucherrelevanter Kriterien bewertet werden können.
Hierbei werden Verfahren und Methoden entwickelt:

- zum Ersatz der Brandrodung,
- zum verbesserten Nährstoffmanagement und eines integrierten Pflanzenschutzes,
- der Erkundung neuer Flächen mittels GIS und GPS,
- zur Verbesserung von Ernte und Logistik,
- zur Reduktion gasförmiger Emissionen wie z.B. Methan,
- zur Entwicklung von value-added Produkten, wie z.B. mitteldichte Faserplatten (MDF), elektrische Energie aus Biogas, Verbundmaterialien für die Automobil- und Baustoffindustrie oder auch chemische Inhaltsstoffe wie Tocopherole,
- zur Vermeidung von Abfall/ Abwasser, durch z.B. einen verbesserten Sterilisationsprozess und Bleicherdeeinsatz,
- zur Einbeziehung einer sozio-ökonomische Begleitforschung, wie z.B. der Einbeziehung von Marktanalysen und der Lebensbedingungen der Menschen in den unterschiedlichen Anbausystemen.

Hypothese

Potentielle Forschungsaktivitäten ergeben sich aus der Kenntnis umweltrelevanter Problembereiche der Palmölproduktion. Deren Idenditifikation sollte auf einer möglichst einfachen und nachvollziehbaren Analyse des Produktionsprozesses vom Anlegen der Plantage bis zur Raffination des Öles beruhen. Dies erfolgt am besten über eine Betrachtung der Stoff- und Energieströme im gesamten Produktionssystem erschlossen werden kann.

Konzept

Das o.g. Ziel soll mit den Ergebnissen der einzelnen Projekte in den vier Projektbereichen

- Projektbereich A: Agrarökosystem,
- Projektbereich B: Produktionstechnologie,
- Projektbereich C: Sozioökonomie,
- Projektbereich D: Stoffstrommanagement und Ökobilanz,

realisiert werden.

In die jeweiligen Projektbereiche sind die einzelnen Forschungsprojekte eingebunden, die aus den eingangs dargelegten Problemstellungen abgeleitet wurden.
Alle vorgenannten Maßnahmen müssen einer Ökobilanzierung unterzogen werden. Diese könnten sogar in ein Ecolabeling einmünden.
Das Projektmanagement von EcoPOP wird vom Institut für Agrartechnik der Universität Göttingen wahrgenommen. Dabei soll eine zusätzliche externe Projektbegleitung helfen Schwierigkeiten zu vermeiden, die mit der Durchführung eines internationalen, interkulturellen und interdisziplinären Projektes einhergehen könnten.

Ausblick

Sollte es gelingen, die von EcoPOP angedachten Lösungsansätze in naher Zukunft in die Praxis umzusetzen, sollten in Zukunft neue Wege beim “Integrierten Umweltschutz in der Palmölindustrie Indonesiens” beschritten werden können, d.h. auf das Plantagenmanagement und die Landschaftsplanung Palmölproduzierender Länder übertragen werden können.

Exhibition - Communication Methods for a Dialogue between Scientists and Farmers

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From collecting information towards the generation of shared meaning

The exhibition introduces communication methods for making agricultural research more client oriented. The 16 posters use photographs, graphics and text to illustrate selected communication methods and their use. These methods have been successfully applied to facilitate dialogical encounters between farmers and scientists in the context of international agricultural research.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has a long tradition in developing new pearl millet varieties to improve production systems in Western Rajasthan. In the last decade participation of farmers has mainly been practiced through on-farm trials. However, scientists involved in such on farm trials felt the need for a deeper dialogue with farmers in order to understand and to target their research better towards the needs of the rural communities.

Therefore the Department of Agricultural Communication and Extension (University of Hohenheim) and ICRISAT started a collaboration project (1994 - 97) focusing on development of communication methods for dialogic and effective communication between farmers and researchers. The project was funded by the Bundesministerium für wirtschaftliche Zusammenarbeit (BMZ) through GTZ.

During the three years of research a wide range of communication tools was applied and tested regarding their usefulness to discuss pearl millet

related issues (soil, seed management, etc.) with different sections (caste, gender, age, literacy, etc.) of farmers. The tools helped farmers and scientists to share their knowledge across their different communication and knowledge systems. The insights gained through such encounters led to a better understanding of the pearl millet production system and identification of ways, how international research can contribute to strengthen farmers agricultural production and knowledge system.

For further information and borrowing conditions for the exhibition please use the above contact information.

Key words: Participation, research, communication, dialogue

Machbarkeitsstudie zur Sammlung von ALTFETT und Aufbereitung zu Treibstoff in Salvador da Bahia, Brasilien

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Problem

Aufgrund fehlender, adäquater Entsorgungsmöglichkeiten und gesetzlicher Bestimmungen werden heute in den meisten brasilianischen Städten Altfett und –öl in privaten Haushalten ebenso wie in der Gastronomie in den Müll geworfen oder in den Ausguss geschüttet. Aufgrund seines hohen organischen Anteils und seines Gehaltes an extrahierbaren, lipophilen Stoffen bereitet Altfett auf Hausmülldeponien und im Abwassersystem erhebliche Probleme. Andererseits muss Brasilien trotz eigener Ölquellen Erdöl importieren. Somit stellen Altfett bzw. -öl einen sekundären Rohstoff mit hohem Energiegehalt dar, der als Kraftstoff und Heizöl einen positiven Beitrag zur Energieversorgung leisten kann.

Ziele

Das Ziel dieser Arbeit war zu analysieren, ob die Installation einer Wiederverwertungs- und Umesterungsanlage von Altfett zu Treibstoff in Salvador da Bahia, Brasilien eine sinnvolle Lösung für die Altfettentsorgung sein könnte. Bei der Felduntersuchung sollten folgende Punkte recherchiert werden: 1. Wie wird das Fett bisher entsorgt ?
2. Besteht ein Interesse in der Bevölkerung das Altfett zu sammeln?
3. Ist die Entlastung der Umwelt bei gleichzeitiger Erzeugung eines Dieselölsubstitutes und Schaffung von Arbeit möglich ?

Materialien und Methoden

Mit Hilfe eines standarisierten Fragebogens wurden Umfragen in verschiedenen Betrieben (Restaurants, Bars, Imbissen, Bäckereien, etc.) durchgeführt. Danach wurde die Grundgesamtheit von 432 Restaurants erhoben und nach einem Probelauf eine Stichprobe in 93 Betrieben,

nach dem Prinzip des ”stratified random sampling” realisiert.

Ergebnisse und Diskussion

Salvador da Bahia ist die drittgrößte Stadt des Landes. Das jährliche Potential an sammelbaren Fetten und Ölen aus der Gastronomie und den Haushalten in Salvador liegt bei ca. 4600 t.

Die anfallende Altfettmenge in den 93 interviewten Betrieben betrug rund 143 t, wobei die Menge im Jahresverlauf schwankt.

Wie die Umfrage ergab, werden in Salvador vor allem Sojaöl und Palmöl zum Frittieren und Braten von Speisen verwendet. Die Untersuchung zeigte, daß ein großes Potential an Altfett vorhanden ist, welches auch noch keinerlei Verwendung hat und zu erheblichen Umweltproblemen führt. Nur 22 % des Abfallfettes bzw. -öles in Salvador werden umweltgerecht entsorgt. Die von einem gewerblichen Unternehmen zur Wiederverwertung gesammelte Altfettmenge bzw. -ölmenge wird gegen Reinigungsmittel eingetauscht (50 l kosten somit ca. 4 DM). Der Gewerbebetrieb transportiert das Fett bzw. Öl zu einer Fabrik in Minas Gerais (1700 km), wo es zu Seife und Hundefutter verarbeitet wird. Die restlichen 78 % werden vorwiegend im Müll deponiert oder in den Ausguß geschüttet.

Das Interesse der Betriebe, das anfallende Altfett zu sammeln, ist zu rund 70% gegeben. Von diesen wiederum begründeten 83% ihre Antwort damit, dass sie behilflich sein wollten. Sie hielten es für sinnvoller, das Fett nicht weg zu werfen, wenn es noch eine Verwendungsmöglichkeit gibt. Nur 8% zeigten Interesse aufgrund ökologischer Gesichtspunkte. Das Interesse der Bevölkerung am Vorhaben des Projektes ist eine wichtige, aber nicht ausreichende Vorraussetzung für das Gelingen. Eine erste im FG Agrartechnik der UGH Kassel erstellte Umesterungsanlage ist an der Universität Santa Cruz in Ilheus, Bahia seit März 2000 im Betrieb.

Key words: Altfett - Salvador da Bahia - Biodiesel - Umesterung - Wiederverwertung

Agricultural Mining in Ethiopia and Congo-Kinshasa

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Problem addressed: Agricultural mining is the extreme degradation of available natural resources for the sake of yielding agricultural produce.

Objective of research: It was attempted to pinpoint the major factors leading to agricultural mining both in Congo-Kinshasa and in Ethiopia as well as the extent of the latter mining at provincial or regional level.

Research question and hypothesis: Shifting cultivation, which used to be sustainable under low demographic pressure, becomes uttermost destructive of the environment as soon as the human carrying capacity is overtaken as can be seen in Congo-Kinshasa. In Ethiopia, the human carrying capacity is competing with high animal stocking rates, leading periodically into a dramatic dead-end.

Methodology and workplan: Within each country the major cropping systems were identified at either provincial or regional level and quantified in terms of rotation cycle and nutrient balance.

Results and their conclusions and their relevance for development: Deforestation in Congo, between 1961 and 1994, reached a yearly level of 300000 ha whose total mineral loss could suffice to fertilise present cultivated land (5.5 Mio ha) at a rate of 38.3 kg of N, 13.5 P_2O_5, 39.4 K_2O and 18.6 MgO per ha. On average, cultivation of field will last 3 years, whereas the subsequent fallow and hence, fertility restoration, will take 7 years. Land use intensity is 1.3 crops/year on average and the Ruthenberg coefficient 30%. The whole Congolese farming system encompasses 16.8 Mio ha out of which 11.3 Mio are fallow land, 0.6 Mio permanent crops and 4.8 Mio under cultivation with rotating crops. Each

year, 1.7 Mio ha are converted into fallow and the same acreage is re-cultivated necessitating wasteful human energy. Average farm size is 5 ha out of which 0.2 ha permanent crops, 1.5 ha rotating crops and 3.4 under fallow requiring each year 0.5 ha to be broken up for recultivation. Each farm comprises less than one TLU yielding not more than 1 t of farm yard manure per year. Seven years of fallow land will restitute about 74 units of N, 25.6 of P_2O_5, 77.9 of K_2O and 27.7 of MgO in the unlikely absence of any bush fire. Yearly requirements for fertilisers amount to 20 units of N, 6 of P_2O_5 and 20 of K_2O per cultivated ha. By implementing integrated plant nutrition systems (IPNS), as advocated by FAO, yearly fertiliser requirements would reduce to only 30000 t of urea. However, in the year 2010, with a projected population of 70 Mio inhabitants, fertiliser requirements will be 295000 t of urea, 64000 t of TSP and 250000 t of K_2SO_4 if agricultural mining is to be avoided.

In Ethiopia, the environmental conditions permitted the adoption of large flocks of animals, including cattle, donkeys and horses. Except for the South-Western part of Ethiopia, dung is generally processed into dung cakes (350-500 g/unit) which are then sold, mainly during the rainy season, as house fuel in the urban areas at about 4-5 cakes/Birr. Moreover, all the cereal straw and legume straw is removed from the field for animal feeding. With the present human population and the animal overstocking the system has ruptured. Each year, cereal imports are nearing to 1 Mio of t coinciding with 16800 t of N, 9400 t of P_2O_5, 5700 t of K_2O and 2000 t of MgO. In Ethiopia, only a minute proportion of permanent crops and a very limited acreage of leguminous crops are to be found. Balancing the system in Ethiopia could be achieved by: (i) preventing the use of dung cakes which also means finding another source of revenue for the poor farmer; (ii) increasing the acreage under permanent crops; (iii) increasing the leguminous fraction in the rotation; (iv) increasing the irrigated surfaces (they only increased from 150000 ha in 1960 up to 190000 ha at present) and, (v) avoiding overstocking.

Keywords: Shifting cultivation, slash and burn

Brooding Hen for Resource Poor Women and Children

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Problem addressed:

Poultry is a major source to generate income and has been adopted by the low (untouchable) caste poor farmers with major share of women and children for long. They have been using them for household nutrition and to generate small amounts of cash income. These people keep low producing broody type local Sakini chicks, which produce 50-60 eggs per annum. If some high producing improved chicks can be introduced into their traditional production system, it may reduce poverty.
A study was conducted at the Institute of Agriculture and Animal Science (IAAS) in Rampur, Chitwan (Nepal) with the following objectives and hypothesis:

Objective of research:

1.to know the minimum days of brooding required by the local hen to accept and raise the improved, day old foreign chicks under scavenging conditions
2.to compare the weight gain and net returns from the chicks raised under scavenging conditions compared to confined conditions

Hypothesis:

1.Brooding hens accept to raise foreign chicks after certain days of brooding.
2.Chicks raised under scavenging is more economical than raised under confined conditions in small scale production system in Nepal

Methodology:

Exp. 1: Seven local Sakini hens were raised under scavenging environment. An individual laying nest was provided for each hen. At the end of the laying they were allowed to warm the nest. 8 eggs were kept in each

nest to brood. The hatching eggs were replaced at night by day old chicks (10 per hen) which were obtained from a local hatchery. The duration of brooding was 18, 12, 9 or 3 days. The 3 days brooding level was replicated 4 times, whereas the other levels were not replicated. On the following day each group of chicks with mother hen were kept under confined condition on commercial feed *ad lib.* and on the next day feed was removed and they were allowed to graze on the ground. During the grazing period on the ground, the teaching –learning behavior of the mother hen and chicks were studied.

Exp. 2: The chicks and mother hens were supplied small amount of feeds in the morning and evening up to 17 days and from 18th day onwards they were supplied only small amount of maize grit. At the same time 10 chicks were kept under confined environment with intensive management. At the age of 68 days, the weight gain and feed consumption of both chicken groups were measured. Using the local market price, the net return was calculated and compared.

Results and conclusion:

Local brooding Sakini hens accepted foreign chicks already after 3 days of brooding and raised them as their own under scavenging conditions. In 68 days, weight gain averaged 1940 g and feed consumption was 6800 g for chicks raised under confined conditions. The feed cost and return were 1.31 and 1.80 US$ respectively with 0.49 US$ net return (cost was calculated only from feed). Weight gain for chicks raised under scavenging environment was 1043 g consuming 700 g commercial feed and 2400 g maize grit which cost only 0.35 US$. The revenue and net returns were 1.78 and 1.43 US$ respectively. Therefore, improved chicks raised by local Sakini hens in a scavenging system was found more profitable than confined management with high feed input under small-scale resource poor Nepalese farmers' conditions. This preliminary study needs further investigation and verification.

Key words: brooding hen, resource poor, scavenging system, foreign chicks, profitable

Increasing crop yields while producing wood: The potential of improved tree fallow in the humid highlands of South-western Uganda.

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Problem addressed

Decreasing per capita food production and insufficient wood availability affect the livelihood of smallholder farmers in the once forested but now degraded highlands of Southwestern Uganda. Fields on bench terraces are under intensive continuous cultivation without any soil amendment to compensate for the nutrients lost through crop harvest and soil erosion. Nitrogen and a degraded soil structure due to terrace scouring, predominantly limit crop performance. Low external input strategies are needed to address these constrains to agricultural production.

Objective of research

To explore the potential of tree improved fallows in overcoming wood deficits and soil limitations.

Methodology

We investigated the potential of indigenous (*Sesbania sesban, Acanthus pubescens*) and exotic (*Calliandra calothyrsus, Alnus acuminata, Tephrosia vogelii)* tree species as improved fallow on previously degraded land. Natural fallow and continuous cropping plots were controls. Tree seedlings were planted at a density of 10,000 trees ha^{-1} in March 1996 in a randomized block design with three replications. After a fallow phase of two years, trees were harvested, wood removed while leaves and twigs were incorporated before crops were grown. Performance of crops was assessed for four seasons. Wheat (*Triticum aestivum* L. var UW0036) and Maize (*Zea mays* L. var H622 and Longe 1) were used in rotation. The effect of fallows on weed biomass and composition was assessed both in the fallow and cropping phase.

Results and conclusions and their relevance for development

Soils sampled at fallow clearance showed significant ($P<0.05$) differences between treatments in their nitrogen (NH_4^+ and NO_3^-) levels, especially on the less fertile upper parts of the terrace with highest levels for Sesbania followed by Calliandra while the continuous cropping and natural fallow plots had the lowest level. In both the fallow and cropping phases, weed biomass was higher in the natural fallow, continuous cropping and the acanthus plots than in the leguminous tree fallows. Sesbania, Calliandra and Alnus produced 27, 26, and 24 tones ha^{-1} of sun-dried firewood, respectively. Farmers preferred Alnus and Calliandra for their firewood qualities and higher farm gate prices. Green manure production from tree fallows was 5.4, 4.9, 2.2, 2.1, and 1.8 for Alnus, Calliandra, Sesbania, Acanthus and Tephrosia, respectively.

Crop performance after the fallow phase followed the trends in mineral nitrogen levels, particularly on the upper sections of the terrace. Sesbania and Calliandra plots had (up to 491%) higher wheat and maize yield across all the four seasons. However, the levels of mineral nitrogen explain only 42% of the yield differences while differences in soil physical properties are thought to be reason for much of the remaining differences. Water conductivity following fallows was found to be doubled as compared to water transmission in the continuous cropping and natural fallow plots.

The yield advantage due to fallows declined over time as nutrients continue to be removed through crop harvest and soil structure deteriorating with continued cropping.

We conclude that Sesbania and Calliandra have high potential of restoring soil fertility through nitrogen additions and soil structural improvements. The effect on soil improvement is much longer (3 to 4 seasons) than if fertilizer nitrogen was applied. The additional wood products make the system attractive to farmers. The system is currently under wide on-farm testing before dissemination recommendations are made.

The influence of working time on physiological status and working capacity of buffaloes worked on shallow and puddle land

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Buffaloes are the major source of draft power in Indonesia. Currently however, there are no recommendations on appropriate working time on different soil conditions. This research was carried out at Kebocoran central Java, Indonesia to investigate the influence of working time on physiological status and working capacity of buffaloes worked on shallow and puddle land.

Twenty four non-pregnant female healthy buffaloes, 3 – 4 years old were used. The design was a Randomized Complete Block in a factorial 2 x 2 treatment combination with three replicates. Factor A (land condition) was shallow land and puddle land, while factor B (working time) was morning at 07.00 – 09.00 and afternoon, at 15.00 – 17.00. Measured variables were physiological status and working capacity. Physiological status covered body temperature change (T), respiration rate (RR), pulse rate (PR), red blood cell (RBC) and packed cell volume (PCV). The measurements of physiological status were taken directly before and after plowing. Data were analyzed using analysis of variance.

Land condition influenced ($P<0.01$) working capacity, T, RR, and PR. Working time influenced ($P< 0.01$) T, RR, and PR. Working capacity and plowing speed of buffaloes were 508.09 ± 31.83 m²/hour, 275.90 ± 38.82 m²/hour and 1.79 ± 0.06 km/hour, 1.06 ± 0.10 km/hour working on shallow and puddle land, respectively. The T, RR, and PR of buffaloes working on puddle land were higher than those working on shallow land (1.75°C, 9.50 times/minute and 19.50 times/minute vs 1.23°C, 6.50 times/minute and 12.83 times/minute, respectively). Working capacity

and plowing speed of buffaloes were 388.88 ± 160.36 m²/hour, 395.10 ± 95.44 m²/hour and 1.41 ± 0.48 km/hour, 1.45 ± 0.33 km/hour in the morning and afternoon, respectively. The T, RR, and PR of buffaloes working in the morning were significant ($P<0.01$) higher than those working in the afternoon (1.82°C, 10.33 times/minute and 20.17 times/minute vs 1.17°C, 5.67 times/minute and 12.17 times/minute, respectively).

It is concluded that (1) Buffaloes can be worked for plowing in the mornings and afternoons , but if worked for more than two hours in the morning, high fatigue results, (2) Plowing in the puddle land requires more power than in the shallow land, (3) High change in physiological status increases degree of fatigue resulting in decreased speed and working capacity, (4) The increase in physiological status is lower in shallow land than puddle land, and higher in the morning than in the afternoon and (5) Working capacity is higher in shallow than puddle land and higher in the morning than in the afternoon. Therefore, plowing paddy fields by buffaloes should be conducted in the afternoon since the working capacity is not different from that in the morning and the fatigue degree is lower in the afternoon.

Key words: Buffaloes, plowing time, working capacity, physiological status, land condition

A Portable Field Laboratory for Management of Saline Environments and Crop Production

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I Problem Addressed

Worldwide annually about 10 million hectars of good agricultural land are abandoned due to increasing soil salinity levels, often caused by long-term unprofessional irrigation management, flooding with brackish waters, rise of saline groundwaters or re-use of treated or untreated waste waters. In most cases a reliable and efficient monitoring system could contribute to establish a sustainable utilization of salinized soils and waters, prevent economical losses and contribute to the protection of natural resources. However, the salinity monitoring is often neglected, even when considered as an important tool for a professional manage-ment of plant growth under saline conditions, as the costs for a stationary laboratory and a qualified staff for running it are high.

II Objective of Research

The objective of the presented field laboratory is to contribute to a professional management of salt affected soils, irrigation with brackish/saline waters for crop production and protection of natural resources from avoidable salinity damages by using efficient field kits and simplified methods, which are salinity specific and easy to learn.

III Materials and Methods

The box itself is Aluminium made and solide enough to be transported even under difficult conditions. It is the purpose of the following list to give an idea of the equipment and tools offered by the field lab. The components can be combined into the following groups:

- Hard-, Plastic- and Paper Ware for:
  - Soil, plant and water sampling
  - filtering and volumetric determinations
  - bottles, beakers and pipettes
  - spatulas, scissors and spoon
- Chemicals for Soil Treatment:

- Salts (Potassium and Calcium Chloride, Sodium Hydroxide)
- Acetic and Sulfuric Acid

➢ Test Kits for Quantitative and Semiquantitative Direct Measurements:
- Calcium and Magnesium
- Chloride and Nitrate
- Hydrogencarbonate and pH
- Potassium and Sulfate
- Phosphate

➢ Electronic Instruments:
- balance
- pH- and Conductometer

Some important determinations can be executed at two levels of precision, a very rapid one as a first orientation and a more precise one in case of specific importance. The definite composition of the equipment is open and may vary according to local conditions and specific needs. and will be adapted by the author after detailed knowledge of the site.

The demands on the proposed analytical methods are:
- to give reliable data with simplified working procedures
- the data must be converted and interpretable according to internationally accepted standards

The full paper will present a table which summarizes the main steps of the proposed and experienced working procedure.

IV Data Interpretation and Recommendations

The chemical determinations are not considered as an end in itself. All measurements have to serve as basic informations with respect to two major objectives including practical recommendations for:

- a sustainable production of crops under saline conditions
- protection of natural resources (soils from desertification, vegetation, quality of ground- and surface waters)

Thus all results obtained with the simplified methods of the field lab have to be converted into values that can be evaluated according to classical

international standards such as e.g.:

- water quality: EC, pH, SAR, ESP, RSC, Ca/Mg-ratio, Gypsum forming ions, Nitrate etc.
- general soil properties: texture, organic matter, colour, Carbonate
- soil degradation: EC of saturation extract, pH, SAR and ESP, Gypsum, CEC etc.
- nutrient supply of plants: N, P and K

All measurements finalize in rating tables which serve as an essential basis for practical recommendations. However we should not forget that the critical values given in various rating tables have to be considered very critical themselves as local conditions may essentially affect them. Thus it is recommended to take critical values as a first orientation only that has to be checked under local conditions before final practical recommendation are scheduled.

V International Experience with the Field Lab: Selected Studies

- Rapid Environmental Impact Assessment of three Minor Irrigation Schemes of Rajasthan/INDIA
- Training course with soils, waters and plants in the Jordan Valley/JORDAN
- Review of the present monitoring activities of SRDI related to the Coastal Salinity of BANGLADESH and salinity research activities
- Project appraisal: Protection of natural ressources of the Senegal-valley/ MAURITANIA
- Agro-pedological approach for the monitoring of soil + water salinity; valley of the Medjerda/TUNISIA
- Preparation of a desalinisation programme for selected sites around the Lac Oro/MALI
- Study on the evaluation of salinity problems in the irrigation project TINAJONES/PEROU

Key words: soil salinity, brackish water irrigation, rapid field test, fertilizer

Potential ecological and social benefits from globalisation in agriculture

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Problem:
The economic globalisation process is commonly blamed for the current 'race to the bottom' of ecological and social standards. Although a free-market type globalisation will necessarily serve the short-term interest of the wealthiest, globalisation offers a huge potential of ecological and social comparative site advantages, particularly in agriculture.

Objectives:
To outline characteristic site advantages in crop and animal production of tropical and temperate regions
To demonstrate that for maximising social welfare globally, national borders of social accountability have to be removed corresponding to free trade regulations of the WTO

Hypotheses:
The global homogenisation of input intensity and the use of comparative site advantages between temperate and tropical areas improve the efficiency of external energy and fertiliser inputs
Social benefits are higher from investments in rural areas of poor than of rich countries

Methodology:
FAO and experimental yield data are used to show examples of agricultural production systems with large comparative site advantages. Effects of changing nutrient input intensities on the global average nutrient use efficiency are modelled with standard curves of diminishing response. Transport energy costs have been ignored because they are negligible when compared to potential gains in yield differences.

Results:
The 2-times higher net primary production (NPP) in the humid tropics than in temperate regions can only be used with perennials such as sugar cane, oil palm, forages, timber or fuelwood trees, with crops having a nearly 12 months growing season such as cassava or with double cropping of paddy rice. Annual upland cereals such as maize, however, produce low yields due to a short growing period at high temperatures and are inferior to perennials in resource capture during the establishment and ripening stage. In addition, perennials are more sustainable in the tropics because in annual crops high rainfall intensities cause severe water erosion and soil organic matter decline due to a 4-times faster decomposition rate than in temperate climates. Currently, the intensive beef production in the temperate zone produces 3-times more meat per hectare than intensive pastures in the tropics when adjusted for NPP differences. However, fish yields of 1.3 t ha^{-1} yr^{-1} carcass weight in The Philippines as compared to 0.7 t beef and 1.1 t ha^{-1} yr^{-1} pork in the temperate zone indicate that the tropics have also a potential comparative site advantage in animal production with perennial forages.

Model calculations with response curves of diminishing returns showed that the average nutrient use efficiency is highest for a given global input level if all countries are fertilising at the same relative intensity. Accordingly, social benefits from investments in agriculture are much higher in poor than in rich countries. In addition, current public discussions about ‘social standards’ and ‘fair trade’ suggest that market integration of developing countries will facilitate the opening of national borders for social accountability.

Conclusions:
Agricultural globalisation offers huge ecological and social benefits due to response curves of diminishing returns (saturation effects). Paddy rice and perennial sugar, oil, forage and tree crops have a comparative site advantage in the tropics, wheat and maize in the temperate zone.

Key words: comparative site advantages, saturation effects

A Study on Fresh Milk Quality Changes From Farmer Stage, Milk Collecting Centres Until Co-operation Centre (KJUB Supraba) in Banyumas District, Central Java, Indonesia

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Farmers in small holder dairy projects in Banyumas district, Indonesia deliver their milk to milk collection centres first, which is then delivered to co-operative centres before being sold to the industry for processing. The milk available for onward transmission to the industry sometimes is rejected due to low quality.

This study was carried out to evaluate fresh milk quality from cattle (before handling), farmers (after handling), milk collecting centres (MCC), and co-operation centre stage. The parameters of fresh milk quality included the total count of bacteria, pH, shelf life and specific gravity. The species of bacteria in the fresh milk were also identified. Five milk-collecting centres were used in this survey, which lasted for one month. Within each MCC, 6 farmers were randomly selected for the study. There was only one co-operative centre and the five tankers available were used as replicates.

At farmer level, milk samples were collected each morning after milking for seven consecutive days, while at the MCC and co-operative levels, samples were collected twice in the morning. The milk was analyzed for total bacterial count, pH, shelf life, specific gravity, and kinds of dominant bacteria. The data were analysed using one way classification which is similar to a Complete Randomised Design. Least Significant Difference (LSD) to test for significance of treatment means were computed.

The results showed that the fresh milk quality in Banyumas district was of satisfactory value. The total count of bacteria increased significantly from the cattle stage (125.73 x 10^{-3}/ml milk), farmers stage (174.90 x 10^{-3}/ml milk), MCC (383.30 x 10^{-3}/ml milk) until the co-operation stage (1010.40 x 10^{-3}/ml milk). Shelf life significantly decreased from cattle stage (684.93 seconds), farmer stage (667.4 seconds), MCC stage (406.5 seconds) until co-operation stage (305 seconds). There was no significant differences (P > 0.05) in pH (Cattle stage 6.60, Farmer stage 6.60, MCC 6.55 and co-operation centre 6.52) and specific gravity of fresh milk (Farmer 1.0271, MCC 1.0262 and co-operation centre 1.0261). *Streptococcus sp*. and *Staphylococcus sp*. were the dominant bacterial species found in all places.

To improve milk quality in Banyumas district of Indonesia, at small holder producer level, the farmers should be trained on proper handling of milk.

Key words: Indonesia, smallholder milk production, milk handling quality.

The Influence of *Sauropus androgynus* (L.) Merr. on Population of Secretory Cells and Synthetic Activities in the Mammary Gland of Lactating Sheep

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The leaves of *Sauropus androgynus* (SA) plant can stimulate milk production in lactating ruminants. It has however not been established if the SA leaves influence milk synthesis process through improving the population of secretory cells and synthetic activities in the mammary gland or through an improvement in the nutrient supply to the mammary gland.

This experiment was carried out to determine the influence of either the powder from SA leaves (SAp) or SA leaf alcohol extract (SAx) on population of secretory cells (as indicated by total deoxyribonucleic acid, DNA) and synthetic activities (as indicated by total ribonucleic acid, RNA) in the mammary gland, and its effect on milk yield.

Thirty-five lactating ewes were divided into five groups and fed with concentrate and dry elephant grass for 35 days. The groups were given SA leaf extract solution at 1.89 g/day orally twice a day (SAx-group; 10 ewes), SA leaf powder solution at 7.44 g/day (SAp-group; 10 ewes), distilled water (control-group; 10 ewes), and untreated (5 ewes). Milk yield was measured. After 14 and 35 days, the ewes were slaughtered to isolate half of the udders. The DNA and RNA of mammary glands were determined by the *p*-nitrophenylhydrazine and by orcinol reactions, respectively.

SAp and SAx administration increased total milk yield for 35 days by 7.75 % and 0.89 % ($P>0.05$), respectively compared to the control (17.89

litres). The mammary cell numbers (total DNA) and synthetic activities (total RNA) were also increased significantly ($P<0.05$) by SA leaf administration for 14 days. The SAp administration had a higher contribution to the increase in total DNA and RNA than SAx administration of respectively, 72.84 % vs 25.93 % in DNA and 112.97 % vs 47.28 % in RNA, compared to the control values of 0.81 g in total DNA and 2.39 g in total RNA. The possible reason of the biological effects is that the active substances in the SA leaves might modulate endogenous lactogenesis and lactation hormones. Further studies should be carried out to identify chemical substances in the SA leaves, which play an important role directly or indirectly in milk synthesis.

The enhancement of milk yield in the lactating mammary gland can be due to the increase in the population of secretory cells (total DNA) and the synthetic activities (total RNA). The higher contribution on the biological effect occurred from SAp administration than SAx administration. Further study on the influence of the SA leaves administration on the improvement of nutrient supply to the mammary gland needs to be conducted.

Key words: *Sauropus androgynus*, milk synthesis, DNA and RNA