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Research for Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia

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Interdependencies Between Upland and Lowland Agriculture and Resource Management

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Preface

Uplands are extremely important and highly vulnerable ecosystems. They operate as storage for fresh water and energy, provide a high degree of biodiversity and act as a significant provider of food for local people. They are at the same time under severe and increasing pressure caused by high population growth, immigration and resource exploitation, thereby contributing to poverty and food insecurity in rural areas. Looking at entire watersheds, the environmental and socioeconomic interdependencies between uplands and lowlands play a key role in preserving natural resources, reestablishing stable ecosystems and developing sustainable land use and livelihood concepts in those regions.

Interdependencies between uplands and lowlands in mountainous regions pose a particular challenge to agricultural and environmental research. The Uplands Program has been taking on this challenge since the year 2000 as a research program funded by the DFG as “Sonderforschungsbereich 564”; it addresses environmental sustainability, agricultural productivity, poverty and food insecurity. Research locations are the uplands of northern Thailand and northern Vietnam. In both countries the project cooperates with universities and research institutes as research partners.

After eight years of interdisciplinary research the Uplands Program organizes their third international symposium “Uplands 2008” in April 2008 in Stuttgart-Hohenheim, Germany. It intends to provide a forum for exchanging research experiences and results and viewpoints on interdependencies between upland and lowland agriculture, resource management and livelihoods with the international scientific community, development practitioners and students of development. The conference provides a multi- and interdisciplinary platform for scientists, natural resource management professionals and development experts on a wide range of environmental and socioeconomic topics addressing methodological, empirical research and integrated modeling issues.

The organizers look forward to stimulating exchanges of information, experiences and innovative ways of looking at upland – lowland interdependencies.

With best wishes for a successful symposium

The Organizing Committee
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Keywords: poverty, environment, upland-lowland linkage, and rice landscapes

EXTENDED ABSTRACT

Promoting sustainable development in uplands of south-east Asia poses important challenges. These upland areas are remote, and are mostly inhabited by ethnic minorities. The incidence of poverty in these areas is very high. To meet their livelihood needs, upland farmers often use unsustainable land use practices. Uplands are essentially caught in a vicious cycle of poverty, food insecurity and environmental degradations. Land use practices in uplands not only degrade the very resource base upon which the livelihoods of upland farmers depend, they also negatively impact on the livelihoods and resource base downstream. Wider environmental impacts also occur in the form of reduced biodiversity, reduced ability of the ecosystem to regulate the streamflow and reduced carbon sequestration.

Despite the increasing attention being given now for upland development, a slow pace of progress can be traced to the failure to recognize and adequately utilize the strong linkages that exist between upland and lowland areas. Often, the development interventions have been piecemeal and focused on tackling the issue of upland on its own, without giving due consideration to the important biophysical, economic, and social linkages that exist between upland and lowlands.

Upland and lowland areas have distinct characteristics, resources and production opportunities. This natural diversity enables them to produce wide range of resources, services and products, which forms the basis for complimentary economic links between the two ecosystems. While the physical resources such as water and soil move down the gravity gradient from upland to lowlands, economic resources flow in both directions.

The upland-lowland interrelationships can be described in terms of ecological, social, economic and political dimensions. The ecological dimension includes a range of natural resources, such as topography, soil, water, climate, forest, biodiversity, and aesthetic aspects of the landscape. Uplands are usually rich in natural resources and provide a wide range of environmental services to lowlands. Resource use and flows between uplands and lowlands are tightly linked. Proper exploitation of this linkage provides a major opportunity for an inclusive and sustainable development of upland and lowland.

For example, increasing the production of food crops in lowlands can relieve the pressure to intensify food production in fragile upland areas. Increased employment of upland people in lowlands and promotion of markets for upland niche products in lowlands provide opportunities for increasing the income of upland population.

Rising population pressures, increasing land use restrictions, emerging opportunities for commercial agricultural production and tenure insecurity are some of the major drivers resulting in unsustainable use of land and land degradation in fragile upland areas of south-east Asia. The paper provides an overview of the role of these
broader “macro” factors in determining the land use practices in uplands and how these are influenced by upland-lowland linkages. A simplified typology based on market access, population pressure and household resource endowments is developed and applied to describe the nature of transitions of agricultural land use systems and the likely impact of such transitions on land degradation in uplands of south-east Asia. It is shown that sustainable use of resources in uplands can be better achieved through approaches that utilize the biophysical, economic and social linkages that exist between upland and lowland areas. A “landscape” management approach whereby interventions for food productivity enhancements are targeted to favorable parts of the landscape is considered potentially effective for reducing the intensification pressure in fragile sloping lands. In the context of rice farming in uplands of Asia, this implies concentrating efforts to increase the productivity of rice in lower slopes, terraces and valley bottoms where rice yields tend to be higher than in steeply-sloping fragile areas. An increase in the productivity of rice, a major staple in Asia, can be an important entry point for breaking the vicious circle, for providing options for income growth that are founded on household food security, and for inducing land use changes that result in environmental protection at the landscape level.

The concept of rice landscape management, which is based on proper utilization of upland-lowland linkages, is applied to explain the transformation of upland agricultural production systems in Yunnan, northern Vietnam and northern Thailand. There is ample evidence that land use changes that have taken place in these areas have resulted in an overall improvements in resource conservation while raising farmers’ incomes and improving the household food security. Increased food productivity has played a critical role in initiating these broader changes in land use although several factors, including policy support, have also been important.

The application of this approach in an on-going research program in the context of rice-based systems in sloping uplands of Laos and Vietnam is discussed. The research results indicate that there are now good opportunities to raise the productivity of food production in uplands substantially and thereby reduce the overall pressure to intensify the most marginal and erosion-prone areas for food production. These opportunities include not only improved rice technologies that are now available but also institutional progress that has been made in promoting community participation in planning and use of natural resources. Some of the preconditions for the success of such an approach and environmental issues that might arise are discussed and potential interventions for addressing such concerns are outlined. Given the substantial environmental services provided by uplands, mechanisms including various ways of compensating land users for environmental services are presented and discussed.
The Need for Integrated Approaches in Sustainable Land Management

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KEY WORDS: sustainable land management; transdisciplinarity; communication

Interdependencies between uplands and lowlands are complex issues reflecting a mix of biophysical energy and matter flows, and equally important political, economic and socio-cultural interrelations. Many of these issues are and were already addressed by research; however, most of them in a highly disciplinary manner and separate from one another. Depending on the scientific realm under which the respective research is conducted projects mostly focus either on environmental issues such as soils and water, or on economic relations, or on social aspects, for example. A wealth of research results has thus been generated for a huge variety of research questions. But how much of this knowledge is actually applied to improve policies, to design development strategies, or to implement technologies that are simultaneously technically feasible, environmentally friendly, economically viable and socially acceptable?

An example from the highlands of Ethiopia may visualise the challenges. Between 1981 and 1998 the Soil Conservation Research Programme established seven research sites monitoring climatic, land use, production, soil erosion and runoff data at different scales, supplemented by socio-economic surveys. After more than 25 years it becomes obvious that the research results and outcomes are being used, for example, when specifying agricultural and resources management rules and regulations, and in technology development. But despite the general satisfaction about the usefulness of this research the impression remains that the science-society interactions could have been more rapid and more effective.

Today, 80% of Ethiopia’s population is still working in the primary sector, i.e. mainly in agriculture. Since the population increased from 26 million in the 1970s to over 75 million by 2006, farm sizes have dropped below 1 ha per household, and the pressure on the land results in considerable degradation of the natural resources as the basis for rural livelihoods. It is obvious that a simultaneous improvement of livelihood opportunities and the maintenance of ecosystem services cannot be achieved in the agricultural sector alone. This example from the Horn of Africa may not be a unique case. Despite all efforts in research and development over the past 50 years, and despite all positive accomplishments in selected sectors the long-term goals such as environmental sustainability and poverty eradication were not achieved and are still on the agenda. In the mean time they are known as the millennium development goals, which at least reflect a political will to set priorities of global relevance.

If researchers – as one out of many societal stakeholder groups – wish to play a more effective role in moving society towards a more sustainable development, the question raises what research approaches are more appropriate than the current ones, and how could interrelations and communication with other societal actors be optimised? A potentially suitable research approach is described by the term “transdisciplinarity” (td). Td involves a more intense mutual exchange between “science” and “society”, while “science” is understood as interdisciplinary science engaging
natural science/technical disciplines and social science/humanities at the same time. In short, td means true interdisciplinarity and true participation of society in the research process.

Inter- and transdisciplinary research projects and programmes currently conducted by the Centre for Development and Environment at Bern University (CDE) are trying to explore the potential and limitations of this approach. The common denominators of these td projects are:

- Research focusing on a societal problem and thus a research topic of societal relevance;
- the simultaneous consideration of three sustainability dimensions by addressing environmental (biophysical), economic and social parameters;
- research teams including natural and social scientists who jointly define their conceptual framework;
- the link to, and use of, previous basic and applied research and existing data bases (e.g. regional climatic and population data, models, etc.);
- the involvement of non-academic stakeholders at an early stage of research, if possible already during the formulation of the research question/hypothesis; and
- innovative mechanisms of mutual exchange between researchers and other actors while the study is ongoing – in contrast to communication through publication, which mostly takes place when research is finalised and cannot be adapted anymore.

The most important advantage of td research is the intense exchange of experience even before final results are available. Transparent communication helps to build confidence of non-academic stakeholders in the usefulness of research. Joint field work is an excellent means of developing mutual appreciation for epistemologies, research approaches and methodologies other than those of the own scientific discipline. Beside these potentials of td research there are also some major challenges ahead. Td research in general and the participation of non-academic actors in particular are time-consuming and, therefore, challenge individual scientists as well as current academic structures, rules and procedures.

Td research in sustainable land management (SLM), for example, addresses societal problems, demands and interests that can change quickly. Thus, SLM research requires a degree of flexibility that may conflict with individual scientific interests and career building, but also with the current modus operandi of proposing, structuring and funding research. An individual soil scientist can neither conduct social instead of soil surveys, nor can he/she continuously modify a sophisticated experimental design. Only an interdisciplinary team can cope with changing societal demands to a certain extent. Frequent interaction with other actors can put individual researchers under pressure since the current academic reference system focuses mainly on producing peer-reviewed scientific papers, and does not value other ways of communication. In addition, for many researchers it is not easy to communicate with non-academic actors, because the development of social competences and communication is not part of standard university education.

Integrated approaches such as inter- and transdisciplinary research require new ways of thinking. Unlike already established academic structures, the effectiveness of new approaches will have to be proven in terms of their benefits for both, science and society.
Rapid Hydrological Appraisal: two case studies in integrating knowledge of watershed functions in Indonesia

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**KEY WORDS**: hydrological modelling; local knowledge; rapid environmental service assessment; watershed function

**WHY RAPID HYDROLOGICAL APPRAISAL?**

Increasing awareness of the importance of maintaining watershed functions has triggered various form of initiatives including providing incentives for people in upper watershed areas to protect watershed functions (Landells-Mills and Porras, 2002). It is known that land use can significantly affect watershed functions such as water quality, water flow, erosion control and sedimentation in downstream areas. However, to develop an effective reward mechanism requires clarity on relations between land use and environmental services that are of sufficient value to become the basis for reward mechanisms (Wunder, 2004). Rapid Hydrological Appraisal (RHA) is a tool that aims to provide such clarity, providing answer on (i) how the watershed function is provided, (ii) who could be responsible for providing this service, (iii) how watershed function is being impacted upon at present, and (iv) how rewards can be channeled to effectively enhance or at least maintain the function (Jeanes et al., 2006).

The approach is based on the following activities that can be carried out in less than 6 months: (1) land cover/land use change analysis, (2) exploration of stakeholders’ local knowledge on hydrological functions, water movement and consequences of land use options on the landscape, (3) analysis of existing hydrological data and (4) modelling watershed water balance including scenario analysis of plausible land cover change and their likely impact on watershed functions.

**APPLICATION OF RHA APPROACH**

The RHA approach was applied in two contrasting watersheds in Indonesia: Talau watershed, Belu-East Nusa Tenggara and Kapuas Hulu basin, Kapuas Hulu-West Kalimantan (Table 1; Figure 1). Talau is a small watershed located in dry climatic region with strong seasonal difference in rainfall, causing water scarcity problem or low flow during dry season. The landscape water balance (Figure 2) estimated using the GenRiver model (van

![Table 1. Site characteristics of Talau and Kapuas Hulu watershed](image-url)

<table>
<thead>
<tr>
<th>Site characteristics</th>
<th>Talau-Belu</th>
<th>Kapuas Hulu</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub-catchment area</strong></td>
<td>720 km²</td>
<td>9800 km²</td>
</tr>
<tr>
<td><strong>Total rainfall</strong></td>
<td>1600 mm/year</td>
<td>4100 mm/year</td>
</tr>
<tr>
<td><strong>Main land cover</strong></td>
<td>grassland (66%)</td>
<td>forest (90%)</td>
</tr>
<tr>
<td><strong>Water use</strong></td>
<td>Farming, household consumption</td>
<td>Household consumption, transportation</td>
</tr>
<tr>
<td><strong>Main issues for local people</strong></td>
<td>Scarcity of water for farming and consumption</td>
<td>Stable river flow throughout the year for transportation</td>
</tr>
<tr>
<td><strong>Main issues for policymaker</strong></td>
<td>Soil erosion/degradation, water distribution</td>
<td>Water quality (impact of mining and logging)</td>
</tr>
</tbody>
</table>

International Symposium 2008, Stuttgart, Germany
Interdependencies between Upland and Lowland Agriculture and Resource Management
Figure 1. The location of RHA studies in Indonesia.

Figure 2. Estimated annual landscape water balance for the two watersheds with land cover scenarios of current situation (Baseline), with complete (Forest) or partial (Agroforestry) tree cover and with full coverage by agriculture systems (Crop).

Noordwijk et al. 2003), showed that around one third of annual rainfall was evaporated and another one third was captured by the soil and drained to the river as low flow. Around 21% of rainfall was translated into run-off. Exploration on the impact of land use changes on annual water balance (Figure 2) revealed that adding trees on the landscape through reforestation or agroforestation will only increase evapotranspiration, decrease run-off but will not increase low flow. Therefore, development of reward mechanism in the area should involve farmers group and be based on soil conservation programme (to prevent erosion and run-off) and water harvesting. Kapuas Hulu represents a typical pioneer landscape where environmental degradation is mostly due to large scale operators (mining, logging). Population density is low and land use activity by smallholder hardly affected the landscape, yet. The estimated landscape water balance, showed that at overall basin level, Kapuas Hulu is still able to maintain its watershed function, particularly in maintaining river flow. Stakeholders concern over the impact of forest loss on watershed functions were not able to be corroborated through field visits or secondary data. Reward mechanism in this situation should focus more on avoiding degradation of environmental services and can be link to activities that can support local community in controlling and managing the landscape and its existing natural resources. Community based water and river monitoring is important to ensure data exist for conditionality of reward mechanism.

The contrasting two study cases showed the ability of the RHA approach to be applied in a wide range of situations. The outputs of RHA are useful information to help bridging the gap of knowledge between stakeholders, as well as creating a basis for buyer, seller and brokers to discuss realistic, voluntary reward mechanisms.

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The highlands: a shared water tower in a changing climate and changing Asia

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KEY WORDS: Climate Change; Highlands; Hydrology; Ecosystem Services; Asia; Uncertainty

THE ASIAN WATER TOWER

The highlands of Asia have an average altitude of 4000 masl; and they extend from an altitude of 3000masl to include the whole of the Tibetan Plateau and most parts of the Pamir Plateau. The highlands contain the most extensive areas of glaciers and permafrost outside high latitudes. The region is often referred to as the ‘Asian water tower’: the source of Asia’s nine largest rivers, the waters of which sustain over 1.3 billion people. The highlands of Asia have been ignored in comparison to other natural ecosystems, even though history has shown that when ecological change takes place in the highlands, changes soon follow in the valleys and in the lowland plains. The importance of highland-lowland linkages in this region points to the need for integrated water resource management for human livelihoods, ecosystems, and economic development. One way forward is to move past realist frameworks of analysis and step forward to paradigms of ‘sharing benefits, not just sharing water’, ‘sharing risk management,’ and ‘sharing costs to support ecosystem services’ at local, national, and transnational level.

CLIMATE CHANGE IMPACTS

The impacts of climate change are superimposed on a variety of other environmental and social stresses in mountain ecosystems, and many of them have been recognized to be severe and to cause uncertainty. Key impacts of climate change on the highlands include glacier retreat, shortage of fresh water, natural hazards, soil erosion, ecosystem degradation, and land desertification. The supply of fresh water, or the snow and ice meltwater component, in large river basins is projected to increase over the following decades as perennial snow and ice decrease. Later, however, most scenarios suggest a decrease, even of catastrophic proportions, by the 2050s. The greatest challenge in the highlands of Asia is the very limited monitoring or understanding of the thresholds and cascades of climate change on the cryosphere, hydrosphere, biosphere, and on human society in the vertical dimension from highlands to uplands and from lowland plains to coastal areas. Impacts on water resources will differ depending upon the importance or influence of different sectors; and between forestry, agriculture, industry, ecosystems, or mitigation measures to reduce water-induced hazards. There are substantial variations within as well as between these sectors in different countries and valleys. Meanwhile, climate change is superimposed on a variety of other environmental and social stresses that cause uncertainty and lead to contradictory perceptions.

COMPLEX RESPONSES

The extreme topographical variation in the region means that the broad predictions of global climate change - especially the emphasis on shifts in mean temperature – inadequately account for important regional complexities across the mountain plateau region. Complexities arise from interactions among different cold climate elements – freeze-thaw and peri-glacial processes, snowfall, valley wind systems, avalanches, glacial processes, and
seasonal or spatial balance between frozen and liquid precipitation, albedo, and evaporation. Not only are they likely to change with general climate shifts, but also interactions among them can buffer, exaggerate, or redirect the impacts of change in any one element.

Equally critical are issues related to the structure, processes, and resilience of ecosystems or biosphere and human adaptations to them, especially given that ecosystems and humans are possibly already stressed by adaptation to topo-climatic diversity. In general, local impacts of the climate do not follow single or simple paths, whether in terms of plant ecology, stream hydrology, erosion and sedimentation, extreme events, or human activities.

DEALING WITH COMPLEXITY AND UNCERTAINTY

The relationship between climate change and the cryosphere on the Tibetan Plateau is not sufficiently understood to drive detailed policy responses. Three suggestions to develop the conditions required for informed policy choice are: a) integrated research to understand highland complexities and reduce scientific uncertainty; b) promotion of regional cooperation and science-based dialogue to regulate blue, green, and virtual water flows; and c) building of social resilience and offsetting lack of knowledge of diverse human and ecological conditions by actively involving local communities, and allowing their knowledge, innovations, practices, and concerns to inform understanding and help direct responses.
Effects of „ENSO-events“ and rainforest conversion on water resources in Central Sulawesi (Indonesia)

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KEY WORDS: Tropical deforestation; ENSO Central Sulawesi; hydrological modelling; mesoscale catchment, water balance

The El Niño/ Southern Oscillation (ENSO) phenomenon is the strongest known natural interannual climate fluctuation. The two most recent extreme ENSO events during 1982/83 and 1997/98 had severe impacts on major parts of Indonesia’s socio-economy. Climate variability is not homogeneous therefore negative precipitation anomalies by ENSO events differ in magnitude and duration across the individual regions of the Archipelago of Indonesia. Understanding the hydrology of humid tropical catchments is an essential prerequisite to investigate the impact of climate variability. In combination with the quantitative assessment of future water resource changes, knowledge on hydrological consequences of “ENSO-events” is an essential part to develop mitigation strategies with rural households on a catchment scale. The results can be integrated into long term Integrated Water Resource Management (IWRM) strategies. Additionally, land use change by forest conversion alters the components of the water cycle in catchments of Indonesia. Rainforest conversion predominately into annual cultures and cacao-systems was intensified in Central Sulawesi during the last decade. The general objectives of STORMA (DFG-project) and IMPENSO (BMBF-project) are to investigate and quantify the impact of ENSO induced climate variability and forest conversion effects on the water balance of a mesoscale tropical catchment and the implications for water resources.

The mesoscale Palu River catchment (1°20’S, 21°01’E) is located in Central Sulawesi, Indonesia and covers an area of 2694 km². The topography of the catchment varies from 0 - 2500 m a.s.l. ENSO years are characterized by reduced precipitation from July to October, which represents the dry period due to the monsoonal setting of Central Sulawesi. Common problems in mesoscale hydrological modelling in developing countries are insufficient time series of input- and output data and insufficient spatial data resolution. For the Palu river catchment only one Indonesian climate station and two automatic stage recorders from the Forestry Department of Palu for two subcatchments existed at the beginning of the IMPENSO-project. Therefore a monitoring program with a network of six automatic stage recorders and eight additional climate stations have been added in August 2002 to the existing STORMA climate stations. Data collection started in September 2002 and the operation of the measurement network is still running. Topography, land use type and soil types are required spatial data to run the water balance model WASIM-ETH.

The Digital Terrain Model (DTM) was generated from digitised contour lines (TK 50) with the SAGA software (System for Automatic Geoeological Analysis) with a grid cell size of 50 m. The main land use classification was derived from a LANDSAT-ETM+ classification from 2001 and 2002 (maximum likelihood and object oriented image classification, resolution 30 m). The main problem was the coarse scale of available soil maps (1 : 1 Mill.) and lumped representation of soil data from STORMA (isolated small areas). Therefore a more general topographic and knowledge based approach has
been applied, that classifies potential homogenous areas (PHA) with morphometric terrain factors [Böhner et al. 2002, Leemhuis 2005]. The parameterisation of soil hydraulic properties was done with a combination of measured soil hydraulic properties by Kleinhans [2004] in an experimental small headwater catchment (Nopu 2.3 km²) which was used as representative transect for the PHA’s. By varying the input for saturated hydraulic conductivity the achieved modelling results was compared with measured discharge and with calibration of kₘ an effective soil physical parameter set for eight PHA’s was established.

The simulation of the water balance with WASIM-ETH was performed for the period from Sept. 2002 to Sept. 2004. The lower and upper limits of the adjustable parameters were determined based on the first calibration runs. Thereafter the automatic parameter estimation model PEST was used. The model was calibrated for three different time resolutions: daily, weekly and exceedance flow duration curve. The performance of the flow duration curve indicates that the baseflow is simulated well. Concerning the temporal resolution model efficiency [r² a. Nash & Sutcliffe, index of agreement a. Willmot] increased with coarser temporal resolution which is related to the smoothing of extreme daily values (convective precipitation events). Good modelling results exists for varying catchment size (from 79 km² test catchment to Gumbasa catchment 1275 km²). The analysis of weighted residuals to assess parameter uncertainties indicates that the hydrological model itself is consistent and can be used for tropical regions.

The implications of possible future climate and land use conditions on the water balance of the Gumbasa River sample catchment were assessed by a scenario analysis, which simulated a sequence of possible future events. The simulation results of the impact of forest conversion up to an elevation of 1200 m.a.s.l. into annual crops (like e.g. maize) and perennial crop (cacao plantations) shows different increase in the total annual discharge with +11% (annual crop) and +6% (cacao plantation). Main contribution is the increase of the monthly high water discharges, whereas low water discharges (dry season flow) demonstrates a moderate monthly rise (“low flow problem” a. Bruijnzeel 2004).

The main results of the scenario analysis for the ENSO effects are:
(1) that ENSO anomalies of precipitation lead to an increase of discharge variability.
(2) that catchment characteristics have a major influence on the impact of ENSO anomalies.
(3) that strong ENSO-events (El Nino) lead to 20% reduction of the water yield and annual crop scenarios showed a 30% increase in river discharge with high increase in overland flow and flooding risks.
(4) that ENSO-events (El Nino) decrease the potential (flooding) area of paddy rice cultivation to one third in the second half of the year.

REFERENCES
Rainfall-runoff relation in a mountainous watershed in Northern Thailand: An approach towards understanding losses of agrochemicals to stream waters

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KEY WORDS: hydrograph, rainfall intensity, response time, transport of agrochemicals, modeling

Growth of population and intensified agricultural land use in the uplands of northern Thailand has caused an increasing input of agrochemicals to the soil. The accompanying losses of agrochemicals to streams in the uplands directly affect the water quality in the lowlands. To study the impact of land use on agrochemical losses in the region we simulate the transport of agrochemicals in the Mae Sa watershed using the SWAT model (Soil and Water Assessment Tool) driven by different discharge volumes and land use scenarios. The focus of the present paper will be on the first steps towards model development. We studied the relation between rainfall input in the upland area and the runoff in the downstream part of the watershed. The study site is located in the mountainous areas close to Chiang Mai. The watershed is characterized by steep slopes and narrow sub-basins with mainly mixed evergreen and deciduous forests. The cultivated area is dominated by flower and vegetable production with a growing number of greenhouses. Discharge was measured at three stations along the Mae Sa River. One station was installed at an upstream position and another one was operated at the outlet of the basin, where the uplands is merging into the lowlands. In addition a flume was operated in one of the tributary basins. Furthermore the spatial distribution of rainfall input was monitored using twelve automatic rain gauges distributed over the entire area of the research basin. Rainfall data were analyzed for intensity and duration and its relation with the discharge volume. The hydrographs were analyzed for peak flow, volume and delay time. The analysis of the spatial distribution of rainfall shows, that there is a high variability in occurrence and duration of single events, especially along the higher elevation bands. The discharge data point to a quick response of the streams on rainfall input. The results are used to estimate the residence time of agrochemicals in the stream water. As the concentration is attenuated by natural dilution process higher flow rate means lower risk for contamination in the lowlands.

The streamflow components will be determined soon, using data on hydro chemistry, electrical conductivity and temperature. With these data, it will be possible to identify preferential flow paths relevant for transport of agrochemicals.
The Role of Pedodiversity for Ecosystem Functioning (Biodiversity) and the Impact of Historical Land Use in Grassland Ecosystems

GRUENDLING, Ralf & SCHOLTEN, Thomas

Key-words: pedodiversity; Periglacial slope deposits; nitrogen mineralization; land use history; montane European grasslands

In montane European grasslands the interrelationship of land use change with plant and soil parameters in terms of mechanisms of biodiversity and sustainability were investigated within the framework of the BIOLOG-DIVA cooperative project of the German government. The main objective of the soil science working group is to figure out relations between pedogenetic diversity, soil properties, and biodiversity. The presentation will present first results from 19 test areas at the Thüringer Schiefergebirge/Frankenwald situated along the boundary of Thuringia and Bavaria in the eastern part of Germany.

The bedrock as precondition for soil developing consists of silt (clay) slate, greywacke and quartzite. The climatic conditions in the investigation area are rather damp with low average temperature (4.6°C in the top regions). The precipitation depends on the intense structured relief (1000 to 1350 mm precipitation per year).

The pedodiversity in the study area covers a wide range of Cambisols. Diversity exists in thickness and specification. The spectrum of soil forms includes Haplic Cambisols (skeletal) with high stoniness, Haplic Cambisols and Stagnic Cambisols. The diversity in soils is mainly due to different accumulation of carbonate-free loess and the position in relief. A first anthropogenic-induced alteration of the soils is caused by long-term agriculture. Soil erosion and colluviation can be proved. Periglacial slope deposits determine the site properties of the grassland vegetation largely.

The nitrogen mineralization increases with increasing temperature to a maximum in July. The decreasing mineralization in September is the result of both decreasing temperature and high plant assimilation of nitrogen in summer. An influence of nitrogen mineralization on biomass production and species richness is barely existent. Thus, nitrogen is not a limiting factor for plants on grasslands in the research area.

The role of these conditions for the grassland ecosystem in a low mountain range will be discussed based on temporal and spatial statistical analyses. Ecosystem parameters will be related to pedodiversity and land use history. Some aspects of main influencing factors are presented in relation to climate conditions as well.
Cattle keeping in northern mountains of Vietnam—depending on lowland and highland local resources

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KEYWORDS: cattle production; lowland; highland; northern Vietnam

INTRODUCTION
In Vietnam, about 90% of the total cattle population is raised in household farms (GAIN, 2006). The current cattle production system relies on a high level on local knowledge concerning animal health, animal feeding and breeding and is not output oriented (MRDP, 2001). The potential for beef production is considered to be high in mountainous regions where land is available for improved pastures (Middleton, 1998). However, the potential of indigenous species of animals and forage plants was not studied in depth and scarce attempts were made to preserve them (Tulachan et al., 2000). Farms under different conditions have to be analysed for their suitability, efficiency and sustainability of cattle production in different production zones to explore possibilities for household farms to direct resource use to a higher output orientation. This study aims to compare cattle production in different local resource conditions of the mountainous lowland and highland zone.

MATERIALS AND METHODS
Data collection was conducted in Mai Son and Yen Chau districts, Son La province from May to August 2007 by using household interviews with a standard questionnaire, key person interviews and PRA tools. Four villages including the Thai village Cu Pe (CP) and the Hmong village Rung Thong (RT), (lowland zone), and the Thai village Nam (Na) and the Hmong village Giao (Gi) (highland zone), were included. A total of 53 farms were selected with 30 cattle keepers in the lowland zone, 13 cattle keepers in Giao village and 10 farmers owning cattle farms in the hilltop pastures in Nam village. In total, data on 203 cattle was analysed. Household data were aggregated to gross margin = (total cash revenues - total cash costs) and the net benefit = (all benefits - all variable costs). Analysis of variance with SAS software version 9.1, Proc GLM, was used to process quantitative data.

RESULTS AND DISCUSSION
Characteristics of selected farms and reasons for keeping cattle: Table 1 shows characteristics of the investigated farms. Farmers in both zones have the similar area of upland field even though the family size in the highland villages is bigger. Each farm in lowland villages is able to keep an average of one to two cattle or buffaloes and very few farms keep both cattle and buffaloes due to the limitations of labour, capital and fodder. While in the highland zone with pastures still available, cattle production is more intensive. The largest herd sizes belong to cattle farmers in Nam village. 90% of selected farms keep an average of two to three buffaloes. Whether farmers keep cattle or buffaloes seems to depend on a variety of factors including their ethnic group and geographic properties of the inhabited area (Gibson, 1997).

Table 1: Characteristics of investigated farms, by zone and village

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Lowland</th>
<th>Highland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CP</td>
<td>RT</td>
</tr>
<tr>
<td>Farms (n)</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Family size (LSM±s.e.) (n)</td>
<td>5.5 a ± 0.5</td>
<td>5.9 a ± 0.5</td>
</tr>
<tr>
<td>Upland area (LSM±s.e.) (ha)</td>
<td>1.2 a ± 0.2</td>
<td>1.7 a ± 0.2</td>
</tr>
<tr>
<td>Cattle (LSM±s.e.) (n)</td>
<td>2.2 a ± 0.9</td>
<td>1.7 a ± 0.9</td>
</tr>
<tr>
<td>Buffaloes(%hh)*</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>(min-max) (n)</td>
<td>(1-2)</td>
<td>(1-4)</td>
</tr>
</tbody>
</table>

LSM in rows by same superscripts do not differ significantly at p≤0.05; *%hh: percentage of households keeping buffaloes

Cattle production supplies draught and transport power, manure, meat, income to farms and additionally has social functions in all villages. However each function yields differently in different zones. In the lowland zone, cattle contribute mainly non-market functions, particularly for work force, while cattle are considered as wealth storage in the highland zone, where cattle are raised for reproduction and sold when the family needs capital. All
selected lowland farms apply cattle manure for crops, while this is very rare in the highland zone due to transport difficulties to sloping fields. Cattle supply beef in Tet holidays and festivals in Nam village, while slaughtering cattle for beef is very rare in lowland villages. Cattle are used as heritage of parents for married children and can be slaughtered at the funerals for worshipping more often in highland villages than in lowland villages.

*Cattle production management:* Local yellow cattle are kept in both zones, but crossbreds with Laisindh are only found in the lowland. Except following the same vaccination program of veterinary department, cattle production management is different between two zones. Cattle are free-grazing in communal pastures and no crop by-products are used as feed in the highland zone. While in the lowland zone, crops-by-products such as rice straw and maize leaves are best utilized as cattle feed besides natural grass along field sides and growing elephant grass. Cattle are fed with cassava, banana stems, and sugarcane-tops in dry season. Maize and/or rice bran are used as high quality feed for cattle in ploughing days. Utilisation of additional feed resources is important due to land and pasture shortage (Ly, 2001). In the lowland zone, high labour force is required for tending animals and doing the cut-and-carry of forage. This is restricted by limited labour available on the farms (Gibson, 1997). Cattle are kept in stables or under Thais’ stilted houses or under stilted maize store sheds. While in the highland zone, groups of Thai farmers have established livestock farms in the hilltops, but H’mong farmers release cattle to pastures without providing shelters.

Table 2: Gross margin and net benefit (LSM±s.e.) from cattle production, by zone and village (in 1000VND)

| Parameter | Lowland | | | Highland | | |
|-----------|---------|---|---|---------|---|
| Farms (n) | 15 15 10 13 | | | | |
| Total cash income* | 19,869± 48,063± 12,890± 13,373± | ± 3655 ± 3655 ± 4477 ± 3927 | | | |
| Gross margin | 362± -380± 1,801± 697± | ± 425 ± 410 ± 562 ± 441 | | | |
| Net benefit | 11,101± 12,727± 30,438± 16,187± | ± 2823 ± 2823 ± 3458 ± 3032 | | | |

* total cash IC from crops, livestocks and offfarm jobs; LSM in rows by same superscripts do not differ significantly at p≤0.05

**Economic success:** Total cash income of farms in the highland zone is lower than in the lowland zone because of low crop productivity as low soil fertility, and low prices of crop products resulting from transport difficulty. Gross margins from cattle production are low in all villages, or even are negative as in Rung Thong, where lacking rice straw, farmers have to buy more sugarcane tops for cattle. Net benefits, however, are generally higher with more favourable values under highland conditions and always positive (see table 2).

Non-market benefits contribute considerable value to the net benefit from cattle production in lowland villages, while value of stock is the major benefit from cattle in highland villages. Where land is available, the medium scale is most economically successful, followed by small scale farms, even though gross output is not high, due to very low feed and labour costs (Hall et al., 2006).

**IMPLICATIONS**

In the highland zone, where natural pastures are available and have potential for improved pastures, cattle still play a major role as bank saving and resource potentials for beef production are not yet fully exploited. Enhancement of vertical integration between cattle breeding in the uplands and cattle production in the lowlands could further increase production and efficiency of resource utilization.

**REFERENCES**


Analysing management practices of smallholder pig keepers in Northern Vietnam using an actor-oriented approach

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KEY WORDS: community driven management program; on-farm performance testing; farmers’ observation; management rules; pig; Vietnam

The increasing land pressure in Northern Vietnamese Uplands hampers the expansion of agricultural production. Livestock husbandry in general and pig husbandry in particular appear as major development opportunities to smallholders (Lemke et al., 2002).

The subproject D2/SFB 564 "The Uplands Program" of Hohenheim University aims to develop community driven breeding and management programs using livestock genotypes with high productive adaptability. Results of the previous phases show not only a high variation in production performance between production systems of different intensity but also intra-system variations (Lemke et al., 2006). The aim of this study is to identify differences in management practices and underlying differences in the knowledge of the livestock keepers that are related to these intra-system variations. This serves to develop management programs that are suitable for systems of restricted resource availability.

The D2 subproject of the Uplands Program established long-term On-farm Performance Testing Schemes (OPTS) to analyze the smallholder pig husbandry system in the northwestern uplands of Vietnam in 2001. The subproject is currently working in nine villages in Son La Province, collecting performance data for sows of the local breeds Ban and Mong Cai as well as their offspring at two-month intervals. According to their resource availability, market accessibility, and predominant genotypes of pigs, three different production systems have been differentiated. Three villages belong to the demand driven system, which demonstrates conditions of the lowland production system. Four villages belong to the system in transition and two to the resource driven system. The latter two systems are considered to be upland production systems. The following methods of data collection have been used to learn about different management areas related to reproductive performance of sows and to gain detailed information concerning different management practices.

1. Focus group discussions were carried out to obtain an overview of pig husbandry practices. Information about different aspects of pig husbandry management, particularly fodder composition and supply as well as animal health management, was collected to gain insight into factors considered to be most important by the pig keepers. These focus group discussions have formed the basis for the structure of the subsequent feedback seminars.

The analysis of the use of the PRA-tools, the seasonal calendar, and the daily activity clock, showed that variations in the management practices between the different pig production systems and between the villages are greater than among the single farmers of each village. In contrast, the daily activities of pig production during the study season, the beginning of the dry season, were similar in all villages. However, to make a general statement, these results need to be compared with information gained through the subsequent research steps.

In the farming households of all three systems, it is mainly the wife who is the person responsible for pig husbandry. This is why for the subsequent research steps it is primarily the women who are addressed.

2. Feedback seminars: The data collection follows a stepwise procedure. For all farmers
involved in the OPTS, the reproductive performance of their sows has been determined. In each village a feedback seminar is organized in which the performance results of their sows are presented to the farmers who take part in the OPTS. Differences in sow performance are discussed in the feedback seminars in a structured way. First, management practices regarding sow management are recorded. A calendar is used to identify the different stages of sow management for one reproductive period (from previous weaning to weaning of the current piglets). Subsequently, different management areas are identified. For each management area and each period farmers achieving different performance levels are asked to give details about their management practices.

Where the management practices differ the Manual Discriminant Analysis (IDS Workshop, 1989) is applied in order to identify the reasons for the differences. At the end of each seminar, management practices that seem to be critical to obtaining good reproductive performance are identified jointly by the farmers. The feedback seminars are recorded using a tape recorder, and the discussions are fully transcribed.

3. Participant observation and semi-structured interviews: To obtain a detailed understanding of pig reproduction management practices, participant observations combined with semi-structured interviews are conducted in sample households of the farmers involved in the OPTS. In each of the nine project villages, three farmers from different pig performance groups are chosen for this in-depth description of their pig management practices. They are asked to explain what they do while they are conducting the management. The interviews are tape recorded and transcribed. Photographs taken by the researcher complement the data collection.

For the different management areas, the information processing of the farmers is analyzed using the cybernetic approach, through which the observations of the farmers and the rules behind their actions are assessed systematically (Kaufmann, 2005). This approach yields the views of the farmers regarding the target values for the different pig performance parameters in the different systems. The disturbance factors that affect the production outcome and the restrictions in the production system, which are considered by the farmers in their routine management, are first identified for the area of reproduction management. For a comprehensive understanding of the system, a further analysis of the management practices and rules of other aspects of pig husbandry is planned.

REFERENCES


Nutritional Evaluation of Boiled Soybean and Ricebean as Replacement for Soybean meal in Broiler Chicken Diets

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\textsuperscript{1}Thai Nguyen University of Agriculture and Forestry, Vietnam; \textsuperscript{2}University of Philippines at Los Baños, Philippines

KEY WORDS: Boiled; Soybean; Ricebean; Nutrition; Evaluation

INTRODUCTION

Three studies were conducted to evaluate the nutritional value of soybean and ricebean on the performance of broiler chicken in the Northern Mountainous Region of Vietnam (NMRVN) where is facing many difficulties such as deforestation and natural overexploitation, bio-diversity loss, land degradation. NMRVN is also under challenges of economic development vs. natural conservation, fill-up economic gap and catch up lowlands, low competition capacity.

The major grain legumes produced in temperate countries are soybeans, field beans, lupins, lentils, ricebeans and peas. However, their utilization as protein source is limited by their amino acid content and by the presence of antinutritional factors (ANFs) which could affect animal performances when they are fed with untreated beans. Most of these ANFs in grain legumes can be reduced by appropriate means such as heat or enzyme treatment.

Soybean (\textit{Glycine max L. merr.}) is found to be a valuable feed ingredient for poultry because of its high oil and protein contents. The protein content of soybeans ranged from 35 to 50% depending on the variety and method of processing. Ricebean (\textit{Vigna umbellata (Thunb.) Ohwi & Ohashi}) is a leguminous plant that can grow well in poor or waterless soil in the upland or mountainous regions. The protein content of ricebean is lower than that of soybeans (23%-25%). This study was conducted to evaluate the use of boiled soybean and ricebean as replacement for soybean meal in broiler chicken diets. Studies conducted at this station (Bos and Flikweert. 1996, Brobio. 1972, Dung. 2003, Herkelman et al. 1991, 1993, Koci et al. 1996, Mateos et al. 1996, Perilla et al. 1997, Tien et al. 2001, To et al. 2002) are capable of supporting performace similar.

RESULTS

The results of three studies were done in 2006. In study 1, optimum boiling time for RSB to reduce urease activity within acceptable range, negative hemagglutinating reaction and improved metabolizable energy was 30 minutes. On the other hand, the RRB had acceptable concentration of urease activity and negative hemagglutinating reaction. The RSB, BSB for 30 minutes and BRB had similar amino acids composition expressed as percent of crude protein. In study 2, replacement of SBM with 75 to 100% BSB significantly (P<0.05) decreased the BWG and FE. Partial or complete replacement of SBM with RRB was significantly depressed the BWG and FE of the broilers. Except for pancreas, livability, dressing, breast and leg meat, abdominal fat and pancreas percentage. In study 3, replacement of SBM-BSB combination (50:50) with more than 25% RRB had similar amino acids composition expressed as percent of crude protein. In study 2, replacement of SBM with 75 to 100% BSB significantly (P<0.05) decreased the BWG and FE. Partial or complete replacement of SBM with BSB in broiler diets did not influence the livability, dressing, leg and breast meat, abdominal fat and pancreas percentage. In study 3, replacement of SBM-BSB combination (50:50) with more than 25% RRB was significantly depressed the BWG and FE of the broilers. Except for pancreas, livability, dressing, breast and leg meat, abdominal fat percentages were unaffected by the level of RRB.
Table 1: Average Summary Performance of Broilers in Study 2

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>TREATMENTS</th>
<th>I</th>
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<th>III</th>
<th>IV</th>
<th>V</th>
<th>Cv</th>
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<tbody>
<tr>
<td></td>
<td>[(%BSB/100%SBM)]</td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>[(25%BSB/75%SBM)]</td>
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<tr>
<td></td>
<td>[(50%BSB/50%SBM)]</td>
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<td>[(75%BSB/25%SBM)]</td>
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<tr>
<td></td>
<td>[(100%BSB/0%SBM)]</td>
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<tr>
<td>Body Weight Gain, g</td>
<td>8 - 28 days</td>
<td>807.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>802.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>810.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>736.89&lt;sup&gt;b&lt;/sup&gt;</td>
<td>736.44&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>8 - 42 days</td>
<td>1551.67&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>1555.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1468.44&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>1727.44</td>
<td>1649.00</td>
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<td>29 - 42 days</td>
<td>1732.33</td>
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<td>8 - 42 days</td>
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<tr>
<td>Feed Efficiency</td>
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<td>2.17</td>
<td>2.13</td>
<td>2.24</td>
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<td>8 - 42 days</td>
<td>2.23&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.35&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.37&lt;sup&gt;b&lt;/sup&gt;</td>
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Table 2: Average Summary Performance of Broilers in Study 3

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<td></td>
<td>[(75%(50BSB-50SBM)/25%RRB)]</td>
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<tr>
<td></td>
<td>[(50%(50BSB-50SBM)/50%RRB)]</td>
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<td></td>
<td>[(25%(50BSB-50SBM)/75%RRB)]</td>
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<td>Body Weight Gain, g</td>
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<td>746.49&lt;sup&gt;ab&lt;/sup&gt;</td>
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<td></td>
<td>29 - 42 days</td>
<td>742.40&lt;sup&gt;a&lt;/sup&gt;</td>
<td>752.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>680.11&lt;sup&gt;b&lt;/sup&gt;</td>
<td>566.22&lt;sup&gt;c&lt;/sup&gt;</td>
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<td></td>
<td>8 - 42 days</td>
<td>1522.98&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1498.84&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1423.80&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1286.51&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>Feed Consumption, g</td>
<td>8 - 28 days</td>
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<td>29 - 42 days</td>
<td>1757.22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1795.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1749.56&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>8 - 42 days</td>
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<td>Feed Efficiency</td>
<td>8 - 28 days</td>
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<td>2.24&lt;sup&gt;ab&lt;/sup&gt;</td>
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<td>3.70</td>
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<td></td>
<td>29 - 42 days</td>
<td>2.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.39&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.57&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.85&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.94</td>
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<td></td>
<td>8 - 42 days</td>
<td>2.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.42&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.58&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.52</td>
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**LITERATURE**


A Novel Beef Production System Based on Grass Resources by Applying Metabolic imprinting

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KEY WORDS: Beef Production; Grass resource; Metabolic Imprinting

INTRODUCTION

Grain is food that human being can eat. In recent time, global shift to produce bio-energy, i.e., ethanol from grain happens because of shortage of oil. The price of grain has become higher. In some of developed countries, a considerable grain feeds are fed to cattle. In Japan, Wagyu (Japanese Black cattle) are known for their excellent marbled beef which is achieved by feeding them with a considerable amount of concentrate (4000 to 5000 kg altogether, until slaughter at 28-30 mo of age). Cattle are ruminant, which means they have an important ecological niche that capitalizes on the symbiotic relationship between fiber fermenting ruminal microbes and mammalian demand for usable nutrients. We aim to produce a high-quality safe beef product while maximizing the used of domestic grass resources. This thing would contribute and could apply the beef production in lowland and upland of South East Asian countries. It has been shown, however, that alterations in fetal and early postnatal nutrition and endocrine status may result in developmental adaptations that permanently change the structure, physiology, and metabolism in adult life in rats, domestic species and mouse and human (Levin et al, 2000). This phenomenon is referred to as “metabolic imprinting” based on the medical research regarding “developmental origins of health and disease (DOHaD)”. However, there are very few reports of metabolic imprinting in cattle.

In this study, in order to study the effects of metabolic imprinting on beef production, a fattening experiment was conducted. In this experiment, we feed mainly roughage and investigated how metabolic imprinting affects the expressions of meat quality or quantity and related genes in Japanese Black steers.

MATERIALS AND METHODS

In this study, Japanese Black steers were nursed artificially until 2 mo of age when they were divided into two groups: groups R (n=7) and C (n=7). In group R, the calves were fed only roughage. In group C, they were fed a considerable amount of concentrate (over 2.5% of their body weight) and given ad libitum access to Italian ryegrass hay (roughage). After 10 and until 26 months of age both groups were fattened with only Italian ryegrass hay. Muscle samples were taken by biopsy from longissimus muscles (LM) at 2, 10, 17 and 22 months of age. Total RNA was isolated from these tissues with ISOGEN. Semi-quantitative analysis of realtime reverse transcription-polymerase chain reaction (RT-PCR) was used to measure the mRNA expression of meat quality-related (intra-muscular adipogenesis) (PPARγ2, C/EBPα, β, and δ, Leptin, G6P, SCD, FASN, ADRP) and quantity-related genes ( myostatin, IGF-1, IGF-I receptor, MyoD, myogenin, MRF4, Myf5, and PGC-1α). G3PDH was used as a standard for each PCR reaction. Volume percentages of intramuscular fat were measured by the Soxhlet method. Adipose cell size diameter was observed using Oil-red O staining methods. ANOVA was used for statistical analyses.
RESULTS AND DISCUSSION

The average live weight was 2.2-fold higher in group C (265 ± 18 kg) than in group R (117 ± 12 kg) just after 10 mo of age (p<0.001). At slaughter, group C was just 1.3-fold heavier (472 ± 42 kg) than group R (357 ± 25 kg) (p<0.001) (Fig. 1).

The expression of PPARγ2 mRNA in LM of group C was significantly higher than in group R only at 22 mo of age (p<0.05). The expressions of C/EBPα, β and δ, Leptin, G6P, ADRP, SCD and FASN in LM were significantly higher in group C than in group R at 5 or 10, and 22 months of age. The diameter of intramuscular adipose cells in LM was significantly larger in group C than in group R at 10 and 22 months of age. The percentage of intramuscular fat content in LM at 26 months of age was significantly higher in group C (10.3 %) than in group R (6.2 %) (p<0.05). In both groups, subcutaneous fat thickness was quite thin (group C: 0.8mm, group R: 0.2mm) at 26 months of age. These results indicate that the effect of metabolic imprinting, or fattening regimen during the early growth period affected the expression of adipocyte differentiation factors and the accumulation of intramuscular adipose tissue. On the other hand, with this feeding system, waste fat such as subcutaneous did not greatly accumulate in group C.

The mRNA expressions of MyoD, IGF-I in LM were significantly higher in group C than in group R at 5 months of age (respectively, p<0.05, p<0.01). The mRNA expressions of myogenin and MRF4 and myostatin in LM were significantly higher in group C than in group R at 10 months of age (respectively, p<0.01, p<0.001). For, myostatin, the mRNA expression in LM was significantly higher in group R than in group C at 22 months of age (p<0.05). On the other hand, the mRNA expressions of IGF-I receptor in LM were significantly higher in group R than in group C at 5, 10 and 22 months of age (p<0.05). In Myf5, there were no significant differences in mRNA expressions in LM between two groups from 2 to 22 months of age. The MRFs family plays important roles as transcription factors during myogenesis (Berkes and Tapscott, 2005).

MyoD and Myf5 are expressed mainly in “determination” at an early stage during myogenesis. On the other hand, after determination, myogenin and MRF4 are expressed mainly in differentiation from myoblast to myotube, and maintain and mature myotube. In vivo, satellite cells may be on an equality level with precursor or stem cells in vitro. In this study, the high expressions of MyoD at 5 months of age and myogenin and MRF4 at 10 months in Group C might suggest that “determination” and “differentiation” occurred and that myoblasts differentiated from satellite cells, which may influence the hypertrophy and hyperplasia of muscle fiber.

In conclusion, the feeding level during the early growth stage influenced mRNA expressions in skeletal muscle. The growth size, meat quantity and quality were markedly different between groups. This may be caused by the effect of metabolic imprinting induced by a high feeding level during the early growth stage.

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Linking smallholder farmers to high-value markets - Comparison of upland and lowland farmers in Thailand

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KEY WORDS: smallholder farmers; lowland and upland agriculture; high-value markets; Thailand

Over the past decades, national and international markets for agricultural products have undergone major transformations. Traditional bulk commodities have lost relative importance, whereas demand for high-value agricultural products increased (Aksoy 2005). High-value agricultural products can be defined as products with special quality attributes such as health and safety aspects (e.g. low pesticide residues) or visual quality attributes (e.g. size and colour) that are usually not offered on wholesale markets. Therefore new markets, especially in form of super- and hypermarkets, are established that offer a differentiated product spectrum that demands for specialised procurement systems. This leads to the development of new value chains in which different actors are increasingly linked through strong vertical and horizontal coordination and smallholders are often integrated through contract farming. Even though this trend was first observed in industrialised countries, growing welfare for at least parts of the population, changing lifestyles, as well as liberalisation processes also spur growth in domestic high-value markets within the developing world (Regoverning Markets 2004; Traill 2006).

These developments offer new chances for smallholder farmers. Their integration into national and international high-value markets is widely seen as one strategy of successful poverty reduction (Maertens and Swinnen, 2006; Birthal et al., 2005). Yet, under certain conditions, smallholders might find it difficult to participate successfully in high-value markets; an unfavourable institutional setting can lead to a further marginalisation of already disadvantaged farmers (Balsevich et al., 2006).

To enable smallholder farmers to take up possible benefits from these developments, ongoing changes need to be analysed to identify and understand mechanisms of smallholder farmers’ access to newly emerging supply chains - as primary producers, as well as in post harvest and value-adding activities. Previously released studies mostly concentrate on qualitative descriptions of emerging high-value markets, existing entry barriers for smallholder farmers and possible benefits. Only recently, quantitative analyses were started in this direction, but studies that explicitly compare possibilities of up- and lowland farmers to get integrated in high-value markets are still missing. However, it can be assumed that differences between up- and lowland farmers in regard to infrastructural connection, institutional setting, agronomic framework conditions, as well as ethnic group and social affiliation, influence their integration possibilities. Therefore a detailed comparison of up- and lowland farmers can give interesting information about their determinants for integration in high-value markets. Results of such a comparison are especially needed as upland farmers very often belong to the group of disadvantaged farmers.

The proposed paper is based on a household survey of 300 farmers conducted in 2007. The survey was undertaken in the Mae Sa watershed that is located in the northern part of Thailand. The Mae Sa watershed consists of 20 villages,
from which nine are included in the survey. Three of these villages are in the lowlands and six villages are situated in the uplands. Even though production patterns of the villages differ a lot, most farmers are market oriented and different marketing channels are found in each village. Besides the supply to the wholesale market, supply to supermarkets, as well as to export markets and to different processing companies gain importance.

In regard to integration in high-value markets, interesting differences appear. Whereas farmers in the lowlands are mostly integrated into high-value marketing channels without any institutional support, farmers in the uplands highly depend on the support of the Royal Project, an initiative developed by His Royal Majesty the King to introduce cash crops as substitutes for opium production in the mountainous regions in northern Thailand. Against this background the focus of the proposed paper is on the following research questions:

- How important are different marketing channels in villages in the lowlands and in the uplands?
- What benefits, monetary as well as non-monetary, do different marketing channels offer?
- Which farmer and farm characteristics determine successful integration into high-value markets?
- How decisive are differences in farmer and farm characteristics and differences in framework conditions for different linkages to high-value markets?

The proposed paper is based on the example of bell pepper. Bell pepper is a high-value vegetable that is sold in wholesale as well as high-value markets. The latter is supplied by farmers partly with and partly without institutional support of the Royal Project. In order to provide answers to the research questions the following approach is undertaken. In a first step, the existing marketing channels in each village are described and their benefits, monetary as well as non-monetary, are assessed. Secondly, a multinomial logit model is estimated that gives parameters for individual farmer characteristics, like education or age, as well as for farm characteristics, like size of farm. The results of the model show which factors are determining the integration into different high-value markets. In a final step, differences in framework conditions are identified and their relevance for integration in high-value markets is assessed. These analyses lead to conclusions about main important factors that, so far, hinder integration of upland farmers without institutional support of the Royal Project. Finally, policy recommendations of how upland farmers can become more independent from project support will be given.

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Agricultural commercialization of the Karen hill tribes in Northern Thailand

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KEY WORDS: Market integration, ethnic minorities, Southeast Asia

INTRODUCTION

With rapid economic development trickling down into the northern Thai uplands since the 1980s, the traditional form of Karen agriculture has transitioned into a more permanent and more intensive form of land use together with the adoption of cash crops, improved technologies, external inputs, and the spread of development assistance such as road connections. This process increasingly links the Karen to urban areas such as the city of Chiang Mai. Although people in the uplands of northern Thailand have seen improvements in economic well-being and food security in recent decades there have been concerns about the sustainability and desirability of the process of agricultural commercialization. A local brand of localism, which goes under the name of Sufficiency Economy, has inspired Thai policy makers to try and partially reverse the process of commercialization (NESDB, 2002; UNDP, 2007).

The objective of this study is to support the debate about agricultural commercialization in Thailand with quantitative analysis. The paper focuses on the Karen as this is the most populous ethnic minority in Thailand and in the literature the Karen have frequently been described as traditional, subsistence-oriented, and conservationist (see Walker, 2001).

METHODS

This paper conceptualizes agricultural commercialization as the process by which farm households are increasingly integrated into five markets: output markets, variable input markets, factor markets, labor markets, and consumption markets. Broadly following von Braun and Kennedy (1994) and using farm performance measures as defined in Dillon and Hardaker (1993), we quantified each level of market integration as the total value that transacted through markets divided by the total value sold, consumed, or purchased.

In the analytical part, the two-way relationship between market integration on the one hand and well-being or efficiency on the other hand was resolved by instrumenting market integration using a two-stage least squares (2SLS) regression model. Instruments included the distance to the output markets, the number of road connections to a village, the frequency of contacts outside the own community, the existence of a rice bank, and the level of crop diversification. Two alternative models were estimated in this second stage: a Cobb-Douglas production function and a net per capita income function.

DATA

Data were collected with a stratified random sample of Karen farm households in Chiang Mai province. Twelve villages were randomly selected at a first stage and 20 households were randomly selected from each village giving a total of 240 households. Sample weights were used in the analysis to correct for the sampling procedure. A structured questionnaire was used and interviews were conducted in Karen dialect. The reference period was the 2006 calendar year.

RESULTS

The results of the study show that—contrary to widespread belief—Karen farm households in Chiang Mai province are well-integrated into markets (Figure 1). Average levels of market integration are 31 percent for gross farm output, 35 percent for variable inputs, and 49 percent for food consumption. On average, Karen households derive 80 percent of their net family earnings through market transactions.
Fig. 1: Average levels of market integration of Karen farm households

The analytical part of the paper further scrutinized the integration into output markets. Distance to markets, crop diversification, contacts to nearby urban centers, and the existence of a rice bank in the community were found to be significant instruments of output market integration. Using the predicted values of market integration in a second stage of the regression, the study found that market integration makes a positive and significant contribution to both farm efficiency and net per capita family earnings.

The results furthermore showed that output market integration is linearly associated with an increased use of mineral fertilizers. No such linear relation was found with regard to pesticide use: the intensity of pesticide use much depends on the specific cash crop that is cultivated; villages growing strawberry or tomato use much pesticides.

**DISCUSSION**

Our results confirm earlier studies that show agricultural commercialization to improve farm productivity and economic well-being (Zeller et al., 1997; Mueller and Zeller, 2002). But contrary to other studies, our results show that, for the Karen, not specialization but diversification is associated with greater levels of market integration. This is because the traditional system relied much on (low-value) rice production for home consumption. A further diversification of the traditional farming system to include a larger variety of cash crops and non-farm sources of income will be important to further improve the economic well-being of the Karen in the future.

The results partially confirm the concept of sufficiency economy: Karen households are much but not fully integrated into markets and might thereby reduce their vulnerability to market fluctuations. Yet knowledge is another important component of sufficiency economy and improved knowledge of agrochemicals could mediate the adverse effects of pesticide use.

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Assessing Consumer Preferences for Quality and Safety of Tangerine in Chiang Mai Province Using Choice Experiment Model

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Key Words: Choice Experiment Method; Consumer Preference; Tangerine; Willingness to Pay

INTRODUCTION

Chiang Mai province is a major tangerine production area, accounting for 31 percent of the overall Thai production in 2003 [Department of Agricultural Extension, 2006]. Tangerine production in the hillsides and mountain valleys of Chiang Mai province is known for its very intensive use of hazardous pesticides. Natural features such as local geology and topography can affect the movement of chemicals in soil and water. In a recent case involving tangerine orchards north of Chiang Mai, pesticide residues have been found in villagers’ blood as well as the area’s soil and water [Bangkok Post, 2003, cited in Rerkasem, 2004]. It also has negatively affected water resources of downstream residents. Therefore, pesticide reduction in tangerine production is considered very important to improve water quality in lowlands. The Thai government has set standards for tangerine production since 2004. Under these standards all tangerine production steps have to follow defined rules. These standards affect farmers’ profits either by lower yield or higher labor cost for pest monitoring. Even though Thai consumers are increasingly concerned about food safety, especially for chemical residues in fresh agricultural products, the market for high-quality and safe-to-eat agricultural products develops slowly. The consumer may doubt whether the higher price of certified agricultural products guarantees better quality and higher safety in comparison to agricultural products from conventional farms. On the other hand, producers do not have any information about the consumers’ willingness to pay more for better quality and improved safety of agricultural products. The information about the factors influencing consumption and willingness to pay for better quality and safety of tangerine is considered essential for farmers, traders, entrepreneurs in the tangerine market and for the government trying to improve the tangerine production and marketing system, which meets both producers and consumer preferences.

OBJECTIVES

Therefore this study aims to examine the consumer’s opinion, to analyze factors influencing the buying decision concerning quality and safety of tangerine and to estimate the consumer’s willingness to pay for quality and safety.

METHODOLOGY

A choice experiment model was employed in order to determine the monetary value in each attribute based on survey data from 400 random samples of Chiang Mai residents. A wide range of attributes, namely taste, color of peel, size, waxing, seed, pesticide-free or organic certification and labels, was used in various combinations (Table 1).

This study also considers various household characteristics as the factors that may influence consumer preferences and willingness to pay. The willingness-to-pay estimates are subsequently compared to the costs of quality and safety production arising at the producer stages. The choice experiment model is an economically efficient method for collecting data regarding consumer preferences for non-market goods (Kaye-Blake et al., 2005). As with many data collection tasks, however, there is a...
Table 1: The attributes and levels in choice set

<table>
<thead>
<tr>
<th>No</th>
<th>Attribute</th>
<th>1st level (Status quo)</th>
<th>2nd level</th>
<th>3rd level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Color of peel</td>
<td>Green</td>
<td>Yellow and green</td>
<td>Yellow and orange</td>
</tr>
<tr>
<td>2</td>
<td>Size</td>
<td>Small (10-12/kg.)</td>
<td>Middle (6-9/kg.)</td>
<td>Big (4-5/kg.)</td>
</tr>
<tr>
<td>3</td>
<td>Taste</td>
<td>Sweet and sour</td>
<td>Sweet and succulent</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Seed</td>
<td>Seed</td>
<td>No seed</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Beauty of peel</td>
<td>Bad-looking</td>
<td>Good-looking</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Certificate of chemical residue</td>
<td>Conventional</td>
<td>Pesticide-safe</td>
<td>Organic</td>
</tr>
<tr>
<td>7</td>
<td>Place of selling</td>
<td>Fresh market</td>
<td>Convenient store</td>
<td>Super market</td>
</tr>
<tr>
<td>8</td>
<td>Identification of resource</td>
<td>No</td>
<td>Have</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Type of package</td>
<td>Plastic bag</td>
<td>Net bag</td>
<td>Box</td>
</tr>
</tbody>
</table>

The expected finding should indicate the consumers into some homogeneous groups based on their preference for appearances, taste, and certificate of chemical residual. The differences between the segments based on the socio-demographic characteristics of age, education, and income. Moreover, a significant segment of consumers would purchase certified tangerines at the anticipated marginal cost of certification. The socio-demographic characteristics should also influence willingness to pay.

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Marketing opportunities for traditional food and feed crops in Northern Vietnam

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Keywords: Food crops; feed crops; marketing opportunities; supply chain; market integration; cointegration analysis.

The traditional food and feed crops have still been playing an important role in the livelihood of inhabitants in Northern Vietnam in general and in Son La province in particular. Although the production of high-value livestock commodities has developed so far in the region during the last decade, traditional food and feed crops such as rice, maize and cassava are still the main sources of staples and income of the farmers in the upland areas. Due to poor conditions of infrastructure in the uplands and bad connection to the lowland areas, the marketing channels for agricultural products including food and feed crops have not been developed and the opportunities for the products to be best sold are limited. In fact, the information on the marketing channels especially in downstream areas is still in shortage and unclear for both policy-makers and farmers. In seeking to scrutinize markets for more traditional food and feed crops for improving benefits of the farmers, the current paper is designed to make an in-depth analysis on marketing opportunities of the products. More specifically, the objectives of the analysis are threefold: i) To describe and analyse the marketing channels for traditional food and feed crops in Son La Province (especially Yen Chau and Mai Son Districts); ii) To determine the level of market integration among local markets and the rest of the economy for the products; and iii) To design relevant agricultural market policies in Vietnam for improving marketing opportunities for the farmers and production sustainability in Son La Province.

Following the supply chain approach, the marketing channels for traditional food and feed crops of Yen Chau and Mai Son district (Son La province) are analysed in this paper. A typical supply chain for an agricultural product involves various actors including: i) Farmers as the producers of the product; ii) Brokers/middlemen/collectors; iii) Processors; iv) Distributors/retailers; and v) Consumers/end-users. In this supply chain, exporters can come to any stage from the third to the last depending on the specific agricultural products. Anyway, the specific value chains of traditional food and feed crops in Yen Chau and Mai Son district have their own features. While rice is the main staple of inhabitants in the local areas and its production is still not enough for the people consumption there. In other words, farmers in Yen Chau and Mai Son are even net-buyers of rice although the situation in Mai Son is a bit better than in Yen Chau. The rice from the study areas can not be exported even to any other regions of Vietnam due to the same reason. To offset the gap, the products or income from other food and feed crops are the resources. Maize and cassava play this role in the investigated areas. The supply chains of maize and cassava in terms of actors involved are somewhat similar to each others despite differences in their products. For maize, the supply chain starts when farmers sell it to village collectors. Subsequently, the product is sold to commune collectors and then traders and large feed processing factories in Ha Tay province, which is almost 300km away from Son La. The final maize products as feeds from the factories are partly consumed in the domestic market and partly exported. The final domestic destination for cassava originated from study areas is also in feed processing factories in Ha Tay province. However, the cassava is also sold to small maltose and starch processors in the province while the first actors

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of the supply chain with village and commune collectors and then middle traders are very similar to the case of maize. Along the supply chain, different markets for the food and feed crops are linked to each other. Their linkages are best reflected perhaps in price interdependency. The level of market integration which is most clearly seen in price interdependency, is therefore also one of the analysis objectives in this paper. Utilising cointegration model, the level of regional market integration including the integration between the upland and lowland markets, the direction and strength of causality in price formation between markets in Son La and other regions such as Ha Tay and Ha Noi are detected for the case of maize and cassava. The results from primary estimation showed that the prices for these two cereals are much affected by the prices of “central” markets of Ha Tay and Ha Noi respectively. The strength of causality in price formation between Son La and these markets has changed over time with stronger relationship recently. It is also practical if we consider Ha Tay and Ha Noi as a whole to play as the “central” market for Son La in cointegration model. Although rice production is an important cereal in Yen Chau and Mai Son districts, the market integration with other regions for the product is not high as the produced rice is basically used for local consumption. In order to see the nature of market integration, the performance of markets for the food and feed crops, including seasonal variability, bottlenecks, and price transmission are also analysed. The government policies with relevant price effects for Son La Province will be identified and described in both marketing chain and market integration analyses. From the first results of the analysis, the effects of these policies on local farm production and income were not really significant. This is simply due to the fact that the number of price intervention policies is quite a few. The government has some policies to provide ethnic minority farmers in mountainous areas in general and in Son La (or in Yen Chau and Mai Son districts) in particular agricultural materials with subsidized rates and this could somehow help the farmers there to be viable in the markets. Primary data from the interviews of over 120 food and feed crop growing farmers in Yen Chau and Mai Son districts in addition to the information from the interviews with key actors of village and commune collectors, processors, traders/exporters at various levels were used for supply chain analysis. Data sources for cointegration analysis is mainly secondary in nature including basically the time series of provincial market prices. This data is monthly price series for 64 provinces nationwide, focusing on Northern provinces especially Ha Tay, Ha Noi and a number of surrounding provinces of Son La.

The primary results of the paper showed a very clear picture of supply chains of food and feed crops of rice, maize and cassava originating from the study areas. Even the quantities of these commodities along each “section” of the marketing chain were also roughly estimated. It showed also that the level of regional market integration for maize and cassava has been increasing, however, the farmers are still left behind in terms of both information as well as financial capacity to take advantages in the marketing chains. The first policy recommendations derived for improving marketing opportunities for traditional food and feed crops in Northern Vietnam are that the farmers need to be supported in both these aspects. In contrast, they need to be informed also about the threat of unsustainability of over production of these products especially maize.

REFERENCES
Product quality and marketing of indigenous pigs in the mountainous region of Vietnam

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KEYWORDS: product quality, carcass characteristics; indigenous breeds; marketing; northern Vietnam.

INTRODUCTION

Mong Cai (MC) and local Ban are two common indigenous pig breeds kept under smallholder conditions in the mountainous Northwest of Vietnam (Lemke et al., 2006). In recent years, specialized supply chains have been emerging to meet the growing demand for indigenous pork as speciality food in urban lowland areas. Indigenous pork meets special consumer preferences because of its particular flavour (Huong, 2007). Participation of upland farmers in these high-value supply-chains could possibly contribute to improvements in their livelihoods. Two studies were conducted in parallel to evaluate a) the carcass characteristics of indigenous pigs and b) their marketing in the northern mountainous region of Vietnam.

MATERIALS AND METHODS

Carcass characteristics of seven MC and six Ban pigs were assessed in slaughter trials as described in Hau et al. (2007). The dissections were divided into lean meat, fat, and bones and their weights were recorded. Slaughter weight was used as a covariate to analyse carcass characteristics. The fixed effects breed, age at slaughter, date of slaughter, and ambient temperature at slaughter date were analysed by a mixed model.

In order to analyze the marketing chains of indigenous pigs, farmers’ downstream supply chain actors were interviewed to quantify net marketing margins. Four collectors of Ban pigs, 10 traders including 5 specializing in Ban and 5 in MC pigs, and 6 retailers including 3 in Ban pigs and 3 in MC pigs in the supply chain were selected for interviews.

RESULTS AND DISCUSSION

The live weight, carcass weight, lean meat percentage, fat percentage, and the weight of valuable cuts of MC carcasses (table 1) were significantly different from those of Ban carcasses.

<table>
<thead>
<tr>
<th>Carcass characteristics</th>
<th>MC (n=7)</th>
<th>Ban (n=6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live weight (kg)</td>
<td>54.7 ± 2.8a</td>
<td>45.5 ± 2.5b</td>
</tr>
<tr>
<td>Carcass weight (kg)</td>
<td>42.5 ± 0.9a</td>
<td>36.6 ± 0.7b</td>
</tr>
<tr>
<td>Carcass dressing (%)</td>
<td>80.7 ± 1.8a</td>
<td>79.6 ± 1.6a</td>
</tr>
<tr>
<td>Lean meat (%)</td>
<td>46.4 ± 1.4a</td>
<td>35.9 ± 1.2b</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>34.0 ± 1.5a</td>
<td>40.9 ± 1.1b</td>
</tr>
<tr>
<td>Shoulder (kg)</td>
<td>12.8 ± 0.5a</td>
<td>10.9 ± 0.5b</td>
</tr>
<tr>
<td>Loin (kg)</td>
<td>9.0 ± 0.3a</td>
<td>7.7 ± 0.3b</td>
</tr>
<tr>
<td>Ham (kg)</td>
<td>8.8 ± 0.4a</td>
<td>7.2 ± 0.4b</td>
</tr>
<tr>
<td>Belly (kg)</td>
<td>6.0 ± 0.5a</td>
<td>4.6 ± 0.5b</td>
</tr>
</tbody>
</table>

Source: Data from slaughter trials
Notes: LSM with different superscript in the rows differ significantly (p<0.05).

Among the other fixed effects, only live weight and age of animals had significant effects on carcass characteristics. There were no significant interactions. The lean meat content is usually used to evaluate carcass quality (Duc et al., 2001; Pulkrabek et al., 2006). MC carcasses had higher lean meat content than Ban carcasses. Weights of shoulder, loin, ham, and belly cuts in MC carcasses were higher than those in Ban carcasses. However, retail prices per kg for different parts of carcass of Ban pigs
were higher than for MC pigs in Son La town (Table 2).

Table 2: Retail price per kg of parts of carcass of MC and Ban pigs (in '000VND)

<table>
<thead>
<tr>
<th></th>
<th>MC</th>
<th>Ban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ham</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>Shoulder</td>
<td>34</td>
<td>37</td>
</tr>
<tr>
<td>Loin</td>
<td>28</td>
<td>31</td>
</tr>
<tr>
<td>Belly</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Bones</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td>Fat</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Leg</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>Head</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Viscera</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>Heart and kidney</td>
<td>30</td>
<td>32</td>
</tr>
</tbody>
</table>

Table 2: Retail price per kg of parts of carcass of MC and Ban pigs (in '000VND)

Source: Group interview with 4 retailers in Son La town in April 2007; Note: 1 Euro = 22,500 VND

The net marketing margin is an indicator of the efficiency of a market. Traders of Ban pigs achieve higher net marketing margins per kg than MC pig traders (table 3).

Table 3: Prices at selling, marketing costs, and net marketing margins in MC and Ban marketing chains (in '000VND/kg)

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LW price</td>
<td>14.2</td>
<td>17.2</td>
<td>19.8</td>
<td></td>
</tr>
<tr>
<td>Carcass price</td>
<td>19.0</td>
<td>21.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M cost</td>
<td>1.6</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NM margin</td>
<td>1.4</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ban</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LW price</td>
<td>15.0</td>
<td>16.0</td>
<td>19.3</td>
<td>22.1</td>
</tr>
<tr>
<td>Carcass price</td>
<td>21.0</td>
<td>24.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M cost</td>
<td>0.6</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>NM margin</td>
<td>0.4</td>
<td>2.1</td>
<td>1.6</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Prices at selling, marketing costs, and net marketing margins in MC and Ban marketing chains (in '000VND/kg)

Source: Retailer group interview and marketing survey
Notes: 1 for traders and retailers live weight equivalents; 2 per kg live weight or per kg live weight equivalent respectively
LW: Live weight; M: Marketing; NM: Net Marketing.
I: Producer; II: Collector; III: Trader / slaughterer; IV: Retailer

Due to higher retail prices for the Ban carcass parts, the Ban carcasses sampled in this study would fetch nearly the same revenue as the heavier MC carcasses sampled (on average 1.1 million VND for Ban and 1.2 million VND for MC).

Retailing of pork takes place in different locations for the two pig breeds. While Ban pigs are primarily sold in central markets in Son La town, where more high quality products are traded, MC pigs are sold in peripheral markets. Only some parts of the carcasses of MC pigs such as ham and loin that contain much lean meat are sold in central markets. Ban pork is – despite its high fat percentage – considered as high quality product in the market.

Linkages among producers in the uplands and supply chain actors in the lowlands in Son La province are currently rather weak. Ban traders try to cooperate more closely with Ban producers through dedicated and specialised collectors in informal marketing arrangements to reduce transaction costs.

CONCLUSION

MC and local Ban pig breeds reared under smallholder condition were different in carcass characteristics and dissection cuts. The MC pig breed had a higher meat production than the local Ban pig breed. Nevertheless, the initial results of marketing analysis showed that the Ban carcasses are highly appreciated in the market with higher retailer price than the MC carcasses. Trading of Ban pigs brings higher profits than trading of MC pigs to actors in the marketing chains. Our results highlight the potential of high-value speciality products from uplands areas to be marketed profitably in urban lowland areas. To scale-up these marketing chains, formalization of marketing institutions and infrastructure improvements would be required.

REFERENCES


Effects of low input nitrogen application on dry matter production and photosynthetic functions of different species of rice plants

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Key words; Chlorophyll content, Low input nitrogen application, Photosynthesis, Rice, Rubisco content, Species difference

The effects of low input nitrogen application on dry matter production and photosynthetic functions, photosystem and gas exchange rate, were investigated using three species (four cultivars); two japonica (Oryza sativa L.) cultivars, Koshihikari, the leading cultivar in Japan, and Shirobeniya, a conventional cultivar grown one century ago, O. glaberrima Steud. var G174, a high dry matter production species grown in Africa, and O. glumaepatula Stued. var. WK35, a wild rice species originated from South America. The reduction in growth parameters, total dry matter weight and leaf area per plant, and capability of nitrogen accumulation in a plant were found to be significant difference among 4 varieties. That is, although plant size of the japonica cultivars used in this study was not so large, these cultivars presented the higher maintenance of dry matter production and higher nitrogen accumulation per unit leaf area than G174 and WK35 under nitrogen supply restriction. The reduction in photosynthetic rate (Pn) was closely related with stomatal conductance (Gs), mesophyll conductance (Gm) and the ratio of photorespiration rate to total CO2 fixation rate (Pr/Tc). Nitrogen utilization efficiency in Pn (NEP) has little significant difference among these four cultivars. In Koshihikari, Pn showed the highest value with nitrogen restriction and a progress of leaf senescence (Fig.1), which was due to not enough stomatal openness but the maintenance of CO2 fixation rate in leaves. In contrast, G174, the lowest variety of nitrogen accumulation unit per leaf area, showed the poorest sustainability in Pn with nitrogen limitation, which was resulted in remarkable decrease in carbon CO2 fixation rate with having enough stomatal openness. The extent of decrease in photosystem II exhibited a similar tendency to that in Pn; That is, the higher values of maximum quantum yield and effective quantum yield, which was recognized as an indicator for photosystem damage to various environmental stresses and an activity of PSII reaction center accepted photo-energy, respectively, were observed in Koshihikari with low leaf nitrogen content. On the other hand, other three cultivars were proved to be the decrease in these parameters with nitrogen supply restriction and leaf senescence, particularly G174 and WK35 showed severe decrease. In Koshihikari, the maintenance of chlorophyll content (Chl) and ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco) content with nitrogen supply restriction also supported the high maintenance of Pn. Chl/Rubisco ratio, regarded as the parameter reflecting the functional energy balance between CO2 assimilation and photosystem II, was revealed different tendencies among four cultivars. In Koshihikari and G174, Chl/Rubisco ratio could retain higher value even in moderate or small nitrogen content of a leaf, implying that these cultivars could maintain the energy balance of photosynthetic functions by the mechanism of efficient distribution of limited nitrogen resource in a leaf. However, in G174, severe nitrogen content in a leaf with nitrogen supply restriction and the progress of leaf senescence raised this ratio rapidly, and resulted in degrading the energy balance. In Shirobeniya and WK35, there were similar tendencies in the ratio that was retained in case of enough nitrogen content in a leaf, however, risen by a decrease in this content. These results suggest that Koshihikari has the highest potential in photosynthesis with the maintenance of the energy balance between photosystem II and CO2 assimilation among the four cultivars used in this study under nitrogen restriction condition.
Fig. 1 A relationship between leaf nitrogen content in a leaf (LNC) and photosynthetic rate (Pn) among four cultivars

Fig. 2 A relationship between leaf nitrogen content (LNC) and the ratio of chlorophyll content to Rubisco content among four cultivars
Land use change in the Mae Sa watershed, Thailand, 1996-2006 and guidelines for management

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KEY WORDS: GIS; Land use; Watershed management

INTRODUCTION

The Mae Sa watershed is located in Chiang Mai province, northern Thailand and is about 14,019 hectares in size. The Mae Sa river is the main stream and flows into the Ping River, the main basin of northern Thailand. The watershed has seen rapid changes in land use in recent decades. Three decades ago the area was mostly used for shifting cultivation, annual crop, and opium poppies. Nowadays, annual crops, greenhouses, fruit orchards, housing, and tourist activities dominate the land use.

In recent decades the Mae Sa Watershed has faced various challenges related to unsuitable land use and deforestation. Crop lands and urban areas have expanded, and tourist activities have exceeded the capacity of forest. For instance, the grazing and trekking of elephants, a main tourist attraction in the area, has damaged large areas of the forest.

OBJECTIVES AND METHODS

The objective of this study was to identify patterns of land use change in the Mae Sa watershed area between 1996-2006 and to define guidelines for land use management in the watershed. The shifting pattern of land use was analyzed using ERDAS IMAGINE 8.7 and ArcGIS on LANDSAT satellite images for 1997, 1999, 2001, 2003, 2005, and 2006.

RESULTS

Figure 1 shows the main results of the analysis. These results show that 71.3 percent of the watershed was under forest cover in 2006 but the area without forest cover increased to 1,210 hectares between 1996 and 2006, which equals 8.63 percent of the watershed area. The rate of deforestation was highest from 1997 to 1999 at 3.75 percent during 2 years, which equals 526 hectares. The speed of deforestation slowed down after 1999 and stabilized in 2005-2006.

Figure 1. Land use change 1996-2006, hectares
Between 1996 and 2006, the newly deforested area was utilized for annual cropland and other opened lands, which increased by 5.10 percent to 716 hectares. In addition, the area of orchards and field crops increased by 0.36 percent to 50 hectares, and finally, the area of urban land use expanded by 3.17 percent to 444 hectares. These land use changes are likely to continue into the future.

The upper area of Mae Sa basin is a so-called ‘head watershed forest’ and comprises several sub-catchments. The results of this study revealed a reduction in forest areas between 1996-2006 in the sub-catchment of Huay Tharn (-23.75%), Huay Nong Hoi (-18.46%), Huay Mae Na Pra (-16.36%), Huay Pong Khrai (-14.43%), and Huay Mae La Ngoon (-13.8%). Furthermore, the analyses showed reduced forest areas in the lower area of the basin in the sub-catchment of Huay Mae Sa (-22.75%) and Huay Rin (-15.70%). These results point to the vulnerability of land use in the Mae Sa watershed. These sensitive areas should therefore be under close-watch.

GUIDELINES

Based on the analyses the following guidelines were recommended. First, the implementation of restrictions on land use activities in the area of watershed class 1 and 2. Second, agroforestry and vetiver grass need to be promoted in the opened areas to control soil erosion and to maintain the fertility of the soil. Third, reforestation is important on sloping areas and in distances of a 20-meter band alongside the Mae Sa stream and its tributaries. Fourth, water check-dams in the basin need to be constructed. Fifth, the grazing and trekking of elephants needs to be restricted to maintain this activity within the capacity of the forest. In addition, supporting conservation groups in relation to regulations and the way of life of local people is required. Last, for the expansion of urban communities in the near future, establishing marginal green strips as a permanent buffer zone in the lower area of watershed is strongly recommended.
Improving living standards of rural farming people through water recourses development: an example of an integrated spatial approach from Northern Thailand

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KEY WORDS: Waters use; socio-economic situation; integration; GIS; RS; Thailand

INTRODUCTION
In the mountainous region of Thailand, water is becoming the scarce resource and water related problems are increasing day by day as in other parts of the world. However, farmers still use the traditional water resource management which cannot cope with future organizational and managerial needs. Thus, many water-related myths and expectations in this regards need to be examined such as whether there are possibilities for better development and use of water on the family and regional levels? Evaluation is therefore needed in the context of the investigation of future strategies for better use using the potentiality of modern planning tools and management concepts, sufficient regional studies in this regards have not yet been carried out. Therefore this research seeks to analyse water resources at the regional and family level through the use of RS/GIS and socio-economic analyses and model in order to see the development of water resources in the past and current situation and to develop future strategies.

METHODOLOGICAL CONCEPT AND APPROACH
Research is based on the methodological concept of combined socio-economic and spatial assessment (Figure 1). Spatial assessment mainly water resources development from the past to date, availability of water resources and agricultural water use, possibility of collecting/harvesting rain water through different means and making them available for the agricultural use were assessed using RS/GIS technology. Socio-economic conditions of the people were assessed based on a survey with in-depth interviews with randomly sampled families. In the second stage of data analysis socioeconomic data were linked to the GIS by using each family’s and their respective farming fields’ geographical position (Figure 2) and further analysis were carried out.

RESULTS
Socioeconomic assessment of farm family including the characterisation of farm family, farm family level water related issues and overall living standard assessment shows that farmers are having a high level of agricultural water scarcity, due to the unavailability of agricultural water specially during the winter and dry season most of the sample farmers were able to grow one paddy crop in the monsoon season only. Rest of the year their entire farming fields lies idle. Spatial income distribution shows that the farmer living near by the water sources or water heads and doing orchards are better-off compared to those living far from the water source and watersheds and growing cereals only. This indicates the high
need of identification and the development and management of agricultural water. Results from satellite images assessment show the significant changes in the water resources development in the past. Almost 239% additional areas were under the water in year 2003 compared to the year 1989 (Figure 3, Table 1 and 2). Spatial assessments including the assessment of hydrological structures were carried out and possible location for collecting the rain water were mapped and presented.

Table 1: Comparison of overall status of resources in 1989-2003 period

<table>
<thead>
<tr>
<th>Resources</th>
<th>Area (ha)</th>
<th>Change 1989-2003</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1989</td>
<td>2003 Area (ha)</td>
</tr>
<tr>
<td>Forest</td>
<td>13015</td>
<td>11738 -1277</td>
</tr>
<tr>
<td>Agriculture</td>
<td>10015</td>
<td>11139 1124 11.22</td>
</tr>
<tr>
<td>Water</td>
<td>64</td>
<td>217   153 239.06</td>
</tr>
</tbody>
</table>

Table 2: Comparison of water resources development and change in 1989-2003 period

<table>
<thead>
<tr>
<th>water body (No.)</th>
<th>Water body area (ha)</th>
<th>Big reservoir (&gt; 20ha) (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>2003</td>
<td>1989</td>
</tr>
<tr>
<td>40</td>
<td>406</td>
<td>64</td>
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<td></td>
<td></td>
<td>19</td>
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</tbody>
</table>

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Impact of land use systems on soil erosion in limestone areas of Northern Thailand

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Keywords: soil erosion; soil properties; Gerlach Trough; EPIC

ABSTRACT

Soil erosion in Northern Thailand is causing severe land degradation resulting in socio-economic problems. Land use patterns are a key factor for the origination of these problems. In order to alleviate these issues the investigation of the effects of different types of conventional land use on soil water erosion and soil water availability is necessary. The present study comprised measurements of surface runoff/soil loss in fields under different types of land use. Additionally, comparison of surface runoff/soil loss between actually measured experimental data and data from model prediction (EPIC-Erosion Productivity Impact Calculator) will be performed in order to test the model reliability.

The field trial was conducted on several sites around Bor Krai, Mae Hong Son Province in Northern Thailand, at an altitude of 550 – 1020m asl, and is ongoing since April 2007. Five types of land use systems were selected. All are located on the locally common soil types Luvisols and Cambisols (according to WRB 1998 soil classification). The types of land use included secondary forest, mixed orchard, upland rice, maize field and fallow land. Soil erosion (soil loss and surface runoff) was measured using Gerlach Troughs, consisting of bamboo tubes connected with 75-liter buckets, which were positioned at different elevations, as well as erosion-pins. Furthermore, time domain reflectometry probes and tensiometers were installed in each respective land use system area in order to measure soil water characteristics. Furthermore, bulk density, aeration porosity, field capacity, aggregate stability, steady infiltration rate, saturated hydraulic conductivity, total stored water within 1m soil depth, pH, plant available P, K and organic matter were determined.

The investigations revealed a high variability for bulk density and field capacity between the different sites, due to different soil types and petrography. The lowest bulk density and highest field capacity were found on limestone soils, while soils from claystone were characterized by a high bulk density and low field capacity.

The surface runoff/soil loss data produced from a site in a secondary forest showed the lowest rate of soil erosion, while upland rice induced the highest rate. In conclusion, soil erosion tends to degrade soil properties and decreases the total water stored within 1m of the soil profile, which is especially severe in upland rice fields.

The results of the soil property analyses will be used to predict soil erosion for alternative land use planning using the EPIC model. This may help decision makers to select and plan sound soil-water management, formulate more sustainable land use planning and achieve erosion control to avoid further land deterioration.
Modeling the fate of nutrients and pesticides in two catchments with paddy rice-aquaculture systems in Northern Vietnam

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KEY WORDS: SWAT; discharge; catchment; Northern Vietnam;

In Son La province, Northern Vietnam, water supply for paddy rice aquaculture systems is mainly regulated by irrigation channels. Often, irrigation water is first used in paddy fields, before it flows to fishponds and further to the discharge system. Because farmers regularly apply considerable amounts of agrochemicals, mainly pesticides, to field crops, fish production suffers and, moreover, communities in the downstream areas are affected by polluted water.

The overall aim of this study is to model the fate of nutrients and pesticides in two catchments in Yen Chau, Son La province. The study evaluates the potential risk of polluted water across the landscape and provides a tool for assessing the environmental impact of adapted and non-adapted land use practices and a guide for natural resource management to develop sustainable agriculture and forestry production in the upland areas of Northern Vietnam. This study is carried out in the framework of the Collaborative Research Center (SFB 564) “Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia”.

Field measurements are carried out with special emphasis on the water distribution system. Water inflow and outflow of the catchment are recorded by automatic pressure sensors. The discharge in irrigation channels will be measured by the integration (gulf) method. Discharge in river will be calculated by water velocity (measured by flowmeter) and water level recorded. Five pressure sensors were installed at two inlets and three outlets in the Chieng Khoi catchment. A weather station was installed in the catchment equipped with precipitation, air temperature, and air humidity sensors.

To model the hydrology of the catchment a GIS data base was installed which will be linked to the SWAT model (Soil and Water Assessment Tool). SWAT is a process-based, watershed scale model which runs on daily time-steps. It was designed to predict long-term non point source pollution impacts on water quality such as sediment, nutrient and pesticide loads. Model processes include calculations of water balance (i.e. surface runoff, return flow, percolation, evapo-transpiration, and transmission losses), crop growth, nutrient cycling, and pesticide movement. Model outputs include sub-basin and watershed values for surface flow, ground water and lateral flow, crop yields, and sediment, nutrient and pesticide yields. The model will be calibrated and validated using discharge measurements.

The poster presentation will depict the basic concept of this study and present the first measurement results.
Figure 1: Chieng Khoi Catchment Overview
The fate of agrochemicals in paddy rice-aquaculture systems in Northern Vietnam

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KEY WORDS: pesticides; pollution; environmental fate; paddy rice; Northern Vietnam.

During the last decades the problem of agrochemicals input and consecutive water contamination in paddy rice production systems has received much attention in many rice producing countries all over the world. However, so far little is known about the environmental fate of pesticides in coupled rice-fish production systems. In Son La province, Northern Vietnam, many irrigation farming systems include fish ponds to produce additional food and income. Often, irrigation water is first used in paddy fields, before it is drained off to the fishponds. The aim of the present study is to assess the environmental fate of agrochemicals in paddy rice-aquaculture systems in Yen Chau, Son La province. The project is a part of the SFB 564 "Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia".

The study sites are located in 2 subcatchments, Chieng Khoi and Moung Lum, of the Yen Chau district of Son La province, North-west Vietnam. In Chieng Khoi, a representative paddy rice-fish production system was chosen as experimental plot.

At this, a weather station equipped with air temperature, humidity, wind speed, solar radiation, and rainfall sensors was installed in the middle of Chieng Khoi valley. The TDR (Time-domain reflectometry) and the tensiometer techniques are used to measure the volumetric water content and the matric potential in depths of 20 and 40 cm. Water flow through the paddy rice-aquaculture system is measured by means of V-shaped (Thompson) weir and HS-flumes equipped with automatic pressure sensors.

A mixture of pesticides with different physicochemical properties and half-lifes was applied. Degradation kinetics was assessed for paddy soil and water, as well as pesticide transport to the adjacent fish pond and outflow to the main river. Transport of pesticides with percolating soil water was determined by the use of suction cups installed at 20 and 40 cm depths. Paddy water and soil samples were taken before application, immediately after application and at 1, 2, 3, 4, 6, 9 and 14 days after application. Paddy outflow and inflow water, pond water and pond outflow water samples were taken as grab samples, as a function of the irrigation schedule.

Pesticides were concentrated in Vietnam by solid phase extraction (SPE) using cartridges filled with graphitized nonporous carbon (Carbopack). The pesticides are eluted from the cartridges at the University of Hohenheim, Germany, and quantified on a gas chromatograph with NPD and mass spectrometer to confirm the identity of the pesticides.

The water quality monitoring in the subcatchment is currently undergoing, with samples of river water being collected every month in between rice growing seasons and
every five days during pesticide application time for two rice crop seasons.

Assessment of environmental fate of pesticides in the paddy rice-aquaculture system will include data for kinetics and peculiarities of degradation of pesticides in soil and water, as well as dynamics of their leaching and transport to adjacent systems (pond and river). The results obtained will contribute to reveal vulnerable environmental compartments of mountainous paddy rice production systems. As another output from our work, a reassessment of the existing agricultural practices will be possible, leading to an improvement of the pesticide use recommendation guidelines and contributing to the development of sustainable agriculture in this region.

Besides presenting the general setup of our study we will show in our poster the first measurement results of degradation patterns of pesticides in the rice paddy system.
Does *Brachiaria humidicola* produce natural nitrification inhibitors released as root exudates?

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KEY WORDS: *Brachiaria humidicola*, nitrification inhibitors, root exudates

INTRODUCTION

Rapid nitrification of ammonium in nitrogen (N) fertilizers in well aerated soils causes environmental problems of N losses by leaching of nitrate and production of greenhouse gases (NOx, N2O) as intermediate products. Because of these losses, which can comprise up to 50% of the applied N fertilizer, synthetic nitrification inhibitors (NI) are widely used to maintain ammonium stability soils. With regard to environmental concerns, increasing attention is placed also on natural products. Subbarao et al 2005 and 2006 reported that some accessions of *Brachiaria humidicola* are very potent in releasing natural nitrification inhibitors as root exudates, even more efficient than commercial synthetic chemicals, such as DMPP and DIDIN. Natural NI compounds have been also identified in various other plant species. *Brachiaria* species have been suggested as a potential forage possessing this ability to suppress nitrification in the soil (CIAT 1983). Later it has been shown that these plants specially *B. humidicola* accession 26159 are very efficient in releasing biological nitrification inhibitors in root medium as exudates (Ishikawa et al. 2003, Subbarao et al. 2007) under ammonium nutrition rather than nitrate.

METHODS

In this study the intracellular accumulation and root exudation of compounds with NI potential was investigated in *Brachiaria humidicola* Rendle accession 26159 in different developmental stages. Plants were grown in hydroponic culture with different levels and forms of nitrogen supply (NO3⁻ and NH4⁺) and different light regimes (180, 240 and 400 μM/sec), respectively. The NI potential was evaluated using a standardized soil incubation test, measuring the production of nitrite from ammonium added as a substrate, in a spectrophotometric assay (Kandeler 1993).

RESULTS

Under all tested experimental conditions, shoot homogenates exhibited the most pronounced NI potential (Fig 2 and Fig 3). The NI activity declined with increasing levels of N supply, while no significant differences were detectable between different N forms. Fractionated extraction of the plant material with solvents of increasing polarity (n-hexane, ethylacetate, ethanol, water) revealed the highest NI activity in the ethanol-soluble fraction (Fig 2), which is consistent with the solubility of low-molecular weight phenolics, - a class of compounds containing substances with NI potential also in various other plant species. In root homogenates, the NI effects were not consistent and in some cases even a stimulation of nitrification was observed (Fig 3). In root exudates; collected for short time periods (2-4 h) to avoid microbial degradation and root injury, or even for longer period collection (24 h) no NI activity was detectable in any of the experiments (Fig 1). These results do not support the hypothesis that roots of *Brachiaria humidicola* release natural NI compounds as an adaptation to cope with N losses in their natural habitats.
Fig 1: Effect of root exudates collected in distilled water (24 h collection) of NO3 and NH4 pre-cultured plants on nitrification (50 h incubation), DMPP as a standard nitrification inhibitor always was used as second control beside water control. The same results were repeated for all other treatments condition.

Fig 2: Effect of extracts from NH4+-precultured plants (shoot homogenates) by various organic solvents + 0.8% DMSO on nitrification. Sequential extraction of a 4 gram shoot, first with Hexan, then EA, then Ethanol, then Water and finally applying the extracted material as a separate treatment.

Fig 3: Nitrification inhibitory effect of (not extracted) shoot (0.5 vs 0.25 g) and root homogenates of plants grown in 1mM of N-NO3, incubated for 50 h

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Plot scale modeling of erosion and runoff with WaNuLCAS 3.2 in Ban Tat, Northern Vietnam

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KEY WORDS: Erosion, Runoff, Modeling, WaNuLCAS, Vietnam

ABSTRACT

Demographic pressure and increasing economic development are the driving forces for an intensification of agricultural production and the formation of fragmented landscapes in Vietnam. Especially, mountainous areas faced rapid changes in land use systems and became prone to environmental degradation and resource overuse in the past decades (Vien et al., 2004). Furthermore, slash and burn agriculture is still applied in many upland areas. Government efforts to stop these methods were not successful and adoption of local environmentally appropriate techniques did not spread in many parts of Vietnam.

The Centre for Agriculture and Ecological Studies (CARES) of the Hanoi Agricultural University carried out a long-term nutrient balance analysis of selected local cropping systems in Ban Tat, Hoabinh Province, Northern Vietnam. The analyzed cropping patterns represented combinations of upland rice, cassava and fallow resembling the local farming practices. Additionally, the tree species *Melia azedarach* was intercropped on the selected fields at different stages of crop cycle. In general, *Melia azedarach* is grown locally for its multipurpose use. It is a fast growing, deciduous tree which reaches a height of about 10 m, and shows high resistance to drought stress.

In order to collect nutrient flow data in a controlled fashion, an experimental small watershed area was selected in the village of Ban Tat. CARES established several masonry walls plots to study on plot erosion and runoff patterns in relation to the applied cropping patterns. The research objective was to understand the nutrient flows from upland swidden fields into lowland paddy areas within the selected experimental site. The assessment of long-term effects of such systems is often difficult to predict. Therefore, the objective of this study was to test the applicability of the Water, Nutrient, Light Capture in Agroforestry Systems (WaNuLCAS) (Van Noordwijk M., Luisana, B., 1999; Van Noordwijk, M., Luisana, B., Khasanh, N.; 2003) model related to erosion and runoff under the conditions of Ban Tat. Results of CARES field measurements and information based on farmer interviews were used to calibrate the model. A selected set of input parameters from the area regarding agricultural management, climate, soil and topography were used for sensitivity analysis and to define threshold values for the model calibration.

(i) Model run scenarios were selected according to different lengths of cropping periods (2-4 years) and accompanying fallow stages of weed growth intercropped with *Melia azedarach*. (ii) In a second setup, *Melia azedarach* was intercropped in an earlier stage of cropping cycle to resemble a local agroforestry practice. The different scenario sets were chosen to test the model algorithm of erosion and runoff on a monthly and annual time step in comparison to
observed field data. Model runs with the 2nd scenario setup were carried out to assess the impact of intercropping *Melia azedarach* to erosion and runoff in an earlier stage of cropping cycling.

The model proofed its capability to estimate runoff and erosion in comparison to collected field data. Statistical analysis adapted from Loague and Green (1991), Walker et al., (2007) highlighted different modeling efficiencies by comparing monthly and annual time steps. A similar trend was found by Favis-Mortlock (1998). Favis-Mortlock evaluated six field-scale erosion models (GLEAMS, EPIC, CSEP, MEDRUSH, WEPP, EUROSEM) with datasets from seven sites in three countries. He concluded that long-term average results are generally best simulated, and there is evidence that relative results are more reliable than absolute model results. Model runs with the 2nd scenario setup did not show a strong impact on reducing erosion and runoff. The applied model algorithm uses a general “surface cover” equation. Thus, it is not important if a tree or a weed is grown. Moreover, the model assumes that a high surface cover in general reduces erosion and runoff amounts. Nevertheless, influences of changing infiltration capacity and root density dynamics were not tested for this study. Therefore, it is recommended to carry out further model runs to test the above mentioned parameters, and reliability of applied model algorithms concerning “surface cover”.

In conclusion, WaNuLCAS 3.2 can serve as a useful tool for an ex-ante testing of new crop management methods within a selected setup of parameters. Model applications, however can help to understand the behavior of a defined system, but should not be taken as authoritative statement per se (Van Noordwijk M., Luisana, B., 1999).

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Land Suitability Assessment for the Large Cardamom *Amomum subulatum* Roxb in hills of Kathmandu Valley.

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Keywords: Land suitability; GIS; *Amomum subulatum* Roxb

**INTRODUCTION**

Nepal is one of the top three exporters of large cardamom in the world market. Only 5% of total production of large cardamom is consumed within the country, and about 95% is exported overseas. So, it is one of the promising cash crops which contributes largely in the Nepalese economy. *Amomum subulatum* Roxb (family Zingiberaceae) is mostly confined to the sub Himalayan ranges of Nepal. The area under cultivation is increasing gradually toward central and western region from original cultivation site at east Nepal.

**OBJECTIVES**

Export of Large Cardamom has increased to about three fold from 2001 to 2005 but productivity has drop down from .57 MT/ha to .53 MT/ha within this period however total production fluctuates with slight increase (AEC/FNCCI, 2006). There is considerably expansion in area under cultivation however productivity from last 5 years dropping down gradually. Rampant expansions of cultivation without considering land capability jeopardize land sustainability as well as productivity. Therefore, objective of this study was set to catagorised available land area in the range of suitability according to FAO system considering physical characteristics of the land.

**APPLIED METHODS**

Kathmandu valley, a bowl shaped land area with alluvial bottom plain is surrounded by boundary hills, is selected as study area. Altitude ranges from 1200 m above sea level to 2800 m with climate range from warm temperate to cool temperate. Methodology has been designed within the framework for the land evaluation given by FAO (1976 & 1983). Physical land suitability evaluation has includes soil characteristics, climatic condition, physiographic setup and some of the socio economic attributes. GIS maps of the land use of Kathmandu valley in scale of 1: 25000 has been use with courtesy from the Department of Survey, GON,. Arc GIS 9 had been use for suitability analysis. Suitability assessment was done through overlaying soil map, land use maps, elevation map, slope map, aspect map, and climatic map.

**RESULTS**

Altitudinal range of above 1000 m above sea level, with annual average rainfall of 1000–2000 mm and mean annual temperature of 18 to 28 is found to be the suitable condition for *Amomum subulatum* Roxb. Sandy loam soil, slightly acidic in nature with gentle sloping land of about 5° - 8° provides highly suitable condition. North-east to north facing slope was very good in retaining moisture and also maintains reasonable temperature range for the optimum growth of plant. Agro-ecological requirement of the *Amomum subulatum* has been cross match with the prevailing land condition. Kathmandu valley, is found to have three main soil category with several soil units, which in-favour of *Amomum subulatum* cultivation. Climatic condition viz precipitation, temperature, humidity and potential evapotranspirator in the higher elevations (above 2000m) around the valley shows higher potentiality for large cardamom cultivation. Result showed that more than one third of total land areas above 1800 meter above sea level are suitable. However topographic constrains (steep slope, orientation, slope) restricts suitability ranking. It is found to be grown well in northing facing slope of more than 5°. 13% of total land
area of study are having gentle slope (3° - 8°) with loamy soil are allocated as highly suitable, similarly 16% of area with north to east orientation are also categorized into suitable class. 44% of flat alluvial plain which are prime agricultural land for paddy cultivation are unsuitable for Amomum subulatum cultivation because of higher clay content of soil. Growth and development is found to be further enhanced by combination of moderate shade providing plants. It has high prospectus to be cultivated in agro-forestry approach. Suitability assessment showed that non-agricultural land (fallow), forest floor and abandoned land, along with agricultural land are rated to be highly to marginal suitability. Hills of northern boundary found to be suitable due to more rainfall distribution pattern compared to southern boundary hills. Most of the slope lands were found to have poor soil quality and perennial crops like Amomum subulatum are supplied with less agricultural input, which results into constantly decreasing in productivity.

REFERENCES


Migration and resource utilization in a community-based forest management in Rizal, Philippines

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KEY WORDS: upland migration; community-based forest management; resource utilization

The Philippine government to address the forest problem to achieve sustainable forestry and promote social equity adopted the people-oriented program approach also known as the community-based forest management. Under the community-based forest management program, the marginal upland farmers who were socioeconomically displaced from their place of origin would have access to provision, assured of tenure and entrusted the responsibility to look after the forest while reaping its benefits.

This paper was exploratory in nature and scrutinized the interplay of social factors that highlighted the migration and utilization of resources in a community-based forest management area by household migrants. It adopted the diagnostic participatory rural appraisal type survey to collect data. Quantitative and qualitative approaches were used to analyze data.

Survey revealed that households migrated in the study area due to invitation received from relatives and friends who first came to know the place, search for employment, and parental migration. It was also disclosed that majority of the existing migrant households acquired the certificate of stewardship contract either as a direct recipient or as form of inheritance from their parents. But for some reasons, holders of the stewardship contract forfeited their right by selling or mortgaging the piece of forest farmland. Thus, recipients of the stewardship contract were categorized as permanent resident, absentee-claimant and pajero (weekend) farmer. Household migrants who stay permanently in the community-based forest area are hopeful the land they till will be titled under their name to attain security.

Figure 1. Conventional way of processing charcoal.
With regard to the utilization of natural resources in the community-based forest area, household migrants primarily used the farmland for income and settlement purposes. They are engaged in farming and charcoal-making. Despite these economic activities, they deemed not to cut forest trees to expand the area for farming. Further analyses showed the decisions on the continued utilization of resources were influenced by the migrants’ household characteristics, availability of farmland, livelihood opportunity, accessibility of the farmland, and nature of migrants’ residential status in the community-based forest area (Table 1).

Table 1. Social and cultural factors influencing utilization of resources.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Eigen value</th>
<th>% of variance</th>
<th>Cum. %</th>
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<td>Employment opportunity</td>
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<td>Status of residency</td>
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</tr>
</tbody>
</table>

Figure 2. Manual method of threshing upland rice as performed by women.
Application of Multi-Agent Systems to assess sustainability of farming systems in mountainous areas

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KEY WORDS: agent-based modelling, integrated modelling; bottom-up modelling; Northern Thailand

Due to tension of resource utilization under population growth and land limitation, the sustainability of subsistence farming systems in Bor Krai village, in the mountainous and conservative forest study area of Northern Thailand, is questioned. Therefore, this paper aims at evaluating the sustainability of the area’s farming systems where agricultural practices are dominated by crops and livestock under upland rainfed conditions. To capture the complexity and to extrapolate the dynamics of farming systems sustainability, a Multi-Agent Systems (MAS) model, named “CatchScapeFS”, has been developed, [Potchanasin et al., 2006]. The model integrates biophysical and socioeconomic components following a bottom-up modelling approach [Becu et al., 2003]. The heterogeneous elements of the components are modeled through the CORMAS platform with individual attributes and internal dynamic methods – corresponding to real-world conditions.

The biophysical component of the model is based on the “CatchScape3” model [Becu et al., 2003] and consists of biophysical sub-models: a hydrological model, a crop model, a water balance model, and a soil erosion model embedded in the study area’s landscape model which is divided into spatial grid cells representing agricultural plots of one rai (0.16 ha).

The 60 farm agents in the socioeconomic component correspond to the real-world farm household population. The farm agents are classified into three groups based on their characteristics and behaviour: market, subsistence and partnership oriented. The Monte Carlo techniques are applied to parameterize the generated farm agents based on the distributional aspects of the 32 random farm samples.

Each simulation time step corresponds to a 10 day time interval and consists of six phases (biophysical dynamics, farm household activities, socioeconomic dynamics, information exchanges and result arrangements). The farm household activities consist of eight sub-phases: knowledge base updating, household resource updating, cropping activities, household activities, harvesting, selling farm products, financial activities and livestock activities.

The model is validated and tested for its stability. Validation is conducted by using both, statistical data comparison and social validation. The stability test results show the model’s consistency. Repeated simulations show small standard deviations, standard errors of mean and ranges. This indicates that the model is a plausible representation of the study area and can be used to analyze and extrapolate the sustainability situation of the study area.

The assessment of sustainability is performed at household and village level. Defined indicators are including household income, net farm income, household capital, household savings, food security, top-soil erosion, and fallow period. At the household level, sustainability is assessed through individual agent performance corresponding to each indicator. Here, the farm agents are classified into Sustained (S), Conditional sustained (C), and Non-sustained (N) classes. Based on the sustainability situation...
at household level, the sustainability at village level is expressed by the Sustainability index (SI) and the Performance index (PI).

The simulation is run for 15 years corresponding to the period of 2003 – 2017. The dynamics of farming systems and sustainability are generated by the model, which captures the complexity of reality by involving heterogeneity, interactions and dynamic processes.

At household level, the results show an increase of unsustainability over time. The proportion of households in S class (yellow part of columns) decreases over time, while the proportion of households in N and C class (orange and brown parts of the columns) increases over time (Figure 1). This pattern is also found for the other indicators.

At the village level, the results broadly confirm the results at the household level. Farming systems in the study area are not sustainable. Unsustainability is expressed by gradually declining values of PI and SI for all indicators in the long term (Figure 2). By considering all single SIs and their dynamics, sustainability issues can be ranked. The food security issue is considered as the most unsustained issue followed by household savings, household capital, top-soil erosion, household income, fallow period and net farm income respectively. Policy development towards sustainability by maintaining food security in the mountainous area is crucial. Further study on strategies to develop sustainability to advance the unsustained issues in the area is highly required.

![Figure 2: Sustainability situation at village level in the study area](source)

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Integrated modeling to guide watershed development:
A case study from Northern Thailand

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KEY WORDS: Multi-agent systems, economic development, cash crops, migration

ABSTRACT
The mountainous part of northern Thailand has seen rapid economic development in the last two decades. For upland agriculture, this development has entailed several changes that strain the balance between resource use and resource conservation, including:

- a shift in focus from food staples such as rice towards high value fruits and vegetables;
- reduced fallow periods and an increased reliance on agro-chemicals (mineral fertilizers and plant protection);
- greater demands for irrigation water during the dry season; and
- a reduced supply of agricultural labor with increased employment opportunities in other economic sectors.

The effect of these changes on the natural resource conditions as well as economic well-being has generated debate about how these developments should be directed. The objective of this paper is to inform this debate with quantitative data and analysis, and to ex-ante explore the impact of alternative development scenarios.

The paper develops an integrated land use model of the Mae Sa watershed in northern Thailand. This watershed, about 100 km² in size, though not representative for northern Thailand, can be seen as at the vanguard of the changes brought by economic development for its proximity to Chiang Mai city and its coverage of both lowland and upland areas. While paddy and upland rice covered nearly 80 percent of the agricultural area in the early 1980s, vegetables, flowers, greenhouses, and fruit orchards now dominate its land use. In addition, a large part of the economically active population, especially in the lowland areas, nowadays engages in activities other than farming.

The developed land use model applies an agent-based modeling approach in which each of the approximately 1,200 farm household in the watershed is individually represented in the model by a computational agent. A household model of constrained utility optimization simulates the decision-making of the agents. Agents face a choice between farm and non-
farm activities and require land, cash, labor, knowledge, and water for their farm enterprise. The total supply of water is limited and is simulated by a routing model that was calibrated to the watershed. Crop yields are reduced if the crop water supply falls below the crop water requirements, following the FAO CropWat model.

The agent-based model was calibrated by combining data from various sources:

- Economic and farm management data were collected from a random sample of 395 households interviewed in October-November 2006.
- Discharge and precipitation data were collected through field measurements between 2004 and 2007.
- Spatial data on land use and elevation were collected from satellite images and aerial photographs between 2000 and 2006.
- Biophysical crop parameters were derived from secondary data and the DSSAT crop model.

The main dynamics in the model relate to demographic change (fertility and mortality rates), monetary savings of the farm households, and the diffusion of agricultural innovations. In the present setup, soil fertility, water supply, and market prices were assumed constant at levels for the year 2006.

Sensitivity testing of the model showed that the irrigation water supply, the household savings coefficient, and the opportunity cost of labor are critical parts of the model. Results are therefore shown for various levels of these parameters.

The model was used to explore the effects of ongoing land use changes in the watershed over the period 2006-2020, including an expansion of the area under greenhouses and a reduction in the area under litchi orchards. Environmental indicators used to evaluate the model results include land and water use, and levels of pesticide application. Economic indicators include net family income and levels of migration out of agriculture. Further scenario analyses were used to quantify trade-offs between economic gains from intensified land use and the environmental costs related to the increased use of water and agro-chemicals.

Two main limitations of the present version of the model are: First, an incomplete calibration of water availability at sub-catchment levels because of lacking data. Second, the exclusion of a non-farm labor market, which constitutes the greatest part of the local economy.

Future activities will include a workshop with stakeholders (farmers, government officials, watershed managers) in the watershed to receive feedback on the model results and to apply it to alternative scenarios of interest to stakeholders.
Modeling the impact of smallholder land-use decisions on the Availability of Rattan

Frank von Walter, Jan Barkmann

1 GENERAL FRAMEWORK

Although being protected areas on paper, the margins of national parks are often cultivated by local agricultural smallholders. Within the projects of DFG SFB 552 (STORMA\(^1\)) and DFG FOR 816\(^2\) we create a modeling environment that can be applied to two such cases in Central Sulawesi (Indonesia) and Southern Ecuador.

For adequate sustainable management schemes it is important to combine knowledge of socio-economic and ecological impacts of land-use changes spatially explicit on the landscape scale. We present an integrated framework, which combines socio-economic drivers and ecological and economic impacts (see fig. 1). This allows us to assess the potential of different management alternatives to impede ecological degradation and to alleviate poverty. From a central Graphical-Users Interface (JAVA-Application) different scenarios and components can be selected and the simulation of a Multi-Agent-System (MAS) is triggered (Repast\(^3\)). Repast loads the necessary economic and ecological data from an Entity-Relationship-database. The decision space available to each agent, i.e. smallhold farmer, is limited by natural resources and financial, personal and social capital. The land-use decisions are made according to an economic optimisation model. The economic and ecological impacts of the land-use decisions are again fed back into the database, from which they can be reused in the next time step or taken up for further analysis. Furthermore the components of the environmental and economical impact are interchangeable, thus allowing for an easy adoption to different scenarios and applications. The core of this model is a MAS with a strong economic optimisation component. With this modelling type, we can cater for individual decisions and their response to different incentives. Furthermore we can differentiate between the perspective (“Merkwelt”) and the environment (“Wirkwelt”) of an agent. Individual land-use decision-making depends on how the environment is perceived. This perception does not necessarily have to match with the underlying system functioning. Exogenous events (erosion, degradation, weather, . . .) might alter the outcome of a management decision.

2 FIRST APPLICATION

As a first application of our model, we chose the harvest of rattan in Sulawesi. In the old world tropics rattan is an important non timber forest product (NTFP), which is mainly collected from

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\(^1\) Stability Of Rain Forest Margins in Indonesia

\(^2\) http://www.tropicalmountainforest.org/

\(^3\) http://repast.sourceforge.net
natural forests. However, studies suggest that the harvest of rattan canes is far from being sustainable, as more canes are extracted than regrow (Dransfield, 2000; Siebert, 2004). In principle, rattan can be also harvested from lowland forests. However, in many traditional harvesting locations the lowland forest ecosystems have either already been converted virtually completely to agricultural lands (e.g. in mountainous Sulawesi (Barber and Matthews, 2002)) stocks of priority rattan have been nearly depleted (Peluso, 1992). Since rattan extraction is hard work, only the poorest group of residents is regularly involved in rattan extraction. For our Central Sulawesi project region, only few individuals appear to collect exclusively rattan. Most household interviewed in 2004, which are involved in rattan extraction are proprietors of a small plot of paddy rice or cacao. Only recently paddy rice, a lowland crop, was introduced in contrast to the long history of rice cultivation on Java. Thus, no extensive terracing of upland hills exists. Buginese migrants have introduced the conversion of lowland paddy rice plots to cacao plantations recently. Cacao is increasingly planted on up the slopes extending from the lowlands. This upslope extension of cacao production is limited by low temperatures in higher altitudes. Several economically interesting rattan species are harvested much higher. If income from lowland agriculture (paddy rice and cacao) is low (drought, no access to land) concerned households turn to rattan extraction. Therefore, upland and lowland land use are linked in a complex way. The household decision-component is initialised using several data sources from the STORMA-Project including data of a representative household survey (Schwarze, 2004). These sources supply data on capital access and restrictions to economic activity of different classes of smallholder households. We model off farm work as rattan extraction; particularly for remote villages such as Au and Moa without road access this is highly realistic. A decision to harvest rattan is modelled as an economically optimised result from a LINGO analysis of single household-level (‘agent’) production opportunities. The impact rattan extraction is modelled by a specific impact module that represents rattan stocks and their changes. This module is initialised by abundance data of Calamus zollingeri, a local priority rattan species, for the year 1996 and calibrated with year 2000 data (Siebert, 2004). One difference between Merkwelt and Wirkwelt of the smallholder agents is exemplified by the problem to actually design a plausible local development and conservation project that maximises long-term rattan benefits for the poorest households. The smallholders know about potential rattan sites (‘Merkwelt’) and also roughly to which extent harvesting has taken place there. However, actual rattan harvesting decisions are not made from an omniscient position according to analyst knowledge on potentially optimal and sustainable harvesting strategies as obtained from an analysis of all ‘Wirkwelt’ data available in the model. By abandoning the assumption of complete knowledge in economic decision-making, this integrated modelling strategy results in a more realistic representation of actual land use - and vastly reduces computing time requirements.

REFERENCES
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(a) Villages of Au and Moa. Taken from (Siebert, 2000) (b) Distribution of Calamus zollingeri cane (ramets) in 1996 and 2000. From Siebert (2004)

Figure 2: Project Area and distribution of rattan Calamus zollingeri
What Make Farmers Appreciate Sustainable Farming: The Philippine Experience

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KEY WORDS: sustainable farming technologies; awareness; knowledge; attitude; practice (AKAP); conservation farming village (CFV)

INTRODUCTION
What make farmers appreciate/adopt sustainable farming technologies even when they do not instantly reap rewards?

This paper discusses results of the study on Awareness-Knowledge-Attitude-Practice (AKAP) conducted by the author among selected upland farmers in Camarines Sur, Bicol, Philippines. These farmers were volunteer-cooperators of a novel approach called Conservation Farming Village (CFV).

CFV is part of the ASIALAND project. It consists of a package of soil conservation technologies (mulching, contour/hedgerow farming, etc.) with complementing trainings and field tours. It was introduced some years back by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, together with the CARE-Philippines Incorporated, an NGO based in Bicol, Philippines.

METHODOLOGY
2.1 Objectives and methods
The study was conducted in one of the depressed regions in the Philippines, in Camarines Sur, Bicol. A survey using 50 farmers, selected purposively, was done from February to March 2004, to get their AKAP on soil conservation practices. To find out the reasons why they adopted such practices even without immediate economic gratification, the researcher complemented the survey with focus group discussions (FGDs) and key informant interviews (KIIs).

RESULTS AND DISCUSSION
3.1. Characteristics of farmer-respondents
From the four pilot sites, 65% of the respondents were males (Fig.1), 83% were married; and 47% had two to five children.

Fig. 1: Gender
Of the total number, 38% were 41-50 years old; 33%, 31 to 40 years old; and 14%, 61 years old and above (Fig.2). Forty-two percent of the farmers finished elementary grade (Fig. 3). As for source of income, almost all depended on farming as their major source of income.

Fig. 2: Age

3.2 AKAP
Survey, FGDs, and KIIs showed that farmer-respondents were already practicing soil conservation measures prior to the introduction of soil conservation-related technologies. They named their parents, non-government organizations, government extension officers, neighbors, and fellow farmers as their primary sources of information.
Fig. 3: Education
To assess the knowledge part, the respondents were asked 10 questions that could be answered with either True or False. A range was made for this from highly knowledgeable (81-100% correct answers), moderately knowledgeable (31-50%) to having low knowledge (0 to 30% correct answers) on soil conservation technologies. Respondents from all conservation farming villages registered “very high” rating for knowledge on soil conservation related technologies. All in all 87% of the respondents got correct answers for the 10-point questionnaire (Fig.4).

Fig. 4: Knowledge across sites
To get their attitude towards soil conservation practices which were introduced through the Conservation Farming Villages, the farmer-respondents were asked to answer 10 questions with “Agree” or “Disagree”. Eighty-five percent of the farmer-respondents agreed to questions related to the importance of soil conservation technologies and showed openness in embracing these technologies in their farms (Fig. 5). As for practice, farmer-respondents said that they will continue to practice soil conservation technologies. In particular, 50 percent of them said that they will practice alley cropping because they found this very helpful in keeping their soils healthy (Fig. 6).

CONCLUSION
In this study, farmers are likely to appreciate/adopt sustainable farming when they come from families whose parents have been practicing soil conservation measures, when they are exposed to related government programs and extension workers, in this case the CFV, and when they are with their fellow farmers who, likewise, practice soil conservation technologies.

Fig. 5: Attitude across sites
Fig. 6: Practices to be continued

REFERENCES
Effects of KClO₃ and temperature on flowering and leaf gas exchange characteristics in Longan

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KEY WORDS: flower induction, gas exchange, low temperature, potassium chlorate

Longan (*Dimocarpus longan* Lour.) is one of the economically most important fruit crops of Northern Thailand. The irregular frequency of flowering and fruiting, with special concern to alternate bearing, is regarded as the main problem of subtropical fruit production in Thailand. Flower induction is regulated by many factors but climatic conditions seem to trigger alterations of floral promoting substances, assimilates and endogenous phytohormones. Longan trees in the north of Thailand require low temperatures between 10 to 20°C for flower induction. Following a period of only four weeks flowers begin to emerge. Since, the discovery of potassium chlorate (KClO₃) as flower inducing agent in longan trees, off-season flowering can be easily induced by applying the chemical as a soil drench, foliar spray or trunk injection. Considering mature leaf stage as a necessary prerequisite at the time of application, all three methods are resulting in flower formation within approximately 3 to 4 weeks [Manochai et al., 2005; Davenport and Stern, 2005].

Although KClO₃ is widely used to promote flowering in longan, the mode of action of this chemical and the exact physiological mechanism of flower induction in longan is not yet known. In this experiment, we studied the effect of potassium chlorate on leaf photosynthesis and flower induction in longan exposed to varying temperature regimes in a controlled environment.

A total of 64 one-year-old grafted logan trees cv. Daw, grown in black plastic bags filled with a 1:10 mixture of organic matter (consisting of cow dung plus rice chaff) and soil as substrate, were used as plant material in two Phytotron cabinets (SGC970, Sanyo, U.K.; Figure 1).Thirty-two longan trees were kept in each cabinet and exposed to 17/12°C and 30/25°C day/night temperature regimes.

Figure 1 - Potted longan trees as plant material kept in phytotrons under low/high temperature regime ± KClO₃.

The experimental design consisted of 4 treatments with 16 trees each, respectively:
1. 17/12°C with KClO₃
2. 17/12°C without KClO₃
3. 30/25°C with KClO₃
4. 30/25°C without KClO₃

In May 2007, thirty-two longan trees at fully mature leaf stage were treated with 0.5 g KClO₃ per pot as a soil drench. All longan trees received 100 ml of water every morning.
Longan trees either exposed to low temperature or treated with KClO₃ resulted in flowering within the same time period. In contrast, low temperature in combination with KClO₃ treatment delayed flower emergence (Table 1 and Figure 2).

Table 1 - Percentage of flower emergences after treated with low temperature and KClO₃.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Flowering trees after treated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35 day</td>
</tr>
<tr>
<td>LT+KClO₃</td>
<td>0</td>
</tr>
<tr>
<td>LT</td>
<td>50</td>
</tr>
<tr>
<td>HT+KClO₃</td>
<td>50</td>
</tr>
<tr>
<td>HT</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 2 - Flower emergence of longan after low temperature ± KClO₃ and high temperature + KClO₃ (a). No flowering at high temperature without KClO₃ (b).

Under low temperature and in consequence of KClO₃ under both temperature regimes, the efficiency of photosystem II, as visible from the chlorophyll fluorescence, was decreased to varying degrees and durations following the commencement of the experiment (Figure 3). In general exposure to the higher temperature showed a greater efficiency of photosystem II than the low temperature treatments.

Figure 3 Changes in chlorophyll fluorescence of longan leaves under low/high temperature regime ± KClO₃ application.

Leaf net CO₂ assimilation rate decreased under low temperature and in response to KClO₃ application for approximately 21 days from the start of the experiment (Figure 4). Transpiration rate and stomata conductance rate also declined over the same period in both low temperature treatments.

Figure 4 - Changes in net CO₂ assimilation rate of longan leaves under low and high temperature regime ± KClO₃ application.

Low temperature and KClO₃ in combination with high temperature resulted in flowering of longan at the same time while KClO₃ application under low temperature regime clearly delayed flower emergence. The efficiency of photosystem II (Fv/Fm) and net CO₂ assimilation rate of longan leaves decreased in low temperature and KClO₃ treatments. This experiment indicates that it might be possible to induce regular flowering in longan through the naturally occurring lower temperature during flower induction period in the highlands and the use of KClO₃ in the lowlands. Additional use of KClO₃ in the highlands might result in delayed flowering.

ACKNOWLEDGEMENT

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Experiments to explain the essential role of mature leaves on KClO₃ induced flower induction of Longan

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KEY WORDS: off-season flowering; cytokinins; auxin, zeatin/zeatin riboside (Z/ZR) and N⁶(Δ²-isopentenyl) adenine/ N⁶(Δ²-isopentenyl) adenosine (iP/iPA)

Research in our SFB sub-project mainly focuses on the improvement and more uniform yield of three fruit tree species which are important components in a more sustainable production system in Northern-Thailand uplands agriculture. Three species were selected representative for the upland (Litchi), the lowland (Mango) and intermediate location (Longan), which all suffer from the problems of bearing low and irregular fruit. The following talk will address aspects of the most serious reasons for this deficiency, irregular “flower induction”. Longan was selected because of its intermediate ecological requirements in respect to up- and lowland and in the hope that expected results may benefit litchi and mango production as well.

Longan fruit (Dimocarpus longan Lour.) are presently one of the most important fresh fruit for commercial production in Northern-Thailand. Recently they became the leading fruit produced for domestic as well as for export markets [Office of Agricultural Economics, 2006]. The main growing areas are located in the upper northern part of Thailand because longan trees require a suitable period of low temperature to stimulate flower induction (FI) and fruit set. In recent years application of potassium chloride (KClO₃) to longan trees became a common practice to cause FI even under non-inductive temperature conditions [Manochai et al., 2005]. This procedure solves the recently increasing problem with insufficient low temperatures and in addition enables the farmer to produce “off-season” longan fruit which are commercially more interesting. The physiology of the mode of action of this treatment is presently not understood. Particularly the role of mature leaves, the second essential requirement beside low temperatures, is still unexplained and was one of the main subjects in our investigation into the regulatory hormonal mechanisms of FI. The experiments for these investigations were performed in Thailand and in the glass-house of the University of Hohenheim.

Figure 1: Longan shoots demonstrating vegetative development (control), flowering induced by KClO₃ -treatment and prevention of this KClO₃ -effect by girdling plus defoliation.

For this purpose the major plant hormones; gibberellins (GAs), auxin (IAA), and cytokinins (CKs), in the apical meristem and in the wood and bark beneath the meristem of KClO₃ treated and control trees were analyzed. To investigate the role of leaves in this process leaves were removed experimentally between the apical meristem and some internodes below the meristem. The defoliated shoot was isolated from the rest of the plant by a girdle which interrupts the phloem connection (Figure 1).
As a result, KClO$_3$ application had almost no effect on the concentration of gibberellins in receptive apical meristems whereas the auxin IAA decreased initially but later significantly increased, particularly in wood and bark (Figure 2). The most significant, sometimes even dramatic, changes caused by KClO$_3$ treatment was an increase in CKs, mainly Z/ZR already 8 days after treatment. These increases in Z/ZR CKs were greatly reduced or even prevented if leaves had been experimentally removed. In contrast to the reduced Z/ZR CKs there was a strong accumulation of iP/iPA CKs in wood and bark of the defoliated shoot (Figure 3). These CKs are the immediate precursors of the Z/ZR CKs. This observation indicates that leaves may be involved in the last step of CK biosynthesis and that KClO$_3$ is able to affect this last step only in co-operation with leaves.

Figure 2. Comparison of endogenous auxin (IAA) levels in wood of KClO$_3$ treated, girdled and defoliated in combination with and without KClO$_3$ treatment. Some of error bars cannot be seen because of the too small statistical differences.

Figure 3. Comparison of endogenous cytokinins (iP/iPA) levels in wood of KClO$_3$ treated, girdled and defoliated in combination with and without KClO$_3$ treatment.

REFERENCES


Physiology of Flowering in Lychee Trees Grown in Mountainous Areas of Thailand

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**KEY WORDS:** lychee; flowering; irregular bearing

Planting areas of lychee (*Litchi chinensis*, Sonn.) are mainly located in the northern part of Thailand. Lychee trees have an irregular bearing habit mainly caused by insufficient flower induction [Subhadrabandhu, 1990]. They need cool temperatures for the induction process of the floral meristem, while warm temperatures are causing vegetative development of the bud meristem [Davenport and Stern, 2005]. Therefore, because of cooler temperatures and a longer lasting cool period in higher altitudes, lychee trees grown in mountainous areas have the advantage to produce more flowers than lychee trees grown in the lowlands. In addition, flowering can be promoted by girdling the trunk at around 3-4 months before flowering [Menzel, 2005].

Interestingly, it has been found that in mountainous areas at 1.200 m above sea level (msl) lychee trees can produce naturally ‘off-season’ flowers, while at 320 and 750 m above msl they cannot do so. Normally, lychee trees are flowering between late December and beginning of January. Fruit growth will progress during January to April and harvesting period will be from April to June. During normal harvesting time of lychee there’s a high competition with other tropical and subtropical fruit on the market. According to this the farmers always get a very low price.

In higher altitudes (1000-1200 m above msl) it was found that lychee trees can naturally flower ‘off season’ between July-August. Fruit develop during August to November and are harvested from November to December. As a few tropical and subtropical fruit compete on the market during that time the lychee price is very attractive for the farmer. We investigated maximum/minimum temperatures all year round at 320, 750 and 1200 m above msl. It was found that during normal flower induction period in December the maximum/minimum air temperatures were 30.4/15.9, 25.2/11.9 and 24.2/12.6°C respectively, while during ‘off-season’ flower induction period in June at 1200 m above msl the difference between maximum and minimum air temperature was not as distinct and only reached 28.6/19.6 °C (Table 1).

### Table 1 Maximum and minimum temperatures at different altitudes (2007)

<table>
<thead>
<tr>
<th>Months</th>
<th>350 msl Max T</th>
<th>Min T</th>
<th>750 msl Max T</th>
<th>Min T</th>
<th>1,200 msl Max T</th>
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<tr>
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<td>30.7</td>
<td>13</td>
<td>25.3</td>
<td>12.6</td>
<td>25.3</td>
<td>12.6</td>
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<td>26.5</td>
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</tr>
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</table>

However in soil temperatures an almost similar drop could be measured in higher altitudes at the end of May after the beginning of the rainy season as compared to cool season in the lowlands. [Schuler personal communications, data not shown]. Although physiology of flower induction in lychee is still unclear there seems to be some evidences that soil temperature rather than air temperature might be one of the decisive factors. In this study, we investigated...
the growth cycle of lychee trees planted at different altitudes of mountainous areas (Table 2) and the relationship between climatic conditions and physiological changes i.e. chlorophyll content, photosynthesis rate, endogenous hormones, carbohydrate and nitrogen content, percentage of flowering and yield. As analysis is still in progress most recent data will be shown at the conference. To understand the physiology of flowering in lychee trees grown in mountainous areas would help to solve the problem of irregular bearing and provide the opportunity to produce more economically interesting ‘off season’ lychee fruit.

Table 2 Growth cycle of lychee trees at different altitudes

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</tbody>
</table>

FL: Flowering; FG: Fruit growth; HA: Harvesting; VG: Vegetative growth; RE: Rest

* Off season flowering

ACKNOWLEDGEMENTS

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Subhadrabandhu, S. (1990), Lychee and Longan Cultivation in Thailand, Faculty of Agriculture, Kasetsart University, Bangkok, 40p.
The molecular basis of flowering in Longan

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KEY WORDS: degenerate primers; flowering locus; off-season fruit; potassium chlorate

Longan (\textit{Dimocarpus longan} Lour.) is a commercial fruit crop mainly cultivated in subtropical countries of Southeast Asia. In Thailand, longan flowers from late December to late February due to flower inducing climatic conditions with a relatively dry and cool (< 18ºC) environment throughout the natural period of flower induction from mid November to mid December. However, the application of potassium chlorate (KClO\textsubscript{3}) can induce off-season flowering within 20-30 days even so climatic conditions may not be suitable. Thus, this chemical offers a unique opportunity not only to improve the irregular bearing behaviour of longan but also to use it as a potent inducer of longan flowering all year. In addition, farmers obtain a higher price for off-season fruit due to the imbalance between supply and demand by the costumer.

It is hypothesized that an alteration in the hormonal status triggers the programmed sequential morphogenetic events and turns the switch from vegetative to reproductive bud meristem. Specific genes, coding for hormone biosynthesis and/or flowering will therefore be up-regulated, temporally or spatially, with the transition to flowering in tree crops. Several genes involved in the switch from vegetative to floral bud meristem have already been identified and characterized in \textit{Arabidopsis}. A network of interactions and regulatory hierarchies among these genes encoding for specific proteins is slowly forming. Some of the molecular basis in this flowering process has been shown to play a similar role in other annuals. A central protein in this process is FLOWERING LOCUS T (FT), which triggers flowering once it accumulates to high enough levels in the plant tissue.\cite{Kardaisky et al., 1999, Kobayashi et al., 1999} (Figure 1). In \textit{Arabidopsis}, the temporal increase in FT expression can be triggered by environmental stimuli such as extended periods of cold temperature or long photoperiods.

![Figure 1 - Conservation of FT-proteins from different species.](image)

We attempt to identify the molecular basis of flower induction in Longan by expression patterns of genes that encode for proteins similar to \textit{Arabidopsis} flowering genes.

Six-year-old potted longan trees located at Chiang Mai University were used. The experimental design consisted of 10 trees treated with KClO\textsubscript{3} and 10 trees served as controls.

Potassium chlorate was applied as soil drench at 1 g/pot to fully mature plants in November 2007. Samples for RNA extraction from terminal buds, lateral buds and leaves were...
collected 6 times at 5 day intervals following application.

Eight degenerate primers of FT (FTDEG) were designed by using five highly conserved regions of Arabidopsis thaliana, Vitis vinifera, Citrus unshiu, Oryza sativa and Hordeum vulgare. Four of the FTDEG primers were successfully amplified in Longan and fragments were subsequently cloned and sequenced. BLAST searches with this sequence aligned with the Arabidopsis genome identified FT with an amino acid identity of 68% and homology of 68%. It was concluded that Longan homologue of FT was successfully isolated (Figure 2).

Further results will be presented at the Symposium.

Figure 2 - Alignment of FT-like proteins including Longan.

ACKNOWLEDGMENT

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REFERENCES


Rewards for Environmental Services: how to engage the poor?

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KEY WORDS: rewards for environmental services; poverty; pro-poor scheme; watershed conservation

Despite increasing global awareness about the need to conserve environmental resources, environmental degradation continues to occur at an alarming rate. Upper-watersheds are often where water is sourced, but these areas are under serious threat from growing populations and development. Land use allocation in upper-watersheds is characterized by scarcity and trade-offs between maintaining the benefits of these watersheds and undertaking privately profitable activities.

It is increasingly recognized that upland communities, through sound management of landscapes, can maintain the environmental benefits of upper-watersheds. These benefits are not restricted to watershed protection alone, but can also include maintaining biodiversity conservation and landscape beauty. In many cases, upland communities do not share in the benefits of their environmental management and typically receive no compensation for the services their land generates to outside beneficiaries. As such, these communities have no economic incentive to take these services into account when making decisions about land use. This situation can result in communities becoming more marginalized and adversely having to bear a large share of the negative aspects of development.

Urgent support is needed to engage with poor, upland communities, and to work with them in a process of self-empowerment so that they can take the decisions necessary to build a sustainable future based on their resources. Developing an approach that provides rewards for environmental services (RES) for poor upland people is one model that can provide powerful incentives and efficient options to address both conservation of watershed functions and enhance livelihoods (Pagiola \textit{et al.} 2002). The central principles of RES are that those people who provide environmental services should be compensated for doing so, and those who receive the services should pay for their provision (Pagiola and Platais 2002).

Initially, the primary aim of RES was not to reduce poverty, but rather to generate new funding for, and reduce the costs of, achieving conservation goals. In its development, RES has attracted interest for its potential to involve communities and be pro-poor. As many poor people are closely connected to their resources and provide environmental services without rewards, RES programs have the potential to contribute to poverty reduction. The main challenge is how the poor can be adequately recognized for their environmental stewardship and rewarded accordingly. Ideally, if these poor communities are paid for their stewardship under an RES scheme, it is not impossible for RES to become a strong option for poverty reduction initiatives.

Some skeptics see the poverty reduction goal of RES as overly optimistic, pointing to a number of potential risks and cons. First, there are risks that RES can have negative impacts on those poor people who do not participate in RES programs. The significant risk being that such schemes may restrict access to resources that they depend on for their livelihood. There are also a number of potential obstacles that may prevent the poor’s participation in RES or their ability to benefit from the results. Considering the potential risks and opportunities, the outcome for the poor largely depends on how RES initiatives are designed and the context in which they are introduced.

This study analyzes multidimensional poverty indicators by addressing the five major capitals: financial; social; human; natural; and physical, based on local perceptions among ES providers. It also analyzes the contraints of communities to effectively benefitting from RES in six sites across three countries in Asia: Nepal; Indonesia; and the Philippines. To conduct this study, a
cross-site training workshop was conducted, resulting in a set of working procedures and agreement on the research steps undertaken. Each site determined its unit of analysis according to local conditions.

Results from the study show that most communities clearly recognize the role of forests and watersheds in providing environmental services. They understand that the services provided by healthy ecosystems do not just have a production role but also an important regulating and cultural value. They also realise that detrimental environmental activities can reduce ecosystem functions and therefore threaten livelihoods. People in the study understood that their efforts in rehabilitating and protecting the environment can benefit both themselves and external beneficiaries. They mentioned the government, including hydropower companies where they existed, and downstream communities, as external beneficiaries.

Only in some sites, did the communities fully understand the concept of environmental services reward schemes. Some did not realise that their environmentally-benign land practices could be negotiated with potential buyers in order to improve their livelihoods. However, they were able to identify some constraints they would face if (potential) reward schemes were developed. Constraints which can prevent the poor from benefiting from RES schemes are as follows.

1. **Internal capability and potential conflict.** Poor people’s concerns are often not given priority because of a lack of capability to effectively participate in the negotiation, planning and implementation processes. In addition, reward schemes on community land has the potential to raise internal conflicts.

2. **External processes.** Planning and realization of RES schemes can be lengthy and cumbersome. Communities demand transparency and publicly-made decisions at every level of reward scheme implementation. In the case of services to protect biodiversity, communities have difficulty proving there will be buyers for such services. Global buyers appear particularly abstract to them.

Communities do not believe rewards should all be financial, and expect also to be rewarded through land tenure, trust and access to public services. With these insights, rewards could be better facilitated to match the expectations of the rural poor. The action-research in this study has shown that the positive effects of RES on poverty reduction may derive from a number of different pathways. In the Rewarding Upland Poor for Environmental Services (RUPES) program, eight such positive effects have been realised so far, addressing different dimensions of (rural) poverty. Some policy implications are proposed to engage the poor in benefiting from RES schemes.

**REFERENCE**


Payments for environmental services in upper-catchments of Vietnam: will it help the poorest?

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Northern provinces of Vietnam suffer from environmental problems such as deforestation, soil degradation, and loss of biodiversity. As a result, the livelihoods of most agricultural households are unsustainable. Moreover, the current land use practices are also producing negative externalities that adversely affect the downstream areas.

Deforestation and slash-and-burn cultivation techniques are blamed by some governmental organizations as the main causes for the problem. A mix of incentives (generally subsidies), technical assistance (usually improved and sustainable agricultural practices), and regulation have been used to address the problem. While some progress can be observed in terms of reforestation, many agricultural households are still employing unsustainable agricultural practices that will in the medium term affect their own livelihoods. Land use practices, which would bring about environmental benefits, include forest plantation, agro-forestry, tree-based land use alternatives and agro-ecologically sound practices such as conservation agriculture (Gouyon, 2002). However, the environmental services these land use provide, i.e. watershed services, biodiversity conservation and carbon storage are usually un-rewarded and only indirectly connected to economic activities (Bui Dung The et al., 2004).

Payments for Environmental Services (PES) schemes present a new approach that focuses directly on creating a conditional benefit transfer between the upland providers of environmental services and the downstream beneficiaries. Such schemes can take the advantage of upland-lowland interactions in generating environmental benefits while improving the livelihoods of upland farmers. The past few years have witnessed a surge of interest in the development of PES schemes in Asia. In Vietnam, while some projects using the conceptual framework of PES are being initiated in the central and southern part of the country (e.g. WWF, 2007), no PES schemes are currently being implemented in the upper catchment areas of Northern Vietnam (Wunder et al., 2005). However, the Vietnamese Government expressed recently its intention to start such a scheme to protect fragile upper-catchments whose degradation is causing problems on hydro-electric infrastructures.

Households in upper-catchments have unequal access to natural resources. The upper-catchments are generally composed of narrow valley bottoms, where irrigated rice fields are found and surrounding sloping land where upland rice, maize and cassava are the principal crops. The differential access to these two types of land has some important consequences on household farming practices and livelihood strategies.

The main objective of this paper is to review the potential responses of the different types of households to a PES scheme that would reward farmers to set aside some land for forestry projects. Subsequently, we will investigate if poorly endowed farmers would gain from participating in such a scheme. While, some analytical work has already given general results (Zilberman et al., 2006), we would look at the specificity of PES schemes targeted at agricultural households of the upper-catchments in Northern Vietnam.

The proposed paper is organized in two parts. The first part proposes a typology of farmers of two typical upper-catchments of the northern province of Yen Bai, Vietnam. The second, using a simplified farm model analyses how
households with different endowments would respond to such a PES scheme.

The Sai Luong and the Pan Cang catchments were selected for their contrasted water availability and access to markets. The villagers of the Sai Luong catchment, in Nam Bung commune, share a relatively large area of flat valley bottom where rice paddies are grown. Most farmers do not have access to the input or output markets. On the other hand, the villagers of the Pang Cang catchment, in Suoi Giang commune, have only access to sloping land. They are now increasingly making use of water runoffs by constructing irrigated terraces along the slopes. Farmers have access to input and output markets and are actively marketing their agricultural products such as tea, maize and cassava. Participatory exercises were conducted to elicit the rules that govern access of households to land and water resources. Household surveys results were used to build a typology of farmers to relate the differences in resource endowments to livelihood strategies and actual agricultural practices.

Results showed that land well-suited for growing paddies, i.e. bottom-valley paddies or terraces established on the sloping areas, is unevenly distributed between households. First, not all bottom-valley plots have access to water during the spring season even if water is abundant in the catchment. As a result, a large proportion of villagers cannot grow rice during that season, while others can grow two rice crops per year. Second, households also have unequal opportunities to build irrigated terraces on the sloping areas. These terraces collect water from very small streams or runoffs. When constructing a new terrace, households have to find a source of water that is not already used to irrigate terraces built by other households (“first come / first served” rule). As a result, households that were allocated land bordering streams, and already built terraces tend to block construction of terraces by other households, or force them to search water further away, therefore increasing these new terraces constructing costs. This inequity in access to water contributes to unsustainable use of sloping land. Households with limited access to water have to grow rice and other food crops on steep sloping land to meet their food needs.

We used farm models to analyse the potential impact of the PES scheme on the different farm types. For this paper, we specifically studied the impact on the poorest agricultural households of the catchment, i.e. with poor access to markets and water. Based on fundamental mechanisms of upland cultivation, a simple model was formulated, focusing on the flow of nutrients, and in particular the use of fallow period for recovering nutrients, the allocation of labour with the purpose of satisfying subsistence needs and maximizing labour productivity, and the management of agricultural land, in particular the re-opening of fields after a fallow period. Heuristic rules have been used to express how farmers select between a numbers of options in order to obtain their goals. Finally, a test of the response of the model to a hypothetical PES scheme is carried out.

The first results showed that farmers with little paddy land are not likely to gain from a PES scheme where some land should be set aside. If the PES scheme is imposed upon them, then the reduction of the cropping area would force them to reduce their fallow period. Land degradation would then increase in the remaining cropping areas. Protection of one part of the catchment will provoke higher degradation rates in other parts of the catchment.

REFERENCES


Making upland resource managers more receptive to “downstream friendly” practices through compensation

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KEY WORDS: Choice experiments; soil and water conservation practices; willingness-to-accept; northern Thailand

There have been rising concerns that upland watersheds in Mainland Southeast Asia deteriorate at a rapid pace due to a variety of reasons, with inappropriate agricultural practices among the most often cited. Excessive use of agricultural chemicals, high demand for irrigation during the dry season, and cultivation of annual crops without erosion control measures on sloping lands bring about problems of reliability of water supply, loss of topsoil and contamination of water quality affecting downstream users. To address these problems, soil and water conservation practices to be adopted by upstream communities are discussed as a potential solution. The voluntary uptake of such measures has been slow, however, since their adoption often reduces available land and requires more labor. In many cases, the effects of such measures can only be reaped in the long-term, while smallholders tend to focus on short-term benefits. As downstream people are the immediate beneficiaries of sustainable agricultural practices, the principle that upstream farmers need to be compensated for their losses when managing water and land in more sustainable and “downstream-friendly” ways has been increasingly accepted by academics, NGOs, donors and – more reluctantly – by national policy makers.

Providing compensation for agricultural conservation practices adopted by upstream farmers is a rather new concept in the Thai political context. The governance of natural resources, such as forest and water, has traditionally been under the control of powerful government agencies (e.g., Royal Forest Department, Royal Irrigation Department), while the contribution of local communities to natural resource conservation have been hardly recognized by policy-makers [Vandergeest, 1996; Ganjanapan, 1997; Neef et al., 2006]. A focal point of command-and-control environmental policies has been the northern part of the country where more than 50 percent of the country’s total forest area and the major head watersheds feeding the Chao Praya River, the lifeline of Thailand’s rice bowl, are located. Drawing on a case study in Mae Sa watershed, Chiang Mai province, northern Thailand, this paper discusses the slow emergence of compensation schemes in a socio-political context where upland farmers – mostly belonging to ethnic minority groups – tend to be considered as forest destroyers rather than providers of environmental services.

The Mae Sa watershed covers an area of 142.2 km² and extends from 20 to 45 km northwest of Chiang Mai, in Chiang Mai province, Mae Rim district. The watershed is intensively used for market-oriented agriculture, mainly fruit, flower and vegetable production. Major parts of the watershed are included in the Doi Suthep Pui National Park, where agricultural activities are considered illegal by law. The population is composed of northern Thai (khon muang) and the Hmong ethnic minority group. The watershed is part of a pilot project of the Thai government to introduce river basin committees and sub-basin working groups to enhance public participation in water governance. The Mae Sa River Basin Management Working Group is the first of its kind in Thailand. Recently, a sub-committee of the working group decided to establish a so-called “Natural Resource Management Fund” with the objective of funding selected resource management projects that would improve watershed functions and services. The pilot project can thus serve as an example how such funds are established and how they can be further developed into viable compensation schemes for environmental services and – more specifically – for the adoption of soil and water conservation practices by upland farmers.
Based on data obtained from 200 households in nine villages located in the upper part of Mae Sа watershed, this paper aims to identify factors determining upstream farmers’ willingness to adopt agricultural conservation practices including application of bio-insecticides, planting vetiver grass in contour lines, and installing water-saving irrigation systems. The willingness to accept compensation for the conservation measures is estimated through the use of choice experiments (CE). Attributes in CE questionnaires were based on both supply- and demand-driven approaches. Under the supply-driven approach, attributes are derived from what policy-makers and/or researchers perceive to be factors that can be influenced by policy measures. The demand-driven approach involves selecting the attributes that individual or groups of farmers consider important when making choices. In this study, four attributes were selected including installing of water saving technology, planting vetiver grass for erosion control, application of bio-insecticides and compensation or subsidy. The levels of each attribute were designed based on the costs involved. Focus group interviews were conducted in two rounds. First, the selected attributes and levels were discussed as regards their likelihood to be put into practice. Among various types of compensation, cash compensation was the most preferred option. The second round of discussions provided the final sets of attributes and levels that were used for designing choice sets for households’ decision making. Each attribute consists of four levels as shown in table 1 below.

**Table 1. Attributes and levels in the choice experiments**

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
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<tbody>
<tr>
<td>Installing water-saving technology</td>
<td>Micro sprinkler 50% of total area</td>
<td>Micro sprinkler 100% of total area</td>
<td>Micro sprinkler 50% of total area</td>
<td>Micro sprinkler 50% of total area</td>
</tr>
<tr>
<td>Planting vetiver grass</td>
<td>1 row of vetiver grass (9.5% of 1 rai)</td>
<td>2 rows of vetiver grass (18.9% of 1 rai)</td>
<td>3 rows of vetiver grass (28.4% of 1 rai)</td>
<td>4 rows of vetiver grass (37.8% of 1 rai)</td>
</tr>
<tr>
<td>Applying bio-insecticides</td>
<td>30% of total area</td>
<td>50% of total area</td>
<td>70% of total area</td>
<td>100% of total area</td>
</tr>
<tr>
<td>Compensation or subsidy</td>
<td>300 Baht/rai</td>
<td>546 Baht/rai</td>
<td>1,010 Baht/rai</td>
<td>1,717 Baht/rai</td>
</tr>
</tbody>
</table>

Various important contributions are provided from this study. First, upstream farmers’ preferences for adjusting their agricultural practices toward more “downstream-friendly” practices are provided as baseline data. Based on previous studies, we hypothesize that the differences in resource tenure security, in particular land and water, affect the choices of agricultural conservation practices of the upstream farmers [cf. Sangkapitux and Neef, 2006]. Understanding farmers’ rationale in decision-making with regard to soil and water conservation is crucial for policy-makers to formulate appropriate policies to achieve sustainable watershed management. Second, upstream farmers’ willingness to accept is derived. This data would help to efficiently reallocate subsidies and compensation schemes to the farmers.

The paper concludes that a specific regulatory framework in support of compensation measures needs to be established to facilitate the implementation of such schemes on a broader scale. The allocation of secure, but conditional resource entitlements to farmers and/or communities in upland areas could be an important incentive to adopt agricultural conservation practices under such compensation schemes.

**REFERENCES**


Watershed Services in the Uplands: A Market for PES?

According to the World Bank, 60% of Asia’s poorest people depend on marginal, fragile lands for their subsistence. While the long-term sustainability of their land use is a critical issue, these communities obviously lack the capability to include sustainability choices within their set of practical choices.

This paper discusses the following potential benefits of using PES as a tool for integrated watershed management: (i) promoting greater synchronization between the activities of upstream and downstream users of the watershed, (ii) removing some of the financial barriers to sustainable agriculture for upstream farmers, (iii) complementing the existing and proposed conservation plans by government institutions, and (iv) offering the possibility to be self-managed by local people with the help of intermediary organisations and without requiring a change in legislation or government policy.

Two study sites were used: Northern Laos and Northern Thailand. In these locations, the PES concept offers interesting opportunities as an approach to manage water quality and quantity by transforming erosion control and sediment load reduction into a marketable environmental service (ES). Together the two studies present a detailed analysis of potential markets for PES in Southeast Asia – a region that has been slow to take up on the examples of Central America and Sub-Saharan Africa. Furthermore, they offer a unique body of work that takes a political economy approach to upland-lowland relations as well as exploring larger questions of institutional capacity and willingness to participate in this innovative form of locally targeted market-driven environmental management.

Willingness to Pay

The study from the Lao PDR focused on downstream communities’ willingness to pay (WTP) for ES such as improved water quality and flood protection in the Houay Xon catchment. The findings were based upon a sampled population of 67 water users from 7 villages of different ethnic groups, representative of five different categories of water user. A fundamental finding of this study is the inability to apply a binary concept of water user vs. water supplier. The complex interaction between location of user and impact upon hydrological services impedes any straightforward implementation of a PES scheme.

The study identified an additional number of social and economic factors affecting the introduction of a PES market in the Houay Xon catchment. Poor communication and social tensions between communities are outcomes of the population relocation policy enforced by the Government of Laos (GoL) after 1975 and the subsequent proximity of diverse ethnic groups. These relocation policies are also responsible for villagers’ low awareness of local environmental issues due to their relative newness to the area.
Most significantly, this policy signifies the non-existence of private property and control of land in the Lao PDR – a sizable impediment to the flexibility required for PES. Despite these obstacles, the study indicated clear opportunities to introduce PES for watershed services based on demand and WTP. The WTP among the sampled population was USD 0.3/month/household to improve waste disposal, not to change land use in the upper catchment. Whilst this figure, applied through PES, would suffice to abate the impact of soil erosion on water quality, it is too low to abate the distributed contamination of the river associated with poor waste disposal throughout the watershed. Therefore, this type of PES market is incapable of achieving an overall improvement in water quality. Chief factors behind the low WTP include a low awareness of environmental issues and the cost of ES. Further education is required to inform villagers on the nature of environmental problems, in order to increase the WTP and success of a PES market in the watershed.

INSTITUTIONAL CAPACITY

The institutional components of introducing a directed PES market were studied in the Northern Thailand site. The structure of a future PES market in the Mae Thang watershed is analysed by combining the responses of upstream and downstream water users with those of local authorities and a survey of the Thai NGO and non-profit sector. Different to Houay Xon, downstream villagers in Mae Thang expressed a preference for erosion control ES as a strategy to guarantee the continued supply of water for irrigation, and not necessarily to improve water quality. The results mirrored the overlap between users and providers of environmental services found in Laos, which may be indicative of a problem common to watershed markets.

A survey of institutions (NGOs, non-profit organisations and government institutions) revealed a substantial willingness and capacity within the Thai institutional framework to support a PES market as an intermediary between buyers and sellers. Results showed a clear bias towards technical roles followed by representation, monitoring and negotiation. Less popular were roles that required direct contact with financial processes or conflict management. The survey also indicated potential for an NGO to act as an interim buyer. This is instructive given the Royal Irrigation Department’s unwillingness to directly address the sedimentation of reservoirs and ineffectiveness of command and control policy in the region. An existing government funded check-dam project in the province has the potential to be incorporated into a future PES market.

COMPARISONS AND CONCLUSIONS

Unlike Houay Xon, the absence of official land tenure in the uplands is not an impediment to PES in Mae Thang. Usufruct rights and a tacit system of land-use and exchange confer flexibility of use equal to legal ownership. The complication of paying for ES on illegally occupied land is also a non-issue due to a tendency for the Government of Thailand (GoT) for leniency in this matter and the precedent set by the Land Development Department, who has paid farmers before to change their land-use. Furthermore, whilst both countries are experiencing an intensification of land-use due to market development and population growth, the GoT does not regulate agricultural expansion through land-use restrictions, as is the practice in Laos. Thai farmers therefore have the choice to pursue less intensive cultivation by planting low-impact crops as part of a compensated PES market.

In both sites, downstream users were reticent to pay for upstream farmers to change their land use; a preference for improving domestic waste disposal prevailed in Houay Xon and doubt of upstream communities’ capacity to effect change limited willingness in Mae Thang. In Mae Thang, those educated in the nature of agricultural erosion and potential solutions to sedimentation, were more supportive of land-use change ES, indicating a higher potential for this type of market than in Laos.

In light of the results, the neoclassical assumptions within the PES discourse can be appraised. The authors conclude that free market environmentalism as it is termed, cannot work with respect to watershed management because of the nature of the service being provided and of watersheds themselves. These findings will be explored in terms of necessary organizational features for any potential PES market addressing watershed issues.
Land Use Changes in Himalaya and Their Impacts on Agricultural Sustainability in Plains of North India

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Key Words: Subsistence agriculture; Population growth; agricultural extension; reduced ground water recharge; food and livelihood securities; land use Policy

Himalaya represents one of the tectonically unstable, ecologically fragile, economically underdeveloped and the most densely populated mountain ecosystems on the planet. Due to the continuous uplift these mountain ranges are highly vulnerable to large-scale tectonic movements and landslides and to the processes of surface removal. Himalaya provides a variety of ecosystem services that sustain livelihood and economy of one of the most densely populated regions of the planet. The nature of terrain imposes severe limitations on the scale of productive activities as well as on the efficiency of infrastructural facilities, and as a result, the biomass based subsistence agriculture constitutes the main source of rural livelihood in the region. More than 77 percent of regional population is solely dependent on this traditional agricultural system even though the availability of arable land is severely limited and the productivity is poor. This subsistence agro-ecosystem in the region is closely interlinked with forests, pastures, and rangelands, and animal husbandry is the natural ally of the traditional crop farming practices as flow of biomass energy from forests and pastures to cropland is mediated through livestock populations. During the recent past, a variety of changes have emerged in the traditional resource use structure mainly in response to rapid population growth and resultant increased demand of natural resources as well as owing to increasing social, political and economic marginalization in Himalaya. This had a large impact on the traditional resource use structure and land use pattern in the entire region. As a result, the agricultural extension has been taking place in forests, steep slopes, marginal and sub-marginal lands depleting and degrading the critical natural resources, such as, land, water, forests, biodiversity etc. and leading to their conversion into degraded and non-productive lands, for the last 25-30 years. The main objective of this study was to monitor land use dynamics in densely populated tracts of Himalaya, to make a comprehensive interpretation of the driving forces of such land transformation processes, and to assess the environmental impacts of these land use changes in the mountains as well as on the agriculture and economy in the adjoining lowland areas. Detailed study of land use dynamics in mountains and their ecological impact on agriculture in adjoining plains ecosystem has been carried out using remote sensing and field mapping techniques and through comprehensive hydrological monitoring in Kumaon Himalaya and its adjoining lowland in newly carved Himalayan State of Uttarakhand in India. It was observed that forest area has reduced from 64 percent to 24 percent, arable land has increased from 24 to 31 percent and the proportion of degraded and barren land has enhanced from 11 percent to 21 percent during the last 25-30 years. Besides, the fast expansion of road linkages has facilitated the rapid urbanization, emergence and growth of rural service centers and increased access to markets. A large proportion of arable land is being encroached upon by the process of rapid urbanization and expansion of infrastructure, services and economic activities in the region,
every year. Moreover, there is a regional shift from traditional crop farming and animal husbandry system to village-based production of fruits, vegetables, flowers and milk for sale both in the nearby and far-off markets, in the villages situated in the influence zone of urban centres and market places, and along and near the roads. This has a large impact on the traditional resource development process and land use pattern. As per the norms of the Planning Commission of India a minimum 60 percent of the geographical area should be under forests in mountain terrain. But, against this, only 28.70 percent of the total geographical area of Kumaon Himalaya is now under forests, and only 4.40 percent of the forest has a crown density of more than 60 percent. The availability of forests to cultivated land is merely 1.26 ha forest for each hectare of cultivated land against the ecologically recommended standard of 5 -12 ha forest area per ha of agricultural land. Similarly, the pressure of grazing has increased far beyond the carrying capacity of available forests and pastures as the average availability of grazing area in the region is merely 0.60 ha/cattle against the minimum requirement of 3.60 ha/cattle. These land use changes have not only disrupted the hydrological regime of Himalayan watersheds through considerable shrinkage of forests, degradation of land and resultant reduced ground water recharge, but have also caused unprecedented adverse effects on ecosystem services and food and livelihood securities on a large part of the plains of north India mainly dependent on subsistence agriculture. As many as 45 percent natural springs have dried due to reduced groundwater recharge and water flow in streams and rivers has reduced by nearly 14 percent affecting basic support systems, particularly drinking water and irrigation and undermining livelihood and food securities in adjoining lowlands. These environmental changes and consequent loss of ecosystem services could cause respectively 25%, 15%, 21% and 20% decline in drinking water, irrigation, hydropower, and agricultural productivity in Himalaya and adjoining plains in the coming 50 years. In order to restore the ecological equilibrium and to enhance the adaptive capacity of both natural and human systems to ongoing environmental changes in Himalaya it is imperative to evolve a comprehensive land use policy for the region based on the interpretation of crucial ecological inter-linkages between highland lowland.
ABSTRACT

Considerable research regarding impact of land use intensification on erosion and runoff production has been carried out in various mountainous regions worldwide. However, little is known about the impact of resulting sediment contribution from eroded upland fields via irrigation channels to lower paddy fields. In North West Vietnam, upland fields are intensively cultivated while valleys are used for producing up to two rice crops a year. The aim of this study was to identify spatial variability in soil characteristics within and among paddy fields along a toposequence, and to link this variability in soil characteristics with variability in crop response. In total, four toposequences of paddy fields (ranging from four to seven paddies in one sequence) were selected and all fields divided in a fertilized (F) and unfertilized (NF) part. Some toposequences were irrigated by a concrete channel while others were using an earth channel. Soil sampling was carried out in each paddy on a detailed grid basis, and samples were taken twice, first after ploughing and second after harvest.

Plant available nitrogen (ammonium and nitrate) and phosphorus, total nitrogen, organic carbon and CEC were analysed for 30% of the soil samples. Further, mid infrared spectroscopy (MIRS) was conducted on all samples for total nitrogen, organic carbon, phosphor and CEC. Additional the samples were analyzed on particle size which was later on used for the calculation of specific surface area (SSA) of the mineral soil fraction. Spatial variability of soil parameters within and among paddy fields in a toposequence was assessed in function of position to irrigation channel and sequence slope gradient. In addition, these findings were linked through correlation and multiple regression analysis to spatial variability in crop response, which was measured in an associated sub-project.

Results indicated that there is a strong correlation between organic carbon and specific surface area (Fig. 1), Furthermore soil parameters such as organic carbon, total nitrogen, clay content, SSA followed the same trend along a toposequence as the rice yield. Initially, as deposition of organic material and finer particles increased with distance from the irrigation channel, rice performance increased accordingly. However, towards the end of the toposequence sediment inputs decreased resulting in lower crop performance (Fig. 2). Figure 3 clearly shows that yield is not only depending on the distance from the irrigation channel but also from the inlet within a field. Same findings were found for the soil characteristics. Nevertheless the data also
indicate that further research is necessary to address additional external impacts on the crop performance towards a better understanding of the impact of sediment distribution through a toposequence on the rice performance. In conclusion, runoff from upland fields delivers sufficient nutrients and organic matter input to maintain a high productivity of two rice crops a year. However, delivery of variable sediment quality and quantity has, depending on the paddy field position within a toposequence, strong implications for crop development and its management.

Figure 1: Correlation for one selection between organic carbon (OrgC, %) in the field and the specific surface area (SSA, m²/g) of soil particles.

Figure 2: Correlation for the non fertilized fields of one selection between the distance of the irrigation channel and the yield performance of rice and org carbon content of the soil.

Figure 3: Spatial variability of yield (kg/m²) in function of the distance from the channel (x-axis) and in function of the distance from the inlet of a field (y-axis) for one selection.
Soil translocation assessment in a mountainous area of NW-Vietnam - consequences for land use planning

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KEY WORDS: soil erosion; soil quality; land use planning; mountainous area;

Population growth in many mountainous regions in Southeast Asia results in intensified agricultural land use. The negative impact of unsustainable land use calls for a vulnerability and soil quality assessment in order to facilitate adequate land use planning. This can be done by the mapping of crop suitability under consideration of parent material, land use, topography and climate.

The research area is situated in the Chieng Khoi catchment, in the Yen Chau district of Son La province in Northwest Vietnam. There the parent soil material consists mainly of reddish clastic sediments varying in grain size distribution and with lower extent limy backed conglomerates. These soils are mainly cultivated with maize and cassava.

Soils were investigated along catenas from foothill to hill-top position. In total 22 soil profiles were analyzed for characterization of the principal site qualities (aggregate stability, rooting depth, plant available water and nutrients).

The investigations revealed that soils on hilltops have the highest contents of organic matter, and good structure but the lowest soil depths, water holding capacity, and non humus bound nutrients. Further, the highest erosion rates were detected in mid-slope and especially in lower slope positions. There rill and gully erosion is common. There soil fertility is very low and correlated with poor plant development. The soil structure is week and the soil surface seals quickly after tillage for maize and cassava planting in the first rainstorms decreasing infiltration and thereby the amount of plant available water.

At toe hill position and paddy fields below high deposition rates were observed. The results suggest that site quality in toe slope position is also reduced by erosion, because relatively coarse and sometimes compacted soil material, poor in organic matter, is sedimented and covers the more fertile top soils in these positions. At the same time finer soil material is transported further onto adjacent paddy fields or downstream into rivers and water reservoirs. Group discussions with local farmers surveyed the history of fertilizer application and yields on local soil types. The above results were confirmed for 11 of 12 local soil units. According to farmers estimation, erosion led to an improvement of soils in lower positions only on so called “black soils”, that means, soils with probable humus-rich horizons erode.

In conclusion the degree of soil translocation depends strongly on the landscape position. In this research area, the lower slope was identified as being the most sensitive part. Erosion control at this site will lead to a positive impact for the land below. Rather than applying general solutions, efficient land use planning should instead focus on the identification and management of sensitive zones.
Assessing alternative conservation strategies on a hillside cropping system of Northeast Thailand by using WaNuLCAS

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KEY WORDS: Erosion; Soil conservation measures; Hillside cropping; WaNuLCAS

In the highlands of Thailand, cultivation on steep slopes without soil conservation measures is a common practice, making farm land fragile and susceptible to soil erosion. Soil erosion affects about 150,000 km\(^2\) or 26% of the cultivated area in the highlands of Thailand. Although soil erosion results in nutrient depletion and low soil productivity, eroded areas are still continuously used for subsistence and commercial agriculture purposes. Since a decade, contour hedgerow farming with leguminous trees or grass barriers, such as \(\text{Leucaena leucocephala}\), \(\text{Brachiaria ruziziensis}\) or \(\text{Vetiveria zizanioides}\) is a common feature of extension programs for sustainable agriculture on uplands in Southeast. According to many studies, soil conservation measures based on contour hedgerows are extremely effective in reducing water runoff and controlling erosion on steep slopes. However, experimental testing of their potential application and limitation of soil conservation measures is expensive, long-standing and laborious. Modelling can be used to investigate these systems relatively quickly and at relatively low costs. Therefore, the objectives of this study were (I) to assess effects of soil conservation measures on yield and erosion (runoff and soil loss) (II) to evaluate both by using the Water, Nutrient and Light Capture in Agroforestry Systems (WaNuLCAS 3.2) model.

Erosion plots were established in 2003 and the experiment was conducted over a period of three consecutive years at Ban Bo Muang Noi in Na Haew district, Loei province of Northeast, Thailand (17°33' N and 101°1' E). The field trial was carried out on a moderate slope ranging from 21 to 28%. The soil is classified as Humic Lixisol and has a silty clay texture. Twelve erosion plots of 4 m width and 18 m length (72 m\(^2\)) were installed on the lower linear slope. The experiment was carried out as a split-plot with 2 replications. The main plots were 2 fertilizer levels, none and 61 kg N plus 14 kg P ha\(^{-1}\). The subplots were divided into 3 soil conservation measures consisting of (i) control without hedgerow, (ii) ruzi grass barrier (\(\text{Brachiaria ruziziensis}\)) and (iii) Leucaena hedge (\(\text{Leucaena leucocephala}\)). In all treatments maize (\(\text{Zea mays}\)) cv. Suwan 1 was planted, relay cropped with jack bean (\(\text{Canavalia ensiformis}\)) using minimum tillage.

Over this three-year period, erosion (runoff and soil loss) and maize grain yield were recorded. After that, a data set of three years from plot studies was used for model calibration and validation. Before simulations were performed, sensitivity analysis and calibration were made with input parameters on agricultural management, climate, soil properties and topography. These parameters were used to define threshold values for the calibration process. At the end of the monitoring period, maize grain yield in the fertilized control plot without hedgerows were up to 5.5 Mg ha\(^{-1}\). These values were higher than those of the contour hedgerow systems (3.9-4.2 Mg ha\(^{-1}\)) due to lack of competition and due to minimum tillage combined with relay cropping with a legume. Runoff and soil loss were strongly reduced (by 73 to 94\%, respectively) compared to the control from the first year onwards on plots with barriers, when fertilizer was applied. This reduction, however, was less fast on unfertilized plots with barriers. Despite extremely high soil loss in the control in the first year, a slight reduction in the second year and almost similar
precipitation in all years, surprisingly no differences between treatments were found for the third year. However, despite reduced soil loss rates under all treatments with time, runoff did not decrease on the control plots in the same way as it did on the plots with contour hedges. WaNuLCAS model outputs of yield and erosion (runoff and soil loss) agreed well with observed total sum of the 3-year period and on yearly basis, but not on event basis (Fig. 1 and Tab. 1). One of the reasons for the later was the overestimation of erosion by the model in periods when soil was not covered by crops. This will need some improvements of respective model routines. Experimental data and model simulations suggest that the control without hedgerow together with minimum tillage, relay cropping with legumes and fertilizer application may indicate a viable alternative for peasant farmers on moderate slopes in tropical mountainous regions.

Table 1 Calibration statistics of observed and WaNuLCAS simulated yield, runoff and soil loss. Dataset is based on the control without fertilizer treatment at Ban Bo Mung Noi, NE Thailand.

<table>
<thead>
<tr>
<th></th>
<th>Yield</th>
<th>Runoff</th>
<th>Soil loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>R²</td>
<td>0.8</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>EF</td>
<td>0.7</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CD</td>
<td>2.4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>RMSE</td>
<td>2610</td>
<td>1.7</td>
<td>0</td>
</tr>
<tr>
<td>ME</td>
<td>1289</td>
<td>90</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Such an approach can effectively reduce erosion and hence sediment transport to lowlands, but will not strongly reduce runoff. Cleaner runoff might be useful in cases where it contributes to irrigation, e.g. lowland paddy rice/fish system during early raining season when water shortages are likely. WaNuLCAS is already a promising tool to study, explore potential management options for hillside cropping systems and may contribute to a better understanding of tradeoffs of upland cropping and the consequences for lowland areas, but requires further calibration.
Modeling land use change dynamics in a small watershed of Northwest Vietnam

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KEY WORDS: Swiddening agriculture, Dynamic modeling, PCRaster, Vietnam

ABSTRACT
Many upland watersheds of mainland Southeast Asia are characterized by fragmented landscapes consisting of remnant forest patches and various human-disturbed land use covers (Ziegler et al., 2006). In mountainous Vietnam, agricultural production areas have expanded on very steep slopes often with serious problems of soil erosion and degradation (Wezel et al., 2002). An increase in population density is associated with a decrease of forest areas and forced farmers to reject fallow periods (Vien et al., 2004). This trend will result in a decline of soil fertility and further associated problems of resource overuse. In contrast to plot level studies, general understanding of soil degradation processes at landscape level are limited due to its complexity and often lack of integrated research efforts. A modeling approach may therefore help to better understand underlying relationships of resource intensification on land-use and environmental services at landscape scale.

The objectives of this study were (i) to develop a spatially explicit biophysical dynamic model of soil erosion and runoff with PCRaster (Karssenberg, 2002) and (ii) to apply and validate the model with a dataset of CARES (Dung et. al, 2007), collected in 2000-2003 for a small watershed (total area: 3.54ha) in Ban Tat, Northwest Vietnam. The watershed is characterized by forest (2.76 ha) and swidden fields (0.76 ha). The climate of the area shows a distinct rainy season from May-October and a dry season from November to March. The PCRaster software is a computer tool to construct dynamic-spatial environmental models. It allows dynamic modeling by computing new attributes as a function of attribute changes over time (Karssenberg, 2002). It requires a set of input tables and raster format maps organized in a "binding script". Herein, input information and maps are structured into static spatial, dynamic, and dynamic spatial parameters. These parameters are combined through the binding script and computed according to defined model algorithms for each time step. The generated results can be visualized and are presented in raster output maps.

For this study, static spatial information is implemented by a topography map with pixel attributes of elevation, slope, local drain direction and a soil map with information on soil erodibility and infiltration capacity. Dynamic information is given in monthly time steps by rainfall and surface cover density/land use type. Land use maps describe the composition of upland rice, cassava, two fallow stages and forest for each year. Different algorithms were implemented in the binding script: f(runoff) = amount of rainfall/month \times vegetation cover density/land use type/month \times infiltration capacity (adapted from Karssenberg et al., 2005; Zöllmer, 2007), f(erosion) = amount of runoff (mm) \times slope tangent \times soil erodibility (derived by Khasanah et al., 2002). The structure of PCRaster enables the user to “sample” output values for each cell. Hence, for each land use type fictive outflow sampling locations were set according to the local drain directions. At this sampling station, outflow values of runoff and erosion are reported for each time step. Different scenarios were applied...
to discuss importance of influencing factors such as soil texture, vegetation cover, land use cycle and spatial distribution of land-use change over time. For a statistical comparison model output results were analyzed according to (Loague and Green, 1991).

Output results indicated that the model overestimated monthly runoff compared to field results by 10-70% depending on the specific scenario setup. Nevertheless, the model was able to resemble similar runoff patterns found by CARES. Moreover, model runs showed that a long but less dense vegetation cover is more effective to reduce runoff than a dense but short vegetation cover. Erosion calculations of the model showed soil loss 20 % lower and up to 55% higher then measured, but nevertheless was able followed observed field trends. The model concept was reliable to describe general biophysical relationships of erosion and runoff within a small watershed. It has disadvantages, as a model concept is generally facing resentments of realistic assumptions and an under- or over-parameterization. To improve model efficiency, it is suggested to include an evapotranspiration reduction factor into the runoff algorithm. Evapotranspiration is influenced by surface cover and potential evaporation, and thus influences the amount of available water to generate runoff. Moreover, soil fertility status is directly related to land use and may change over time. Therefore, an additional algorithm is needed which links soil loss and soil fertility to define potential land use. The result would be a decision rule which defines potential land use for a certain area or pixel from a biophysical point of view.

To date, the presented study is a simple approach along a line of higher entity dynamic modeling concepts, e.g. CLUE-s (Verburg, 2006). It is suggested further examine and test the model under different environmental setups and hence discuss its applicability on a broader range.

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Transitions towards sustainable livelihoods through local innovations in upland-lowland integration

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Keywords: transitions, endogenous development, sustainable livelihoods, upland-lowland integration, local innovations

A transition denotes a long-term change in an encompassing system that serves a basic societal function (Elzen and Wieczorek, 2005). In a transition, both the technical and the social-cultural dimensions of such a system change drastically. Farming communities thriving in the upland and lowland environments towards sustainable livelihoods are managing agricultural resources so as to achieve a better balance between economic, ecological and social performances (Limnirankul et al., 2004). In Northern Thailand, agriculture and livelihood practices undergo trajectories of recent change that have tied to governmental policies, increased levels of private interventions, rural-urban migration, communications and technological innovations, etc. Diversification of household economic activities, as commonly practiced by smallholder farmers, is a multifaceted process that is not only economic in nature but also involves the combination of cultural beliefs and values along the role of social relations and networks in making of economic decisions (Zimmerer, 2007).

In this paper, we discuss our understanding on land use dynamics embedded with biodiverse systems, and resource flows between upland and lowland ecosystems in the Northern Thai context, and innovation and processes that induce and stimulate the occurrence of transitions. The study explores the extent to which local innovation and processes that combine social organizations, technological intervention, and production-marketing integration have led to transitions and land use change, and aims to give insights into the ways organizational social cohesion have on agricultural resource management. The case study was conducted at Ban Huak, a Thai-Lao trans-boarder village in Phayao province of Northern Thailand, where physical environment is dominated by contiguous features of mountains and undulating uplands interrupted with lowland paddy fields. The community action research approach was employed to develop common understanding between the research team and the community on integrative utilization of the upland and lowland landscapes, and to generate knowledge with anticipating the possibility of positive intervention. The data collection was based on exploratory visits, interviews and meetings with key informants. The process integrated multi-stakeholder dialogues and field-based studies, specifically on-site discussion with different farmer groups during the growing seasons. The outcome of one step was used to formulate the sub-topics for the next meeting. The iterative process has improved understanding of how the local systems operate and interact. Focus-group discussions with 4-6 participants were conducted to collect information on historical profiles, production systems, land use changes and drivers of change, and local innovation in marketing arrangement.

Ban Huak, which was a resettlement village inhabiting by local residents and former communist insurgents in the early 80s, has led by devoted and visionary leaders since 1980s. Community collectively develops and makes use of village development plans as guidelines for action. Local initiatives are implemented through village meeting, interaction and coordination. The endogenous development initiatives forming partnership with state authorities include construction of water reservoirs, small irrigation schemes, road transportation, and co-management of community forest and protected forests. Other local initiatives managed and owned by community are establishing village saving funds, and resource sharing such as labor exchange systems, etc.
Local innovations that make full use of upland and lowland ecosystems include: arranging diverse land use practices to achieve economic benefits and resource conservation, selecting locally adapted crop species and varieties which have comparative advantage such as hybrid maize, large-seeded groundnut, etc. rehabilitating land use on sloping lands with rubber in response to government’s rubber promotion scheme, establishing community rice seed production to meet local need and developing into rural seed enterprise, adopting green manure crops in rice farming to reduce agro-chemical use, coordinating agricultural production groups, and arranging contract farming with the Laotian partner. Dry season cropping, irrigated by village water reservoir and weir, is differentiated by groundnut and maize on lighter soils and shallot or garlic on clayey soils. The production process is partially supported by exchange labor system during planting and harvesting. The heterogeneous households have also worked out certain production and marketing solutions through cooperation among individuals of similar interests. A few local farmers have become traders, collecting local farm produce for assemblers in the neighboring districts, and providing fair benefit to local farmers. A group of better-off farmers formed partnership and invested in production and marketing of maize with Laotian state agency and farmers. The group has established close connection with local authorities and Laotian officials through trading across the boarder. The success of cross-boarder trading of agricultural products has encouraged a few individuals with capitals and connections to develop own business. There is no evidence of trading conflicts between influential individual and power group. The local gains access to individual land use rights and community forest by collaborating with local natural park authorities to establish clear demarcation between farming areas and forestlands, and establishing local organizations to protect forest resources. The local authority has claimed that the collaboration has been effective that no forest encroachment has been observed. The local administration organization has promoted self-sufficiency in local vegetable consumption by supporting individual households to establish homegardens. The result varies depending on household’s need and circumstances. The paper concludes that transitions in upland-lowland landscape of Northern Thailand is characterized by a range of production technologies and farming alternatives, infrastructures, patterns of endogenous development, leadership and social relations, and policies, etc. The innovation processes involving a range of actors including village leaders, farmers, group leaders, traders, governmental offices, etc. have provided incremental change towards sustainable livelihoods. Studies on relationships among households reveal that wealthier and influential households, through closer connections with local authorities, have gained access to cross-border trading of agricultural products with Laotian partners. The cross-border trading will certainly benefit a few. Its effects on local land use changes between uplands and lowlands have not been determined. The challenge towards sustainability is for the community to continue maintain the resource flows between upland and lowland environments with conservation measures. The coordination mechanism within community to ensure fair benefit sharing extended to all members especially socially disadvantaged groups is vital for implementing effectively village development plan. It has yet to be seen that how those wealthier farmers who have developed entrepreneurial skills could improve upland-lowland integration in Ban Huak and extended the systems of practice to benefit the neighboring Laotian communities.

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Improvement of yield and fruit quality of mango neglected orchards in Yen Chau, Son La

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KEY WORDS: Mango; pruning; bagging; Tron; Hoi;

Mango - a tropical fruit tree – is popularly grown as a cash crop in the South of Vietnam where climatic conditions are suitable for its flowering and fruit set. Due to the high market demand for mango fresh fruit many attempts have been made on introduction of mango to the Northern part of the country where the climate is characterized by a cool and wet winter, which is unfavorable for fruit set of mango. Unfortunately, so far these attempts have not brought expected results, therefore the fresh mango market in the North still heavily depends on the supply from the Southern mango growing areas with high price of the product.

Being located in the North-west of the country but surrounded by numerous high mountains called Truong Son range Yen Chau has higher temperature and solar radiation regime than other parts of the North. With two local high-quality mango cultivars called Tron and Hoi, and warm, dry winter Yen chau is well- known as the only traditional mango growing area in the Northern Vietnam. With more than 500 ha of mango sparsely grown in the district, Yen chau annually supplies about 2000 tones of mango to the market (Pham Thi Huong, Trinh Mai Dung, 2006). Nowadays mango has become one of main income generating crops for mango growing farmers in the district. However, the local growers are all Thai ethnic people whose mango orchards are extensively cultivated for years. Most of the orchards are of 20-30 years with high crown (10-15m), poor flushes coming out, and seriously infected by diseases and insects. These all together lead to low unstable yields, poor fruit external quality, short fruit shelf life, and finally lead to the low price offered at market for the product in spite of its high fruit quality (Pham Thi Huong, 2004; Pham Thi Huong and Trinh Thi Mai Dung, 2006).

It was reported that post harvest pruning of mango had positive effect on regular fruit bearing and maintaining good radiation in the canopy in high-density orchards, especially effective for erratic fruit bearing cultivars (Fivaz J., Stassen P.J.C., 1997). For improvement of fruit appearance and quality Bondad, N.D. (1989), Mendoza, Jr. D.B; Will, R.B.H. (1984); Buganic R.D. et al (1997) reported that in Philippines pre-harvest bagging increased percentage of fruits for export thank to reduction of fruit infection by pest and diseases.

There was a need to work out appropriate cultural practices suitable to the local conditions to help the local growers shift from the extensive cultivation to commercial intensive mango cultivation.

The objective of this study is to improve yield and external fruit quality of neglected orchards through developing a system of low-input cultural practices suitable to local conditions. These were participatory on-farm experiments carried out in 10 farmers’ 12-16 year orchards on the two local mango cultivars called Tron and Hoi during 2006-2007 in Tu Nang commune, Yen Chau district.

The main research question was to show the local mango growers the benefit of intensive growing of their neglected orchards, at the same time to train them the techniques being applied in the research.

The research activities were: post-harvest crown reduction pruning and pre-bloom thinning, fertilizer and pesticide application, pre-harvest bagging of fruit and post-harvest treatment of fruits with Ethrel for acceleration of fruit ripening.
The results of the study showed that:
- Post-harvest pruning and pre-blooming thinning significantly reduced canopy height, improved light penetration through the trees making pest and disease control more efficient, promoted shoot growth, improved fruit set, and fruit size.
- Spray of the foliage fertilizer called Pomior accelerated shoot growth and also contributed to the yield increase.
- Preharvest bagging of fruits significantly reduced fruit drop, disease and pest infection, improved fruit external quality compared with unbagged fruits.
- Artificial ripening of bagged fruits by dipping of green mature fruits after harvest into the 0.4 % solution of Ethrel during 20 minutes made fruit ripe faster and more uniformly with better external quality compared with untreated ones, at the same time reduced weight loss and percentage of spoiled fruits infected by anthracnose and fruit flies during ripening.
- Application of these cultural practices together on both mango Tron and Hoi cultivars increased yield of 2.1 and 2.4 times respectively. The farmers’ trials also showed higher net income per hectare of treated trees compared with untreated ones (increased by 2.8 and 3.5 times respectively).
- On the spot-meeting organized in June 2007 local authorities and mango growers highly appreciated the success of the demonstration orchards. This combination of improved cultural practices are being transferred to other local mango growers of the district through so called “Farmer mango growing interest group” at commune level.

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Adaptation of Shifting Cultivation Systems in Lao PDR.
Potential and challenges of new market forces
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Keywords: Laos, upland agro-ecosystems, land use, shifting cultivation

Rural Laos and especially the uplands of the north are experiencing a major shift in agriculture and general utilization of its natural resources. Previously, the system was based on long term shifting cultivation with sustainable fallow periods of 10-15 years but this has changed over the last 5 to 10 years and is becoming less sustainable. Pressure exerted on the system is manifold, but mostly through opening of markets across the borders to China, Vietnam and Thailand and an increase of population.

A formerly highly diversified agricultural system, based on a mixture of large areas for upland, and smaller areas for paddy rice made sustainable use of the multi storage fallow and forests in its various stages, in the higher mountains often combined with opium poppy (Papaver somniferum) cultivation. The forests provided additional food through NTFP’s and were also used for interplanting with shade tolerant crops like cardamom, ginger and others. Wildlife was abundant and could supplement their basic diet. Only few commodities were sold or bartered to outsiders.

From the late 90’s onwards a major transition started to happen. Merchants from China, Thailand and Vietnam made the border crossings as their land use systems had limitations and Lao PDR was seen as a new frontier with bountiful resources. Tree crops e.g. rubber (Hevea spp.), commercial tree plantations like teak and eucalyptus (Tectona grandis, Eucalyptus spp.) were introduced for medium and large scale plantations, and farmers were encouraged to grow crops like maize, jobs tears, etc. at large scale. The merchants also provided the necessary back-up with sometimes questionable contract farming and access to markets.

In addition, markets in China and Vietnam started to use Laos as their cheap supply for valuable NTFP’s, especially medicinal plants, but also anything tradable from the forests and the fallow areas. This combination had an immensely negative effect on the agro-ecological land use mosaic and land use pattern of northern Laos. Formerly small holder patchwork-farming with small agricultural plots nested in long term fallows of different stages and natural forests has now been replaced in many areas by a system of much larger agricultural plots, and the diminishing of forests and long term fallows. Increased pressure came in through introduction of crops potentially suitable for biofuels and accelerated the shift from subsistence to commercialization leading to an overexploitation of natural resources. NTFP’s are now scarce and some exploited beyond sustainable natural re-growth.

In an effort to stem the negative impact of shifting cultivation with unsustainable short fallows the Lao government is also trying to discourage upland communities of all ethnic minorities to continue with shifting cultivation and has introduced relocation programs to move villages out of the uplands. Main reasons are related to improve the access of government services and infrastructure i.e. health, education, markets, etc. At the same time, population pressure and the natural thrive of communities to increase their cash income continues to put pressure on the land.

URDP, the Upland Resource and Development Project of the National Agriculture and Forestry Research Institute (NAFRI), funded by Swedish Sida, tries to support sound and equitable development efforts with field research in 4 provinces in northern Laos. In a first attempt field
research focus’ at the present agro-ecological systems by utilizing and delineating agro-ecological zones as a base for the development of agriculture and forestry planning in the future. Land use patterns are examined and with the support of GIS and remote sensing a first assessment is carried out to understand the present system, its strength and weaknesses.

This forms the base for discussions with the district authorities and local communities and together target villages are selected for 3-5 year research and development activities. The main aim of the research is to find ways and means to stabilize and improve the present system and to gradually introduce, where possible and necessary adapted cropping patterns and improved management practices. The long term goal is to support the agro-ecological system and to preserve its inherent culture to come up with long term solutions and not to introduce unsustainable cropping patterns which might result in short term gains but have a negative impact on the environment.

URDP researchers are experimenting with rice based systems i.e. combined with zoned livestock and suitable off-season cash crops and multi-storey systems with high value tree crops. NTFP’s are seen as having a major potential for income generation and new inventory techniques are employed as well as market chain research and research to support a sustainable quota systems are looked at.

This paper reports on these research and development efforts, including the evolution of improved institution and capacity building for better resource planning and management with local and district support. It also discusses plans for further expansion and the potential for wider application and adaptation in other parts of Laos and the region.
Livelihood Strategies of Karen Uplanders in Mae Hong Son Province, Northwestern Thailand

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KEY WORDS: agricultural transformation, livelihood strategies, dry-rice farming, wet-rice farming, cash-cropping, wage-labour

This study focuses on the agricultural transformation process of Karen upland farmers in Northwest Thailand. Against the backdrop of diminishing natural resources and rising population pressure, Karen uplanders are experiencing marked challenges to sustain their livelihoods. The combination of severe resource constraints and new market-based opportunities has significantly changed the livelihood context of today’s Karen upland farmers. Increasingly uplanders operate in a middle ground between subsistence and commercially-oriented farming. While most existing work on Karen livelihood has been preoccupied with political discussions (i.e. subsistence farming based on the local knowledge – ‘rai mun wian’), few studies have examined the actual dynamics of Karen agricultural transformation in the era of commercialisation.

These challenges constitute the core of my research: How do Karen farmers adapt their agricultural livelihood strategies to the economic, social and environmental changes over the last decade? For the investigation, my methodology covers a set of ethnographical field studies based on participatory observation which was conducted in the following steps: Firstly, I carried out household survey over 250 households in five Karen villages on their production and consumption activities. Secondly, I conducted interview (both semi-structured and open-questions) with the Karen people and local middlemen as well as development workers. In my research sites, key economic activities among the Karen farmers can be divided into four types: (1) dry-rice farming in upland fields, (2) wet-rice farming in terraces, (3) cash-cropping on both uplands and terraces, (4) and wage-labour. These four activities can be further distinguished into two basic livelihood strategies: the former two cropping systems are mainly used for personal subsistence, whereas the later two options generate cash-income. To each livelihood options, I examine potentials and constraints for the Karen farmers.

Based on in-depth case studies in five villages in Mae Hong Son, I analyze the viability of Karen swidden cultivation (dry-rice) and current attempts to extend agricultural livelihood strategies towards intensification (wet rice), diversification (cash cropping) and detachment (wage labour). While rotational swidden cultivation has been significant sustenance for many upland Karen farmers, agricultural commercialization has been beneficial for the wider population. In the case of cabbage cultivation based on well-established market system, job-opportunities have increased not only in urban trading spots, but also inside upland villages. It is helpful for those who are marginalized from intensification methods and labour markets due to their lower socio-economic status. Meanwhile, under less strict forestry regulation, swidden dry-rice farming is still an essential livelihood source available for many Karen. It is also a backup for the farmers to compensate their failure of wet-rice farming or cash cropping.

Against the background, one key finding is that classifying Karen livelihood as either ‘subsistence-based’ or ‘commercially-oriented’ is misleading. The fact that more and more farmers decide to partially intensify or diversify their crops, does not preclude them from combining these ‘commercial’ orientations with the local knowledge and inherited farming traditions (e.g. rotational swidden systems). In
other words, although Karen uplanders are becoming more market-oriented over time, their decision-making cannot be isolated from the rural community structures and social systems they are embedded in. Thus, contrary to common arguments of deagrarianization (e.g., Riggs and Nattapoolwat 2001), the current transition in North Thailand’s uplands is not a linear process. Instead, it can be characterized as a dynamic trial-and-error process in which farmers seek a new balance between subsistence and market economy. The evidence of this study highlights that the *synthesis* of commercial and non-commercial orientations (rather than the adherence to any one extreme) is the most promising path towards a sustainable livelihood at this point of time.
Managing Rice Landscapes in the Uplands for Improvement of Livelihoods and Conserving Resources

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KEY WORDS: rice germplasm; crop and field management; modeling approach; Laos

More than 20 million people are directly dependent on the land and water resources of the upper catchments of the Mekong and Red rivers for their livelihoods. Poverty and food insecurity is very high in this region; with many households relying on rice-based cropping systems to meet their food needs. Since productivity of land and water resources is low and access to both markets and agronomic inputs is limited, increased pressure to intensify use of these resources is leading to their rapid degradation. Farmers are caught in a cycle of low crop productivity, hence food insecurity. Food insecurity spurs farmers in the uplands to exploit marginal lands and leads to degradation of soil and water resources which exacerbates poverty.

An entry point to breaking this vicious cycle poverty and environmental degradation is to raise the productivity of rice. Increased rice productivity in favorable areas is expected to reduce the pressure to intensify cropping on fragile portions of the upland ecosystem and open opportunities for farmers to diversify into environmentally sustainable production systems on fragile upland systems.

Two rice-based agroecosystems co-exist in a continuum in the Lao uplands: upland rice-based systems on hill slopes and lowland rice-based systems on bunded fields where there is sufficient water availability, typically on valley bottoms and river beds. Upland rice accounts for about 36 percent of the total rice area in Lao PDR. Over half of the rice grown in the northern Laos is rainfed upland and almost a quarter this was under slash-and-burn shifting cultivation. Poverty incidence in the uplands of Laos is about 52%. Stopping slash-and-burn shifting agriculture, and the move towards sedentary upland cultivation systems, was a policy prompted by claims of the serious environmental impacts of slash-and-burn shifting agriculture.

Upland rice-based systems typically begin with a crop of upland rice after the fallow vegetation has been slashed, left to dry and burned. Rice is direct seeded on dry soil on hill slopes and is entirely rainfall dependent. In contrast, lowland rice is transplanted on puddled soil in bunded fields. Lowland rice may be completely dependent on rainfall (grown once a year) or may be irrigated which may allow the cultivation of two crops of rice a year.

The cultivation and consumption of rice is an integral part of the culture of Laos and of the surrounding Greater Mekong Subregion countries. In a region where food sufficiency is synonymous to having rice to eat, restrictions on rice cultivation based on environmental protection concerns are difficult to implement without providing options for the attainment of rice sufficiency for household consumption throughout the year.

The productivity of these two ecosystems is dependent on water availability, soil fertility and labor inputs. Developing alternatives which increase rice productivity and food security must utilize an approach which recognizes the hydrologic and economic linkages between the rice ecosystems as well as other agricultural production elements. These realities suggest that a two-pronged approach is needed: (1) increasing the productivity of both the upland and lowland rice ecosystems, and (2) generating alternative landscape management schemes which effectively maximize the use of available water and other biophysical resources. This paper presents results of initial progress at two research sites in Luang Prabang province in northern Lao PDR.

Increasing the productivity of upland and lowland rice-based ecosystems concentrated on improvement, development, testing and dissemination of germplasm, crop and field management technologies. The objective of the germplasm work was to identify and disseminate rice seed material for both upland
and lowland rice ecosystems which are more productive and meet farmers’ acceptability criteria. Purification, testing and dissemination of local rice landraces was undertaken at the same time that new rice cultivars and lines from IRRI’s International Network for Genetic Evaluation (INGER), China and other countries were being tested for adaptability to upland environmental constraints such as low soil fertility and shortened fallow cycles (Table 1).

Table 1. Grain yield of traditional and modern varieties and lines selected for their adaptation to short fallow cycles, continuous cropping and response to fertilizer application in northern Laos.

<table>
<thead>
<tr>
<th>Variety/Line designation</th>
<th>Grain Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short duration, short fallow</strong></td>
<td></td>
</tr>
<tr>
<td>Nok</td>
<td>1.7</td>
</tr>
<tr>
<td>Makfay</td>
<td>1.7</td>
</tr>
<tr>
<td>Palawan</td>
<td>1.8</td>
</tr>
<tr>
<td>Chaodo</td>
<td>1.6</td>
</tr>
<tr>
<td>IR600080-46A</td>
<td>1.9</td>
</tr>
<tr>
<td>IR65261</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Medium duration, short fallow</strong></td>
<td></td>
</tr>
<tr>
<td>Makhinsoung</td>
<td>1.7</td>
</tr>
<tr>
<td>Paisevan</td>
<td>1.5</td>
</tr>
<tr>
<td>Non</td>
<td>2.0</td>
</tr>
<tr>
<td>Pasiew 1</td>
<td>1.8</td>
</tr>
<tr>
<td>Pasiew 2</td>
<td>1.9</td>
</tr>
<tr>
<td>Phaenoi</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Continuous rice cropping</strong></td>
<td></td>
</tr>
<tr>
<td>Laboun</td>
<td>2.0</td>
</tr>
<tr>
<td>Chao Mad</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Low input</strong></td>
<td></td>
</tr>
<tr>
<td>IR55432-1</td>
<td>1.9</td>
</tr>
<tr>
<td>B6144-MR-6</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Fertilized (60-60-60)</strong></td>
<td></td>
</tr>
<tr>
<td>IR55432-1</td>
<td>3.0</td>
</tr>
<tr>
<td>B6144-MR-6</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Coincident with germplasm testing, evaluation of crop and field management technologies to improve productivity were conducted. Some of the technologies developed and tested include the restoration of soil fertility under short-fallow conditions and rehabilitation of crop land invaded by *Imperata cylindrica* (Linn.) in the upland rice ecosystem (Table 2).

Table 2. Comparison of rehabilitation techniques (one application of glyphosate and pigeonpea cover crop + rice, pigeonpea cover crop alone + rice) of land invaded by *Imperata cylindrica* (Linn.) in rainfed upland in Luang Prabang, Lao PDR.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Imperata before planting (number/m²)</th>
<th>Imperata after rice harvest (number/m²)</th>
<th>Rice grain yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate + Pigeonpea + Rice</td>
<td>349</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>Pigeonpea + Rice</td>
<td>360</td>
<td>176</td>
<td>0.7</td>
</tr>
<tr>
<td>Rice</td>
<td>435</td>
<td>182</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Technologies to increase paddy rice productivity included the use of seed bed shelters to protect rice seedlings from low air temperature and use of locally available materials as fertilizer sources (Table 3). Incorporating small grain legumes such as soybeans as a post-rice crop has been tested as a means of increasing land productivity and crop diversification.

Table 3. Comparison of local farmer practice (no fertilizer application), pig manure, *Chromolaena odorata* green manure and inorganic fertilizer on rainfed lowland rice grain yield in Luang Prabang, Lao PDR.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>Grain Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>80</td>
<td>2.7</td>
</tr>
<tr>
<td>Pig manure (5 t/ha)</td>
<td>80</td>
<td>2.6</td>
</tr>
<tr>
<td><em>Chromolaena odorata</em> green manure (25 t/ha)</td>
<td>92</td>
<td>3.5</td>
</tr>
<tr>
<td>60-30-30 (N-P-K)</td>
<td>85</td>
<td>3.1</td>
</tr>
</tbody>
</table>

To complement analysis of crop and field level management, a spatially-based suite of modeling...
tools form a platform for characterizing the land and water resource base which form the biophysical context to the upland Lao rice-based ecosystems. This modeling suite, currently under development, integrates ArcGIS; MIKE SHE, a distributed physically-based watershed hydrology modeling package; and Simile, a systems dynamics visual modeling package which links with ArcGIS. This suite provides robust representations of land, water, and other components of the Lao upland biophysical resource base and enables analysis of impacts to water availability, rice production, and economic flows under various land use scenarios, including upslope land use mosaics and increased paddy area. It is envisioned that this analysis will serve as a starting point for subsequent efforts which could incorporate alternative water management technologies and improved cropping systems.

Biophysical and economic resource characterization in support of model development and initial analysis utilized a combination of participatory methods, field observations and spatial data collection, and quantitative hydrologic field measurements. Two data collection tracks were employed: (1) a resource linkage appraisal developed qualitative descriptions of biophysical resources and perceptions of linkages in 2 target villages, enabling comparative analysis of villages with differing resource endowments, and (2) a detailed land and water resource characterization effort of a sub-watershed within one of the sites quantified significant resource flows and endowments which then formed the basis for subsequent modeling. Outcomes from the former track include participatory maps of village areas and comprehensive descriptions of significant resource flows and management paradigms from the perspectives of both the researchers and the farmers. Results from the latter track include detailed mapping of topography, land use, and stream networks from the target watershed (see Figures 1 and 2), as well as multi-location climate and streamflow data streams allowing characterization of water flow regimes and providing calibration data for subsequent hydrologic modeling.
Bounded rationality in Contingent Valuation: empirical evidence using cognitive psychology

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KEY WORDS: Contingent valuation, environmental valuation, bounded rationality, cognitive psychology

GENERAL RESEARCH APPROACH

The Contingent Valuation Method (CVM) has become popular and widely applied for assessing the social value of environmental goods even in developing and emerging countries. As a survey based valuation technique, however, it relies particularly on the premise of respondents’ rationality when answering the willingness to pay (WTP) question. Results of CVM surveys demonstrating a wide variety of procedural biases have repeatedly put this fundamental assumption of this widely used method into question. These effects of inconsistent and theoretically unexpected responses to CVM questions represent violations to the postulate of fully rational decision making. Therefore, it appears promising to analyze these biases from the perspective of a different notion of rationality.

This study adopts a more realistic view of rationality by accounting for respondents' limited capacities to process information, thus acknowledging the possible bounds of rationality. It aims at an exploration of how the conceptual framework of bounded rationality can contribute to better understand respondents' behavior in CVM surveys in order to recommend changes in the design of such surveys leading to more rational responses and, consequently, to better benefit estimates of environmental change scenarios. Accounting for bounded rationality may, therefore, improve environmental policy decisions of allocation of public goods.

The theoretical approach of this paper is based on research on cognitive psychology. Following findings of this field the observed anomalous response behavior in CVM studies is assumed to be rooted in the dual-process nature of human information processing. Various cognitive psychological models claim that scarce cognitive resources for information processing are allocated to two fundamentally different systems of reasoning resulting in a kind of "economy of cognition". One system often called heuristic or intuitive-experiential performs relatively effortless information processing relying on stored situational rules and mental shortcuts while a second system called analytical or systematic is occupied with effortful reasoning processes requiring conscious thought and largely serial processing.

Based on this model of reasoning a technique to detect and analyze the bounds of rationality inherent in WTP statements is developed. The empirical instrument for measuring the degree of bounded rationality in the practical CVM survey conducted here is based on existing and validated psychological scales regarding individual differences in people's cognitive characteristics. One of these instruments, the rational experiential inventory (REI) developed by Epstein et al. (1996), is adopted here from which suitable survey instruments to be included in CVM questionnaires are developed. In the study conducted here, two different but related approaches to measure these cognitive characteristics are taken: the first instrument focuses on the assessment of people's general cognitive dispositions, i.e. their tendencies to employ more intuitive versus more analytical information processing, the second instrument elicits directly whether respondents in the survey have made use of specific strategies of information processing.

THE EMPIRICAL APPROACH AND RESULTS

Two separate sets of question items were included in a broad empirical CVM study aiming at an assessment of the social value of an improvement of tap water and environmental quality in a suburban area in northern Thailand near the city of Chiang Mai. Using factor analysis it is found that the respondents of this...
CVM survey can indeed be classified into different cognitive types of information processing and decision making both on the levels of general cognitive dispositions and of the specific strategies used. As expected, a number of systematic relationships between the types of information processing and responses to the WTP question are found. The intuitive-experiential types exhibited a significantly negative effect on stated WTP for both elicitation question formats employed in this study whereas the analytical-rational type was found to be significantly positively related with WTP. From these results it can be concluded that the cognitive dispositions of respondents as elicited by the measurement instrument of bounded rationality developed in this study have explanatory power for WTP in addition to the usual socio-economic and attitudinal characteristics of the sample respondents and, therefore, play an important role in this CVM study. It is demonstrated that the focus on respondents’ information processing types constitutes a suitable approach to gain additional insights into respondents’ decision making behavior in environmental valuation studies. This focus allows to assume a more comprehensive perspective on response behavior in environmental valuation interviews than the often adopted concentration on the numerous procedural biases. It is recommended, therefore, that future surveys adopt this methodology for an analysis of bounded rational information processing. The results of this survey in northern Thailand demonstrate that a large part of respondents show characteristics of bounded rationality since strategies of limited information processing were widely adopted for the evaluation of the CVM scenario. It can be concluded, therefore, that full rationality is often not assured in practice. Rather, the results highlight the necessity to take greater efforts to induce respondents to invest more cognitive resources and process the provided information more analytically when evaluating the personal relevance of a CVM scenario.

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Refining direct methods of environmental valuation: which insights can be gained from citizen expert groups?

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KEY WORDS: Contingent valuation, environmental valuation, citizen expert groups, survey methodology, New Environmental Paradigm

GENERAL GOALS

Environmental valuation aims at the assessment of the social value of changes in the environment, especially when they are caused by public projects. While the costs of environmental projects are not too difficult to compute, this is not true for the benefits they generate. Project costs typically consist of costs for labor, capital, materials etc. which are all market goods that can be valued by their market prices. The benefits accruing to society from projects like the preservation of rare species, a reduction in the pollution of soil, air or water or improvements in environmental beauty are not traded in markets so that no market prices exist for their valuation. Therefore, other valuation methods have to be found. In principle, there are two main approaches to the economic valuation of environmental projects: indirect methods and direct methods. Indirect valuation methods rely on the observation of people's behavior regarding the use of the environmental good that is created by some environmental project and the private expenditures they make to use this good. These techniques can only assess the use value such environmental goods produce for people. They are blind for the so-called non-use values like existence values etc. But in the context of environmental issues existence values are most important so that the indirect valuation methods systematically underestimate the true value created by environmental projects. Therefore, the research underlying the paper proposed here focuses on the improvement of the direct methods of environmental valuation.

These direct methods rely on personal interviews with people potentially affected by some environmental project and their valuation of this project. That means that they try to assess people's preferences for the environmental values created by a project as stated directly by respondents in the course of personal interviews. It is obvious that such a method is prone to manifold different biases since people's opinions stated in interviews are typically not really reliable.

In the valuation projects described in this paper we try to improve the reliability and validity of direct valuation methods illustrated by the contingent valuation method (CVM). On the one hand we try to improve ex ante validity by involving so-called citizen expert groups (CEG) in the process of designing a CVM survey in order to obtain better results. On the other hand we try to develop techniques for the ex post assessment of the reliability of CVM results by adding a standardized set of attitudinal questions to our survey questionnaires, the so-called New Environmental Paradigm (NEP) questions. These questions ask respondents' opinions regarding several different environmental topics in order to identify five separate groups or types of people which differ by their general attitude towards environmental issues. By allocating respondents to the different types of ecological worldview one can test the plausibility of their answers with respect to the specific environmental project in question.
THE ANALYSIS IN DETAIL

Participatory approaches like focus groups have been part of the standard repertoire of questionnaire design in contingent valuation (CVM) surveys since the 1990s. In contrast to in-depth interviews with individual households, the group setting intended to make use of social interaction to boost the group participants' motivations to think about the valuation topic and reflect upon the arguments of the other participants in moderated discussions. While most studies employing such focus groups stressed their importance for developing a suitable survey design, very little systematic research on their effects on the validity of survey results has been conducted, so far.

In this paper we present research on citizen expert groups (CEGs) as a refinement of participatory approaches in contingent valuation and demonstrate how a specified procedure of CEGs leads to a significantly improved validity of CVM results in Thailand. The main distinction of CEGs to traditional focus groups is the degree of involvement of the group participants into the topic of the survey and even into the process of designing a CVM survey and questionnaire. Normal citizens as representatives of the population to be surveyed are considered to function as genuine experts regarding the knowledge of the typical characteristics of respondent households, of the perception of the public project to be valued within the respective population and, consequently, of possible pitfalls of asking personal questions. With this specific knowledge and their potential to contribute valuable information for designing the survey, citizen experts are meant to form an integral part of the research team.

Results from two CVM surveys employing citizen experts are presented here. Both surveys deal with the valuation of externalities from upland agriculture on lowland communities in northern Thailand. The central methodological objective of these studies is the improvement of the quality of CVM surveys, especially of mail surveys. In the literature, mail surveys are still considered a problematic interview form of CVM surveys since due to generally rather low response rates results are far from representative. It was intended, therefore, to increase response rates of mail surveys substantially and thus improve their validity by eliminating so far unknown response barriers in the questionnaire design of our CVM surveys.

The first survey aimed at assessing the social value from a tap water improvement program accruing to the suburban population of Mae Rim located in the vicinity of Chiang Mai in northern Thailand. After an initial CVM mail survey citizen experts were recruited out of the respondents to this survey. In repeated group meetings they were given the opportunity to discuss controversial issues of the valuation scenario and the questionnaire used in the survey. The insights gained in these groups regarding respondents' perceptions of the water improvement project and their problems with the questionnaire were used to revise and reformulate the questionnaire. This procedure resulted in a doubling of the response rate to the following mail survey, further, identical estimates for people's willingness-to-pay (WTP) for the tap water improvement were achieved for the mail survey and a complementary survey with face-to-face interviews. In a second study the cooperation with citizens is intensified by forming citizen expert groups that accompany the whole valuation process from the beginning. In this study citizens were involved also in the creation of the CVM scenario, a public project to reduce the risk of flooding in the city of Chiang Mai. The specific methodological aim of this second study is to test whether such an intensified cooperation with citizen experts achieves the same improvement of survey design as in the first study without having to conduct a costly initial mail survey first. Presently, empirical data are being collected, results are expected by early next year.

In order to test ex post validity of the survey results 15 NEP questions were included in the questionnaire in order to allocate respondents to the five different environmental types provided by the NEP. For each of these environmental types hypotheses regarding their probable answers to different questions regarding their appraisal of the project under consideration are developed and then compared to the actual answers obtained during the survey. This procedure is meant to provide a test for judging the quality and plausibility of the CVM answers obtained during the survey. It is intended to generalize these results to obtain a standardized plausibility test for CVM surveys.
Economic losses due to landslides in upland areas of Yen Chau district in Vietnam: Causes, protection strategies and willingness to pay

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KEY WORDS: Contingent valuation, environmental valuation, citizen expert groups, New Environmental Paradigm

OBJECTIVES

In areas with unsustainable agricultural and forestry practices, such as the mountainous provinces of Northern Vietnam, landslides are quite common. Landslides in Yen Chau district of Son La Province have in the past caused severe road blockings, thereby affecting the trade with Hanoi and other major cities in Vietnam. Within Yen Chau district, trade between lowland and upland areas can be seriously affected as well. Apart from losses in inter-district and interregional trade, other local economic losses include the loss of employment opportunities or the destruction of standing field crops. The objectives of this paper are twofold. As an empirical goal we want to highlight the economic, social and psychological background and implications of the landslide problem in Yen Chau district. As a methodological goal we want to scrutinize the possibilities for using monetary quasi-market valuation methods for environmental changes, like the Contingent Valuation Method (CVM), in a former communist country that is in transition to a market economy. The empirical analysis in this paper is based on personal interviews with citizens from Yen Chau and with farmers in the surrounding uplands.

Empirical objectives

Landslides are a severe problem in Yen Chau district. Several times each year during the rainy season the National Road which connects Yen Chau with Hanoi and several smaller country roads connecting Yen Chau with neighboring villages are blocked by landslides. Our interviews in this region showed that nearly every household is regularly affected directly or indirectly by landslides and their consequences. Either people are caught personally in landslides for several hours or even days when the roads are blocked or they suffer indirectly from consequences of landslides like interruptions or delays of commodity supply, which affect shop owners as well as private households. Further, landslides cause damages to farmers’ fields and fish ponds, sometimes also to their homes.

In the empirical analysis of this paper we scrutinize in detail the degree to which different household groups in Yen Chau are affected by landslides and how they cope with the problem. We ask them about the causes of landslides according to their personal opinions and the segments of population they deem responsible. We further want to find out if they accept the occurrence of landslides as an inevitable fate or if they think that something can be done and should be done in order to reduce the risk of landslides in their region. In the latter case we want to learn about their ideas regarding suitable strategies against landslides.

Further, we want to find out if people are ready to contribute personally to measures against landslides and, if yes, in what form and to what extent. In very poor regions like the Yen Chau area such contributions typically are offered at least partly in terms of voluntary work instead of money. A special challenge in such cases is the transformation of such voluntary working hours into monetary terms since market wages...
obviously cannot be used here. This transformation is necessary since people's readiness to contribute personally to landslide protection works is taken as an indicator for the aggregate utility they obtain from a landslide protection program, i.e. for the social value of such a project. For this purpose a full-scale contingent valuation survey for the valuation of a landslide protection program concentrating on the lowland communities in Yen Chau district is conducted with 500 randomly selected households (Subproject F1). In addition, a short version of this CVM study is implemented in a random sample of 300 households, mostly farmers, in the whole district (Subproject F2). The results of the two studies are compared especially under the aspect of the different socio-demographic backgrounds of the respective populations.

Methodological objectives

The methodological focus of our analysis lies on the applicability of a market valuation method like the CVM in a post-communist country in transition to a market economy. Contingent valuation depends on people's ability to express the utility they obtain or expect from some "commodity" (such as improved landslide protection) in monetary terms, i.e. their ability to attach "prices" to such commodities. Coming from a planned economy where commodity prices were administered by the government the Vietnamese are hypothesized to have difficulties to attach utility prices to a public project like landslide protection. Hence, one essential methodological goal of this paper is to test the applicability of the CVM in Vietnam.

As mentioned above, direct valuation methods like the CVM rely on personal interviews with people potentially affected by some public project and their stated valuation of this project. It is obvious that such a method is prone to manifold different biases since people's opinions stated in interviews are typically not really reliable. Answers may systematically differ depending on the political or socio-economic status of the respondents.

In this research great efforts are made to control for the socio-economic and political status of respondents in order to form an idea of the credibility of their CVM answers. The tools used for this goal are in-depth interviews with representatives of different socio-economic groups (classified mainly according to income, education and profession). Such interviews allow us to address group-specific aspects like budget constraints, attitudes towards authorities etc. to be taken into account for the design of the CVM questionnaire. This information is complemented by participant observation data from meetings of residents during which they discuss landslide-related issues following an ex-ante structured schedule.

RESULTS

The interviews in Yen Chau district show a high degree of awareness of the landslide problem in the population. Nearly every household has been affected several times in the past by landslides and a feeling that something has to be done prevails among all groups of the population.

Although most people think that first of all government funds should be used for financing measures to prevent future landslides most of them are also ready to contribute personally to a landslide protection project. Nevertheless, the interviews show a tendency among the population to shift the main burden of such a project to government institutions far away from Yen Chau, such as the central or provincial government. Only a small part of the money should come from the affected district itself, according to the respondents. As expected, many households would be willing to contribute to such a project in terms of voluntary working hours.

These findings will be contrasted with the results of a second wave of interviews with Yen Chau citizens (conducted by Subproject F1) and with farmers from the surrounding mountainous areas (Subproject F2). These interviews are based on a revised version of the questionnaires where the revisions were based on the experiences from the first round. Especially the conformity of the answers to some of the questions made revisions necessary in order to reveal tendencies towards socially desirable answering behaviour.
Could carbon payments be a solution to deforestation in Central Sulawesi?

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KEY WORDS: Payments for environmental services; carbon sequestration; agroforestry; linear programming; avoided deforestation

Primary forests are lost or modified at a rate of six million hectares per year due to selective logging or deforestation, and there is no indication that the rate is slowing down (FAO, 2006). Deforestation, in turn, plays an important role in the global warming process as it accounts for up to 25 percent of global greenhouse gas emissions. Indonesia has the second highest annual net loss in forest area worldwide and is the third largest greenhouse gas emitter (WorldBank, 2007). On the island of Sulawesi in Indonesia, the forest margin of the Lore Lindu National Park has been facing encroachment and consequently deforestation. The main cause is rapid agricultural expansion in the uplands that has taken place during the last twenty years, specifically cocoa plantations. A village survey in 2001 revealed that 70 percent of the villages bordering the National Park have agricultural land inside the park. In addition, an intensification process among the cocoa agroforestry systems (AFS), where farmers gradually reduce the shade tree cover, can be observed. The research is motivated by the need to understand which level of incentives is needed to motivate the farmers to desist from forest conversion activities. Recently the “payments for environmental services” have been advocated as an approach to promote forest conservation initiatives. As defined by Wunder (2007), these are voluntary, conditional agreements between at least one “seller” and one “buyer” about a well-defined environmental service – or a land use presumed to produce that service. Therefore, we investigated what impact payments for carbon sequestration in forest ecosystems have on smallholders’ land-use decisions. The purpose of this paper is to provide an insight, as to whether current carbon credit prices are sufficient to induce the farmers to adopt more sustainable land use practices and, thus, contribute to forest conservation.

We chose a comparative static linear programming model to analyse the behaviour of the households and their resource allocation. These models simulate the farmers’ reactions to interventions and the effect of technology changes on economic decisions concerning natural resource use management (Barbier and Bergeron, 1999). Linear programming has proven to be a reliable method for studying the impact of policy activities such as, in this case carbon payments (Vosti et al., 2002). The objective function of the model is to achieve a maximum total gross margin of the farm by optimising the area shares of several crops. The model accounts for the resource constraints present in the research region, and it depicts forest conversion activities. Four cocoa AFS can be distinguished whereby AFS I exhibits a high degree of shading and less intensive management, while at the other hand of the spectrum AFS IV involves intensive management and fully sun grown cocoa. Cocoa gross margins increase in profitability when moving along the cocoa AFS intensification gradient from I towards IV, a result observed in other studies as well (Steffan-Dewenter et al., 2007). Hence, payments are needed to induce farmers to hold up the intensification process.

The data was collected in a household survey in six villages in the surroundings of the National Park in 2006. We categorised the households according to the dominant AFS among their cocoa plots and identified four corresponding household types (HH I - HH IV). A random sample of 46 households was drawn. The carbon payments were calculated by applying an accounting scheme of temporary emission credits. These credits are limited to five years, after which they can be re-issued. As we envisaged a total project horizon of 25 years, we assume that the carbon credits will be issued five times (Olschewski and Benitez, 2005).
At the plot level, the net carbon accumulation is highest for the most shade intensive AFS and for the shade free cocoa plantation. The annual remuneration from carbon payments for the farmer was obtained for each AFS by calculating the net present value and its equivalent annuity. With low carbon credit prices of 5€ tCO\textsubscript{2}e\textsuperscript{-1} (comparable to the lowest traded medium-risk CER prices), the resulting annuity payments constitute 5 percent of the cocoa gross margin for the high shade AFS, and less than 1 percent of the fully sun grown AFS cocoa gross margin. At carbon credit prices of 25€ tCO\textsubscript{2}e\textsuperscript{-1} (comparable to the May 2007 trading prices in the European Climate Exchange for 2008-10 carbon allowances), the payments amount to 28 and 2 percent of the respective cocoa gross margins. The variation between the four AFS is not very pronounced. However, the highest annuity payments from carbon sequestration are always obtained for the high shade AFS as it has the highest total carbon sequestration potential. Focusing on the household level, the baseline TGMs exhibit an increase from HH\textsubscript{I} towards HH\textsubscript{IV}. With the introduction of the payments, the HH\textsubscript{I} experiences the most pronounced relative impact on its TGM, ranging from 9 percent with a low carbon credit price to 18 percent with a high price. The corresponding impacts for HH\textsubscript{IV} are extremely small. However, when looking at the absolute impact of the carbon payments on the TGM, household IV receives the highest additional payments, and the amounts gradually decline for HH\textsubscript{II}, HH\textsubscript{I} and HH\textsubscript{I}. At this range of carbon prices, none of the households realises a shift in their land-use management practices. Economic incentives, such as price premiums offered through carbon certificates for shade intensive cocoa could be a solution to slow down the intensification. With carbon prices of up to 32€ tCO\textsubscript{2}e\textsuperscript{-1}, an incentive is provided for the first three household types to either grow the full shade or slightly less shaded cocoa AFS. However, the household IV would need very high carbon prices of 185€ tCO\textsubscript{2}e\textsuperscript{-1} to induce it to adopt more of high shading cocoa production practices. Avoided deforestation is increasingly being recognised as an important strategy for preventing greenhouse gas emissions in the first place. Results from the model indicate that for the households II-IV a minimum carbon price of 125€ tCO\textsubscript{2}e\textsuperscript{-1} would be necessary to halt the deforestation processes.

The study demonstrates the importance of including smallholders when targeting the reduction of greenhouse gas emissions, as uncontrolled agricultural expansion in the uplands contributes to forest loss. The results indicate that different household types have different opportunity costs. Thus, on the one hand the current prices of carbon certificates, which are traded on markets, could be sufficient to stimulate the adoption of sustainable land-use practices for the households I-III in the research region. However, on the other hand, due to very high net-revenues in the intensive cocoa production, the current carbon prices are not high enough to stop the deforestation activities of most of the households. A solution could be to target payments only at the shaded and least intensively managed cocoa agroforestry systems.

REFERENCES


Determinants of Adoption of Soil Conservation Technologies in Upland Areas of Northern Vietnam

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KEY WORDS: Land tenure security, technology adoption, soil conservation, Vietnam.

INTRODUCTION

In the past 20 years, population growth and the rapid economic development in Vietnam have put considerable pressure on natural resources, land in particular. In Yen Chau, a district of Son La Province in the north western mountains of Vietnam, the population has increased by 52% in less than twenty years (Yen Chau statistical office, 2007) leading to deforestation due to the expansion of rainfed agriculture. The observable consequences today are severe soil erosion in the uplands, a growing incidence of sedimentation, landslides and road blockings in the lowland, and a decrease in soil fertility. In spite of these problems, this paper shows that soil conservation technologies (SCT), such as contour ploughing, ditches, strip-cropping, and agroforestry, are rarely practised by farmers. In Yen Chau, where no more land is available for extending cultivation, SCT represent a major tool to ensure the sustainability of agriculture and food security for the coming generations.

The determinants of adoption of SCT have been the subject of many research studies. In most such studies, benefits are perceivable in the medium and long term while costs are incurred in the short term. Therefore, the adoption decision partly depends on the discount rate farmers determine to evaluate the present value of future benefits and costs. Mechanisms of adoption are thereby linked to the capacities of farmers to have long-term planning horizons and to their perception of the future, which are conditioned by the degree of food security as well as tenure security and credit access (Lutz et al. 1994). This paper focuses on the role of policies and institutions in the adoption of SCT by Yen Chau farmers.

In the late 1980s and early 1990s, Vietnam has started a wave of reforms leading its economy to a market oriented system, strengthening farmers’ decision authority over their own production, enhancing food security, and reducing poverty. Among these measures we focus our attention on the following two policies: (1) the rural credit policy and the development of state banks providing credit to rural poor households, and (2) the land allocation policy and the issuance of Land Use Right Certificates (LURC) to households for a period of twenty years that started in 1993. Because of administrative inertia (World Bank, 2007) there has been a great variation in the time of issuance of these certificates, and upland households and ethnic minorities have been the last in line to receive them. Moreover, resettlement projects in the area, the establishment of new households after LURC allocation, and the definition of new objectives in land uses lead the state to proceed to a re-allocation of land to farmers and, consequently, a probable re-issuance of LURC, raising uncertainty regarding the length of these land use rights.

This paper goes one step further by analyzing the problem of adoption of SCT under an upland / lowland interdependency point of view. On the one hand, soil erosion in the uplands has direct and indirect economic and environmental effects in lowland areas, namely on production...
(e.g., sedimentation of paddy fields or landslides), on roads, or to a larger extent on water quality (McConnel, 1983). On the other hand, the adoption of SCT by upland farmers is influenced by economic and institutional factors generally decided upon by political institutions in the lowlands, such as access by upland farmers to markets, agricultural extension, and credit. We focus our analysis on the adoption of SCT by upland farmers (i.e. farmers cultivating sloping fields) in order to assess the consideration of this environmental service in the actual design and outreach of Vietnamese policies.

RESEARCH QUESTIONS AND HYPOTHESES

The research questions we address are: (1) what constraints are farmers facing in mountainous areas to adopt SCT? (2) Are state policies successful in promoting sustainable development and adoption of SCT? To what extent could they do better? (3) Do these constraints differ between upland and lowland areas? Are differences in policy outreach between lowlands and uplands an explanation for differences in the adoption of SCT?

Based on economic theory and observations in the field we hypothesize that (1) farmers in Yen Chau are unlikely to invest in SCT because of their short planning horizon; (2) the land allocation policy is currently not providing enough tenure security to encourage farmers to adopt SCT; (3) upland farmers face more severe adoption constraints than lowland farmers because of their remoteness, higher degree of vulnerability and poverty, and poorer access to credit, markets, agricultural extension, and other institutions and policies.

RESEARCH AREA AND METHODOLOGY

Our research area is Yen Chau district, which is located along the highway linking Hanoi with the west of the country, in the north western mountainous region of Vietnam. Data were collected in 2007 in a random sample of 300 households in the district.

RESULTS

We observe that most farmers are aware of soil erosion on their plots and of the methods to mitigate this problem. Seventy-three percent of respondents know at least one soil conservation method. However, adoption rates are very low, only 30% of uplands plots surveyed are covered with a SCT.

The main constraints identified are the lack of land and labor available, as well as the high costs for implementation of such technologies. Moreover, we show that tenure security is not fully achieved despite the land titling policy, since 80% of respondents believe that a reallocation of their land before the current term of their LURC is (very) likely to occur.

Finally, we show that farmers in uplands areas are poorer and more severely constrained in their access to credit, potentially leading to higher discount rates that discourage the adoption of SCT. Based on these descriptive and econometric analyses, we derive a number of conclusions potentially relevant for enhancing the sustainability of agricultural production in mountainous areas.

REFERENCES


Water and nutrient budgets of native and managed watersheds under tropical montane forest in Ecuador

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KEY WORDS: element export; forest management; interception loss; near-surface flow; nutrient budget; water budget

INTRODUCTION

Tropical montane rain forests protect downslope areas from flooding, prevent soil erosion, and maintain a constant baseflow during dry periods [Hamilton et al., 1995; Bruijnzeel, 2000]. In spite of this importance, by 1991 already more than 90% of the original forest cover in the north Andes had been lost [Henderson et al., 1991; Hamilton et al., 1995]. The protection of the remaining native forests and the development of sustainable land-use practices require the understanding of forest functioning. Our objectives in a long-term ecological experiment in south Ecuador are (i) to set up the water budget in small watersheds under native forest, (ii) to assess the element export from upland to lowland areas and (iii) to determine the influence of a natural forest management measure on water budget and element export.

STUDY SITE AND METHODS

The study area is located on the eastern slope of the eastern Andean cordillera in south Ecuador between the cities of Loja and Zamora at 4° 00’ S and 79° 05’ W. We selected three 30-50° steep and 8-13 ha large microcatchments (MC1-3) under forest at an altitude of 1900-2200 m a.s.l. for our study in 1998. In 2004, we added a ca. 12 ha-large fourth watershed for a forest management experiment.

The underlying bedrock consists of interbedding of palaeozoic phyllites, quartzites and meta-sandstones. Recent soils have developed on postglacial landslides or possibly from periglacial cover beds [Wileke et al., 2001]. Soils are Humic Eutrodepts on transect MC1, Humic Dystrudepts on transects MC2.1, MC2.2, and MC2.3, and Oxyaquic Eutrodepts on transect MC3. All soils are shallow, loamy-skeletal with high mica contents. All soils were covered by a thick organic layer.

We installed our equipment (throughfall collectors, lysimeters below the O horizons and at 0.15 m and 0.3 m mineral soil depths) in each MC on transects, about 20 m long with an altitude range of 10 m, on the lower part of the slope at 1900-1910 m a.s.l. (transects MC1, MC2.1, and MC3). At 1950-1960 (MC2.2) and 2000-2010 m a.s.l. (MC2.3) we installed extra instrumentation. All transects were located below closed forest canopy and aligned downhill. Stemflow was measured at 15 selected trees. The stream flow of each watershed was recorded at a weir with a pressure gauge. Three unforested sites were used for rainfall gauging. All catchments drain into the Amazon basin.

In the forest management experiment, potential crop trees with a high economic value were identified and supported by removing 1-2 competitors resulting in the felling of 32 trees per ha [Günter et al., 2008].

In the collected ecosystem fluxes and in soil we determined C, N, P, K, Ca, and Mg concentrations [see Wilcke et al., 2001 and Goller et al., 2005 for the methods].

RESULTS AND DISCUSSION

One important observation of the first five years of our study (1998-2003) was a remarkably high interception loss ranging between 25 and 52% of incident precipitation [Figure 1, Fleischbein...
et al., 2005] which is at the upper end of other tropical montane forests [Bruijnzeel, 2001]. We attribute this high interception loss to the frequent weak drizzle and advected thermal energy in addition to the insolation.

Figure 1: Mean water budget of three ca. 10 ha-large watersheds under native tropical montane forest in south Ecuador between 1998 and 2003. P = incident precipitation, TF = throughfall, SF = stemflow, I = interception loss, ET = evapotranspiration, R = runoff; black bars indicate measured values, white bars calculated ones; error bars indicate standard deviations.

Peak C (14–22 mg l⁻¹), N (0.6-0.9 mg l⁻¹), K (0.5-0.7 mg l⁻¹), Ca (0.6-1.0 mg l⁻¹), and Mg (0.3-0.5 mg l⁻¹) concentrations in stream water of the undisturbed watershed were associated with lateral flow (fast near-surface flow in saturated topsoil) while highest P (0.1-0.3 mg l⁻¹) concentrations occurred during low baseflow conditions. All elements had higher concentrations in the organic layer than in the mineral soil, but only C, N, K, Ca, and Mg were flushed during lateral-flow conditions. P, in contrast, was retained in the organic layer and released by weathering in the subsoil. Baseflow accounted for 32% to 61% of P export. Near-surface water flow through C- and nutrient-rich topsoil during rainstorms was the major export pathway for C and N (contributing >50% to the total export of these elements) and also accounted for one third of base metal export.

The management measure did not have an impact on the water budget of the forest. We did not observe any significant changes in throughfall nor in surface flow. We also did not observe significant changes in throughfall and stream flow chemistry but there was a higher nutrient concentration in topsoil solution as a consequence of enhanced mineralisation and reduced nutrient use after logging.

CONCLUSIONS

The water budget of the study forest is dominated by high evapotranspiration and near-surface flow of water in soil. The latter is a consequence of the steep gradient in water conductivity from the thick organic layer to and through the stone-rich mineral soil. This is not changed by selective logging in the natural forest management measure.

REFERENCES


THE LINKS BETWEEN UPLAND AND LOWLAND AGRICULTURE IN THE 21ST CENTURY VIETNAM

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KEY WORDS: Upland agriculture; lowland agriculture; swidden agriculture; livelihood; decentralization

THE LINKS BETWEEN UPLAND AND LOWLAND AGRICULTURE

With water shortages as well as increased floods and droughts in Vietnam, growing attention is being devoted to the environmental services that the uplands provide to the lowlands. However, these services are now needed more badly than ever, trends in the uplands threaten to continue to force profound changes in upland land management systems, especially in agriculture. In swidden agriculture, fallow periods have been getting shorter and shorter, leading to soil degradation and reduced yields. Monocultural cultivation in permanent fields on sloping land has been expanding. Market fluctuations, disease, and other dangers can make livelihoods vulnerable and their ecological sustainability is not assured.

Due to these changes in upland agriculture, the well-being of the entire country can be negatively affected. Every effort, therefore, must be made to help upland farmers to practice sustainable and economically viable livelihood strategies while maintaining the flow of environmental services to the lowlands.

THE CHALLENGES FACING US

It can be said that agriculture in Vietnam is being transformed as a part of the changes of the Vietnamese culture and society after the “Doi moi” reform. In the process of changes, both upland and lowland agriculture have been growing more intensive, more productive, and more market-oriented. Confronted with a growing shortage of arable land, land degradation, falling yields, changing market opportunities, different farmers are adapting different livelihood strategies. Moreover, as transportation and communication improve and educational levels rise, as urbanization proceeds rapidly and Vietnam becomes more deeply embedded in the world economy, agro-ecosystems and rural livelihoods will continue to change rapidly as well.

Moving into the 21st century, Vietnam has a very limited land area and the per capita levels of both arable land and forest land are very low, while the population has increased by about 400 percent in roughly the past sixty years. Although deforestation has been halted or even reversed in some places, the quality of existing forests has generally declined. Therefore, in the not too distant future things are probably going to get much worse. Many of the refugees from lost delta land will inevitably end up in the uplands.

For all challenges we are facing, what we need to do now is to find ways to live with the changes that cannot be avoided. We need to study and debate the impact of various land management practices upon rural livelihoods, upon agricultural productivity and sustainability, upon biodiversity, and upon carbon sequestration.

WHAT IS THE BEST WAY TO PROCEED?

There is no single solution to current problems, many approaches have been tried in Vietnam. Despite of the fact that for the most part the results have so far been disappointing, there have been some successes and many of the existing approaches may well have a role to play in certain places. What we must do now is improve our ability to identify and clarify just which combinations of approaches are most appropriate in which places and how every hamlet and every farmer can create and develop these preferred farm systems. And then we must find effective ways to help farm households find the resources to make necessary and desirable changes.

We need to begin moving much more forcefully toward building a new upland development strategy that emphasizes a step-by-step approach to development and conservation, a strategy that gives a bigger role to local communities, one that takes greater account of differences in local conditions and customs, incorporating local knowledge and experiences.
and one that is more responsive to local problems. So that, there are a few key elements in a new approach to sustainable upland development I would like to mention. First of all, I would like to see a much deeper and much stronger process of decentralization. This is important because effective decentralization can have a significant positive impact on many other efforts. Closely related to decentralization, we should pay much more attention to strengthening community organizations in the uplands. Community-based forest management (CBFM) has worked very well in some places. In other places, such organizations once existed but have been weakened or disappeared. So that, we must continue to raise our understanding of why community-based forestry works well in some places but not in others.

I also think it is absolutely essential to maintain an intense focus on people’s livelihoods. If people cannot meet their subsistence needs, they will ignore policies and regulations and do whatever they have to do to feed their families. A very important part of this effort is recognizing the important fact that, the livelihood of most upland farmers has been and in most places remains closely linked to swidden agriculture. Many people will probably continue to practice swidden agriculture for many decades to come and most of them will have no other choice.

A trend has been emerging so far in some localities to replace rotating swidden cultivation with permanent field cultivation. But the long-term sustainability of permanent field cultivation at many upland sites is open to serious question. Concerning swidden agriculture, I can confidently say that in Vietnam efforts to eliminate swidden agriculture and to blame it for so many problems in the uplands was based on a mistaken understanding of swidden agriculture. Swidden agriculture can be made more productive and more sustainable based on what we already know. We can assist these land-use systems to continue to provide the downstream environmental benefits that are so urgently needed and which will become even more important in the future. Particularly, composite swidden agriculture offers great hope for becoming an important part of developing agriculture in the uplands improving farmer livelihoods. Furthermore, our data and experience have led us to believe that swidden agriculture need not be incompatible with preserving the forests and maintaining biodiversity. Thus, we believe that a new and more effective strategy for upland development should help people to create composite swidden agriculture systems in the uplands of the North Vietnam.

One key element in improving swidden agriculture is the way fallow fields are perceived and how they are managed. We have been badly mislead in the past by looking at fallow swidden fields and seeing them as “barren” or “land not yet in use” when in fact that land is very much in use, providing many benefits while restoring soil fertility. A scenario for achieving more profitable and more environmentally beneficial swidden farming, especially composite swidden agriculture, is all the more practical.

Nevertheless, the range of options people will have to choose from in carrying out swidden agriculture and in making appropriate choices in other productive elements of their farming systems is heavily dependent on efforts to help them develop and exploit alternative markets. The economic viability of options that would be useful from the perspectives of productivity and environmental benefits is tremendously dependent on their access to markets. There is great potential to improve many upland farming systems by expanding livestock production as an integrated part of these systems. There seems to be sizable and growing market opportunities for livestock. I would argue that helping farmers to fully exploiting this opportunity involves two main issues: integrating livestock production into fallow field management and decentralization of livestock production. A decentralized approach to livestock production can potentially strengthen farmer livelihoods while minimizing environmental damage. Appropriate participatory research and extension work along with infrastructure development and better access to credit and a wider range of markets can enable the step by step construction of farming systems — including a swidden component — that I think can be more profitable and more sustainable than most upland farming systems that now exist or are envisioned.

Overall, I think a higher diversification of land-use systems is required to maintain flexibility and provide resilience. This means we must keep working to expand the options available for farmers in diversifying their farming systems.
Integrated modelling approaches


Changing socio-economic conditions and the introduction of new technologies are rapidly altering land use in northern Vietnam and Thailand. Intensification of farming practices on steep slopes, without adoption of adequate conservation strategies, is inducing severe land degradation by soil erosion in the uplands associated with increased sediment load to rivers and lowland fields. Additionally, increased run-off during storm events is leading to intensive flooding in downstream areas as well as reducing recharging of upland water storages. Alternative cropping systems, such as cultivation of vegetables are increasingly being implemented in the peri-urban uplands of Chiang Mai increasing the pressure on the natural resources. Permanent cultivation systems, like fruit trees with grassland vegetation cover, are potentially reducing run-off and erosion risks but they are under threat due to the changing marketing conditions due to the strong competition from the Chinese producers. Development of new off-season fruit production techniques is seen as an alternative approach to increase the attractiveness of fruit production systems in these areas. However, this will increase water use and hence the need for irrigation and thus potentially lead to water shortages during the dry season. Thus intensifications in agricultural practices have led to higher systems productivity with an associated increased resource use and degradation and pollution risk. Furthermore, these land-use changes are leading to potential conflicts between upland and lowland communities. Such conflicts may arise associated with wrong perceptions, i.e. lowland communities are blaming upland communities for their increased flood risks during the rainy season or water shortages during the dry season. However, there is currently a lack of scientific evidence to prove such hypotheses.

With the increasing rainfall fluctuations driven by climate change extreme events are likely to increase with impact for both upland and lowland communities and ecosystems. Thus there is a need to better comprehend the biophysical and socio-economic linkages and drivers of land-use changes in upland areas of Vietnam and Thailand and their impact on systems productivity, sustainability and environmental services. This can be only assessed by an approach, integrating the various biophysical and socio-economic systems and processes at stake and looking at their interconnectivity at landscape level. Of special interest is the quantification and modelling of the interrelationships and feedback mechanisms between agricultural and social components within such complex ecosystems, hence needing an integrated modelling approach.

The approach to develop and integrated systems model depends on the goals of the output of the model, i.e. prediction vs. modelling alternative scenarios. The main difference lies in the precision and resolution in time and scale required. When up-scaling to the landscape to simulate interdependencies between uplands and lowlands, particular emphasis has to be given to the representation of important interactions between the systems, i.e. water fluxes and erosion/sedimentation at one hand but also feedback mechanism between communities which affect the behaviour of individual farmers and consequently the management of their production systems. A major challenge to integrated modelling in tropical ecosystems is the poor availability of data. Hence integrated modelling approaches which are useful for a wide range of stakeholders need to strike a balance between model complexity and model parameterization.
data requirements. Finally, the model developers need to well define who are the end users not only of the model outputs but also the model users, which determine the model-human interface and the capabilities of the model.

The main challenge of integrated model development is validation. While it is feasible to obtain validation data for individual model components, validation for a dynamic integrated model is often not easily possible. It might be possible to use past patterns to test a model but that does not necessarily indicate that future behaviour will be the same, in view of the large changes in factors exogenous to the model. Thus clear boundaries need be set for scenario modelling and model stakeholders need to agree on model behaviour.

The way different models can be linked also differs strongly. The development of fully integrated models derived from single comprehensive submodels into a common platform is time consuming and complex. Linking specialised biophysical water-soil-plant submodels to socio-economic models via a ‘wrapper’ which ensures output sharing and time related interactions is also technically challenging and often leads to slow model performance while still requiring large data sets for calibration.

Development of integrated approaches with model components which are taking a simplified approach, using transfer functions derived from specialised models, offer an interesting alternative approach if they can well represent the major systems component linkages, interactions and feedback mechanisms.

The proposed model developed within the DFG-SFB564 Uplands program consists of a spatially explicit, integrated dynamic biophysical model for land use change impact assessment (LUCIA) to understand systems relationships at the landscape level and a multi-agent-system (MAS) model. The model uses transfer functions derived from various subprojects, e.g. water (SWAT), soil (SOTER) and plant (CropWat, WaNuLCAS) models and from other subprojects to derive insights into food security and farmers behaviour (participatory approaches) to estimate expenditure models, and farmers decisions (Figure 1). The integrated LUCIA-MAS models will allow assessing alternative options so that policy-relevant conclusions can then be drawn regarding the promotion of improved conservation and management systems, adapted to both the local populations and systems of governance in tropical humid mountainous watersheds from Thailand and Vietnam.

Figure 1: MAS-LUCIA integrated modeling approach
The results of study on improvement body size and productivity of Vietnamese horse for mountainous area

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Keywords: Mountainous region; hybrid horse; Vietnamese horse; Carbadin

### INTRODUCTION

Viet Nam has 325,490 sqkm in which mountainous area is about 75%. The transportation in the mountainous area is very difficult, roads are absent or poorly developed, and therefore horses are used to transport goods and people in these areas. We can say that horse is as a ‘’Car’’ of mountainous people. The use of horses is not only to provide a means of transport, and as a source of power to supplement human labor in land preparation and crop cultivation, manure for fertilizer, but also they are used as companionship. Horses tend to be favored for transport because of their higher speed of travel compared to the ruminants. However, Vietnamese horse has small size and low productivity. They should be improved body size and productivity by selection and hybridization. A series of studies were conducted for that purpose. Carbadin horse was imported from Russia in 1959 and 1964 to improve Vietnamese horse. They have large body size, body weight of male mature horse: 450 – 500kg and the height: 153 – 155cm, female mature horse with body weight: 430 – 460kg and height: 141 – 145cm. In recent studies, 7 male hybrid horses with 50% imported horse blood (Carbadin) and 140 selected Vietnamese horses were used to create hybrid horses with 25% imported horse blood and an investigation was conducted. In this paper, we focused to review some recent studies that demonstrated of Vietnamese horse breeding situation, improvement of body size, working ability of Vietnamese horse and we also want to emphasize again the very important role of horse for people in mountain that in very long time, was neglected by Vietnamese government and many scientists when they planned developmental projects for mountainous regions.

### NUMBER AND DISTRIBUTION

There was no change in the horse population between 1994 and 2000 there was a decline thereafter (Fig.1). The distribution of horse is mainly in North West and North East region (Fig.2). In these regions, the roads are unsuitable for motor vehicles, man has continued to make use of horse for transport throughout the centuries and even today, despite the replacement of animal power by mechanical power in some regions which are near the town or city. The horse population in these regions is about 88% of total heard.

![Figure 1: Number of horse from 1995-2005](Source: Nguyen Thi Mui: General Statistics, 2000 and FAOSTAT, 2006)

![Figure 2: 10 provine with large number of horse](Source: Dang Dinh Hanh, 2002)
BODY WEIGHT AND SIZE AND RESULTS OF HYBRIDISATION

An investigation was conducted by Dang Dinh Hanh et al. (2005) revealed that Vietnamese horse has average body weight (Tab.1) at 12 months of age: 110 kg (Tab.1) as compared 137 kg with hybrid horse. At 36 months of age, body weight of hybrid horse was higher 15% than that of Vietnamese horse (Tab.2). The working ability of hybrid horse was also better than Vietnamese horse (Tab. 3), specially caring and pulling ability. Hybrid horses with 25% imported horse blood adapted well with mountainous area and poor management conditions of household.

CONCLUSION

Although the animal power will be replaced by mechanical power in many regions, horse still have a very important role for transport of goods, people, and as a source of power to supplement human labour in land preparation and crop cultivation, manure for fertilizer and companion. Vietnamese horse should be selected and improvement of body weight, working ability by hybridization with hybrid horse with 50% blood of Carbadin horse. Hybrid horses with 25% imported horse blood may be developed for mountainous regions.

REFERENCES

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Dang Dinh Hanh, Nguyen Duc Chuyen, Ta Van can (2005), The results of investigation Vietnamese horse in Bac Ha – Lao Cao. The results of research, National Institute of Animal Husbandry.

Table 1: Body weight of Vietnamses horse

<table>
<thead>
<tr>
<th>Months of age</th>
<th>n</th>
<th>$\bar{X} \pm m \bar{X}$</th>
<th>n</th>
<th>$\bar{X} \pm m \bar{X}$</th>
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</thead>
<tbody>
<tr>
<td>Day old</td>
<td>25</td>
<td>18 ± 0,52</td>
<td>28</td>
<td>17 ± 0,72</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>78 ± 2,48</td>
<td>45</td>
<td>77 ± 2,25</td>
</tr>
<tr>
<td>12</td>
<td>9</td>
<td>110 ± 3,26</td>
<td>20</td>
<td>109 ± 3,19</td>
</tr>
<tr>
<td>24</td>
<td>9</td>
<td>152 ± 3,45</td>
<td>22</td>
<td>150 ± 3,38</td>
</tr>
<tr>
<td>36</td>
<td>10</td>
<td>167 ± 3,59</td>
<td>23</td>
<td>165 ± 3,55</td>
</tr>
</tbody>
</table>

(Source: Dang Dinh Hanh et al, 2005)

Table 2: Body weight (kg) of hybrid horses with 25% imported horse blood

<table>
<thead>
<tr>
<th>Months of age</th>
<th>n</th>
<th>$\bar{X} \pm m \bar{X}$</th>
<th>Months of age</th>
<th>n</th>
<th>$\bar{X} \pm m \bar{X}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day old</td>
<td>6</td>
<td>22 ± 0,92</td>
<td>24</td>
<td>6</td>
<td>171 ± 2,74</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>108 ± 4,17</td>
<td>36</td>
<td>6</td>
<td>192 ± 4,75</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
<td>137 ± 2,25</td>
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</table>

(Source: Dang Dinh Hanh, 2003)

Table 3: Working ability

<table>
<thead>
<tr>
<th>Working</th>
<th>Unit</th>
<th>Hybrid horse</th>
<th>Vietnamese horse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carring</td>
<td>kg</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>-Average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Maximum</td>
<td></td>
<td>225</td>
<td>170</td>
</tr>
<tr>
<td>Carring speed</td>
<td>Km/hr</td>
<td>4.73</td>
<td>4.5</td>
</tr>
<tr>
<td>Pulling</td>
<td>kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Average</td>
<td></td>
<td>750</td>
<td>500</td>
</tr>
<tr>
<td>-Maximum</td>
<td></td>
<td>1950</td>
<td>1450</td>
</tr>
<tr>
<td>Pulling speed</td>
<td>Km/hr</td>
<td>5.3</td>
<td>5.2</td>
</tr>
<tr>
<td>Racing speed</td>
<td>Km/hr</td>
<td>28.8</td>
<td>26.2</td>
</tr>
</tbody>
</table>

(Source: Dang Dinh Hanh, 2002)
Sustainable Agricultural Practices of Upland and Lowland Households in the Mae Sa Watershed, Thailand

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KEYWORDS: Sustainable agriculture; uplands and lowlands; technology adoption

ABSTRACT

Sustainable development of highland agriculture is a long-term goal in many countries including Thailand. Various sustainable agricultural practices and technologies have been introduced to both upland and lowland households in the Mae Sa watershed in Chiang Mai province of northern Thailand. These include vetiver grass strips, contour ploughing, terracing, and irrigation technologies such as sprinkler and drip irrigation, water tanks and reservoirs.

To further promote sustainable agricultural practices, the paper explores the reasons why some household adopted certain practices but others did not. Hence, the objective of the paper is to analyze factors affecting the adoption of sustainable agricultural practices at a farm household level as well as to compare lowland with and upland areas.

The paper uses data from the Mae Sa watershed, which includes people of both Thai and Hmong ethnic origin in both upland and lowland areas. Primary data were collected for 395 randomly selected households in September-November 2006. Data were analyzed using descriptive statistics and a logistic model of sustainable agricultural technology adoption.

Sustainable agricultural practices were grouped in three categories:

1. Soil fertility management such as non-chemical pest control, relay cropping, fertilizing with compost, mulching and green manure.
2. Erosion control such as vetiver grass strips, terracing, and contour ploughing.
3. Investments such as sprinkler irrigation, drip irrigation, individual pond and water tanks.

Adoption curves of sustainable agricultural practices were estimated from the data. In terms of soil fertility management, relay cropping was most widely adopted by households in the Mae Sa watershed (Figure 1). In the category of investments, sprinkler irrigation was most widely adopted (Figure 2); while in the category of erosion control measures contour ploughing had the highest adoption rate (Figure 3).

Figure 1: Adoption curve of soil fertility management in the Mae Sa Watershed.

Poster Session II
Comparing lowland and upland areas, the results show that the most common sustainable agricultural practice of lowland Thai households was fertilizing with compost (32% of all lowland households), followed by relay cropping, and rotational cropping (27% each). The most common sustainable agricultural practice of the upland Hmong households was fertilizing with compost (54% of all upland Hmong households) followed by sprinkler irrigation (48%) while for upland Thai households the main practice was terracing (77%), followed by sprinkler irrigation (74%).

The factors affecting sustainable farming varied among the practices considered. The use of erosion control (including vetiver grass, contour farming, and terracing) was primarily affected by the availability of household labor and knowledge about sustainable agriculture, which was measured by a multiple choice test included in the questionnaire. The main factors affecting the adoption of soil fertility management (including non-chemical pest control, relay cropping, fertilizing with compost, mulching and green mature) was the household knowledge about those practices. Also the use of investment in irrigation technologies such as sprinkler, drip irrigation, individual ponds, and water tanks, was mostly constrained by labor availability and knowledge of sustainable agriculture. In addition, access to credit was an important factor behind the use of these technologies.

In summary, these results suggest that the use of sustainable agriculture is feasible in the watershed area. Sustainable agriculture can be further promoted by relieving credit and knowledge constraints. The results also suggest that researchers developing new sustainable practices need to consider more explicitly the demand for household labor that these practices require.
Identifying land management and livelihood options and opportunities for shifting cultivation and sloping land areas

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Key Words: Land management, livelihood, participatory technology development

The recent change in the shifting cultivation practice is fuelled by demographic transition mostly the population growth and increase in household size and number. The demand for more food and land shrinkages often put pressure on shifting cultivation fallow cycle often leading to the intensification of agricultural practices and change in cropping pattern. To overcome this problem, LI-BIRD with technical and financial support from ICIMOD and IFAD implemented action research in western region of Nepal. The overall goal of the project was to enhance food security, diversify income generation and improve land management on sloping land and in shifting cultivation areas. It aims to develop a workable model that encompasses socio-economic and technological options and opportunities to improve livelihoods of communities involved in shifting cultivation and sloping land management.

This paper is based on the output of project mentioned above. The good practices and outcomes of the project is documented using participatory tools like focused group discussion, key informants interview and questionnaire survey. This information was then analyzed to draw the empirical evidences and conclusion.

The findings show that the proposed project has selected and tried out several technological options and opportunities including traditional good practices and farmers’ innovations that already exist in pockets in shifting cultivation areas. The participatory on-farm trials and demonstrations were designed to adapt and improve these technologies and practices for increased productivity, income and food security. Various land management interventions and farm based income generation activities were designed and implemented based on the experiences and already available good practices generated by LI-BIRD and partner institutions. The output of participatory intervention design and model has provided strong knowledge and technological support for program and policy level interventions in shifting cultivation areas of Nepal, as well as to the land management projects of Government of Nepal (GoN). More specifically, the project generated models that can be easily replicated by Leasehold Forestry and Livestock Development Program in marginal and resource poor areas. Since the improved land management options are designed by and for the poorest of farmers, they were used for take-up in the leasehold forestry programme on a wider scale. Nevertheless, the proposed project influenced the forestry policies to become more flexible and accommodative by demonstrating different land management and livelihood options and opportunities.
Optimization of pig breeding at smallholder farms in North-West Vietnam

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KEY WORDS: Smallholder pig production; Vietnam; village breeding programs; local communities

INTRODUCTION

Pig production in Vietnam is expanding all over the country, boosted by national and international investments. The national government has been strongly promoting the pig production with the aim to industrialize production. Policies are mainly implemented in lowland areas, focusing on e.g. the increase in number of improved breeds and new institutional arrangements such as cooperatives. Nonetheless, it is estimated that 80% of the national pig population are still kept at smallholder farms (FAO, 2005). In contrast to farms in lowland areas where exotic pigs are gradually replacing local breeds, smallholder pig production in the northern uplands, is mainly based on local sow breeds. Although these are mated to exotic sires in order to meet the demand for lean pork, the growth rate and meat quality of crossbred pigs, remain poor as compared to exotic breeds (Thien et al., 1996). Hence, smallholders in the uplands face many barriers in effective participation in the market for pig meat. One possible key entry point to improve smallholder pig production is the development of village breeding programs. A significant number of breeding programs failed in developing countries, often as a result of the limited involvement of communities in the whole process of the development and implementation of the programs (Valle Zárate, 1995). Therefore this study attempts to involve smallholders in the definition of the breeding objective for village breeding programs that do not yet exist in the investigation area. Its overall aim is the optimization of smallholder pig breeding. Specific objectives are the evaluation of different smallholder breeding schemes by ZPLAN, a PC program that was developed for advanced livestock breeding. This study further included the identification of suitable institutions for breeding organisation at village, regional and national level by approaching different stakeholders.

MATERIAL & METHODS

Research was conducted in the frame of the Uplands Program, subproject D2.3. D2.3 aims at the development of community-driven breeding programs for smallholder livestock production systems. Information from the currently implemented pig breeding program was used for model development. In addition, an inquiry of 120 smallholders (keeping 169 sows) was realised in 5 project villages with market-oriented pig production in Son La (April-December 2006). Smallholders’ production objectives as well as their preferences for pig breeds and traits were validated, and data on herd structure and breeding management collected and analysed with SAS 9.1. Based on these data, a basic breeding plan was modelled and evaluated by the computer program ZPLAN (Nitter et al., 2000). Based on genetic, biological and economic parameters, the program calculates the genetic gain for breeding objective traits and the profit per dam.

FIRST RESULTS & DISCUSSION

Most smallholders in the market-oriented production system used improved sow genotypes (improved Vietnamese Mong Cai breed or exotic genotypes). Smallholders preferred the Mong Cai breed for its ability to feed on a variety of locally produced feed (spectrum of feed intake), and for the quantity of feed consumed (feed intake capacity), and for its large litter size (prolificacy). A considerable number of smallholders, however, wanted the latter to be improved, with only 52% of smallholders perceiving this characteristic to be good. Feed requirement was also the most important trait considered for exotic genotypes.
Only 50% of all smallholders, however, considered this trait to be good in these genotypes, being less adapted to local feed and requiring higher inputs for purchased feed as compared to local breeds. Smallholders preferred exotic dam genotypes because of (crossbred) offspring being easier to sell, and showing better growth rate. Crossbreds improved marketing chances are due to a higher lean meat content in the carcasses. For the same reasons smallholders perceived these traits to be advantageous, both traits should receive proper attention in future breeding programs. Roessler et al. (in press) concluded that breeding programs for market-oriented pig production in the investigation area should improve growth rate of pigs, while maintaining reproductive and adaptability traits. In accordance with their trait preferences, smallholders considered the ability to consume a high quantity of different feedstuff as most important selection criterion for female breeding stock, besides the outer appearance and the number and size of teats. Lemke et al. (2002) reported that Thai farmers in northern areas knew a considerable number of selection criteria for their pigs. Female breeding stock was mainly acquired from others within the village. The purchase of gilts at local markets was rarely reported by smallholders, as they preferred to buy gilts within the village in order to avoid importation of diseases. Dams were predominantly mated with exotic sires to produce crossbred terminal products. Lemke et al. (2006) observed already 4 years earlier for the same area that Large White was becoming the most common sire breed in villages close to towns. Local sires were only used to produce purebred replacement stock. In general, smallholders preferred natural mating over artificial insemination. Average fees were estimated at approx. 2.05 € for natural mating and approx. 1.53 € for artificial insemination, latter services being easily available. Based on these results, the basic breeding scheme was modeled for market-oriented smallholder pig production. First results indicate that this basic breeding plan reflecting current conditions is not profitable.

CONCLUSIONS

Smallholders with market-oriented pig production try to combine adaptability traits with performance and carcass traits by using improved local Mong Cai sows, mated by exotic sires. Hence both should be used in village breeding programs for this type of production, improving the reproductive and growth performance, as well as the carcass quality in order to ensure profitability and sustainability. Continued success of village breeding programs depends on the profitability of breeding measures. With the basic breeding plan reflecting the current situation no profit is obtained and the long-term sustainability of this breeding scheme seems unlikely. Thus, this study is further investigating how to optimize breeding plans. Based on the results of interviews in 3 further villages, alternative breeding schemes are evaluated for resource-driven production conditions and possible linkages with market-oriented pig production are derived. Besides, an institutional analysis was performed in order to identify different institutions involved in pig breeding organisation.

ACKNOWLEDGEMENTS

The financial support of the Federal State of Baden-Württemberg and the German Research Council (DFG) are gratefully acknowledged.

REFERENCES


Application of Airborne Radiometric and Magnetic Data in Lithological Mapping of Mae Sa, Chiang Mai, Thailand

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KEY WORDS: Gamma-ray; Magnetic; Chiang Mai; Thailand

INTRODUCTION
Mae Sa Water shade locates in the mountainous area in the northern part of Thailand. It covers area about 138 square kilometers. Both geological and pedology study are the fundamental factor to make natural resources management more effective. However, the geological mainly map the rock unit according to the time of deposition, intrusion and metamorphism that is very difficult for non geological background to use. Additionally, the soil that cover rock unit maps as different units according to soil forming process. There are many standard to group soil unit that is different for each country. However with radiometric method, it maps rock or soil as a distribution of potassium (K), uranium (U) and thorium (Th) element. In addition of magnetic data the distribution of magnetite content will add up information of chemical composition of rock and soil.

GEOLOGIC SETTING
According to Tiyapirat and Tiyapan [1992] the major rock unit in this area comprise Metamorphic complex (PE), Granitic rock (Gr) and Quaternary sediment (Qc, Qff, and Qa).

Granite covers more than 50% of Mae Sa area and this unit consists of granite, pegmatite and aplite. The metamorphic complex (PE) consist variety of gneiss, schist, migmatites, calc silicates and marble lenses. Quaternary sediment expose along the eastern side of the area including fluvial, alluvial colluvial and terraces deposit.

From geological map, the old consolidated rock, especially metamorphic complex; gneiss and marble that have different lithology were map in the same group because the metamorphism had been occurred at the same period. Where as the unconsolidated Quaternary deposit had been grouped form different sedimentary process.

Figure 1 Geological Map of Mae Sa Water Shade. [Tiyapirat and Tiyapan, 1992]

RADIOMETRIC AND MAGNETIC METHOD
Dickson and Scott [1997] stated that the different of geochemical abundance of potassium, uranium and thorium can be measured by using radiometric method. With the application of the rock, Dickson and Scott [1997] also concluded that generally the ultra basic and mafic rocks have a lower radioelement concentration than the felsic one.

Basically, magnetic method maps the differentiation of magnetite mineral including magnetite pyrrhotite, hematite, ilmenite and maghemite. According to Clark [1997] the magnetic properties of igneous rocks depend on the magnetite content of ferromagnetic mineral. Normally, the felsic igneous rock tends to have lower magnetite content of ferromagnetic mineral than the basic igneous rock.
While sedimentary rock has very low magnetic susceptibility value.

Both radiometric and magnetic data of this study area were flown in the same time in east-west direction with line spacing one kilometer.

The radiometric data presents as a ternary map (figure 2) which is the combination of potassium in magenta, uranium in yellow and thorium in cyan. The high concentration is dark color the low concentration. The different color of ternary map can indicate the different chemical composition of the rocks.

The magnetic data present as a contour overlay the radiometric ternary map.

RESULT

Compare with the geological map overlay with radiometric map (figure 3) illustrate the geological boundary does not match with the radiometric map. As mention before that the geological map group rock unit according to the time that it’s occurs but radiometric show the distribution of different radiometric composition. Then with the radiometric data, can not differentiate between PE and GR. However, radiometric can separate different lithology among them. So PE and Gr unit have at least three different lithology including the first show high abundant of Th concentration and the second one show lower concentration of Th and the last one shows low values of K, U and Th. The ground radiometric was check along the main road in east-west direction of the Mae Sa Water Shade. These measurement confirm that the higher abundant of Thorium can be located in the western side of the study area. As shown in table 1. The magnetic result shows with the thick boundary in figure 3. This area should contain higher amount of magnetic mineral than the other part of the area. However this study still need more laboratory confirm.

Table 1 show the statistic value of ground gamma-ray investigation along the road

<table>
<thead>
<tr>
<th></th>
<th>Western Side</th>
<th></th>
<th>Eastern Side</th>
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<tbody>
<tr>
<td></td>
<td>K</td>
<td>U</td>
<td>Th</td>
<td>K</td>
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<td>min</td>
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Quality and Microbial changes of fresh-cut mango, lychee and longan fruits

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Keywords: quality and microbiology, fresh-cut mango, lychee and longan.

ABSTRACT

The fresh-cut industry wants to know if mango, lychee and longan can be marketed successfully as a fresh-cut product in packages. To respond to this question, a study was undertaken to determine the quality and microbial population changes during processing of fresh-cut mangoes, lychee and longan that were held at 5 degrees C. This information will be helpful to the industry in preparing and supplying fresh-cut products to the public. Low temperature has an effect on quality of fresh-cut products. The microbial population reduced on samples treated with sanitizers. The marketing period of fresh-cut products and post-cutting quality changes will be discussed.

A feasibility study on process development of the minimally processed mango (cv. Nam Dok Mai, Chok Anan, and Maha Chanok), lychee (cv. Hong Huay, Kim Jeng, and Emperor) and longan fruits (cv. Daw, Biew Kiew, Kalok, and Si-chompoo) indicated that the application of 100 ppm peroxyacetic acid at pH 3.2-3.4 could decrease the total number of aerobic bacteria on the peel of mango and lychee fruits to a greater extent than that of a 200 ppm sodium hypochlorite solution. However, no significant difference for the total number of aerobic bacteria was observed with longan peel treatment. For the minimally processed fruits, a treatment of 50 ppm sodium hypochlorite solution on lychee and longan was less effective than peroxyacetic acid at a similar concentration level. A clean peel is important because any microbes left on the peel are transferred to the cut product.

The maturity stage of mango fruit for the production of a fresh-cut product was studied using two varieties (cv. Chok Anan and Maha Chanok). Mango fruit were stored for 3 days, 6 days, and 8 days to bring fruits to 3 differences stages of ripeness for processing. After each storage period, fruits were removed and evaluated for colour, texture, weight loss, total soluble solids, titratable acidity, and pH. The results indicated that a 3 days storage period for intact mangoes was optimal for inducing the least quality change compared with the other storage period durations prior to cutting. It is suggested that a storage period of 3 days for intact mango fruit before processing is suitable for optimal ripening.

The application of calcium chloride was investigated for effect on firmness of mango, lychee and longan fruits. Fresh-cut fruits were dipped in 1.0, 1.5 or 2.0% calcium chloride for 5 min. Calcium salt could improve sliced mango and lychee firmness in all concentrations. Although the soaking of fruits with calcium chloride helped improve the firmness of sliced mango and lychee, such improvement was not observed in flesh longan.

The cutting style of mango (cv. Nam Dok Mai, Chok Anan, and Maha Chanok), lychee (Hong Huay, Kim Jeng, and Emperor) and longan (E-daw, Biew Kiew, Kalok, and Si-chompoo) were also studied. Mango fruits were cut into six
styles: two longitudinal pieces per fruit, two longitudinal pieces per half fruit, two traverse pieces per half fruit, four pieces per half fruit, four traverse pieces per half fruit and eight pieces per half fruit. Peeled whole fruits, peeled fruits with seeds removed and fresh pulp were the 3 styles of lychee and longan fresh-cut processing. Each style of processed fruits were evaluated for electrolyte leakage and respiration rate. Electrolyte leakage was determined using double deionized water at room temperature for 1 hour. Respiration rate was evaluated by measuring the rate of CO$_2$ produced from a given quantity of fruits per unit time. For fresh-cut mango fruit, the highest percentage of electrolyte leakage and respiration rate was on the eight pieces cut per half fruit and the lowest percentage of electrolyte leakage and respiration rate was on the two longitudinal pieces cut per fruit, likely due to having the most and least cut surface, respectively. Fresh lychee pulp showed the highest percentage of electrolyte leakage and respiration rate and the same result was found for longan.
Promoting Community-Managed Agroforestry Extension towards Sustainable Upland Development in the Philippines

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KEY WORDS: agroforestry; community-managed agroforestry extension services; multisectoral partnership, sustainable upland development

INTRODUCTION

The Philippine uplands constitute about 17.6 million hectares or 59% of the total land area. These areas serve as the home of about 20 million Filipinos (NSO, 2003). The punitive measures in alleviating forest destruction proved to be useless as indicated by the continued environmental degradation particularly in the forests and upland areas. This scenario paved the way for realizing the value of involving the active participation of forest occupants in protecting and conserving the forest resources.

The Ford Foundation-funded Agroforestry Support Program for Empowering Communities Towards Self-Reliance (ASPECTS) that was implemented by the University of the Philippines Los Baños Institute of Agroforestry from 1997-2000 has proven the role of educational institutions in enhancing agroforestry development and promotion.

ASPECTS built a grassroots-oriented extension model for empowering upland communities while strengthening the agroforestry education programs of collaborating schools (Arboleda et al, 2001). Its ultimate aim is to enable the empowered communities to establish and maintain their own farmer training center and agroforestry extension services. This would contribute to increased farm productivity and income, improved ecological stability, and effective and efficient extension service organization (Figure 1).

ASPECTS: A New Approach to Agroforestry Development

Agroforestry is a collective term for land-use management systems and technologies in which woody perennials are deliberately combined on the same land with herbaceous crops and/or animals, either in some form of spatial arrangement or temporal sequence (Lundgren and Raintree, 1982). It is further considered as the science, art and practice that deals with the production, management and utilization of woody perennials in combination with agricultural crops, animals, aquatic and/or other resources for the twin purpose of conservation and is a land-use management system that addresses the twin goal of ecological stability and economic productivity (UPLB Agroforestry Program, 1992).

METHODOLOGY

- Building the capacity of partner communities in managing CMAFES. This is done through farmers’ training, establishment of agroforestry demonstration farms and nursery, farmer-level training curriculum development, establishment of farmer training centers, and farm-based agroforestry research.

- Strengthening agroforestry programs of the collaborating schools. This is done through curriculum development and...
review, staff development programs, networking, enhancing grassroots-oriented agroforestry extension services

- Working together through multisectoral partnership, where the local development organizations are convened in a Project Facilitating Team (PFT) to develop synergy among the local organizations, and facilitate community-level and school-level project activities.

PROJECT IMPACTS

Agroforestry farm development and technology adoption in the three partner upland communities. The farmers who used to practice monocropping of tomatoes, have transformed their farms into agroforestry farms, combining a number of different annual and perennial crops (Palma, 2007). The agroforestry systems that are currently being practiced include alley cropping, planting of natural vegetative strips, woodlots, and aqua-silviculture. Community demonstration farms integrating high value fruit tree crops and annual crops have been established.

Increased farm productivity and income. This impact is very evident in Mindanao project site. The study conducted by ASPECTS-Mindanao team in 2000, indicated that the farm income of the farmers, has increased to an average of US$ 361 after project implementation, from an average income of US$196 before the ASPECTS project (Palma, 2007).

Operationalization of the community-managed agroforestry extension services. Farmer-to-farmer training programs have been on-going in the three project sites from the last phase of the project until present. The training facilities that were established and/or improved are being used as venues for these training courses.

Improved the teaching capacity of the three collaborating schools. The number of agroforestry teachers in the three collaborating schools has increased brought about by the staff development programs that were organized by the ASPECTS Project (both at the formal and non-formal education). This improvement is also indicated by the increasing involvement of the agroforestry teachers in the research and extension activities at local levels.

Integration of agroforestry projects in the development programs of the local government units. Realizing the importance of agroforestry in the sustainable management of the natural resources, the local government units at the municipal and village levels have started to integrate agroforestry activities in their municipal and barangay/village development plans. This suggests the regular allocation of budgetary requirements to carry out the development and promotion of agroforestry initiatives in their respective areas.

Institutionalization of multisectoral partnership in the three project sites. The partnership that was established by the collaborating school, the partner community and the local organizations was sustained even after the project implementation, as indicated by the continuous collaborative undertakings in agroforestry development and promotion in their respective areas. The PFT in Visayas was sustained with the local government unit as the main convenor.

Replication of ASPECTS Model in Other Areas. Building from the lessons and experiences of the ASPECTS project, this model was embraced by other academic institutions in the implementation of the Collaborative Agroforestry Research and Extension Project.

REFERENCES


Utilization of Paper Mulberry by farmers in Laos: a comparative study of the villages in Bokeo and Luang Prabang Provinces

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KEY WORDS: Paper Mulberry; Laos; Livelihood; Uplands

INTRODUCTION

Non-timber Forest Products (NTFPs) are a reliable income source for rural livelihoods in Laos, especially for villagers in the uplands. Paper mulberry (*Broussonetia papyrifera*) is one of the most common NTFPs for upland farmers. The plant is a fast-growing tree belonging to Moraceae and attaining a height 12-35 m in a mature form (Berg, 2001). The natural reproduction of paper mulberry is by seed or root suckers and it is a vigorous pioneer plant rapidly spreading after canopy disturbance of forest. The bast fibre from the inner bark that is about 2 mm thick has been used to make paper. The leaves can be used for feed of domestic animals and the stems for fuel.

As the economic value of paper mulberry in rural development in Southeast Asia has been recognized, many studies on the utilization of the plant have been reported. For example in Thailand, Japan International Cooperation Agency (JICA) and Kasetsart University conducted a project on the research and technology of the use of paper mulberry during 1991-2001 (Siracha et al. 2001a, b, c). German Technical Cooperation (GTZ) also made a survey on the commercial products and marketing in Thailand (GTZ 2005). In Laos, since the government adopted a policy to revitalize the market in 1989, production of paper mulberry has been promoted as one of the measure of cash income. Thus many projects on rural development in Laos have included a component of paper mulberry production (e.g. Forsen et al. 2001; JICA 2003; Hamman 2001; Khamphai 2001). In keeping with the rural livelihoods, the upland agriculture were changed as reported in some case studies (Nakatsuji 2004, 2005). The utilization of paper mulberry by farmers, however, is not clear in different villages. The present study aims to reveal the difference of utilization of paper mulberry in different villages with a comparison of two provinces in northern Laos.

METHODS

The survey was carried out in Bokeo (BK) and Luang Prabang (LPB) provinces in 2007. BK is a north-western province with smallest and second least populous province in the country bordering on the northern Thailand and on eastern Myanmar, while LPB is a northern province becoming one of the country’s richest provinces based on tourism and regional trade. According to a uniform questionnaire format, we gave interviews to 50 farmers of 3 villages in BK, and 12 farmers of 3 villages in LPB in November 2007. Since there are two sources of collecting the bark of paper mulberry (forest and cultivated stands), the interview attempted to clarify the differences in terms of socio-economic situations.

RESULTS AND DISCUSSIONS

The result showed that, in both the provinces, the bark of paper mulberry is one of the main income resources (Table 1). In general, the income from paper mulberry is limited. The
farmers of BK depend on the income from maize and/or sesame, while LPB farmers from Job’s tear and/or broom grass. The average amount of income is higher in LBP than BK. The interview also revealed that collecting patterns of the bark is different between two provinces. The farmers of BK tend to collect the bark from forest more than LPB. In general, the farmers collect PM from forest at the age of 1-2 years old. Looking at the result at village level, the difference is more distinct because the distance from the market and ethnic background vary in villages. At provincial level, the policies and regulations are slightly different. LPB has more developed social infrastructures and encourages the farmers of fixed agriculture. The existence of processing factories in LPB would be another reason of the differences.

**REFERENCES**


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**Table 1. The result of interviews in Bokeo and Luang Prabang provinces**

<table>
<thead>
<tr>
<th>Province</th>
<th>Village</th>
<th>Number of households interviewed</th>
<th>% farmers collecting PM</th>
<th>% farmers collecting PM from forest</th>
<th>Harvest of PM (kg/family)</th>
<th>Income from agriculture (USD/family/year)</th>
<th>PM income (USD/family/year)</th>
<th>% PM income</th>
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<td>Bokeo</td>
<td>HS 20</td>
<td>80.0</td>
<td>87.5</td>
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<td>55.0</td>
<td>63.9</td>
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<td>12.68</td>
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<tr>
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<td>54.0</td>
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<td>287.33</td>
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abbreviation: PM, paper mulberry; HS, Houay Sang; HP, Houay Paen; TP, Thampakae; PS, Phon savang
Interdependence of Upland and lowland village communities for forest products and water flow in Meghalaya, India

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KEY WORDS: Valuation; forest products; water flow; upland; lowland

Forests, water bodies, pastures and agricultural fields are often the universal elements of mountainous and hilly landscapes inhabited by traditional societies in south and south east Asia. These landscape elements interact with each other through transfer and cycle of materials and energy in time and space and the interactions are affected by human activities at times leading to distortion or disruption of the natural processes and patterns. Generally people living in the foothills depend on uplands for natural water and forest products viz., fire wood, forest edibles and medicinal herbs while most fertile lands used for cultivation are found in the valleys and lowlands. While a good number of cases have been documented relating to dependence of big urban centers for water on upland forested watersheds there is glaring dearth of research on upland lowland interdependencies in case of rural areas. Present study aims to study the linkages between upland and low land villages in terms of sharing of water and forest resources in a local level. The study also aimed to find out if the water flow could be treated as an ecosystem service provided to the lowland villages by the forest patches harbouring the origin of streams located in the upland villages.

Meghalaya, a hilly state of India, inhabited by the tribal people having strong social bonds generally supported by traditional institutions and harbouring seventy five percent land under forest cover, provides an ideal location for such a research enquiry. Eighty percent of people of the state live in rural areas and depend on surface waters derived from streams and springs originating in forested uplands for household consumption as well as for other purposes. In most upland lowland landscapes the source of water is located in the upstream villages which protect and manage the water source while the users generally live downstream. Such interdependency exists all along the hill slope from the hill top to the valleys and plains.

The study was conducted in three clusters of upland and lowland villages connected by a common stream (river). Secondary data on the extent of forest cover, land use, socio-economic profile of the villages were collected from the village microplans prepared for development of the village and government records. Household survey, group discussion, workshops, involving local people as well as experts of the field, spatial mapping using GPS and GIS techniques was employed for collection of primary data. Training workshops were conducted involving the local people and the research team for developing the methodology as well as motivating the local people to participate in the research. The location of origin and course of streams, forests and human habitations was surveyed and mapped. The quantity of water used by the residents for various purposes e.g. drinking, domestic uses, institutions (schools, community centers etc.) was found out and total water consumption at household level and at village level was computed.

All the three clusters selected for the study have got significant forest cover, although they differ in their types and areas. In the Pdengshnong cluster, Pdengshnong is the upstream village and Nongpriang and Pomsohmen are the
downstream villages. Significant forest cover was observed in the cluster. The total area under forest cover in this cluster comes to 320 ha. Altogether, five types of forest exist in the cluster which is classified as Law Kyntang (sacred forest), Law Adong (restricted forest), Law Shnong (village forest), Law Ri-Kynti (private forest) and Law Kur (clan forest). Twenty four NTFPs species of plant origin and 14 NTFPs of animal origin are regularly collected by people of this cluster. There are four types of forest present in the Mynring Cluster viz., Law Shnong (village forest), Law Ri-Kynti (private forest) and Law Kur (clan forest) and Law Raid (community forest). The total area under forest in the cluster is 160 ha. Twenty NTFPs of plant origin and 15 NTFPs of animal origin were collected by people in this cluster. In the Pingwait cluster also four types of forest are present. These are: Law Kyntang (sacred forest), Law Adong (restricted forest), Law Shnong (village forest) and Law Ri-Kynti (private forest). The area under forest in this cluster is 433 ha. As many as 24 NTFPs of plant origin and 16 NTFPs of animal origin are collected by people in this cluster.

The results suggest huge dependence of lowland communities on the uplands for water as well as for NTFPs. The water sources are invariably located in community/village managed forests. The water tanks constructed by the government invariably draw the water from these forests for supply through water pipes. Each cluster has 160-433 ha upland forest which is also source of about 25 NTFPs of plant origin and 15 NTFPs of animal origin mostly collected from the streams. Households and domestic cattle consume maximum water collected from the streams. At the rate of Rs 50 (1US$=Rs 40) per kilolitre water the value of water collected per household per year from the streams varied between Rs 10156-16090. Considering the income category of the households it can be said with confidence that this is beyond the paying capacity of most household living in the area. Adding to it the value of NTFPs the total benefit from the forests comes to be nearly equal to the average annual income of the household of the area. The study shows that the downstream villages owe to the upstream villages for supply of clean water and a variety of NTFPs majority of which are edible and extracted from the forest streams. This ecosystem service cannot be compensated in terms of money as neither the users (lowland people) have the paying capacity nor alternatives to fall upon. The study also brings to fore the importance of community, village and clan forests which are, in most cases, providing this vital service to the rural poor in hilly regions. The study underlines the need of recognition of the contribution of upland communities towards the livelihood of lowland people which is so vital but remains mostly unnoticed by the development planners and policy formulators. These age old and working system of mutual recognition of interdependence is in contrast to modern water harvesting systems from the forested landscapes near big cities around the world where the city people often pay to the owners of the land and forest for the protection of forests in the catchments of their water sources. Customary laws and strong traditional institutions play a vital role in sustenance and perpetuation of this mechanism of resource sharing without any user fee and formal contract between the service provider and beneficiary.
Challenges and Opportunities for Smallholder Upland and Lowland Pig Production Systems in Northern Vietnam

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* Subproject E4.1 “Food Quality and Safety Issues in Markets for High-Value Products in Thailand and Vietnam” of the Upland Program (SFB 564)

Key words: Pig production, quality, safety, Ban pig, Vietnam

ABSTRACT

In Vietnam, domestic demand for meat is rapidly rising, especially in the urban centers. Beyond mere quantitative growth, quality and safety aspects have received increasing attention by consumers in recent years. Livestock products guaranteed to be free from diseases and pathogens are in high demand. Furthermore, demand for indigenous livestock breeds, with special taste characteristics, is growing. Such products are currently offered only in niche markets, but are considered to have high potential to expand. So far, domestic supply chains have responded insufficiently to changing consumer preferences, with the consequence that higher-income households partly have to switch to imported products. This study is concerned with the opportunities and constraints for pig producers in northern Vietnam and how these are related to aspects of quality and safety. More specifically this paper focuses on such issues as: (i) regional production structure, (ii) regional and international trade flows, (iii) recent quantity and price developments, (iv) regional producer competitiveness and cost of production estimates, (v) transportation and handling costs, (vi) description of potential foreign direct investment activities in the sector, (vii) description of food safety and quality issues in the sector (including standards and regulations), and (viii) description of the different marketing channels available for northern upland producers (especially in Mai Son district of Son La province) with particular emphasis on opportunities and constraints.

The findings from this study suggest that the main constraints for enhancing competitiveness of the small-and medium scale pig production sector are: (i) quality, safety and price of pork in both the domestic and for export markets; (ii) the large gap of pork quality and safety between the formal regulations and practical standards applied, particularly with regard to the ratio of lean meat which is one of the most important indicators of pork quality in Vietnam; (iii) poor quality controls of pig breeds, particularly the local upland ‘Ban’ pig, that still exist within different husbandry systems with varying environments and feeding regimes, leading to reduced pork quality due to diseases and poor hygiene; (iv) ‘Ban’ pig producers in upland areas still face an unsolved technical challenge between higher animal productivity versus pork quality. In fact, if ‘Ban’ pigs are fed with the same type of feed as crossbred pigs, the ratio of fat of ‘Ban’ pig is generally higher and unwanted changes of taste occur; (v) feed costs are the highest cost factor in pig production; on the one hand small-holder farmers have to cope with relative higher prices of industrial feeds, on the other hand they can utilize different domestic sources, such as...
by-products from crop production; (vi) while market forces tend to have a positive impact on ‘Ban’ pig production, the local animal production sector is constrained by relatively poor infrastructure, including material, technical, economic and social aspects; and (vii) live pigs and pork are distributed by a poorly organized marketing system, with low efficiencies in terms of time, place and value. Main reasons are poor slaughtering and storing facilities, lack of transportation means, merely visual quality evaluation, and methods of price determination that are based on face-to-face negotiations only.

Major opportunities for the pig sector in northern Vietnam as identified in this study are: (i) rapid growth of demand for pork, including local ‘Ban’ pork, due to rapid income growth and a change in diet patterns particularly in urban areas from staples toward higher value and protein rich foods; (ii) the potential of animal productivity can be exploited if technical and management skills and input supply are improved; (iii) in the upland areas, farmers can expand their pig farms from small to medium scale to exploit comparative advantages and economies of scale; (iv) northern upland provinces, such as Son La province, have a rich supply of raw-material sources for the feed industry, such as corn and cassava; (v) the private sector and foreign companies, e.g. from Thailand, have responded with high investments in the feed industry, breeding, livestock herds, and slaughtering industry; and (vi) the state has to direct more policy effort towards establishing a sound regulatory framework, e.g. through certification systems, capacity building, and research and extension activities, rather than only focusing on production and commercial aspects.
Farmers’ indigenous knowledge of Northern Upland Vietnam in their interaction with Farmer Field School

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KEY WORDS: Indigenous knowledge; Upland Vietnam; Soil-Tree interaction; Farmer Field School.

PROBLEM AND RESEARCH QUESTION

Indigenous knowledge (IK) or local knowledge is built up over a long time through the knowledge system of a certain specific area. In this study, indigenous knowledge is regarded as knowledge acquired by local people which constantly changes as they learn new things about their environment and ways to manage natural resources in a more sustainable manner. Thanks to this localized characteristic, indigenous knowledge has been tested and overcome pressures of choice. As a result, it has high reliability, is close to reality and suitable to people without formal education. Unlike academic knowledge formed mainly by scholars and transferred through books, indigenous knowledge is formed directly from the work of farmers in the community. It has been perfected gradually in response to the environment and is transferred intergenerationally through emulation or through oral traditions in families, in villages, through folksongs, epics, customs etc. Normally, the study of indigenous knowledge compares it with academic knowledge which claims to have validity regardless of location. While academic knowledge is formed by scholars and scientists through experiments and systematic testing, indigenous knowledge mainly relies on the practical activities of human beings working on and influencing the material world. However, similar to academic knowledge, indigenous knowledge reflects the relationship between thinking and phenomena in reality.

Farmer Field Schools is an interactive and ‘participatory’ method used in Vietnam and elsewhere of disseminating academic agricultural knowledge among farmers, and of ‘localizing’ this knowledge in interaction with IK and the environment. The main question we pose is: How do farmers’ indigenous knowledge and farming activities interact with academic knowledge in the Farmer Field School approach?

METHODOLOGY

The steps taken to accomplish the task included the use of a qualitative approach. The research design employed was a cross-sectional survey and the method was deemed suitable because it enabled the required information to be collected on several pre-determined variables of a single point in time and from a cross-section of a fairly uniform group. The study was conducted in Dongrang village-Dongxuan commune-Luongson district and Vaisieu village-Thuongha commune-Baoyen district of Northern Vietnam. The approach allowed in-depth observations of some of the practices mentioned by respondents during individual interviews and at the same time cross-checking of the responses.

RESULTS

The study highlighted the new farming system based on the old farming experiences. It showed that it is essential to study the valuable experiences when using the farming calendar in order to integrate with the Farmer Field School approach in preventing soil erosion, in soil selection, in the cropping system and in environmental protection with regards to planting and protecting forests, cultivating on sloping land, or in the garden economy including home garden, hill garden, and forest
garden. Solving these issues facilitates economic development and brings about sustainable use of the environment for people in the uplands generally and for minority people in northern Upland Vietnam particularly.

CONCLUSIONS

The research has revealed the consistency of local-ecological knowledge about soil-plant interactions at the field and landscape levels in the uplands of northern Vietnam and the fact that it’s complementary with existing scientific knowledge. Farmers already have their indigenous knowledge and experiences before entering into Farmer Field School (FFS) where they gain new scientific knowledge. Farmers’ indigenous knowledge as well as their agricultural experience are influenced by the environment and the socio-cultural setting in which they live. Indigenous knowledge may be implicit, i.e. embedded in folkloric or religious narratives (myths, beliefs) and/or embodied in everyday agricultural practice. Understanding local knowledge is, in conjunction with understanding practice in the context of social, economic, cultural and environmental variables, an important means of understanding needs and constraints facing farmers. The creation of explicit knowledge combining interdisciplinary scientific knowledge with that of farmers, has potentially profound impact on the research and development of FFS in terms of targeting research at gaps in farmers’ knowledge that constrain the productivity and sustainability of their farming system. It is necessary to transfer valuable experiences in using the farming calendar, in preventing soil erosion, in soil selection, in crop rotating and in environmental protection not only on upland but also on low land farming systems.

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The Munessa project: an Ethiopian perspective on functional ecology and management of mountain forests

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KEY WORDS: Ethiopia, forest plantations, functional ecology, natural forests, sustainable forestry

Despite the many and indispensable services of forests for the livelihood of the Ethiopian people, they are being depleted at alarming rate. Lack of scientific knowledge for both effective conservation of natural forest remnants as well as for sustainable management of forest plantations play significant roles in their rapid depletion. In the framework of a DFG project package, a German-Ethiopian group aims at increasing our understanding of the functional ecology of the Munessa mountain forest as a scientific basis for sustainable management of this ecosystem as a model for other semi-deciduous forests in Ethiopia. Major findings so far showed different plant functional types of indigenous versus exotic species with respect to soil-plant hydrology and photosynthesis. Different functional types can be also indicated by host plant specific community-compositions of arbuscular mycorrhizal fungi. Likewise, the nutrient cycling in the soil-plant system strongly depends on the tree species. A major result of the last project phase was that there is a good regeneration of indigenous tree species in the plantation forests. In particular, Eucalyptus saligna and Pinus patula proof to be promising nurse trees. Soils under these plantations had a close nitrogen cycle and barely loose nutrients with leaching. Cupressus lusitanica, in contrast, had an unfavorable light climate, and no regeneration of indigenous tree species is possible. Further, significant nitrogen losses from soil under Cupressus could be observed.

The next step is now to investigate the ecophysiological traits of important functional types at the individual tree level in detail. Together with the analysis of important ecosystem attributes with respect to process regulation and stability at the stand level and defined silvicultural experiments, this should provide an important prerequisite for sustainable management and conservation of forest resources in Ethiopia.
The experiments will be carried out by close collaboration with the Addis Ababa University, the Ethiopian Institute for Agricultural Research and the Munessa-Shashamane Forest Enterprise which offered us the research sites. It is the hope that in particular the collaboration with the enterprise may open the door for the transfer of our scientific results to practice.
Water in soils of a tropical mountain forest in south Ecuador

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KEY WORDS: Complexity and information measures; signal propagation, preferential flow, dye tracer, soil hydrology, mountain forests

INTRODUCTION

Hydrological signals are transformed in several ways along their path through the ecosystem from precipitation over throughfall, sapflow, water fluxes in the soil to the catchment discharge. In a tropical mountain forest of south Ecuador we analysed the changes of autocorrelation structure, smoothness and signal propagation of hydrological time series with complexity and information measures (Wolf, F. 1999, Lange, H. 1999). Furthermore we studied the dynamics and patterns of water fluxes in the soil with dye tracer experiments and conditional simulations (Schlather, M. 2001).

The study site is the private forest reserve San Francisco (ECSF) about 2000m a.s.l. between Loja and Zamora in south Ecuador. This region in the Andes is characterised by natural landslides which lead to a heterogenic soil structure and a cycle of disturbance and regeneration.

METHODS

The information theory has many variables to measure the complexity and information content of time series. We use the main information gain (MIG) to describe the information content and the fluctuation complexity (FC) to calculate the complexity what represents the degree of structure.

The dye tracer experiments were made with an irrigation system using Brilliant Blue as tracer to visualise the flow paths in the soils. Afterwards the flow patterns were analysed with SoPhy a package for R (Schlather, M. 2005). For the conditional simulation of patterns on the plot scale we used RandomFields (Schlather, M. 2001).

RESULTS

The complexity and information measures have characteristic values for each parameter of the hydrological cycle. They can be interpreted as a fingerprint of each type of time series. Fig. 1 shows the signal propagation in hydrological time series along the passage through the ecosystem. The precipitation is a parameter with a highly random signal (the maximum value for MIG is 1) and only few complexity (the maximum of FC is 1,8). In the following hydrological time series on the way through the compartments of the ecosystem the information content degresses and the complexity increases.

![Signal propagation ECSF](image)

Fig. 1 Signal propagation in the ecosystem tropical mountain forest.

Especially the soil moisture is a signal with exceptional high complexity. This leads to the conclusion that the various processes in the soil which are the result of many abiotic and biotic interactions build up structure from information.
The Brilliant Blue experiments Fig. 2-4 show a well developed pores structure in the soil under primary forest after centuries of soil development. With the impact of a landslide the pore continuity is destroyed almost completely. And even after some decades the previous pore structure is not be reached again.

For the simulation of patterns of soil moisture kriging techniques are limited to produce natural like field images. With new geostatistical approaches as RandomFields patterns can be generated from point datas more convincingly.

REFERENCES


The impact of land use and climate change on water services in meso-scale riverbasins

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KEY WORDS: Land use change, integrated modelling, water quality, river basin management

INTRODUCTION

Scenarios can be regarded as possible alternative future developments. Such alternative pictures can assist in appreciating the complex effects of policy measures (interventions) interacting with changing climatic and socio-economic conditions. The MOSDEW integrated regional model has been developed in the Neckar basin, a 14 000 km² river catchment in South-West Germany as a model cascade of nine submodels covering large scale hydrology, groundwater flow, water demand, agricultural production, point and non-point pollution and chemical as well as biological water quality. Then it has been transferred and tested in river basins in West Africa (Ouémé basin) and Central Asia (Chirchik-Ahangaran-Keles basin, CHAB). MOSDEW has been extensively used to develop quantitative scenarios of climate and land use changes using the SAS (Story and Simulation) approach. In all basins three dimensions of driving forces have been considered (1) climate (2) socio-economy and (3) policies. Assumptions on the expansion of arable land (both irrigated and rainfed) under story lines with either optimistic or pessimistic economic development were defined in all river basins. In the Ouémé basin (West Africa) the expansion of farm land observed in the past will most likely continue due to the strong increase of population, which is higher in the pessimistic scenario (Figure 1). In the Neckar basin, the new EU Common Agricultural Policy (CAP) will, according to simulation runs with the agricultural sector model ACRE-Neckar (Henseler et al. 2006), cause a decrease in cultivated land and an increase in fallow. However, this trend may be reversed when biomass crops turn out, on the long run, to become profitable on the energy market.

RESULTS AND DISCUSSION

The impact of these major land use changes and of additional climate scenarios on water resources (in particular water quality) were quantified with MOSDEW, using the submodels SLISYS, MONERIS and QUAL2K. The Soil and Land Resources Information System SLISYS (Gaiser et al. 2005) produces estimates on diffuse pollution from various land use types. The output is handed over to the water quality model MONERIS (Behrendt et al. 2000) which receives additionally estimates on emissions from point sources (waste water treatment, urban systems, industrial sites) from the Water
Evaluation and Planning system (WEAP). All emissions collected by MONERIS together with the daily discharge values provided by the hydrological model feed into the surface water quality model, which assesses parameters that characterize the surface water status like pH, temperature, electrical conductivity, suspended solids, nitrogen and phosphorus forms.

Figure 2 shows the output of SLISYS-Ouémé with respect to the changes in nitrate loads to the ground water due to the land use changes under economically optimistic (luA2030) and pessimistic (luB2030) scenarios. The increase in both scenarios is due to the strong expansion of farm land within the basin, which is higher under the assumptions of the pessimistic scenario.

The increase in pollution through non-point and point sources in both scenarios is translated into the quality of the surface waters as shown in Figure 3. In contrast to the Ouémé basin, the decrease of arable land in the Neckar basin due to the CAP reform, tends to lead to decrease nitrate loads over the basin according to the results of the SLIYS information system. This is independent of the evolution of other socio-economic indicators like population growth, economic development and urbanization (optimistic scenario A and pessimistic scenario B, Figure 4). The assumed increase in urbanisation and subsequent reduction of arable land in both economic scenarios had no effect on nitrate leaching. A sensitivity analysis shows that the complete conversion of cropland to grass fallow could decrease nitrate leaching by as much as 63%.

The scenario results demonstrate that integrated modeling is a powerful tool to shift from qualitative assessment of environmental impact caused by future land use and climate changes to more quantitative evaluations.

REFERENCES


Using ants to measure a degree of human disturbances in agroecosystems

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KEY WORDS: Agroecosystems; Biodiversity; Ants; Upland Agriculture

Agroecosystems produce food via farming under human guidance and because of the interruptions, the qualities and quantities in agroecosystems are quite different from natural ecosystems (Swift et al., 1995). Although insects in agroecosystems may seem to play minor roles if they are not so serious pests nor important natural enemies, they can be used as bioindicators of the ecosystems.

Ants are basically predators, and rather common insect in agroecosystems. Although the whole taxonomic information is not established, the species number of ants in Asia would be estimated about 6000 or more (Ogata, 2005). In terms of species richness of a taxon, local abundance and wide distribution, ants have a value as useful bioindicator group of ecosystems (Alonso, 2000) and indeed in some areas, they are already applied to monitor or evaluate the environments (e.g. Kaspari and Major 2000).

Our preliminary surveys in E Asia also showed the following patterns: (1) the ant communities of agroecosystems are occupied by a few predominant species followed by several less dominant ants comparing with those of forests, (2) the perennial crops field like sugarcane have richer in species diversity than annual crop fields (3) species richness of agroecosystem would be affected both by latitudinal gradient of resources diversity and degree of human interruptions (Ogata and Kuboki 2007).

Those are the patterns of ant communities in lowland agriculture fields. The question arise whether the pattern is the same in upland agriculture. To investigate the ants in upland field, one of the authors (WS) surveyed ant diversity in different land use types of forest and traditional hill-tribe agricultural systems in northern Thailand.

The survey was made in five different land use types in Mae Chaem and Mae Trang highland districts of Chiang Mai Province, Thailand: tropical montane forest (MF); forest fallow for one year (F1) and eight years (F8); jungle tea site (JT); and annual crop site (AC). The degree of human disturbances is highest in AC, followed by F1, F8, JT and MF. The samplings were conducted by hand collecting in 8 plots of 30 x 30 cm quadrats using a sieve of 4 mm mesh in each of 5 different types of land use. All the study sites were located between 700 and 1,120 m asl.

A total of 130 species of 48 genera in 7 subfamilies of ants were collected. JT had the highest average number of species followed by MF and F8. F1 and AC had lowest species richness. The indicator species analysis showed that JT has 3 species of higher indicator value (more than 60 %): Centromyrmex feae, Odontomachus rixosus and Anochetus rixosus, all of which are litter or soil dwellers and have rather narrow distributions occuring in Tropical Asia. JT maintains significantly greater species richness than F8 but has no significant
difference from MF, suggesting that JT has nearer natural ecosystems than forest fallow land use.

The jungle tea (*Camellia* spp.) is referred to as “Miang” by local people. The plant is cultivated by native Austro-Asiatic hill tribe people without particular silvicultural management (Preechapanya 1996). The planting scale is relatively small (2-3 ha) under a variable shade canopy of remnant forest trees nearby the villages. This indigenous agroforestry has been widely practiced in Mae Tang highland.

Tropical montane forest and jungle tea plantation are less disturbed sites in our survey. The ant community analysis confirmed that both have higher species richness and unique indicator species.

To compare agroecosystems in upland and lowland by ants, there are still several factors to be considered in addition to the degree of human disturbances. For example, the direct comparison of species richness between upland and lowland agroecosystems would be affected by the altitudinal gradient in species diversity of ants. This background bias would be a future topic of the research. Even so, the present study showed that the species richness of ants is useful to see the degree of human disturbances both in lowland and upland ecosystems.

REFERENCES


The role of harvest maturity in postharvest concepts for fresh longan fruits from Northern Thailand

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KEY WORDS: fresh fruit marketing; fruit quality; longan; postharvest; ripeness; shelf-life

INTRODUCTION

Sapindaceae fruits are the major subtropical fruit crops in Thailand, where the cultivation of the two economically most important species, longan (Dimocarpus longan Lour.) and litchi (Litchi chinensis Sonn.), is concentrated in the Northern provinces. Whereas litchi orchards are found in the upland areas, longan trees are mainly planted in the lowlands. For farmers of both areas, fresh fruit marketing still plays a key role. However, due to the high perishability of the fruits, the profit for the local farmers is often unsatisfactory, with sale being limited to local markets and some export within Southeast Asia. To avoid decay and browning, pre-treatments like sulphur dioxide fumigation and application of fungicides are commonly used, but make the produce less suitable for international markets. Sustainable fruit production and consideration of quality aspects are crucial for improving income security through enhanced marketability of fresh longans and litchis and hence for access to new, more distant export markets. Customers from different markets request diverse sensory qualities for dessert fruits, which differ from standards for fresh fruits delivered to processing facilities. Selection of the proper raw material, depending on the intended use, is always decisive. Postharvest handling starts with harvest time decision and suitable picking maturity, being crucial for adequate quality with necessary shelf-life, since postharvest ripening of the non-climacteric litchi or longan fruit is impossible. This study aimed at identifying the levels of purpose-orientated quality and shelf-life that are achievable through proper physiological maturity without any further postharvest treatment. The experiment was exemplarily carried out with longan fruits.

METHODOLOGY

Longans cv. Daw were obtained during main harvest season 2007 from a research orchard near Lamphun in Northern Thailand. By selecting 5 harvesting dates H1-H5 relative to the usual commercial harvest time (UCH), the whole harvest period was covered. Sound fruits were harvested 10 days (“unripe”) and 5 days (“half-ripe”) before UCH, at UCH (“ripe”), as well as 5 days (“fully ripe”) and 10 days (“overripe”) after UCH. Harvests were followed by sorting according to size (g/fruit) into 2 categories (A: 9.4-10.6 g; B: 11.4-13.0 g). The maturity-depending fruit quality was assessed directly after harvest. For monitoring of shelf-life, all samples were stored for 21 days at 5 °C and 90% relative humidity (RH). Outer and inner quality parameters of the fruit, i.e. colour, firmness, moisture content, titratable acids (TA, as malic acid) and total soluble solids (TSS), were regularly analysed by analogy to Vásquez-Caicedo et al. [2006]. Respiration rates, based on gaschromatographic CO₂ quantification, and enzymatically assayed ethanol contents were included as physiological and chemical indicators of senescence and microbial decay.

RESULTS AND DISCUSSION

During on-tree maturation, TSS increased until UCH (H3A/B) up to a temporary maximum of 20.3 °Brix. Since TA continuously declined, the TSS/TA ratio accumulated from 201 at H1A/B to 222 at H5B, thus being a better maturation criterion than TSS alone [Jiang et al., 2002; Tongdee, 1997]. During storage, different rates of acid catabolism caused considerable increase in TSS/TA, particularly when initial TSS/TA levels were low. After 21 days, TSS/TA ranged from 596 to 369 for fruits harvested at H1A/B and H5B, respectively. As expected for longan under cold storage [Tongdee, 1997], fruit respiration (Figure 1a) declined, while passing through a slight maximum. Lowest physiological activities were determined for fruits harvested post UCH (H4A-B, H5B). Since acid catabolism and ethanol production (Figure 1b) were reduced in those late harvested fruits, a shift to anaerobic metabolism, which had been reported for overripe fruits [Pesis, 2002], was...
excluded. Longans are extremely susceptible to microbial decay due to their striking pH value > 6.5. Hence, ethanol contents may rather be ascribed to a fermentation process that already began pre-harvest and boosted sensory deficiencies during storage. Consistently, unripe fruits (H1A-B, H2A-B) having thinner peels, which are less resistant to microbial infections showed enhanced ethanol production. Irrespective of harvest maturity, high perishability became evident by rapid changes in peel properties as observed after three days of storage (Table 1). The thicker peel of small, late harvested fruits (H4A, H5B) was less susceptible to desiccation and embrittlement, making them more appropriate to chilled storage and transport [Jiang, 1999; Lin et al., 2002]. Rapid browning of the peel occurred within the first 2-3 days of storage, as indicated by the rising CIE a* value (Table 1). More intensive browning assumed for more mature fruits [Paull and Chen, 1987] was confirmed by the significantly higher a* values observed after 3 days for the peel of fruits from H4A-B and H5B. Although peel characteristics altered considerably, only minor changes in colour and firmness of the aril were noted.

CONCLUSION

Fruits of H3B (UCH) were preferred for local markets, because of max. TSS. Late harvest (TSS/TA ~220-240; H4A, H5B) conducted to shelf life for distant markets due to thicker peel and reduced acid catabolism during storage. Particularly, small fruits, which realise minor prices on local markets, are most suitable. For the longan farmers, this information makes utilisation-oriented harvest time decision more reliable. Current analogous studies will show to which extent this knowledge is applicable to the litchi fruit, where a lower pH is characteristic and peel colour retention during postharvest ripening of mango cv. ‘Tommy Atkins’, J. Agric. Food Chem, 54, 5769-5776.

Table 1

<table>
<thead>
<tr>
<th>Browning - a* [│</th>
<th>Moisture content [│</th>
<th>Brittleness [N/mm]</th>
<th>Thickness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>Day 3</td>
<td>Day 0</td>
<td>Day 3</td>
</tr>
<tr>
<td>H1A</td>
<td>-0.14 ab</td>
<td>5.63 y ab</td>
<td>54.15 a</td>
</tr>
<tr>
<td>H1B</td>
<td>+0.05 ab</td>
<td>5.12 y a</td>
<td>55.23 a</td>
</tr>
<tr>
<td>H2A</td>
<td>+1.26 ab</td>
<td>5.32 y ab</td>
<td>56.60 a</td>
</tr>
<tr>
<td>H2B</td>
<td>+2.11 ab</td>
<td>5.28 y ab</td>
<td>57.66 a</td>
</tr>
<tr>
<td>H3A</td>
<td>+0.80 ab</td>
<td>6.14 y abc</td>
<td>55.66 a</td>
</tr>
<tr>
<td>H3B</td>
<td>+0.77 ab</td>
<td>6.08 y abc</td>
<td>54.68 a</td>
</tr>
<tr>
<td>H4A</td>
<td>-0.64 ab</td>
<td>7.20 y c</td>
<td>56.34 a</td>
</tr>
<tr>
<td>H4B</td>
<td>+0.54 abc</td>
<td>7.67 y d</td>
<td>55.85 a</td>
</tr>
<tr>
<td>H5A</td>
<td>+0.23 c</td>
<td>6.61 b bd</td>
<td>55.16 a</td>
</tr>
</tbody>
</table>

Different letters a-g horizontally indicate significant differences due to storage, different letters a-d vertically significant differences due to harvest time and size (Tukey’s standardized range (HSD) test, α = 0.05); * as indicated by the CIE green (-) red (+) colour coordinate a*, * determined gravimetrically after drying of the peel (105 °C, 2d); as quotient of max. load and displacement at max. load by puncturing with a 0.5 cm probe; * calliper reading

Figure 1 Respiration rates (CV ≥ 9.98%) (a) and ethanol contents (CV ≥ 7.78%) (b) of longan fruits from harvests H1-H5, with sizes A-B, during 21 days of storage (5°C, 90% RH).

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Litchi drying by upland producers versus established lowland processors: Can value-adding be reallocated?

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KEY WORDS: Lychee, Litchi chinensis, fruit drying, smallholder farmers, upland agriculture, Thailand

INTRODUCTION

Litchi (Litchi chinensis Sonn) is a typical crop in northern Thailand, where growers are almost entirely small-scale producers located in highland areas. In Chiang Mai and Chiang Rai provinces, 12,000 ha are cultivated [Sethpakdee, 2002] and revenue from litchi production contributes significantly to the local livelihood. Market prices, however, are notably unstable - a reality felt in Thailand as the value of fresh litchi is rapidly declining. In 2002, the farm price paid for fresh litchi at US$ 1.50 per kg [Menzel, 2002], about 75% higher than in 2007. Consequently, farmers are experiencing lower profitability and are switching to other crops. Due to high seasonality and perishability, marketed litchi requires post-harvest processing for preservation and extended availability [Jiang, et al., 2006]. Besides treating litchi for the fresh market, canning is the most common preservation technique used in Thailand [Sethpakdee, 2002]. Litchi drying is a practical preservation technique that is relatively new in northern Thailand [Sithiphong, 1992], with several drying facilities having been recently established in lowland areas south of Chiang Mai. Interestingly, the dried litchi market remains almost entirely domestic in Thailand, even though the export prospective for fresh Thai litchi is stated as high [Hau and Oppen, 2003] signifying growth potential for other litchi products. Thai litchis are dried peeled and destoned, resulting in a process that increases value 3-4 fold and the domestic wholesale price of dried litchi is relatively stable at USS13/kg.

Unfortunately, the current litchi market chain is not conducive to alleviating the problems of the upland producers. Farmers sell to middlemen traders who establish the wholesale farm price. The traders transport and sell the product to domestic retailers and exporters, or to lowland processing facilities, who then produce the high-value litchi commodities [Sethpakdee, 2002; Sithiphong, 1992]. In this respect, while the farm price of fresh litchi drops, profits of the traders and processors increases. To help amend the situation, a project was established where the production of dried litchi was organized in an upland village with the objective of encouraging the farmers to benefit from the value gained by drying litchi. Research evaluated the upland drying operation and product against ones in the lowlands.

MATERIAL & METHODS

The study site was located in Mae Sa district (MS), near Chiang Mai. Meetings were held with villagers to discuss drying of the litchi harvest. Interested farmers were invited to a training session at Chiang Mai University. Finally, a group from one village decided to start the pilot production. A cabinet-type tray dryer was installed in the village and researchers supported drying efforts. The study recorded the setup, running and development of the operation over the drying period. Litchis were dried with (S) and without (-S) added sugar, samples of which were analyzed according to Pott, et al., 2000. Sensory evaluations given by 150 respondents (90 Thai, 30 Asian, 30 Western) were conducted to determine market acceptance of the product variations. For comparison, two lowland cooperatives, Ban Kwae (BK) and Sun Pa Heing (SPH) were investigated and product quality evaluated against the upland samples.
RESULTS

Lowland coops show greater output capacity, but also higher absolute investment and operating costs and labor requirement (Table 1). Assuming 10% depreciation on investment, the lowland coops had higher profit margins with BK and SPH at 19.5 and 28.5% respectively, compared to 14.5% for the upland operation. Lower fuel costs as a result of using wood increased the margin of the SPH facility. Costs at the MS facility were considerably reduced due to own supply of fresh litchi and family labor (not calculated). Whereas the markets for the lowland products, including supermarkets, specialty food and coop shops, were well established, the upland farmers faced initial difficulties to sell their dried litchi. Nevertheless, they succeeded in marketing their total production, mostly to restaurants. Since it was the first year for the MS project, profit margin is expected to rise in the future.

Table 1. Economic evaluations of the facilities

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MS</th>
<th>BK</th>
<th>SPH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>Gas</td>
<td>Gas</td>
<td>Wood</td>
</tr>
<tr>
<td>Dryers x load (kg)</td>
<td>1 x 300</td>
<td>1 x 800</td>
<td>3 x 1200</td>
</tr>
<tr>
<td>Labor (persons)</td>
<td>5-10</td>
<td>10-15</td>
<td>10-15</td>
</tr>
<tr>
<td>Output (kg dry/a)</td>
<td>150</td>
<td>2,500</td>
<td>10,000</td>
</tr>
<tr>
<td>Output (THB/a)</td>
<td>55,000</td>
<td>1.0 x 10^7</td>
<td>4.0 x 10^7</td>
</tr>
<tr>
<td>Investment (THB)</td>
<td>75,000</td>
<td>150,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Supplies (THB/a)</td>
<td>37,000</td>
<td>640,000</td>
<td>2.2 x 10^6</td>
</tr>
</tbody>
</table>

Between the upland product and the lowland samples, moisture content, water activity (a_w) color and vitamin C content differed (Table 2). Samples from SPH were drier than from BK and MS, while samples from MS without added sugar were considerably moister. This was also seen from water activity, however MS (-S) did not exceed the storability threshold of 0.6. Color exhibited differences, with the hue of MS (-S) samples being significantly lighter. Vitamin C was highest for BK and lowest for SPH, with the two MS samples showing intermediate values, but overall differences are not believe to be considerable. Excessive temperatures in the wood burning dryer likely caused the undesired low moisture and vitamin C contents of the SPH samples.

Table 2. Results from product quality analyses

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture (% w.b.)</th>
<th>a_w</th>
<th>Color (Hue, °)</th>
<th>Vitamin C (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS (S)</td>
<td>13.6^a</td>
<td>0.43^a</td>
<td>63.4^a</td>
<td>7.67</td>
</tr>
<tr>
<td>MS (-S)</td>
<td>17.5^b</td>
<td>0.50^b</td>
<td>56.2^b</td>
<td>9.78</td>
</tr>
<tr>
<td>BK</td>
<td>14.6^a</td>
<td>0.41^a</td>
<td>62.3^a</td>
<td>14.52</td>
</tr>
<tr>
<td>SPH</td>
<td>11.6^c</td>
<td>0.43^c</td>
<td>61.7^c</td>
<td>5.94</td>
</tr>
</tbody>
</table>

No differences were found in the sensory evaluation between MS product with and without added sugar. However, preferences were found based on ethnic origin (Table 3). On a hedonic scale of increasing magnitude from one to five, Thais ranked the samples with low bitterness intensity, which they exceptionally approved. In contrast, they found the samples too tough, which they disapproved. Thai respondents even suggested these specific product qualities strongly influence their buying decisions, not indicated by the other two groups.

Table 3. Differences in sensory evaluation

<table>
<thead>
<tr>
<th>Origin</th>
<th>Bitterness Intensity</th>
<th>Approval</th>
<th>Texture Intensity</th>
<th>Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>1.56^b</td>
<td>3.3</td>
<td>1.44^a</td>
<td>3.6</td>
</tr>
<tr>
<td>Thai</td>
<td>1.01^a</td>
<td>4.0</td>
<td>1.73^b</td>
<td>3.3</td>
</tr>
<tr>
<td>Western</td>
<td>1.82^a</td>
<td>3.1</td>
<td>1.26^b</td>
<td>3.8</td>
</tr>
</tbody>
</table>

*same letter indicates no significant difference at α = 5%

CONCLUSIONS

It was found that the upland facility was comparable with those in the lowlands, since it was economically competitive and the product was of similar quality. Although the pilot project faced initial difficulties, it is believed production and marketing will improve and the operation will become even more competitive with lowland litchi drying coops in the future. Further research will focus on the organization and advancement of the operation and pursuing its ultimate success and adoptability. The first step towards reallocating the value adding chain of litchi drying to upland farmers has been made. Also, variation in quality parameters, consumer acceptance and cultural preferences of dried litchi products are now documented.

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Solar drying of peeled longan using solar tunnel dryer

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KEY WORDS: Solar drying; longan; tunnel dryer; solar energy

INTRODUCTION
Longan (Dimocarpus longan Lour.) is an important fruit of Thailand with an export value of $109 million in 2004 (Office of Agricultural Economics, Thailand, 2005) and it shows an increasing trend in production rate since 1990 (Varith et al., 2007). It is a seasonal fruit and its price is low during the season. Several preservation techniques are available to add value to this seasonal product such as canning and drying.

Drying is one of the oldest methods for preservation of fruits and vegetables and it also an energy intensive operation. Improved drying technology is needed for improvement of the quality of dried products for value addition and reduction of post harvest losses and also for conservation of energy.

Thailand being located in the tropical regions of the Southeast Asia receives annual average daily solar radiation of 18.2 MJ/m\(^2\)/day (Janjai et al., 2005). Thus, utilization of solar energy to produce quality solar dried peeled longan has been considered to be the most promising option. Furthermore, solar energy is a renewable and environment friendly. Therefore, the use of solar energy to dry longan is of great interest.

OBJECTIVE
This research work is aimed to investigate the performance of a side loading type solar tunnel dryer for drying peeled longan.

METHOD
The new version of the solar tunnel dryer (side loading and unloading through windows and glass cover type) was constructed at Silpakorn University, Nakhon Pathom, Thailand. This solar tunnel dryer consists of a solar air heating system and a drying unit. These are connected in series and are covered with glass. The schematic diagram of the dryer is shown in Fig. 1. The floor of the collector acts as an absorber and it was painted black to absorb solar radiation and high density foam sandwiched between two galvanized iron sheets was fitted at back of the dryer to provide insulation to reduce heat loss from the back of the dryer. A dc fan driven by a 15 W solar module was used to provide air flow inside drying system.

Solar radiation passing through the glass cover heats the absorber. Ambient air is forced through the collector and while passing it through the collector gains heat from the absorber. This heated air while passing through the drying unit absorbs moisture from the peeled longan. The product receives heat from solar passing through the glass cover of the drying unit in addition to the heat received from the drying and this enhances the drying rate of the product.

A total of five full scale experimental runs were conducted and the dryer was loaded to a capacity of 100 kg of ripe and peeled banana for each experimental run. The drying was started at 8 am and continued till 6 pm. The control sample was also dried under similar conditions.

Fig.1 Schematic diagram of the side loading type solar tunnel dryer.
Full scale tests of the side loading type solar tunnel dryer for drying of peeled longan were carried out in the months of August, 2007 to September, 2007.

RESULT

The typical results for drying of longan are as follows.

The drying air temperature varied from 32°C to 88°C. The drying time of peeled longan in the solar tunnel dryer was 16 hours to dry peeled longan from an initial moisture content of 84% (w.b) to a final moisture content of 12% (w.b.) whereas it required 16 hours in natural sun drying under similar conditions to reach a moisture content of 40% (w.b.). The quality of solar dried product was also good in comparison with the sun dried product in terms of color, taste and flavor.

![Fig. 2 Variations of air velocity inside the dryer during a typical experimental run](image)

**Fig. 2** Variations of air velocity inside the dryer during a typical experimental run

![Fig. 3 Comparison of the temperatures between the inlet and exit of the drying unit](image)

**Fig. 3** Comparison of the temperatures between the inlet and exit of the drying unit

![Fig. 4 Variations of relative humidities in three different positions inside the drying unit during a typical experimental run](image)

**Fig. 4** Variations of relative humidities in three different positions inside the drying unit during a typical experimental run

![Fig. 5 Variations of the moisture contents in the different locations of the drying unit for a typical experimental run during drying of peeled longan](image)

**Fig. 5** Variations of the moisture contents in the different locations of the drying unit for a typical experimental run during drying of peeled longan

CONCLUSION

Solar radiation varies almost sinusoidally with the peak at noon. The temperature inside the collector varies with the positions but it varies within a narrow band for the positions starting from the middle of the dryer to exit of the dryer in the middle of the day. Pattern of changes of air velocity inside the solar tunnel dryer follows the pattern of changes in the solar radiation.

Field level tests demonstrate the potentiality of solar drying of peeled longan in the side loading type solar tunnel dryer. Solar drying of peeled longan in the side loading type solar tunnel dryer resulted in considerable reduction in drying time as compared to the natural sun drying and the products dried in the solar tunnel are quality dried products. The payback period of the side loading type solar tunnel dryer is about 2.1 years.

REFERENCES


Fruit maturity and quality at-harvest and ex-store of selectively picked mangos (*Magnifera indica* L., cvs. ‘Tron’ and ‘Hoi’)

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**KEY WORDS:** mango postharvest; temperature effect; storage duration; shelf life

Mango (*Mangifera indica* L.) is becoming a commercially important fruit crop in Vietnam, particularly in the mountainous areas of the Son La Province in the north. The lowland of northern Vietnam has typically cool and wet weather conditions around the time of mango bloom. This environmental constraint leads to relatively low fruit set of mango. In contrast, the mountainous areas near Yen Chau, Hat Lot and Truong Sai of the Son La Province experience warm and dry conditions that favour higher initial fruit set of mango. These areas are typically used for commercial mango production. The two main local varieties cultivated in this region are ‘Tron’ and ‘Hoi’.

Recent investigations indicate that there is a high domestic demand for these locally grown mango varieties due to their superb taste and aroma. However, fruit quality is often unacceptable due to poor traditional crop management practices by ethnic minorities. It is therefore necessary to improve fruit quality to match consumer expectations in the market place. It is further intended to investigate how consumer preference and purchasing behaviour can be best exploited to produce more product of preferred quality. To assure this, we need to understand which fruit quality characteristics meet market requirements by setting up a detailed consumer preference survey approach. This in turn requires determination of specific qualitative fruit maturity parameters not only for determining optimum harvest strategies but also for improving postharvest storage and shelf-life behaviour.

In 2007 a survey approach included 10 representative ‘Tron’ and ‘Hoi’ orchards near the township of Yen Chau, Son La Province. Ten fruit were collected three times at 10-day intervals from 8 trees at each location, respectively. A total of 4,800 fruit were harvested and used for detailed fruit quality assessment and sensory analysis at harvest and following various poststorage durations. A ten fruit sample of each cultivar x harvest time x location combination was stored for 5 and 10 days at 20°C and 10, 20 and 30 days at 12°C, all at a relative humidity of about 70%.

For post-storage fruit quality assessment, fruit were held for 24 hours at 20°C. Air temperature and humidity inside the storage rooms were logged by an Onset Hobo logger.

At each assessment date, fruit weight, flesh weight and thickness were recorded by conventional methods. Skin disorders were also evaluated. Total soluble solids (TSS) were measured by a portable refractometer and flesh firmness was determined using a standard penetrometer. Carotenoids, vitamin C, carbohydrate were analyzed by spectrometry, polarography and HPLC, respectively.

Skin disorders were evaluated based on a 1-5 score; 1 - no disorder, 2 - slightly affected (1-5% surface area), 3 - medium damage (5-15%), 4 - severe damage (>15%) and 5 - spoiled (black colour and sunken skin). Fruit conditions during shelf-life were evaluated as follows:
stage 1 - ripe and marketable fruit; 2 - ripe, none-soft fruit; 3 - slightly over-ripe fruit with no rot; 4 - over-ripe fruit with 10% rot; 5 - over-ripe fruit with 25% rot. Stages 2 to 3 are classified as most acceptable by consumers.

Average fruit weight of ‘Hoi’ was twice that of ‘Tron’ (Figure 1), indicating a genetically greater fruit size potential. Fruit weight of both cultivars decreased with storage duration considerably more at 20°C than at 12°C. No chilling injury symptoms were observed even at 12°C storage conditions.

Figure 1 - Fruit weight (averaged over three picks) of ‘Tron’ and ‘Hoi’ mango varieties.

Soluble solids of both varieties increased from the first to the third pick and ‘Tron’ fruit tended to have much greater TSS concentration than ‘Hoi’ fruit (Figure 2). This indicates that ‘Tron’ is a sweater variety, yet fruit might have been generally picked too late. TSS of ‘Hoi’ increased considerably with storage duration at both temperatures; an effect that was not seen to the same extent with the variety ‘Tron’. As expected, TSS of ‘Hoi’ following 10 days storage was higher at 20°C than at 12°C. Fruit firmness of ‘Hoi’ was greater than of ‘Tron’ at each pick and following fruit removal from storage. This might also indicate that harvest management for ‘Tron’ was not optimal and selected picks tended to be too late. The least loss of fruit firmness for both varieties was after 10 days at 12°C. All other storage treatments had an unacceptably high decline of fruit firmness.

Skin disorders of both cultivars are often caused by diseases, latex oozing and/or scars. Fruit of both varieties were significantly spoiled (score > 3), following 10 days of storage at 20°C and after 30 days at 12°C. Consequently, the longest shelf-life resulted from fruit stored for 5 days at 20°C and less than 20 days at 12°C.

Figure 2 - Soluble solids (averaged over three picks) of ‘Tron’ and ‘Hoi’ mango varieties.

First results indicate that both ‘Tron’ and ‘Hoi’ fruit stored for 5 days at 20°C and for less than 20 days at 12°C gave sound fruit quality in terms of acceptable weight loss, flesh firmness, total soluble solid and skin disorders. ‘Hoi’ fruit showed a better postharvest potential than ‘Tron’.

Effects of crop load and postharvest treatments, e.g. with warm water, will be investigated next to further develop optimum harvest management practices for ‘Tron’ and ‘Hoi’ in relation to storage behaviour and fruit quality consumer preference at the point of purchase.

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Marginalization of upland communities in the post-tsunami Aceh and Nias in Indonesia

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KEY WORDS: natural disaster; conflict; tree crops; environment; economic development

Deforestation and land degradation are strongly linked to rural poverty and economic opportunities. Major natural disasters, such as the tsunami and earthquake of December 2004 in Aceh, Indonesia, are often followed by large number of reconstruction and rehabilitation projects. This in turn exerts serious pressure on existing natural resources. The high demand for construction materials, mainly timber, leads to serious deforestation. The impact often extends much further beyond the site of disaster. However, this link between site of development and site of impact are often ignored in livelihood and environmental programs.

Aceh remains one of the poorest provinces in Indonesia despite its rich natural resources. The 3-decade long political conflict, economic isolation, lack of technology and weak institutional setups are part of the reasons. There is much disparity in the poverty of people living in the coastal areas and those living further upland. The upland or inland people suffered more from political isolation, conflict and fear; they are poor and disadvantaged. The long political dispute between the government and the Free Aceh Movement (or GAM) killed nearly 15,000 people and displaced more than 35,000 households. In most rural areas, infrastructure sustained serious damage and further deteriorated due to lack of security and access for development. The 2004 earthquake and tsunami thus occurred in a province that was already experiencing large-scale disaster and damage.

Soon after the earthquake and Tsunami of December 2004, unprecedented amounts of aid money from international development agencies and governments were spent in big projects for reconstruction, rehabilitation and economic development. The narrow strips of coastal areas that were directly affected by the Tsunami waves remained the focus for most, if not all, projects.

An extensive survey was conducted in June-August 2007 along coastal and upland areas in three locations - accessible East Aceh with strong conflict history, less accessible West Aceh with some conflict history, and the remote island of Nias with no conflict history. Primary data and secondary information were collected through household interviews, group appraisals and expert consultations from sample villages, both in coastal as well as inland areas. Data on deforestation were analyzed and comparisons were made between coastal and upland regions regarding livelihood strategies, land use household income, environmental damage after December 2004. There are apparent economic, environmental and development links and interactions between coastal and upland areas. While the upland communities suffered seriously from pre and post Tsunami activities, development initiatives have largely ignored these upland-lowland links. The upland communities and their development issues so far remain marginalized.

About 54% of the district populations live inland and nearly 94% of these inland people rely on agriculture compared to 55% in the coastal areas. The proportion of households below the poverty line in all study sites is far higher than the national average. People in Nias
Island and inland Pidie are among the poorest of the poor. There is disproportionate distribution of poverty between coastal and inland areas as well as between locations (accessible East Aceh (strong conflict history), less accessible West Aceh (conflict history) and the remote island of Nias (no conflict history).

Poverty and livelihoods are closely linked to natural resources. In rural communities in the uplands of Aceh and Nias, agriculture is the basis of daily lives. In the inland average of 76% total income comes from agricultural activities and 21% from off-farm activities. Among the agricultural activities, tree crops are the most important providing 60 to 78% of total income. Rubber, cocoa, areca nuts, coffee, coconut and oil palm are important income generating tree crops (Table 1). Compared to coastal communities the upland people depend more on tree crops and other forest resources as there are fewer off-farm economic opportunities. Most post-tsunami livelihoods programs in Aceh and Nias focused mainly along coastal areas on marine fishery, rice production and other minor activities.

During the ‘construction boom’ phase (for about 3 years following the Tsunami), the high demand for construction materials (sand, stone, timber and brick) has led to intensified logging and sand/rock mining activities throughout Aceh and Nias. Reconstruction works, mainly in the coastal areas, in Aceh have already used an estimated 850,000 cubic meters of illegal logs (nearly 50% of the total timber used). It is estimated that illegal logging is destroying around 20,769 ha of rain forest each year in Aceh. Most of this is in the upland areas that had remained relatively intact during the conflict years. The deforestation sharply intensified after the earthquake and Tsunami. The price of rice doubled within a year after the Tsunami, leading to clearance of more land for growing rice. The clearance of peat area for human settlements and oil palm plantations is also an environmental problem. Most of these changes are occurring in the upland areas. The intensity of interaction between the development activities in the coastal areas and environmental impact in the upland rural areas had not been anticipated to the full extent.

In many rural areas forests and other natural resources that provide environmental protection are also used by local communities to meet their economic requirements. The case study in Aceh and Nias clearly demonstrates that many of the environmental problems in such post-disaster context cannot be solved through short-term measures and only through conservation oriented programs. A focus on trees and tree-based systems and how such forest and agroforest systems can be managed in a sustainable manner is a key to the success of economic and environmental programs.

There is an urgent need for an increased awareness among development and policy professionals of the livelihood-environment links of upland-lowland communities in post-disaster support initiatives. The plight of the upland communities must be considered and steps taken for a more equitable development between the lowlands and uplands. Necessary precautions to minimize the impacts of intense development activities in the lowlands on upland communities and their natural resources in the upland should be appropriately designed and implemented.

### Table 1. Household income (%) from economic activities in West Aceh and Nias

<table>
<thead>
<tr>
<th>Income source</th>
<th>Coastal area</th>
<th>Upland area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>West Aceh</td>
<td>Pidie</td>
</tr>
<tr>
<td>On-farm (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paddy field</td>
<td>87.0</td>
<td>56.3</td>
</tr>
<tr>
<td>Other crops</td>
<td>4.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Tree crops</td>
<td>59.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>46.8</td>
<td></td>
</tr>
<tr>
<td>Livestock</td>
<td>22.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Fishing</td>
<td>1.0</td>
<td>7.8</td>
</tr>
<tr>
<td>Off-farm (%)</td>
<td>12.2</td>
<td>41.7</td>
</tr>
</tbody>
</table>

International Symposium 2008, Stuttgart, Germany
Interdependencies between Upland and Lowland Agriculture and Resource Management
Marginalisation through integration? Vietnam’s (northern) uplands in the postcolonial context

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KEY WORDS: Vietnam; uplands; rural development; ethnic minorities; marginalisation

EXTENDED ABSTRACT

This paper analyses social and environmental changes affecting rural people’s livelihoods and environmental change in Vietnam’s northern uplands. It aims to bring into dialogue related arguments from social science research with recent case studies of agrarian change, in order to move towards an integrated understanding of the main drivers of change as well as a nuanced assessment of ongoing social change. The main drivers for change identified for the postcolonial period are political integration and, more recently, open market forces, local people’s livelihoods strategies, and environmental change. The overriding process is the unprecedented degree of integration into the national, lowlands-dominated political-economic system. Understanding this process of integration properly, however, demands that we also look at the forms of marginalisation and exclusion it creates.

To this end, the paper uses a multidimensional understanding of marginality as outlined by Blaikie and Brookfield (1987: 19-23). The concept of marginality, understood as comprising economic, ecological and political-economic aspects, informs the reading of the historical literature on uplands/outside relations and lets the northern uplands emerge as only loosely connected to external, precolonial centres of power. The notion of marginality also informs the engagement with Patricia Pelley’s (1998) account of postrevolutionary ethnic Vietnamese (Kinh)/minority relations, which she describes as repeating patterns of colonialism in important respects. Pelley’s account of the postcolonial uplands in which minority ethnic groups became rearranged around the Kinh ‘civilising’ centre, and the way in which she problematises its homogenising and suppressive effects, both remain highly topical. While acknowledging the hegemonic role assumed by the Kinh ethnic group in the postcolonial era, this paper argues that Pelley’s line of analysis overestimates the capacity of the postcolonial party state fully to integrate and control the uplands, and overlooks important dynamics that cross-cut ethnic divisions.

Empirically, this paper is based on observations and interviews conducted in several Hmong, Black Thai and Kinh villages in Yen Chau district, Son La province, between 2002 and 2005. These data serve to highlight important differences between the studied villages’ recent trajectories of development and integration and villagers’ own perspectives on the changes.

After explicating the underlying empirical data and the methods used, the paper presents an historic overview up to the immediate postcolonial period. The discussion of relations between external centres of power and the diverse ethnic groups inhabiting the northern uplands shows that larger, more centrally dwelling ethnic groups such as the Thai have historically been more integrated than smaller, highland-dwelling groups such as the Hmong. In the following section, the literature on Vietnam’s uplands in the postrevolutionary
phase will be reviewed to position the present argument in the debates surrounding the impact of national development efforts on ethnic minorities. The argument for understanding the dynamics of Vietnam’s postcolonial uplands as concurrent processes of integration and marginalisation will then proceed in four steps. First, a review of the implementation of a number of national policies (immigration, resettlement, collectivisation) in the uplands demonstrates that while they were only ever partially implemented, they often discriminated against ethnic minorities and contributed to marginalising them economically and socially. Second, the discussion of temporal and spatial patterns of agricultural innovations suggests that inversions occur over time; e.g. historically particularly marginal groups such as the Hmong have recently become more integrated into, and in cases profited more from, cash cropping than traditionally more integrated groups such as the Black Thai. Third is the impact of development project activities, and fourth the politics of knowledge concerning conceptions of disease. These latter examples show how global integration, expressed through international development and modern biomedicine, increasingly shape locally available concepts, practices and struggles. But the introduction of institutional innovations by international development projects is constrained by conflicts with local political culture and seems to remain largely ineffective. The biomedical conception of disease, underlying and transported by the public health system in turn threatens to undermine and hence marginalise local conceptions of disease grounded in ethnic culture; its reach though is limited - just as the above external influences.

All examples hence undermine the sharp dichotomy of ‘lowland colonising power’ versus ‘colonised uplands’. Instead, this paper concludes that while Vietnam’s northern uplands have indeed been subject to strong if changing external influences in the postcolonial period, the outcomes thereof are much more diverse locally than anticipated by lowland planners and scholars alike. The variety of outcomes can be explained by geographical factors, the limited means to implement external agendas, and local people’s cultural resilience and agency. The paper closes with a reflection on how far the focus on integration/marginalisation helps understand important differences between the Central Highlands region and Vietnam’s northern uplands. In the Central Highlands, integration has been linked to massive immigration of lowlanders seeking to profit from the coffee boom of the 1990s; indigenous ethnic groups in contrast have mostly been unable to profit from these economic opportunities and have often lost their land. As a result, ethnic minority farmers have repeatedly protested, and the region continues to be characterised by tensions between local people and the state. The paper concludes that the balance of positively experienced integration and processes and feelings of marginalisation and exclusion is a key analytical question for understanding and assessing the consequences of uplands integration in Vietnam.

REFERENCES


Knowledge transfer in the context of upland and lowland agricultural interaction in northern Vietnam

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KEY WORDS: Upland-lowland interaction; lowland knowledge; knowledge transfer; adoption; Vietnam

Since the first five-year plan (1961-1965), the strategy of integrating the ‘backward’ Northern Mountainous Region (NMR) of Vietnam into the lowland economy and supporting ethnic minority groups to catch up with the lowlands and dominant Kinh (ethnic Vietnamese) has been promoted. The government thus has enforced a series of policy measures aimed at increasing the agricultural productivity by promoting advanced technologies, enhancing forest exploitation, and ensuring food security by emphasizing on the production of food crops and promoting the industrialization and modernization of agriculture [Sadoulet et al., 2002; The et al., 2004]. Focusing on the analysis of agricultural knowledge transfer in the upland and lowland interactions and its driving forces, this paper challenges the conventional assumption that the adoption of lowland knowledge in uplands has been mainly driven by benevolent government policies and generated a win-win economic relationship between uplands and lowlands. Rather we claim that knowledge transfers and innovation processes have been instigated by multiple socio-economic driving forces and that this has caused a number of adverse effects on the uplands’ ecosystem and society. Our findings are mainly based on a review of the existing literature and government documents and on primary data collected from group meetings and open interviews with 16 officials from various national research and extension organizations and 30 farmers in Son La province, who have adopted different lowland agricultural innovations in Son La Province.

The term ‘lowland knowledge’ in this paper refers to the technologies, which have been traditionally practiced by the lowlanders or were recently developed by researchers under the specific conditions of the lowland areas based on the government’s socio-economic development strategies. The lowland knowledge transferred to the Northern Uplands is characterized by a ‘linear transfer-of-technology model’, whereby local people’s active participation in technology adaptation and their indigenous knowledge, culture and conditions are widely neglected. The transfer of the lowland knowledge during the last five decades has been carried out by several major actors, both from public and private sectors, who use different approaches in the transfer process [figure 1]. Government actors focus on the technology promotion for food security and agricultural modernization, mainly “advanced technologies for commodity production”, “reforestation and silvicultural technologies” and “advanced technologies for food security”, based on principles of transfer of advanced, modern technologies via high-tech or modern farming demonstration models established with key farmers to prove successful experience, coupled with the use of inputs subsidies to encourage the technology transfer and adoption process. Kinh migrants adapt their “lowland farming knowledge” to their new residential areas and play the roles of both transporter and adopter in the uplands. Under the current context of strong socio-economic exchanges between lowlands and uplands in recent years, agricultural extension staff often acts as sales agents and individual service providers and adopt the role of knowledge carriers.
Adoption in early stages of upland development was strategically decided by either collective communities or individual farmers to gain tangible or intangible incentives in terms of political and cultural gains or material and financial subsidies [Clement et al., 2006], which can be classified as “adoption for incentives”. This type is often seen in the adoption of “advanced technologies for commodity production” and “advanced silviculture technologies”, which are promoted by the government and always accompanied by input subsidies and other incentives. Typical examples have been soil conservation measures, such as hedgerows, which were mostly adopted to attract the side-benefits of development projects or to be eligible for land titling programs. More recently, adoption processes have been characterized by “adoption for local consumption” and “adoption for cash income” depending on characteristics of knowledge, local conditions and local farmers’ interests, individual behaviors and capacity, social perception and culture, and market demands. The “adoption for local consumption” is commonly found with advanced technologies or innovations that uplanders can apply to increase productivity to satisfy their consumption needs, which is referred to as “advanced technologies for food security”, promoted by the Government since the late 1980s in the Uplands. This is exemplified by the rapid adoption of hybrid rice varieties of Chinese origin which has increased food security, but has also made farmers more dependent on continuous seed supplies.

“Adoption for cash income” refers to knowledge transfers applied in the agricultural production system to serve the market demands, mostly generated by lowland society with rising incomes and a mounting desire for a higher share of animal protein in their diet. This knowledge can be classified as “advanced technologies for commodity production”. The adoption of high-yielding varieties of maize – a highly erosion-prone and fertility-depleting crop in sloping upland areas – for the rapidly expanding large-scale feed industry and the related introduction of exotic pig breeds is the most prominent example for this type of innovation adoption.

While a number of lowland-generated technical innovations of the “adoption for incentives” type have failed after a short-lived adoption due to various reasons, such as incompatibility with indigenous knowledge systems, neglect of ethnic minority and topographical diversities, incomplete processes of knowledge transfer and lack of concern for the economic, cultural and environmental vulnerabilities of the uplands, the latter two forms of adoption often have a longer lifespan in the upland communities, because they are strongly driven by local socioeconomic and market factors. The stronger involvement of individual service providers, and the commercial companies together with trade flows and trader networks with their multiple...
roles of middlemen, rural financial institutions, investors, input providers, extension workers and processors are strong promoters for the “adoption for cash income” by integrating uplanders into dynamic market processes, albeit mostly on terms that are imposed on the latter by more powerful market actors.

An understanding of the movement of lowland knowledge in the current context of dynamic socio-economic development of the Northern Uplands is crucial for improving mountain people’s economic opportunities to ensure that they receive a fair return from the adoption of these technologies. In the short run, the knowledge and innovation transfer appears to create a win-win interaction between the uplands and the lowlands in terms of improvement of food security, immediate income generation and improved market access for uplanders. In the long run, however, the indiscriminate adoption of lowland knowledge under market-driven forces leads to resource exhaustion and increases social costs in the upland societies. The uplands and their inhabitants are facing long-term economic and environmental threats due to the exploitation of natural resources for maximizing short-term profits, whereby concerns for sustainability of the fragile agro-ecosystems and of rural livelihoods are being neglected. We conclude that future innovation processes need to be embedded in a long-term agricultural development strategy, build on local resources and human capacities, and take into account the ecological fragility of upland areas and economic vulnerability of their inhabitants in order to foster a more balanced upland-lowland integration.

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Moving people, shifting problems -
The impact of state-enforced lowland-upland resettlement on land use and natural resources in Ethiopia

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Increasing population pressure and deteriorating ecological conditions led to severe resource degradation in lower central Ethiopia. Large sections of the local population are vulnerable to chronic food insecurity due to low agricultural output and droughts. Ever since the 1970s, the Ethiopian governments carry out large scale resettlement programs in which peasants are relocated inter alia from lower central Ethiopia to the upland areas in the Southwest of the country. The areas of destination are less densely populated and widely covered with Ethiopia’s last remaining rainforests.

The rationale behind state-enforced resettlement is to reduce population pressure and to facilitate resource rehabilitation in lower central Ethiopia and at the same time to provide peasants with a better livelihood by making use of ‘under-utilized’ resources in the mountainous forested areas. Massive forced resettlement programs were implemented by the communist-inspired Derg regime in the 1970s and 1980s. The new ruling government under the EPRDF, however, shows a prolonged commitment to this policy. Currently, it pursues plans to resettle a total of about seven million people in the midterm, concerning different parts of the country. So far, about 400,000 of them have already been resettled.

Advocates of the resettlement argue that it is the most cost-efficient policy option to cope with resource degradation and food insecurity in the long-term. In the past, however, resettlement did not prove to solve the problems in the lowland areas, while simultaneously posing massive irrevocable ecological and socio-economic problems to the upland areas of destination. Most apparently, resettlement fosters the process of degradation and loss of the rainforest, leading to the impairment of ecosystem functions, soil degradation and loss of biodiversity. Beyond that, it aggravates the disruption of indigenous land use and resource management regimes causing conflicts between the original population and the new settlers.
Upscaling of soil mapping in NW-Thailand:
Gaining synergy by blending different approaches

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KEY WORDS: Maximum likelihood; SOTER; local knowledge

Until present, information on highland soils of NW Thailand is quite sparse. Reasons for the low data density are mainly terrain inaccessibility, steep slopes, remoteness from research centers and political reasons like declaration of conservation areas and use by ethnic minorities. The population growth in the highland areas entailed an extension of arable land, intensification of land use and increased application of fertilizers and pesticides in the highlands causing intensified flooding and water pollution in the lowlands. This leads to social conflicts between the lowland “Thai-majority” and the ethnic minorities in the highlands. In order to reduce the existing problems, more sustainable land use practices have to be aspired. This can only be achieved by sensible land use planning and modeling. Both require detailed information on soils and their properties. Intensive soil mapping of whole NW Thailand is very costly and time consuming. An alternative is given by the SOTER (SOIlTERrain) approach, which combines soil and terrain information through a so called SOTER map. SOTER maps use hierarchical map units, which are linked with a database. The highest level consists of terrain units representing major landforms, while the lowest level is represented by soils and their properties. In order to map the soils within the different landforms of NW Thailand in an efficient way, three different petrographic areas (Bor Krai: limestone, Huai Bong: sandstone, Mae Sa Mai: granite and gneiss) were chosen and intensively investigated. Each investigation area represents a small section of their respective landform, dominated by a certain petrography. Soils of the respective areas were mostly investigated along transects. In zones of expected high soil variability additional investigations were carried out. The investigations resulted in reference soil maps, representing a best guess of the actual pedology. In addition local soil knowledge was elicited in each area. Subsequently, soil mapping based on the maximum likelihood (ML) approach was carried out and compared with the respective reference maps.

The reference soil maps showed the highest accuracy. Even minor soil types were detected. However, the compilation of the reference soil map was the most time consuming and costly. The reference maps showed for all three areas mainly soils which are dominated by clay illuviation. The Mae Sa Mai area is dominated by Acrisols followed by Cambisols. Acrisols are prevailing on moderate steep slopes and on elevations below 1300 m asl. Above 1300 m asl Acrisols pass over to Cambisols, due to a decrease of clay translocation. The Huai Bong area is dominated by Luvisols and Cambisols. Luvisols occur mainly on moderate inclined slopes, while Cambisols are common on more strongly inclined slopes and in the valley bottoms. The Bor Krai area is characterized by three soils types. Among those, Luvisols prevail on gentle slopes at lower elevations, above 800 m asl they pass over to Acrisols. Cambisols occur on steeper slopes and in the bottom of most karst depressions.
The elicitation of local knowledge revealed that farmers have a profound knowledge of their area. In all three areas, soils were differentiated according to soil color. Further criteria for local soil classification were bulk density, stone content and topsoil thickness. In Mae Sa Mai six different local soil types according to soil color and topsoil thickness were identified. For Huai Bong five soil types according to color, stone content and topsoil thickness were detected. In the Bor Krai area eight different soil types could be distinguished according to soil color and bulk density. All elicitated local soil maps provided an overview about the main soil types of the respective area. Furthermore, background information like crop suitability, water infiltration, erosion hazard was given for each local soil type by the farmers. Mapping of local soils and their properties was the cheapest and fastest method. The degree and kind of local knowledge varied among the villages. Furthermore the respective local soil knowledge is restricted to village areas and therefore mapping at larger scales is not possible.

The ML approach was carried out according to the following procedure: First, soil types were sorted according to their abundance within an area. Soil types occurring in more than 15% of all samples build up the group “major soil types”. The less frequent soil types, representing between 2 and 15% of all samples were grouped as “minor soil types”. Exceptional soil types representing less than 2% of all samples were excluded from the maximum likelihood mapping, because their abundance is not sufficient to calculate the covariance matrix (therefore at least 5 different sampling points are required). The second step comprised a factor analysis of both groups using the software PAST 1.69. The aim of the factor analysis was to select the raster data with the highest explanation value for the given soil data. In a next step the maximum likelihood approach was applied for all sampling points of the major soil types within the area. This step was implemented using the ArcGIS 9.1 software. Several solutions of the factor analysis consisting of different shares of the respective raster data were compared with the reference soil map. The solution with the highest accordance was selected. The same approach was applied for all sampling points of the minor soil types. The final maximum likelihood map was compiled by overlaying the maximum likelihood map of the major soil with the map of the areas where the minor soil types show a probability of more than 90%. Once a useful solution is found, the maximum likelihood approach can be extended to larger areas, exceeding the size of the respective reference maps several times. The only conditions are comparable elevation range and petrography. The soil maps based on the maximum likelihood approach delivered information about the distribution of the main soil properties and the probability of their occurrence. For all three investigated areas a correspondence of ≥58% with the reference soil map was achieved. An essential contribution to the maximum likelihood classifications came from bands of SPOT and LANDSAT images indicating vegetation and drought stress. All used SPOT and LANDSAT images were taken during dry season. Therefore, it seems that the response of vegetation to drought correlates with soil moisture and with the major soil types. The effort for the investigation of the necessary calibration area for the ML approach is high, but using this method also the mapping of areas exceeding the size of the calibration area at 15 times seems to be feasible. Despite the restriction to village areas local knowledge is very helpful to make soil mapping of the calibration area more efficient by providing information on key sites and soils. In conclusion, the combination of the SOTER concept with the ML approach along with the investigation of local soil knowledge can create synergy effects, which enable an efficient soil mapping of whole NW Thailand.
Traditional Knowledge on Highland Forest Management and Tropical Forest Restoration

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KEY WORDS: FORRU; Karen; Lawa; Rotational shifting cultivation; Seedling recruitment; Thailand

ABSTRACT

Deforestation is one of the most important environmental problems in Thailand and Southeast Asia. Traditional forms of reforestation focused mainly on increasing tree cover by planting fast-growing trees. Now, more ecologically based, “forest restoration” is being attempted. This involves planting indigenous forest tree species to restore forest ecosystem structure (such as multilayered canopy), functions (such as nutrient cycles and food webs) and biodiversity, to similar levels that were present before deforestation occurred. Ethno-science has recently gained momentum in its potential application to conservation and sustainable development of natural resources. Some ethnic groups of Northern Thailand’s indigenous peoples have been recognized as sustainable users of natural resources. For example, the Karen and the Lawa practice rotational shifting cultivation. This form of farming involves 1-2 years of upland rice cultivation, followed by 3-10 years of fallow (varying among villages). Furthermore, indigenous people are also knowledgeable about wildlife. Birds and medium-sized mammals, are essential seed-dispersers, without which recovery of tree species richness in regenerating forests could not occur. However, this knowledge has not yet been applied to ecologically-based forest restoration research. In Chiang Mai Province, one Karen and one Lawa village practicing rotational shifting cultivation were selected. In each village, land is categorized as forest and fields at various stages in the rotational cycle (cropped, young-, middle-, and late-fallow). The vegetation are surveyed using transect belts. Plant species richness and diversity are calculated. Seedling recruitment (from tree coppicing, the seed bank, and from incoming naturally dispersed seeds) are assessed. Traditional knowledge of the rotational shifting cultivation practices will be gathered using questionnaires and by interviewing key informants.

RESULTS

Preliminary plant surveys in rotational shifting cultivation fields of the selected Karen village revealed numbers of tree species as 48, 77, and 98 species in the 1-, 3-, and 6-year fallow fields, respectively. The total number of tree species was 114. The species with the highest relative density were Eugenia fruticosa (15.9 %), Flacourtia indica (27.0 %), and Mitragyna hirsuta (10.4 %) in the 1-, 3-, and 6-year fallow fields, respectively. Table 1 shows the Sorensen’s similarity indices of the tree species among the studied plots. Numbers of seedlings in the 1-, 3-, and 6-year fallow fields, were 18, 21, and 34, respectively. The total number of the seedlings was 46. The species with the highest relative density were Melicope glomerata (17.2 %), Aporusa octandra (28.8 %), and Archidendron clypearta (16.7 %) in the 1-, 3-, and 6-year fallow fields, respectively. Table 2 shows the Sorensen’s similarity indices of the seedlings among the studied plots.
Table 1. Similarity indices of the tree species among the studied fallow areas of Mae Hae Tai (Karen) village, Mae Chaem district, Chiang Mai, Thailand

<table>
<thead>
<tr>
<th>Plot</th>
<th>1-yr fallow</th>
<th>3-yr fallow</th>
<th>6-yr fallow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>H' = 2.78</td>
<td>H' = 3.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E = 0.71</td>
<td>E = 0.71</td>
</tr>
<tr>
<td>1-yr fallow</td>
<td>1.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3-yr fallow</td>
<td>0.72</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>6-yr fallow</td>
<td>0.59</td>
<td>0.71</td>
<td>1.00</td>
</tr>
</tbody>
</table>

H' = Shannon-Wiener’ Diversity Index  
E = Shannon-Wirner’s Evenness Index

Table 2. Similarity indices of the seedlings among the studied fallow areas of Mae Hae Tai (Karen) village, Mae Chaem district, Chiang Mai, Thailand

<table>
<thead>
<tr>
<th>Plot</th>
<th>1-yr fallow</th>
<th>3-yr fallow</th>
<th>6-yr fallow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>H' = 2.37</td>
<td>H' = 2.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E = 0.84</td>
<td>E = 0.76</td>
</tr>
<tr>
<td>1-yr fallow</td>
<td>1.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3-yr fallow</td>
<td>0.41</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>6-yr fallow</td>
<td>0.38</td>
<td>0.55</td>
<td>1.00</td>
</tr>
</tbody>
</table>

H' = Shannon-Wiener’ Diversity Index  
E = Shannon-Wirner’s Evenness Index

CONCLUSION AND OUTLOOK

Gathering of indigenous knowledge related to plant dispersal and seedling recruitment in rotational shifting cultivation fields will be done.

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Suitable Farm Ponds into the Integrated Watershed Development Programme in Northeast Thailand

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KEY WORDS: Farm pond; integrated watershed management; small scale water resources; New Theory farming systems; shallow ground water

ABSTRACT

North-eastern of Thailand is well known as the poorest region due to the unstable and low agricultural productivity under poor soil and rainfed dependant majority with extremely erratic rainfall distribution. Degraded soil is noticeable resulted of heavy land use after falling forests without appropriated soil and crop practice measurements. Runoff is consequently resulted in emerging of shallow layer and skeleton soil in upland, expansion of saline and alkaline soil in lowland. Various soil and water resources management to cope the sustaining agricultural productivity are full responsible of related departments of Ministry of Agriculture and Cooperatives through the small scale water resources development. Recently, the number of various farm ponds is up scaling intervened in rainfed farming development programmes as a key option especially in (i) a His Majesty the King’s initiative programme on “New Theory Farming” an integrated farming practice, government once have provided grants and supports to extend this New Theory farming for qualified hometown laid-off labors whom suffering from “Tom-Yam-Kong” economic crisis in 1997. Subsequently, a number of 6,783 New Theory farm ponds were implemented country wide in which 4,423 of these ponds loaned by Asian Development Bank. Meanwhile another comparative smaller of 252,200 farm ponds implemented by Land Development Department during 1997-2001, which 5-15 units specified to implement in each land development villages as micro-watershed representative which the degree of soil degradation and water shortage are high. Pond size is limited to 1,260 m³ of water storage. There are 56 units of pond implemented in two benchmark watersheds in Northeast under (ii) a holistic watershed management programme on “Participatory Watershed Management for Reducing Poverty and Land Degradation in SAT Asia” a multi-sectoral consortium approach of the International Crop Research Institute for the Semi Arid Tropics and Thai research organizations, since 1999 and 2003 under the financial support of the Asian Development Bank. The lesson and learns from the interventions as well as the impacts of this two farm ponds were discussed and addressed in this paper.

The studies revealed that the New Theory farm structure is basically designated into ratio 30 / 30 / 10 respectively for farm pond body / paddy field / crops / farmhouse, However, on survey of farmer practices across 535 New Theory farm owners in Khon Kaen Province, exhibited that the allocation of his/her new-structured farmland were accounted only a half...
to designed size (15%) for pond body, 28% for crop land, and only 2% for farm house. These were making paddy field area accountable to 55%. The ponds typically located in lowest part of flat-lowland paddy. Pond body sizes, practically varied in width and depth upon the capable of farm-owners to provide partial co-sharing cost, were average of 7,700 m$^3$ water storage capacities. Water utilization was sufficient enough to available for paddy and dry season crops throughout year round, enable farmers increase crop intensification, engage wider alternatives for farm activities, promote fish-animal integrated farming practices, obtain more labor employment opportunity, farm income and better livelihood. Meanwhile, at two benchmarks integrated watershed development sites, 17 ponds located in hilly site and the other 39 in subsequent rolling upland site. Even through a relative small farm pond, but within proper land use and water and crop management, these farm ponds resulted in significantly not only increased water availability and crop productivity but also reduced soil loss to 5-6 t/ha per year compared to 25-33 t/ha per year in the traditional systems. Water saving utilization were observed and indicated that hilly farm pond water was mainly used for rainy season vegetables and home garden crops whereas rolling landform farm pond water was occasionally used for rainy season paddy rice securing during critical dry spell as well as for various vegetables and field crops cultivation in dry season. These enable families earn additional income of which about 85%, 10% and 5% were derived from vegetables, fruit trees and local herbs respectively in the hilly watershed, as opposed to 78%, 10%, 8% and 4%, derived from paddy, fish, vegetables and fruit trees in the rolling watershed. Investigation of de-leveling of water ponding revealed that soil properties, clayey in particular, play a key role with regard to the water holding capacity in the hilly areas, whereas the pond water levels in the rolling areas showed a close relationship to shallow ground water levels. De-leveling water ponding of farm ponds in lower elevation performed per smaller rate in compared to the upper elevation-ponds. Previous hydrological study on North-eastern rainfed paddy, exhibited that the horizontal water seepage through downward paddy plots was predominant in valley-paddy field. Even these two types of farm pond located separately in differed topo-sequences of watershed, but each are usually surrounded with earthen bund-paddy plots “a shallow pond” structure-alike which water seepage performed similarly. These can be clarified why the much closer location of farm pond to the upper most watershed are, the much poorer water storage capability were evident. These lesson and learns recommended that not only run off rain-storms “recharge water” but also the horizontal flow of shallow ground water “discharge water” should be taking into account to quantify water ponding capability and further farm pond design. Therefore, fitting to farm-owners’ need and enhance water storage capacity, the excavation of pond in limited paddy-land suggested that the depth rather than the width of pond body should be considered. In aspect of holistic watershed management, apart from proper integration of soil and crop management, earthen bund paddy, terrace or contour bund upland, vegetated strip bund highland, etc., suggested a series of farm ponds network-placement to intercept the runoff rain-storm as well as horizontal shallow ground water as possible, the optimize rain water utilization and sustainable North-eastern Thailand agricultural productivity will be achieved.
The improvement of crop productivity and water use efficiency for sustainable highland rainfed agriculture*

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KEYWORDS: alley cropping; mulching; contour furrow cultivation; soil loss; water use efficiency

Sustainable crop productivity and water use efficiency under highland rainfed condition is dependent on rainfall characteristics and soil water availability. Strategies to increase the soil water storages are to reduce surface runoff, increase infiltration rate and decrease soil water evaporation. Anti-erosive contour cultural practices and surface mulching are most practical methods used to increase soil infiltrability and soil water availability on sloping land (Panomtaranichagul et al., 2006). This paper reports a part of the results obtained from the 3 year - field trials which were conducted during January 2004 – March 2007 in Borkrai Village, Pangmapa District, Maehongson Province, Northern Thailand. The experiment aimed to evaluate the effects of modified contour cultural practices on soil erosion control, soil water storages and crop water use efficiency for multiple crop productions under highland rainfed agricultural system. The experimental plots, Site A and Site B were selected from the farmer's fields in the 2 basins at hill slope gradients of 80% and 50% respectively. A completely randomized design with 3 replicates of 4 treatments (modified contour cultural practices) was applied to each experimental site. The studied treatments were (i) Conventional contour planting (CP), (ii) Contour furrow cultivation with alley cropping (CF-AL), (iii) Contour furrow cultivation with surface mulching of Imperata grass panel (Site A) and Bamboo trunk panel (Site B), with alley cropping (CF-M-AL), and (iv) Conventional contour planting with Alley cropping + additional Vetiver grass rows next to the fruit- tree hedgerows (CF-AL-VG). Each studied site consisted of 12 sub plots (5 x 30 m) with rotational growing of the three cash crop varieties, Sweet corn (Zea mays), Upland rice (Oryza sativa) and Lablab bean (Lablab purpureus), during early–mid rainy, mid-late rainy and late rainy – mid dry seasons respectively. The mixed varieties of fruit trees Mango (Mangifera indica Linn.), Lemon, (Citrus aurantifolia) and Jujube (Zizyphus jujuba Mill.) plus ground cover with Graham Stylo (Stylosanthes guianensis) were grown in the hedge rows of alley cropping. The parameters to evaluate the effects of the 4 treatments on sustainable crop productivity were conducted as follows; (i) soil chemical and physical properties were carried out 2-3 times a year. (ii) Surface runoff and soil loss were measured after every effective rainstorm. (iii) Soil water contents within 1 m soil depth were measured by TDR once a month. (iv) Crop development as total dry biomass and yields were measured at different stages of crop growth and harvested at the end of each crop growing season. Water use efficiency (WUE) of each crop was calculated based on total dry biomass and yield production per unit actual crop evapotranspiration during the growing seasons. Both experimental sites showed similar trends of results during the 3 year trials. Only results of runoff, soil loss, soil water storages, water use efficiency and crop yields including costs of benefit return under the studied treatments in Site A are presented in this paper. The results showed that (i) CP gave the highest runoff and soil loss amounts, whilst, CF-M-AL gave the lowest soil loss amount during the 3 experimental years. Similar runoff amounts were given under CF-AL, CF-M-AL and CP-AL-VG (Figure 1). The amount of total runoff and soil loss were more completely collected in 2006, consequently giving higher total amounts of runoff and soil loss compared to those measured in 2004 and 2005. (ii) Generally, the highest and the lowest soil water storages tended to occur in CF-M-AL and either CP or CP-AL-VG plots respectively, compared to CF-AL plots.
throughout the 3 experimental years. However, inconsistency variations of stored soil water within 1 m soil depth not only depended on different cultural practices, but also depending on rainfall distributions (Figure 2). (iii) CF-M-AL tended to give the highest while CP gave the lowest dry matter, yields and water use efficiencies of both corn and lablab bean, compared to either CF-AL or CP-AL-VG during the three experimental years. Upland rice grown as the second crop was not successful due to late sowing time in 2004 and pest invasions in 2005 and 2006.

Costs of benefit return after the third year experiment obtained under CF-M-AL was twice higher than that gained under CP. This results indicated that the best strategy to develop a sustainable highland crop production appear to be composite systems, consisting of contour furrow cultivation with mulching and alley cropping with hedgerows of mixed fruit trees plus leguminous ground cover crops (CF-M-AL). The advantages of multiple crop productivity may lead to broadly adoption and applications of this composite technique to build up the sustainability of highland rainfed agriculture.

**Figure 1.** The total amounts of surface runoff and soil loss influenced by different modified contour cultural practices (CP, CF-AL, CF-M-AL and CP-AL-VG) during the 2004 – 2006 growing seasons.

**Figure 2.** The effects of different cultural practices (CP, CF-AL, CF-M-AL and CP-AL-VG) on variations of total stored water with in 1m soil depth, from 1 January, 2004 to 24 February, 2007.
Rice and fishery productivities in relation to potential water resources in Red River Basin, Vietnam

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KEY WORDS: water resource availability; climatology; wetness index; rice; fishery; Red River

INTRODUCTION

Food security has become one of the urgent issues in Vietnam, which is induced by rapid population growth together with urbanization, industrialization, etc. For keeping up with these growing demands, farming systems are getting more and more intensive which thus causes agricultural land-use changes in whole of the country. In general, there is a limitation in water resources availability which is mainly affected by climatic and geological conditions, and land-use. Especially, agricultural land-use affects water resources of both quantity and quality in downstream areas. Therefore, it is essential to understand how land-use change would have impacts to water resources in a certain area. The present study aims to conduct preliminary analyses on the relationship between potential water resource and agricultural productions of rice and fishery in Red River Basin, Vietnam.

METHODS

The present analysis is based on officially available statistical data on general, agricultural and climatic conditions (General Statistic Office (GSO), 2007). Due to limitation in climatic data, the following five provinces are targeted in this study (Fig. 1): Lai Chau, Son La (North West), Tuyen Quang (North East), Hanoi and Nam Dinh (Red River Delta).

First, climatological characteristics of the target provinces are evaluated based on Wetness Index (WI: \( WI = P/ET \) where \( P \) denotes precipitation and \( ET \) evapotranspiration (Kondo, 2000). Then, potential water resource (PWR) was evaluated by \( PWR = P - ET \). In the evapotranspiration estimation, Hargreaves method (Hargreaves, 1994) was employed for its simplicity and to meet available climatic data, in which only measured value of mean, maximum and minimum air temperatures are required. The maximum and minimum temperature difference was taken from the literature (Nguyen Khan Van et al., 2000). Rice and fishery productivities are then analysed with water resources in each province using five-year data from 2002 to 2006.

Fig. 1. Target provinces in Red River Basin, Vietnam.
RESULTS & DISCUSSION

As a result of preliminary analysis (Fig. 2), WI indicates that the target provinces would have rich PWR in 1-year period but fall into severe dry conditions in some months of the year. This suggests the necessity of careful planning, management and monitoring on both land-use and agricultural activities at least on a monthly basis. From the statistics from GSO (2007), the annual productions of rice and fishery keep on growing, while the planted area remains stable or decreasing gradually. This may indicate the growth in these productivities, however, no such trend was found in the present analyses, in which the productivities were evaluated as the ratio of annual production to annual precipitation (fishery) and annual evapotranspiration (rice). The growth seems to be stable in rice except for the case in Lai Chau where fishery productivity also grows (Fig. 3). The decrease in rice productivity was found in Nam Dinh in 2005 (Fig. 3b). This is due to decrease in yield of summer rice (GSO, 2007) that might be caused by the heavy rainfall (48.2% of annual rainfall) observed in September through November in 2005. A similar heavy rainfall (38.0%) was observed in the same period of 2003 and the yield was also decreased. In the present study, trends in fishery and rice production were analysed in terms of water productivity on an annual basis. No clear relationship was found between climatic factors and agricultural production; monthly-based analyses may be needed. Since the strong competition for water resources between sectors, cities, and upstream and downstream regions is unavoidable, further studies on water and land resources are necessary to achieve sustainability in integrated water resources management in the region.

![Fig. 2. Climatic conditions and wetness index of the target provinces of Lai Chau (1), Son La (2), Tuyen Quang (3), Hanoi (4), and Nam Dinh (5) for 2002-2006.](image)

![Fig. 3. Trend of fishery and rice productivities in relation to water resources by provinces](image)

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Degradation and movement of chlorate in longan plantations

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KEY WORDS: chlorate; organic matter; leaching; sub-soils; longan.

INTRODUCTION AND OBJECTIVES

During the 1990s longan (Dimocarpus longan, L.) production in Northern Thailand was increased substantially. Consequently, the area was extended from the Ping River Basin to the surrounding foothills. In 1998 it was found that the application of chlorate induces flowering in longan trees. Since then potassium and sodium chlorates have been used in most longan plantations all over Thailand and some neighboring countries. Subsequently, concerns arose on whether these substances may contaminate ground waters of the upper Ping River catchment.

A first environmental impact study on the effects of chlorate application was carried out in the year 2000. The maximum rate in the early years of application was approximately 500 g for a medium size tree. It was found that if farmers apply once a year chlorate residue is unlikely to accumulate over the years and the long-term effect on soil environment is nil. However, the application rate of the substance has gradually been increased. In 2003 the maximum application for a medium size tree was approximately 2,000 g which is beyond the scope of the above mentioned study. Consequently, there has been concern on the accumulation and leaching of residues through soil profiles and the risk of ground water contamination in the long run. Thus, a re-study on the environmental impact has been done.

MATERIALS & METHODS

Movement and degradation of the heavily applied chlorate (equivalent with 2 kg per tree) at various depths in four control plots on four representative soils were monitored over a period of two years. Soil samples of these four profiles taken from the depths of 0-200 cm were incubated with chlorate for 270 days under laboratory condition. Then chlorate residues were analyzed. Additionally, the application and the residue of chlorate in 42 commercial longan orchards were monitored during the same period.

RESULTS AND DISCUSSION

The multiple simple linear regression between the percentage of degraded chlorate and soil properties of the soil samples from 38 layers of the four profiles is:

\[
Y = 107.150 - 9.632X_1 + 33.327X_2 + 0.186X_3 - 0.012X_4 - 0.0029X_5 - 0.065X_6 + 0.197X_7
\]

When Y = degraded chlorate in 270 days (%)

X1 = pH
X2 = Organic matter (%)
X3 = available phosphorous (mg/kg)
X4 = exchangeable potassium (mg/kg)
X5 = exchangeable calcium (mg/kg)
X6 = exchangeable magnesium (mg/kg)
X7 = clay (%)

The effects of each Xs to Y due to simple linear regression are 0.38, 22.60, 0.07, 4.38, 5.91, 1.36, and 4.02 respectively. Coefficient of multiple regression is 0.748, which are highly significant. Therefore, organic matter is the most important factor controlling the degradation of chlorate.

Figure 1 shows the very slowly degradation of chlorate in soils with less than 0.2% of organic
matter, regardless of their textures and depths. Only 18-67\% of the incubated amount was degraded in 270 days. On the other hand, in the soils with more than 0.8\% organic matter the degradation was 67-98\%. Therefore, there is high risk for the residue chlorate will be leached to the depth where organic matter is less than 0.2\%, will persist and move downward in the soil profiles.

Two years after the application significant concentrations of the residues were found at a depth of 150-230 cm in upland sandy soils (figure 2). Equal concentrations were found at the same depth in the commercial orchards with this type of soil. In loamy and clayey soils significant chlorate residues were found at a depth of less than 100 cm. of both the control plots (figure 3 and 4) and the farmers’ orchards. The slowly degradation in the soil with less organic matter and the well drainage capacity of sandy soil are the main reasons for the relative fast moving downward of chlorate residue in sandy soils.

CONCLUSION

There is high risk of ground water contamination by chlorate from longan plantations provided farmers continue apply it at high rate on sandy soils. Consequently, measures to eliminate chlorate residues after the flowering should be encouraged. It has been found from the previous studies that the application of any form of sugars is able to enhance the degradation of chlorate residues. In addition, the control of the application rate can be achieved provided that the practices for the efficient chlorate application are available.

ACKNOWLEDGEMENT

This study is a part of the research on solutions for the problems of increasing of application rate of chlorate in longan plantations, financially supported by Thailand Research Fund (TRF).
Effect of concentration and duration of colchicine treatment on polyploidy induction in *Dendrobium scabrilingue* Lindl. *in vitro*

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**KEY WORDS:** orchid; colchicine; polyploidy

*Dendrobium scabrilingue* Lindl. is one of those native Thai orchids which have a high potential to be of great commercial value in the future, because it has not only beautiful flowers but also a wonderful fragrance (Figure 1a).

Although many growers tried to cultivate it, so far they had no success because this orchid is very sensitive regarding its growing conditions. It only prospers in a very specific type of habitat and can be found solely in mountainous areas of some northern Thailand province. Therefore these orchids were taken out from the natural forest for local orchid trade. At present, not only this but also many other species of wild orchids have already been extinct in the wilderness because of climatic changes, floods and forest fires and especially the negative human influences for example by illegal logging. Micropropagation and induction of polyploidy are methods which could help to solve the problems in cultivating and optimizing wild orchid species because polyploid plants are easier to grow, have larger flowers, longer blooms, increased blooming time and give flowers several times a year as it has been reported for *Dendrobium* [Kamemoto et al., 1972], *Phalaenopsis* [Griesbach, 1981] and *Paphiopedilum* [Watrous and Wimber, 1988]. In this study the induction of polyploidy in *D. scabrilingue* Lindl. was conducted by using colchicine treatment while being cultured on semi-solid VW (1949) medium. Protocorm like bodies (plbs) of diploid *D. scabrilingue* Lindl. were treated with 0.00, 0.025, 0.05, 0.075 and 0.1 % colchicine for 3, 7, 14 and 21 days. After one month the survival rate, expressed as percentage of surviving plbs, has been determined. Eight months following treatment the percentage of polyploid plantlets was examined by counting the number of chromosomes. Additionally the degree of polyploidy was confirmed by measuring the DNA level by flow cytometer. The most effective treatment was 0.075 % colchicine for 14 days, resulting in about 36.8 % of surviving plbs (Table 1), 58.33 % polyploids (Table 2) and 43.05 % tetraploid plantlets (Figure 2). Polyploid plantlets (Figure 1b) showed the morphological differences in shape, thickness and length of leaves and stem compared to the diploid ones (Figure 1c). From the results of this experiment it could be demonstrated that colchicine treatment can be used successfully to induce polyploid plants from plbs of *D. scabrilingue* Lindl. as in many orchids.

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**Figure 1** Flowers of natural grown *D. scabrilingue* Lindl. (a) Morphology of diploid plantlet (b) and polyploid plantlet treated with colchicine after being cultured for eight months (c)
Table 1  Effect of in vitro colchicine treatment at various duration on the percentage of surviving plbs. of D. scabrilingue Lindl. after being cultured for one month.

<table>
<thead>
<tr>
<th>Colchicine conc. (%)</th>
<th>Survival (Yo)</th>
<th>Mean</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Treatment duration (days)</td>
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<tr>
<td>0.000</td>
<td>3</td>
<td>7</td>
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<tr>
<td>0.025</td>
<td>90.2 a</td>
<td>90.0 a</td>
</tr>
<tr>
<td>0.050</td>
<td>91.7 g</td>
<td>90.5 c</td>
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<tr>
<td>0.075</td>
<td>91.2 l</td>
<td>90.5 f</td>
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<tr>
<td>0.100</td>
<td>91.3 l</td>
<td>91.0 j</td>
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<tr>
<td>Mean</td>
<td>91.3 l</td>
<td>91.0 j</td>
</tr>
</tbody>
</table>

Values followed by different letter in the same letter sequence are significantly different at the 95% confidence level by the least significant difference test.

Table 2  Effect of in vitro colchicine treatment at various duration on the percentage of polyploid plantlets of D. scabrilingue Lindl. after being cultured for eight months.

<table>
<thead>
<tr>
<th>Colchicine conc. (%)</th>
<th>Polyploidy induction (Yo)</th>
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<tr>
<td></td>
<td>Treatment duration (days)</td>
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<td>0.000</td>
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<td>0.100</td>
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<td>Mean</td>
<td>95.8 i</td>
<td>95.8 i</td>
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Values followed by different letter in the same letter sequence are significantly different at the 95% confidence level by the least significant difference test.

CONCLUSIONS

The best compromise between acceptable low mortality and possibly high percentage of polyploidy induction could be found for colchicine treatment at a concentration of 0.075 % over a period of 14 days. This combination also revealed the highest percentage of tetraploid plantlets, which represent the best source material for further breeding efforts. From the results obtained so far, it can be expected that in the near future the ongoing selection process will provide improved and easier to cultivate polyploid plant material of D. scabrilingue Lindl. to Thai orchid growers in both high and lowlands. If, as might be expected, not only private buyers but also fragrance industry will take advantage of the optimized properties of the polyploid orchids, the demand and hence the danger of extinction for wild, diploid orchids, taken from natural forests of the highlands, will be dramatically reduced. Like this the positive example of D. scabrilingue Lindl. could also help to protect further wild orchid species from extinction.

ACKNOWLEDGEMENTS

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Applicability of deficit irrigation strategies in lychee and longan production in Thailand

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KEY WORDS: water saving; partial rootzone drying; Litchi chinensis; Dimocarpus longan

INTRODUCTION

Thailand is one of the biggest lychee (Litchi chinensis, Sonn.) and longan (Dimocarpus longan, L.) producing countries. Longan is produced in the lowlands, while lychee is restricted to upland areas, because it needs low temperatures for flower induction. The main production period for both fruit tree species is during the dry season. Thus, irrigation is necessary to obtain good yields at a marketable quality.

Water is an increasingly scarce resource all over Thailand. Periodically appearing droughts threaten agricultural production and are a source of conflict between upland and lowland farmers. For the single farmers irrigation is related to high energy costs for pumping. The situation is more severe as many farmers produce off-season during the whole dry season.

In order to save water, emphasis of research is put on increasing water use efficiency (WUE). Therefore, deficit irrigation strategies offer large water saving potentials. Namely, partial rootzone drying (PRD), a novel irrigation method, has been reported for many crops to increase WUE substantially. In PRD at each irrigation time only one side of the tree row is watered while the other side is left to dry to a pre-determined level, before being irrigated next. The plant’s stress response decrease water consumption by closure of the stomata and decrease the vegetative growth. On the other hand, yield decline is minor. In Thailand PRD for longan trees has been investigated, without significant yield reduction as compared to well watered trees (Satienperakul et al., 2006).

MATERIALS AND METHODS

Production data from three years of longan cropping (Ongprasert et al., 2007) and two years of lychee cropping have been analyzed for irrigation, yield and WUE and the water requirement as well as the water saving potential was assessed based on weather data provided by “The Uplands Program” (Mae Sa Mai) and the Meteorological Department of Thailand (Chantabury, Lamphun).

Three types of farmers have been surveyed and compared with respect to water savings potentials and requirements to adapt their irrigation systems to practice PRD. 16 farms have been visited and the farmers interviewed by use of structured questionnaires: a.) Upland lychee-farmers in Mae Sa watershed, Chiang Mai Province b.) Longan farmers in the upper Ping River basin in Chiang Mai and Lamphun Provinces and c.) Longan Farmers in Chantabury Province, Central Thailand.

RESULTS AND DISCUSSION

In longan production in the lowland, PRD offers a good potential to save irrigation water. For lowland farmers who use more modern irrigation systems, costs of adaptation of the
systems are smaller. Increased management requirements on the one hand are balanced by lower energy costs for pumping, especially where farmers rely on deep wells. Thus, for longan farmers in the lowlands, PRD might be an interesting way to save water and reduce production costs.

The irrigation period in the uplands is too short as to make a substantial impact of the savings potential. Early rainfalls also interfere in the wet-dry cycle which is required to establish a successful PRD irrigation. Thus, even though it was found, that the physiological responses of lychee are generally in favor of PRD (Spreer et al., 2007) it seems hardly feasible in the upland areas. Moreover, irrigation systems used by many uplands farmers, rely on outdated technology, which make a precise allotment of water impossible. Changes in the systems would be much more costly as to be compensated by water savings. Potential benefits from water saving are difficult to be quantified, as water is not priced and is supplied to the fields by gravity. Thus, variable costs are minor.

CONCLUSION

For lowland farmers all prerequisites for a successful establishment of PRD are given: the drought period is long enough and the technology for precise water distribution is available. Furthermore, through pumping and maintenance of reservoirs, irrigation water is costly and improving WUE is economically interesting. We conclude that PRD should be widely recommended for longan farmers in areas that are affected by water scarcity.

For upland farmers neither the eco-physical conditions nor the socio-economical framework favor the establishment of PRD. Emphasis should be given to the research and establishment of appropriate irrigation technology, which reduce water consumption and improve WUE by more sophisticated ways of irrigation.

ACKNOWLEDGEMENT

The financial support of "Deutsche Forschungsgemeinschaft" (DFG) in the framework of the SFB 564 "The Uplands Program" is gratefully acknowledged.

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Possible physiological mechanism of premature fruit drop in mango (*Magnifera indica* L.) in northern Vietnam

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**KEY WORDS:** Fruit abscission; microscopic studies; plant hormones; separation layer; stress physiology; vapor pressure deficit (VPD)

Mango (*Mangifera indica* L.) is one of the most important fruit crops worldwide. Although this subtropical fruit is primarily consumed in the main producing countries such as India, Indonesia, Brazil and the Philippines, there has been increasing demand for mango in the Northern hemisphere. Responding to the increasing global demand for fresh mango and processed mango products, Vietnam has expanded traditional production areas in central and southern Vietnam. Mangos are also produced by ethnic minorities with traditional crop management practices in the mountainous areas in the Northern Province of Son La. These highlands typically experience warm and dry climatic conditions that favour flowering and adequate initial fruit set of mango. However, mango fruit quality does not meet international market-orientated demands. Consequently the fruit is primarily consumed locally, however, the two main mango varieties ‘Hoi’ and ‘Tron’ become increasingly popular nationwide due to good flavor and taste.

Both varieties have relatively low tree performance due to mainly poor husbandry work. In addition, the climatic conditions in the mountainous areas of northern Vietnam with relatively hot, dry prevailing winds during the initial fruit set period aggravate the problem of severe fruit abscission, commonly known as premature fruit drop. However, the exact physiological mechanism of this process is not clear and requires further investigation. Understanding the physiological basis of premature fruit drop in mango is not only of scientific interest but it also helps farmers to improve or even replace existing traditional crop management practices to ensure economically sustainable cultivation of mango in this region.

Therefore, our working hypothesis suggest that in the mountainous regions of Northern Vietnam, the hot dry winds with an high vapor water pressure deficit (VPD) may cause premature fruit drop mid February to mid March. Moreover, throughout this period there is lack of precipitation and this may constitute a significant stress factor in typically non-irrigated mango orchards.

The experimental plot is located near the township of Yen Chau. The experimental design includes 20 randomly selected 10-year-old trees of ‘Hoi’ and ‘Tron’, respectively. Half of the trees were irrigated with micro-sprinklers (2 h every 4 days with 120 l/h) and the remaining trees served as non-irrigated control trees.

To investigate climatic impacts on fruit drop, an automated weather station (DELTA-T) recorded air temperature and relative humidity (RHT2nl-02), light intensity and sunshine hours (BF3), wind speed (A100R), wind direction (W200P/L) and rainfall (ARG100) within the orchard throughout the growing season.

Soil temperature probes (10108TM) recorded at 10-min intervals at 10 and 20 cm depth near one irrigated ‘Tron’ tree and at 10 cm depth near one non-irrigated ‘Tron’ tree. Theta-soil moisture probes (ML2x) recorded at 10 and 20
cm depth near one irrigated and one non-irrigated ‘Tron’ tree, respectively. These sensors were placed at approximately 50 cm distance from the tree trunk. In addition, soil moisture was measured weekly from 10 to 40 cm soil depth on 2 irrigated and 2 non-irrigated trees of each cultivar, respectively, by a mobile probe (HH2/Moisture Meter, Delta-T). Within-canopy microclimatic conditions of temperature and relative humidity were automatically recorded using one logger (Onset HOBO) per tree for three replications of each treatment combination.

Phenological studies (flower opening, full bloom, flower abscission) were conducted on 30 inflorescences (6 on each of 5 trees) per cultivar and irrigation treatment. Fruitlet drop was counted on 20 randomly selected inflorescences on each of five irrigated and non-irrigated mango trees of both varieties, respectively, and results are shown in Figure 1 and 2.

The period of the highest fruit drop at the end of February through to middle of March seems to correspond with the time of severe environmental stress.

Leaf and fruit samples at different stages of development were taken from four irrigated and non-irrigated trees of both cultivars, respectively, for subsequent analysis of plant hormones such as indole-3-acetic acid (IAA), cytokinins (CKs), abscisic acid (ABA) and gibberellins (GA1,3,20) measured as GA3 equivalents.

To understand the formation of the separation layer, samples of the fruit peduncle from attached and absised fruit of both cultivars at different developmental stages (pin- to marble size) were taken for microscopic analysis.

The study is aimed at offering a physiological explanation for the premature fruit drop; particularly focusing on environmental impacts on the morphological and hormonal changes in the fruit stem of mango. Determination of timely changes of plant hormones and microscopic analysis of the fruit stem are ongoing and results will be presented at the Symposium.

**ACKNOWLEDGMENTS**

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Efficiency of foliar micronutrient fertilization in Lychee
(Litchi chinensis Sonn.)

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KEY WORDS: Lychee; foliar fertilization; Boron

Lychee production in Thailand can be divided into two planting types: lowland or raised-bed type, and upland type. Fruits are harvested beginning in March until April for the lowland type and from May until June for the upland type. There is a good complementation of both types for a long market supply of fresh fruits.

In Northern Thailand Lychee is one of the most important cash crops and 60% of the total Lychee yield is produced in this region. Nevertheless low yields and non-sufficient fruit quality are still limitations in Lychee production. The local soils show Boron (B) and Zinc (Zn) deficiency, a common disorder in many other production areas of the world.

Intensive sunlight and reduced temperatures during winter in Northern Thailand result in photooxidative stress inducing chlorosis at the south/south-west exposed branches. Affected plant parts show no or at best reduced flower induction. Under photooxidative stress, optimal B and Zn supply can decrease the development of free radicals and increase their detoxification for remediation of transient chlorosis.

Foliar fertilization could be a cheap and target-oriented alternative to correct deficiencies compared to soil fertilization. However, information concerning leaf penetration and mobility in the plants is yet very limited and common foliar spraying of Zinc mainly on the upper side of the Lychee leaves resulted in a complete failure.

The aim of this study was to identify factors influencing the success of foliar micronutrient penetration and distribution using Lychee and Soybean (Glycine max L.) as examples.

Lychee leaves are highly water repellent and adding of a surfactant in the spray formulation was necessary. In a pre-test we compared 5 different surfactants which are common in practice worldwide, representing the different groups of properties, but omitting surfactants based on oil which earlier resulted in leaf drop. One of the surfactant was purchased in Thailand. Adhesion amount and wetting rate were determined using a self made rating chart. Optimal concentrations for Lychee and Soybean were documented and surfactants grouped in 3 categories (A: high wetting amount, B: high wetting rate, C: in between). The influence of surfactants to promote penetration and translocation were analysed for Soybean. Group A and B showed highest uptake rates. In addition, group A seemed to improve translocation in the leaves.

We choose surfactant 1 (group B) for the experiments, because we wanted to have 100% wetting to insure all possible penetration pathways.

Boron was applied as boric acid (0, 3%) labelled with the isotope $^{10}$B + surfactant 1 to individual leaves of plants previously treated with $^{11}$B. To determine the mobility of the nutrient, the formulation was painted using a brush on the lower part of a leaflet. Sampling was done separately for segment1 (application zone), segment2 (acropetal translocation (the tip of the leaflet)), segment3 (basipetal translocation (other leaflets of the leaf)) and segment4: (re-translocation into meristemic tissue) as shown in Fig.1. The leaves were harvested one week after application and prepared for ICP analysis.
Lychee leaves are hypostomatal with a steric wax layer on the lower leaf surface and amorphic wax layer on the upper leaf surface. To test whether the side of the leaf has an influence on the penetration rate we applied the spray formulation separately on each side of the Lychee leaf. We quantified penetration and translocation of $^{10}$B in each treatment. The $^{10}$B content decreased from segment1 to segment3; in segment4 we found a small amount of $^{10}$B similar to the control. High amounts of $^{10}$B in segment1 after application on the lower leaf surface reflect the difficulty to remove the B bound in the epicuticula waxes on the lower leaf surface (Fig.2). We repeated this experiment with Soybean including plant nutritional status as a second factor. The results were similar to Lychee, but the nutritional status had a significant impact on penetration. Plants under B-deficiency showed much lower uptake rates than plants receiving sufficient B.

In conclusion, leaf penetration and uptake of boric acid in Lychee is possible and effectivity can be influenced by surfactant type. There is no or very limited phloem mobility of B in Lychee. Application on the lower leaf surface tends to increase uptake and translocation rates of B. Reduced uptake rates of deficient plants need to be considered for adaptation of spray formulations.

![Fig.1: Application and sampling design for Boron treatments](image)

![Fig. 2: Average $^{10}$B concentrations in segment 1-4, comparison of Boron treatments on the lower and upper leaf surface](image)
Importance of collective alps for local farmers and for preservation of mountain areas

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KEY WORDS: Allmende; Collective alps; Bavaria; lowland farmers; economic significance; under-utilisation

In Germany the Allmende, the old German designation for the collective pastoral organisations, have a long tradition going back many hundreds of years. The Allmende systems were widespread throughout Germany until secularisation in the 19th century when they decreased strongly in number (BSiMELF, 1972). Nowadays they are mostly restricted on higher altitude of the Alpine region in southern Bavaria. At present in the alpine range, from a total number of around 1,400 alps¹ we count 150 under the status of collective alps, totalling an area of approximately 55,000 ha (including pasture, woodland and wasteland) and accounting for over 40%² of the total acreage of the alpine pastures. The survival of these organization forms seems to be motivated by the specificity of the pronounced geographic relief, where agriculture could not operate the process of intensification (Gueydon et al., 2006). The aim of these organisation forms is to achieve collective action in order to reach economic objectives.

This paper analyses the economic advantages for the lowland farmers to participate in the collective alps. Investigations were carried out on altogether 26 collective alps and 47 participating farms located in the pre-alpine and alpine region of Germany. The interviews were carried out according to indicators and questionnaires. A bundle of data were recorded including farm size (in livestock unit LU), stocking density, collective labour, grazing fees, costs and income of the collective alps. The economic indicators, e.g. forage provision, workload, profits and revenues, were calculated using Bavarian standard charges and prices and estimation from Handler et al. (1999). The calculation indicates the economic significance for the farmer to participate in the collective alps according to the provision of forage, the diminution of workload and the allocation of payment (retribution of collective labour and redistribution of profits). The results show that on the one hand the collective alps seem to provide an important economic benefit for a big majority of small farms (up to 50 LU) situated in the alpine region (Fig. 1). In this area of pronounced relief the availability of pastoral forage is often the limiting factor for the development of the farms. There, the collective alps provide low cost additional forage. The farmers can reduce in summer the fodder requirements and labour on the farm. Moreover, some of them benefit from additional monetary advantages. The collective alps benefit from sizeable agricultural and environmental payments generating substantial profits, which are in some alps redistributed to the members. On the other hand the collective alps seem to have a low relevance for a dozen of small farms, for the bigger ones (50 LU and more) and for the farms situated in the pre-alpine region. For these lowland farms pastoral forage is not a limiting factor because they dispose of land available in their vicinity. Moreover, the bigger farms are often compliant with an intensification trend where they are, among other stresses, confronted with increasing productivity and work overload. The increasing milk productivity (ca. 100 kg more per cow per year (BSiMELF, 2002)) means that

¹ We use the term alps to design areas composed of pasture, wood and wasteland, situated in the alpine fringe, on altitude higher than 700 m a.s.l. and used for pastoral purpose.
² Source: Own survey carried out among the Bavarian boards of agriculture, 2004.
the number of animals per farm needed to fulfil the milk quota is constantly decreasing. The total demand of fodder per farm follows this trend. The high work overload on these bigger farms make the farmers less willing to engage in efforts on the collective alps whose pastures have a lower quality and where the remoteness of the land makes the grazing activities more time consuming.

![Graph showing economic significance of collective alps for the farms (€/LU/year)](image)

**Fig. 1:** Economic significance of the collective alps for the farms (€/LU/year)

The investigations also reveal that although the investigated collective alps are highly subsidized (on average around 300€/ha), more than half of them (58%) are facing problems of under-utilisation of the pastures. This fact reveals that under the current area payment scheme, the incentive for most alpine pasture systems is to maintain the maximum area of pastoral land with the minimum number of animals. Indeed, the subsidies remunerate the acreage of open pasture but the main expense is labour, and is strongly related to the number of animals kept. Therefore, some alpine pastures voluntarily stock fewer animals than they could with respect to the carrying capacity of their sites. The representatives of the Alpine farming societies stated nonetheless that globally strong encroachments are under control as long as financial support from the authorities is maintained (personal communication with P. Danks and M. Hinterstoißer, 2005).

The utilisation of the collective alps depends on the interests of the farmers to integrate them in their farms’ activity. Governmental intervention is also needed to prevent the decline of the number of farms in the region and to motivate farmers to continue using them. The collective alps are important to conserve because, beyond their agricultural value, they provide a range of goods and services for the local economy. They provide an important biodiversity pool (Lederbogen et al., 2004), they play a significant role for the development of tourism activities through the maintenance of the region’s landscape, of recreational areas and as holders of cultural values within the generation. However due to their low profitability these systems may be rapidly swept away by the market and political changes currently operating under a surrounding environment of better economic conditions. The consequences of a decrease of utilisation of the collective alps means a conversion of the pastures into encroached areas. Under the Bavarian Forestry Law which promulgates that all trees over one metre in height belong within the domain of Bavarian Forest Agency (*Der Almbauer*, April 2000), it means a legally disappearance of the collective alps.

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Structure of production system and constrains of tea sector in north western Vietnam

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KEY WORDS: Contract farming, market participation

INTRODUCTION

Tea is one of the favorable agricultural products in uplands, which only can be grown under mountainous climate. Meanwhile, the domestic demand of tea is mainly made by low land consumers, which means in rather big cities, and has been increasing as well as foreign demand. Moc Chau, is one of the mountainous regions in Son La province, which locates in North West of Vietnam and its well known as producing high quality tea and daily farming under the advantageous natural conditions. The special tea species; Shan Tuyet which are grown in Moc Chau accounts for 29% of domestic green tea production (MPI, 2006), are popular to Vietnamese domestic consumer with higher reputation than other green tea grown in Vietnam. Meanwhile the domestic demand for green tea in Vietnam has been increased, the positive influence can been observed in Moc Chau that the dramatically change has been accomplished in expanding tea area per household, from 3022 m² in 2004 to 4697 m² in 2007 in average.

Although the amount of tea production has been increased in Moc Chau, the production system and marketing system has been quite underdeveloped under the strong political constrains and the unclear tea pricing system. Yet the potential exists for producing high-quality tea, and a number of development programs in the region aim to improve the situation.

At present, the tea sector in Moc Chau district is characterized by different type of organization of production, ranging from “worker farmers” in state owned enterprises to smallholder farms. With respect to inputs supplies and tea selling price, some households choose contracts with processors while others choose to be the independent farmers. At present, no knowledge exist which type of production organization and marketing channel is more productive and cost-efficient, and income secure for rural households.

OBJECTIVES

Against this background, the objective of this research is to investigate the importance of income from tea production of poor households in Moc Chau. For this objective, the structure of tea production system and tea marketing channel are identified.

Hereby, the distinction is made between different types of organization of smallholders /producers, and different types of marketing channels. Through this, the study can identify the type of production organization and marketing channel that is most effective in reducing poverty.

In this study, the actors in the marketing channel are limited which have direct linkage to the farmers, to focus on production level analysis.

Specific Objectives

In the household level, the living standards of farm households are analyzed to measure the poverty level of farm households. In addition in household level, identification of income source and assessment of total income of households are analyzed to estimate the importance of income from tea production.

In the regional level, the different types of marketing channels with respect to employment opportunities and production support by tea institutions are identified to analyze the structure of the tea market in Moc Chau district. To building this objective, the pricing strategies, costs and benefits performances for different types of contracts and marketing channels are analyzed.

METHODOLOGY AND PREVIOUS STUDY

Tea is a labour-intensive industry. The harvesting is a year-round activity. This harvesting, the so-called ‘plucking’, accounts for 40% of the production costs. According to a previous study on tea estates, there are several yardsticks to judge the efficiency of tea production: plucking productivity, processing
productivity, input productivity, and management productivity (Sivaram, 2000). The plucking productivity is the most labour-related and costly factor, and the productivity would be directly related to the skill of the farmers (Sivaram, 2000), therefore the efficiency analysis will be focus on this measure.

Types of Organization of Smallholders/Tea Producers

According to the previous research on tea production in Vietnam, most of the poor smallholder farmers produce tea along with other crops because of market fluctuations or other uncertain factors. A case study on tea production in Phu Tho and Thai Nguyen province emphasized the difficulties smallholders face when they attempt to get involved in the tea industry, which might lead to a further diversification of smallholders’ crop production and income sources (ADB, 2004). For smallholder farmers crop diversification mainly serves to meet their subsistence needs; products are often not marketed due to insufficient quality, quantity and market access. An expansion of tea production, along with off-farm income opportunities in the tea industry, could be a way out of poverty.

Types of Tea Marketing channel

To analyse the structure of tea marketing, semi-structured in-depth interviews were conducted with the processors and contractors/farmers. Based on this information, cost-benefit analyses will be conducted for the different types of contract/marketing channel from producer side. Indeed, there are several kinds of marketing channels, but one choose economically rational channel, others not. To evaluate the fact which influences market participation of farmers, the transaction costs are analyzed with respect to fixed transaction costs, which are strongly related to the household capacity and affect farmers decision making. This study applied two methods for data collection from June 2007 to October 2007 which consisted semi-structured in-depth interviews with contractors and processors and a household survey among different contracted farmers.

EXPECTED RESULTS

Under the socialistic society, the pricing system of tea has not worked as it under the market economy. In present, the tea market price in Moc Chau is controlled by state owned enterprise, and it is seldom seen the rational producer behavior with respect to tea marketing strategy. Up to know, this producer behavior seems to be strongly influenced by the political constrains, and the land tenure systems. The results from this study can be expected to contribute to a better understanding of high-value products marketing study and of efficient tea production system for rural mountainous region in Vietnam. The findings of this study will be available by March 2008.

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Rubber-boom in Xishuangbanna - where will it end?

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KEY WORDS: biodiversity; land-use cover change (LUCC); LILAC; sustainability

This contribution presents first impressions and figures gathered within the recently established Sino-German research cooperation “Living Landscapes China, LILAC” in the uplands of Xishuangbanna, Yunnan Province, P.R. China. Although data collection is still in its infancy some general trends on land-use change can already be described and put into a greater perspective.

THE SETTING

Xishuangbanna is a Dai Autonomous Prefecture in Southwest-China, belonging to Yunnan Province. It marks the transition zone between the tropics and subtropics and harbors the northernmost extension of the tropical rain forest (Zhu 2006). Due to its geographic location and geo-ecologic history it is one of the world-wide biodiversity hotspots (Zhu 2006).

At the same time Xishuangbanna represents the second largest rubber production area in China besides Hainan. In December 2007 China’s largest natural rubber processing plant was laid foundation in Jinghong City. It has an annual processing capacity of 40 000 tons and focuses on the production of high quality rubber for steel tires (Xishuangbanna Sinochem 2008). The majority of natural rubber goes into the production of truck tires (Weber & Schaer 3/2004).

THE CURRENT SITUATION

Compared to the project definition phase two years ago (2005) a clear increase of rubber planting could be. At that time at least stream banks and very steep slopes still showed some woody, unmanaged vegetation. Now, the situation has completely changed. All available spots, no matter what conditions, are cleared and planted with rubber. Even home gardens are transformed into rubber plantations. One village head explained that the whole village gave up traditional agriculture and now focuses on rubber management. Rice will be bought on local markets. The same could be heard from single farmers in other villages. This trend has also been described for other areas in Xishuangbanna (Fu et al. 2005), where rubber became the dominating source of income within few years, going parallel with the disappearance of local crop varieties.

According to a local farmer in our research area rubber prices rose from 3.8 RMB/kg in 2002 to 30RMB/kg at present, that is by nearly 800 % within 6 years. A mature tree (10-12 years) delivers ca. 5 kg of sap per year (that is 150 RMB). A single ha carries about 450 trees which results in an annual income of 67500 RMB resembling about 6750 € per ha. These figures are supported by data from nearby Laos (McCartan 2007), where similar figures are given for production and income. According to that source rubber is nearly as profitable as opium. Another economically important aspect is the development of a rubber wood industry. While rubber wood was a low value product before it now achieves good prices. Some rubber farmers who had to log their young trees (12 years old) due to dam construction and flooding, respectively, reported that the smaller timber dimensions achieve 600 RMB and the bigger ones 800RMB per m³, resembling 60-80€.

It is hardly imaginable that - on the short run - any large scale production scheme can parallel the pure economic figures of rubber production.
There are other large scale cash crops that experienced - or just experience - an economic boom. That is the traditional tea business on the one hand and that is *Jatropha* for bio-fuel on the other hand. *Jatropha* covers already 33,000 ha in Yunnan, and there are plans to extend this area to 667,000 ha (Anonymous 2008). But both plants have different habitat requirements and do not (yet) compete with rubber. On the other hand they further contribute to the destruction of Yunnans natural habitats.

**OUTLOOK**

Depending on a single crop is very dangerous, especially when a whole region is affected. Since rubber strongly depends on world market prices the ‘sustainability’ of the present economic figures is far from secured, although, given the current economic development of China, demands for rubber will stay high. At present, e.g., the high oil prices support natural rubber since synthetic rubber prices correlate with oil prices. If oil prices drop, synthetic rubber will become more competitive and natural rubber prices will go down. Additionally, the risk of pest outbreaks cannot be underestimated, and rubber is prone to many pests (Balsiger 2000).

While the long-term socio-economic consequences of that rapid development can still hardly be predicted some consequences are already obvious. The interactions between the rural environment and Jinghong City are closer than expected. While rural people usually do not play an important role in money economy of the city, they now obviously become players. Social structures will be affected by the rubber boom. Villages give up their traditional production systems to fully rely on rubber production. That also includes giving up rice production.

When it comes to environmental consequences it can be safely stated - and already be observed - that soil erosion will increase since each available spot is used for the establishment of rubber, no matter what the environmental conditions are. Biodiversity decline is also a serious issue. It stays to be seen how a society that strongly depends on natural products for its health system (Traditional Chinese Medicine - TCM) reacts on the declining natural resources. It will be very interesting to accompany these developments within the “Living Landscapes China” project.

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