Sustainable land use and rural development in mountainous regions of Southeast Asia

Conceptual framework and summary of a collaborative research program

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in cooperation with

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Hanoi Agricultural University, Thai Nguyen University of Agriculture and Forestry, Vietnam Agricultural Science Institute and National Institute of Animal Husbandry, Vietnam
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Conceptual framework of a collaborative research program in northern Thailand and northern Vietnam

Problem statement

Rapid population growth enforced by resettlement programs and migration processes, have dramatically increased pressure on both natural resources and rural populations in marginal and fragile mountainous regions of Southeast Asia. Shortening of fallow periods, erosion in sloping land and loss of soil fertility and biodiversity have decreased agricultural productivity and degraded environmental quality, thus creating vicious circles of increasing rural poverty, food insecurity and destruction of natural resources that differ between more subsistence-oriented regions in northern Vietnam and more market-oriented regions of northern Thailand (see figure 1).

Figure 1. Vicious circles of land scarcity, degradation of
natural resources and rural poverty in northern Vietnam and northern Thailand

Objectives

The objective of this research program is to contribute to a better management of natural resources and to the improvement of rural livelihoods in mountainous regions of northern Thailand and northern Vietnam. This can only be achieved, if the research activities in these areas take into account priorities of stakeholders involved in the management of natural resources and in rural development processes. Therefore, project area A ‘Participatory research approaches and interdisciplinarity in an intercultural context’ has been designed as an umbrella for all other project areas and subprojects (see figure 2).

![Diagram of research program]

Beside project area A, five other areas of research were developed and divided into two main research focuses:

1. Sustainable land use
2. Sustainable rural development

(1) Sustainable land use

In this research focus the activities of the University of Hohenheim in cooperation with its Thai and Vietnamese partners will concentrate on the stabilisation of land use systems in mountainous regions. This requires a system approach focusing on a whole watershed area. This research field comprises three project areas: Soil, water and energy conservation (B), Biodiversity in agroecosystems, plant and animal resources (C), and Sustainable and integrated production systems (D).

(2) Sustainable rural development

In this research focus opportunities will be analysed to better integrate sustainable land use systems into the regional development process. By elaborating appropriate technologies for the local or regional processing industry of agricultural products as well as by designing suitable institutions and policy measures the development is intended to be influenced in such a way that sustainable land use systems and agricultural...
practices are supported. This research field comprises two project areas: Processing and marketing of agricultural products (E) and Rural institutions and policy measures (F).

The concept of the research program is based on the hypothesis that sustainable land use can only be achieved if off-farm employment is created and an appropriate institutional framework is designed. The agricultural sector with its limited resource potential in marginal uplands can not cope with rising population pressure. The development of rural linkages is a necessary prerequisite for the sustainable management of natural resources and alleviation of rural poverty.

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Summary of project area A, "Participatory approaches and interdisciplinarity"

Research in this project area is directed at the process of cooperation between researchers, farmers and local institutions from different cultural backgrounds (A1).
Subproject A1 aims at evaluating the concept of integrating farmers into the research process. In this phase of the SFB the subproject intends to assess the potential and limits of participatory research and to design and test suitable institutional frameworks for integrating local knowledge and experience of farmers, extension agents, development projects and NGOs in the research process. It will analyze which forms of participation are suitable in which phases of the research process, differentiated by different research subjects. The project will pay particular attention to gender-specific issues of participation. Research under this subproject will be carried out by the SFB’s Hohenheim coordinator in close cooperation with the Thai and Vietnamese counterparts.

Interdisciplinary cooperation between German, Thai and Vietnamese research institutions and their researchers will present a particular challenge. Moreover, participating farmers in the mountainous areas belong to different ethnic groups with their own cultural traditions and values which again may differ from those of researchers and their institutions.

**Summary of project area B "Soil, water and energy conservation"**

Project area B will collect all information from research activities concerning the characterisation of the project region in Northern Thailand in terms of soil and water resources. The subprojects will focus on the modelling of the water and nutrient balance of landscapes under mixed cropping systems on hill slopes and on the environmental effects of fertigation and chemical plant protection. The subprojects are designed to perform a synchronous upscaling from field to watershed scale. Methods and models will be largely transferable to the project regions in Northern Vietnam.

The first step will be to take inventory of the local knowledge that is either unpublished or published in Thai language. Remaining knowledge gaps shall be closed by field research, mainly investigating the meso- and macroscale variability applying geo-statistical methods. These parameters are a prerequisite for the following modelling. Simultaneously to the data collection a database will be created to be fed by the gained information on the concerned watersheds. This database will be jointly designed together with the subprojects of the other project areas as a vital contribution to the central documentation of all activities within the SFB.

Measurement methods for the specific parameters of the water and nutrient balance in heterogeneous cropping systems with fruit trees and application of fertigation systems have to be developed on-station (B1, B2). Already during the first phase, these methods shall be tested at three on-farm sites with different geological conditions. One of these sites shall be used jointly from subprojects B1, B2, C1 and D1.

**Summary of project area C "Biodiversity in agroecosystems, plant and animal resources"**

Description and analysis of biological diversity is fundamental to the understanding of ecosystems and their potential agricultural productivity. Therefore, project area C comprises subprojects whose results are essential for other project areas in the first phase of the SFB as well as in subsequent research phases. Description and analysis of biodiversity can be done at different levels: On the one hand, it can be focused on the inventory of species, e.g., in a given agro-ecosystem, and, on the other hand, on the genetic diversity within and between species groups, species, or populations. Both approaches are represented in project area C. All projects have the common objective of providing a clearer picture of the diversity of biological resources to establish a framework for their conservation in ecosystems influenced by man. The main objective of project area C in the first SFB phase is the description of floral and faunistic biodiversity and to develop first approaches for their conservation and utilisation.

Project C1 provides an analysis of agro-ecosystems in Northern Thailand hillsides that are used for fruit tree production. The rapid increase in established fruit trees on sloping land is expected not only to increase soil erosion. Fruit tree production is accompanied by an increasing dependency on and overuse of pesticides, which pose serious problems, such as pest resistance and resurgence. Furthermore groundsoil covering plants undergo an enormous change and will shift to a grass-dominated weed population mainly induced by herbicide application. This in return will affect beneficial insect populations that might help to reduce fruit tree pests. After identifying genotype x environment interactions of multi-purpose cover plants, species adapted to different altitudes can assist in designing farming systems that use less chemicals, integrate forage and fruit production, and are more productive at a sustainable level.

In project C2 a classification method based on soil-vegetation units will be developed for different soil degradation levels of barren hills in Vietnam. The loss of genetic diversity caused by decreasing forest vegetation and the increase in barren land area are not well documented yet. Ground assessment of vegetation and soil characteristics, the acquisition of local knowledge on wild-plant uses, and data integration using geographical information systems (GIS) will assist in understanding the dynamics of vegetation
composition and in identifying potentially useful plants for this common type of degraded lands.

Projects from the C area are linked to most of the other project areas with regard to participatory elements (project area A), intensive data exchanges (especially project areas A, B, and D) and methodology development (project areas A and B).

**Summary of project area D "Sustainable and integrated production Systems"**

Research in project area D aims at analyzing the components and determining factors of land use systems found in mountainous regions of Northern Thailand and Northern Vietnam. The focus is on analyzing the use of resources in cropping systems and animal husbandry activities and their interrelationships within production and farm/household systems. Projects in this area intend to identify possibilities that will enable farmers to intensify land use at the slope sites and guarantee them a stable income from sustainable land use. In the first phase the focus will be on analyzing the present situation, identifying linkages and constraints and formulating innovations that will be tested in subprojects for their technical, socio-economic and ecological viability.

In Thailand it is intended to lay the scientific foundations for developing sustainable fruit tree systems with cover crops and substitute them for the existing erosion-prone annual crop and vegetable production systems. Subproject D1 aims at stabilizing in fruit tree crops the alternating bearing of fruits and yield fluctuation by modifying flower induction. In close cooperation with D1 subproject C2 will focus on establishing cover legumes and analyzing their impact on and interaction with fruit trees. Cover legumes are particularly relevant in the early years of perennial crops when root development and canopy coverage are not sufficiently developed to protect the soil from erosion. Fruit trees in combination with cover crops present extremely complex challenges both for adequate nutrient supply and irrigation. Issues of plant nutrition will be reviewed as part of subproject D1 by the project's co-leader, Prof. Römheld. He will analyze nutrient balances (N, S, B, Zn) on the basis of soil and leaf analysis and trials with varying Nitrogen supply through fertigation combined with induced drought stress in the root zone, the latter in cooperation with subproject B1. Water balance and irrigation are issues dealt with in subproject B1. The results will be fed into activities in project area D. Research in this area starts from the hypothesis that integrated production of fruit trees plus cover legumes presents complex issues for flower induction as it is likely to be affected by amount, timing and sequencing of nitrogen and water supply. Close cooperation of these subprojects is therefore a precondition for achieving meaningful results. On the output side, the fruits produced will be tested in subproject E2 for processing and conservation purposes. These projects will carry out suitability and quality analyses and feed back those results to D1. The longer term market potential of fresh and processed fruits is subject of research in subproject E3. It also will provide important information to D1 and E2 concerning seasonal variations in markets, quality standards and variety aspects.

In Vietnam animal production plays a central role in the existing land use systems in mountainous areas. In subproject D2 the determining factors and interlinkages between animal performance and production intensity for local and improved breeds will be analyzed. The subproject will follow a gradient approach identifying different forms of small animal husbandry with varying intensity found along the mountain slopes. The objective will be to develop more efficient production systems with improved and sustainable resource use.

Subproject D3 aims at characterizing and modeling the complex mountainous farming systems in Thailand and Vietnam. Particular emphasis will be placed on determining factors and interrelationships and the role of ecological, ethnic, social and institutional/infrastructural factors on the decision process within those farming systems. A special focus will also be on the labor economy in different crop and animal husbandry activities, resource conservation and on off-farm activities. This will provide important feedback to technology development research in subprojects of project area B, C and D. The results at farm household level are intended to be aggregated and upscaled with the geographical information system to the level of watersheds and regions. In cooperation with other subprojects it will build up a data bank for all research activities focusing on sustainable land use.

Project areas B and C will provide important base information for project area D. This requires close coordination of the research program in the connected subprojects including a joint selection of region, farm households and research plots. This is a precondition for a joint use of data from different crop activities (crops, cover plants, animal husbandry, economics) and their use for the different levels of aggregation (crop activity, farm household, region).

**Summary of project area E "Processing and marketing of high-value agricultural products"**

The objective of project E2 in Thailand is firstly to develop basic solutions for mango and lychee processing technologies, which can be realized in small- and medium-size companies. Research focuses on
technological and scientific optimization of fruit processing combined with economic evaluation of process technologies and market potential. Fruit processing will be considered with regard to purée production and derived products. In Southeast Asia, where canning is still prevailing among processing technologies, purées and derived beverages can be considered largely as novel products.

Technological-scientific evaluation and optimization of fruit processing is based on the nutritive value of the raw material. In the case of mango products, the nutritive value mainly consists of the vitamin A potential. Among tropical fruits, mangoes possess the highest vitamin A potential due to their b-carotene content. Moreover, carotenoids are important natural pigments, which are prone to degradation by oxidation and light. In contrast to this, lychees are a rich source of vitamin C. Therefore, the nutritive significance of derived products from these fruits consists in the supply of important micronutrients. In this context, mangoes can be understood as a model for investigations of fat-soluble micronutrients, lychees as model for water-soluble micronutrients.

Taking mangoes as an example, alterations of carotenoids on technological processing will be investigated by means of stepwise process analyses. In food technology, vitamin C degradation has been often used as an indicator for quality changes on processing. In E1, kinetics of vitamin C degradation during lychee drying will be investigated.

A particular feature of section E is the close collaboration of E3 with E2 within the fields of estimating market potential and cost recording for fruit processing. In this way, the market potential of fresh versus processed products and the costs of development of processing innovations, including labour, material and other costs as well as processing costs themselves will be recorded. Thus, E3 will provide data on market prices for field E.

As a result of the limited availability of low-cost industrial fruit varieties, industrial processing of mangoes and lychees in Thailand is actually limited to the short harvesting periods of only few weeks. With respect to both extended processing periods and the expected higher prices for fresh fruit marketing, the production of ‘off-season’ fruits will be investigated in D1. In the scope of a joint research of D1 and E2 on technological properties of fruit varieties and ripening degrees, processing properties and micronutrient contents of off-season produced mangoes and lychees will be determined. Here, D1 will focus on the determination of the ripening degree and the aroma of fresh fruits, whilst technologically important enzyme activities, the content of nutritive constituents and texture will be analyzed in E2.

Summary of project area F "Rural institutions and policy measures"

The introduction of sustainable land use systems, the development of forward and backward linkages to the agricultural sector and linking a dynamic agriculture to regional and international markets needs an appropriate institutional framework and regional policies to support these processes. In the first phase of this project area, the impact of current policies and the institutional framework on sustainability of land use and rural development in mountainous regions will be analyzed.

Subproject F1 focuses on access to land and control of natural resources in the uplands of Thailand and Vietnam. In a comparative analysis the impacts of different legislative frameworks on the shaping of local land tenure systems and on the management of natural resources in Northern Thailand and Northern Vietnam will be analyzed. While in Vietnam the trend is towards a wide-scale individualization of use rights on both agricultural and forest land, the Thai government is still indecisive whether to opt for state control or communal use rights on forest land in the highlands of Northern Thailand. Results of this research project will provide important information not only for land and forest policies in both countries but also for other countries of Southeast Asia.

In subproject F2 the demand structure of rural small enterprises (farm/households and processing industries) for rural financial services to support improved agricultural production systems, sustainable resource management and off-farm rural activities will be analyzed. The analysis of demand for rural financial services that is oriented towards the needs of the clients is especially important as Vietnam is still working with sector-specific mono-banks and inflexible service packages. The analysis of clients’ needs and their determining factors will lay the basis for recommendations to create innovative rural financial services which can assist particularly the rural poor in adopting sound strategies for natural resource management and support a sustainable development process.

In Northern Vietnam subproject F1 and F2 will be connected through the linkage between documented land use rights and access to formal credit. In the first phase the focus will be on research at district level (in the case of F2) and at subcatchment level (in the case of F1).
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