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Recording, validating and scaling up local ecological knowledge of ethnic minority farmers in Northern Thailand and Northern Laos.

Dissertation

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Chalathon Choocharoen, 2014

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List of Acronyms

Abbreviation	**Full term**
ADB	Asian Development Bank
AKT5	Agro-ecological Knowledge Tool Kits
ANOVA	A one-way analysis of variance
CIA	Central Intelligence Agency
CK	Construction of knowledge
DOIN	Department of Inspection
FAO	Food and Agricultural Organization of the United Nations
GPS	Global positioning system
GTZ	Gesellschaft für Technische Zusammenarbeit (today GIZ)
KB	Knowledge base
KBS	Knowledge-based system
kip	Lao local currency
KM	Knowledge management
Lao PDR	Lao People Democratic Republic
LEK	Local Ecological Knowledge
LK	Local knowledge’
LSD	Least significant difference
masl	Meters above sea level
MAF	Ministry of Agriculture and Forestry

NAFRI	National Agriculture and Forestry Research Institute
NGO	Non Government Organization
NRM	Natural Resource Management
NTFPs/NTFP	Non Timber Forest Products
PRA	Participatory Rural appraisals
PSM	Participatory soil mapping
RDMA	Rural Development in Mountainous Areas
REDD	Reducing Emissions from Deforestation and Forest Degradation
RFD	Royal Forestry Department
RRA	Rapid Rural Appraisals
SAS® 9.2.	Socio-ecology Studies in details
SE Asia	South East Asia
SFC	Soil Fertility Conservation project
SK	Scientific knowledge
SOTER	World Soils and TERrain Digital Data Base
spp.	Two or more species of a genus (e.g. of *Amomum* spp.)
SSI	Semi-Structured Interview
TAO	Tambon Administrative Organization
VC	Value chain
WFP	World Food Program
WRB	World Reference Base for Soil Resourc

1 Introduction

In Southeast Asia over the last several decades, there has been a growing awareness of the rights of indigenous people to get access to natural resources. It is now recognized by many scholars and development practitioners that these indigenous people have detailed ecological knowledge concerning the sustainable use of natural resources. This is due to their familiarity with the ecosystem and, ultimately, their dependence upon its effective functioning to maintain their livelihoods. Acknowledging this knowledge and utilizing it within local and project management is more likely to produce more effective conservation and sustainable development strategies.

This study focused on Northern Thailand and Northern Laos where much of the land that was previously under shifting cultivation has been converted to large expanses of cash crops in recent years. These include commercial temperate vegetables (such as cabbage), fruit orchards and rubber plantations. Both regions have been severely affected by reduced resource availability, compacted by depletion of biodiversity, and adverse effects on soil, water and air qualities. The livelihood of the communities living in these areas depends on living from and utilizing national resources in the forests. In addition both Northern Thailand and Northern Laos are areas that have been subject to very rapid population growth (PECH, SUNADA, 2008; THONGMANIVONG et al., 2006; FORSYTH, WALKER, 2008), with a doubling of the population within a single generation. Population growth at this level may require particular adaptations of new agricultural technologies to increase food production. This requires diversification of rural livelihoods, building on existing knowledge systems while integrating new knowledge from outside. For this reason natural resource management knowledge has to be considered as generated and held not only by individuals, but also by groups and communities, in addition to formal research and knowledge organisations.

In the study area community residents have accumulated extensive knowledge on forest resource use, watershed management and ecological system conservation. However, this knowledge is mainly passed on verbally from generation to generation, and may be incomplete or eventually lost. RAJASEKARAN, et al. (1993, p 25) define indigenous knowledge as *“the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments, and intimate understanding of the environment in a given culture. Indigenous knowledge systems are dynamic, changing through indigenous mechanisms of creativity and innovativeness as well as through contact with other local and international knowledge systems”*. Local Ecological Knowledge (LEK), otherwise referred to as indigenous knowledge or traditional ecological knowledge, potentially offers rich insights into the functioning of the natural environments (BROOK et al., 2008) in otherwise data sparse locations. This important resource is at risk of being underutilised because of a multitude of factors including rapidly changing natural environments, fast paced economic, political, and cultural changes. In some cases, local people’s knowledge may have become inappropriate for new challenges because they adapt too slowly. Within a growing global network of regional and national actors, resources are allocated to document the historical (i.e. traditional) and contemporary local knowledge of numerous ethnic groups[1] around the world. However, many practices and knowledge are disappearing because of the intrusion of foreign technologies that promise short-term gains or solutions to problems without being able to sustain them. The implication for other parts of society can be detrimental as well, when skills, technologies, artifacts, problem solving strategies and expertise are lost (WARREN, 1991; 1992a). In the process of technology development, knowledge of indigenous livelihoods is an indispensable resource (HAVERKORT, ZEEUW**,** 1992). Local knowledge may not be as abstract as scientific knowledge. It is often concrete and always dynamic. It relies strongly on intuition, directly perceivable evidence, and an accumulation of historical experiences. Local knowledge reflects the dignity of the local community and puts its members on an equal footing with the outsiders involved in the process of technology development (HAVERKORT, ZEEUW, 1992).

Local or indigenous knowledge systems also provide mechanisms for facilitating understanding and communication between outsiders (extensionists, researchers) and insiders (farmers). Improved understanding and communication enhance participatory approaches to problem identification (WARREN, 1992b). Agricultural researchers and extensionists usually are not aware of local classification systems of farmers regarding soils, crops, livestock, and other natural resources. Therefore, several interdisciplinary case studies were conducted by scientists of the Uplands Program to collect and analyze local ecological knowledge and create a respective knowledge base and, furthermore, expand it into appropriate applications that can be of use in development assistance of communities living in mountainous areas.

This thesis is structured as a cumulative dissertation, and is composed of three individual articles which have already been published.

1.1 Background and Study Context

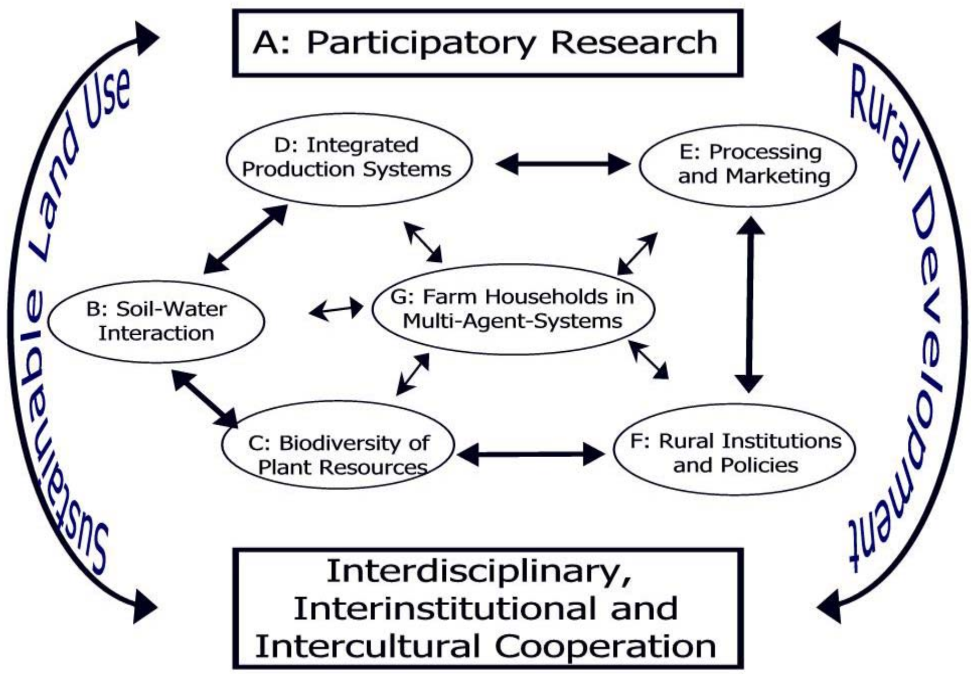
1.1.1 The Uplands Program Framework

This study was part of the Uplands Program or SFB 564 “Research for Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia”. The main objectives of the Uplands Program were the creation of a scientific knowledge base for developing and testing sustainable land use, production and processing systems in ecologically delicate environments. It is a research collaboration between the University of Hohenheim and Thai and Vietnamese universities (Thailand: Kasetsart University, Chiang Mai University, Maejo University and Silpakorn

[1] Presented by FEARON, 2003. There are approximately 820 ethnic groups in 160 countries included.

University and Vietnam: Hanoi University, Thai Nguyen University of Agriculture and Forestry, Vietnam Agriculture Science Institute and National Institute of Animal Husbandry). Its aim was to scientifically support the partner countries (Thailand and Vietnam) in South East Asia in their stated objective of conserving natural resources and improving livelihoods of the mountainous populations. The project consisted of different subprojects that were implemented during four phases between the years 2000 and 2012.[2]. Figure 1 shows the conceptual framework of the research program.

Figure 1: Conceptual framework of the Uplands Program



Source: The Uplands Program SFB 564, UNIVERSITÄT HOHENHEIM, 2003

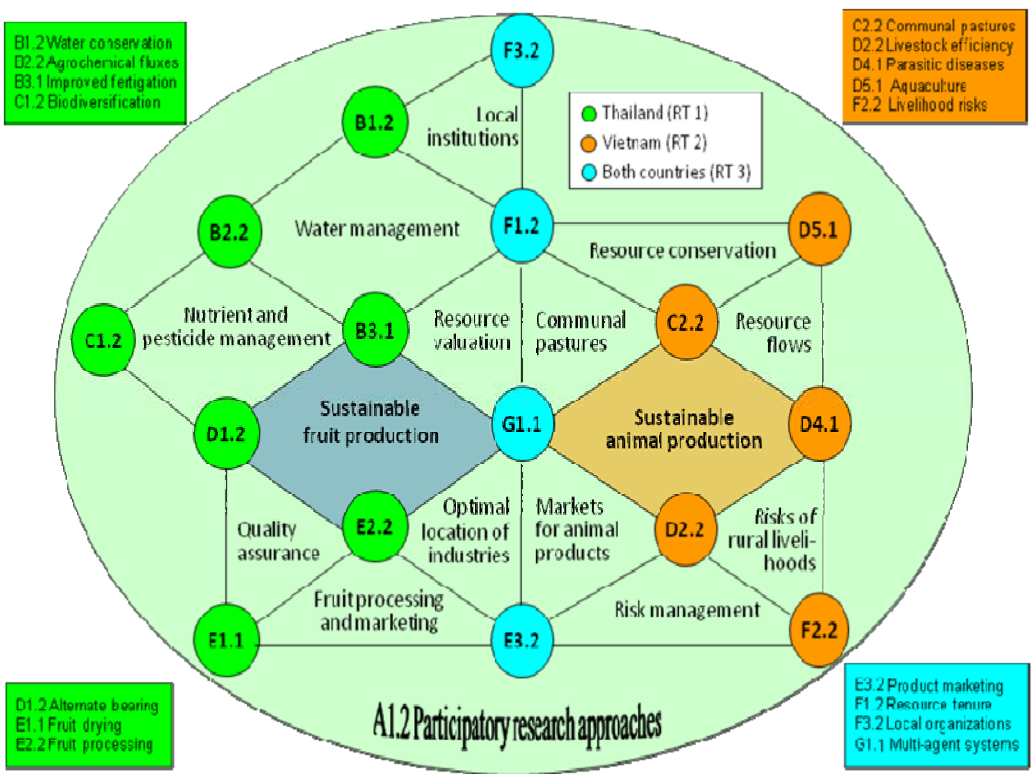
This study was realized under the support of the subproject A1 (Participatory research approaches). The main aim of this subproject was to develop and scrutinize participatory and interactive methods and approaches for analyzing complex agro-ecological systems and their dynamics with special consideration of the interactions between ecological context, ethnic diversity and heterogeneous institutional, political and social frameworks. This research is focused on the process of cooperation between researchers and farmers and local institutions in an interdisciplinary context (Figure 2). One focus of the activities in the field work of this subproject was on recording the

[2] The Uplands Program was a twelve-year Vietnamese-Thai-German collaborative research program looking at sustainable land use and rural development in the mountainous regions of mainland Southeast Asia, and is funded by the Deutsche Forschungsgemeinschaft (SFB 564, University of Hohenheim), see: https://www.uni-hohenheim.de/sfb564/.

local knowledge on soil classification and soil mapping in collaboration with subproject B1.

Mountain areas are often economically depressed and socially marginalized areas. The project outputs are designed to lead to develop concepts for rural institutions and policies that can contribute to solve problems of rural poverty. Therefore it aims at improving the livelihoods of the upland populations through scientific research as well as improving the resilience of rural households in the dynamic economic environment of Southeast Asia (NEEF et al., 2006).

Figure 2: Research fields in the second phase of The Uplands Program



Source: The Uplands Program (SFB 564), UNIVERSITÄT HOHENHEIM, 2003

Local knowledge is meaningful within its own limited spatial and temporal contexts. Thereby understanding the causation and process of knowledge creation and transformation is more important than focusing on the knowledge outcomes. Local knowledge is located at the individual and household level as well as collectively through community stewards and other key social actors (e.g., elder people, shamans, local religious and political leaders). In this study I distinguish between common knowledge (i.e., knowledge held by the whole community) and professional knowledge (i.e., knowledge retained by a few local experts, e.g., healers with specific medical expertise and knowledge of local curative plants; knowledge of local plants known only by women; or knowledge of crops known only by men). BERKES (1999) and ANTWEILER

(1998) also distinguished common and specialist knowledge from shared knowledge, that is knowledge held by many but not all (e.g., knowledge of herders, hunters, or farmers).

The research was initiated in the mid of 2004, the year when I started to work for subproject A1. The use of local knowledge provides many diverse opportunities in ecological and conservation research, but it should be undertaken with support from experienced LEK researchers and only after developing a collaborative relationship with the communities that are involved in or affected by the research. As I have a background in anthropology and rural sociology and good experience in applying participatory research methods with minority people in the Northern Thai mountains, members of other subprojects easily accepted my assistance in their fieldwork.

1.2 Objectives and Scope of Study

This study aims to collect and evaluate local ecological knowledge (LEK) and its importance for management of local agricultural and ecological systems. The collected data was used in building a knowledge base (KB) application for the development of appropriate research approaches for land use development. The study aimed at the following objectives:

- To assess essential ecological knowledge focusing on land use of ethnic minority communities in the mountains of Northern Thailand and Northern Laos
- To systematically record and validate local ecological knowledge (LEK) using PRA methods and the Agro-ecological Knowledge Tool Kits (AKT5)[3]
- To explore the integration of LEK with scientific knowledge, particularly in supporting soil and land use mapping, regional land classification and land use modelling at the watershed and landscape scale
- To contribute to improve local people's livelihoods and their ability to generate food security and income.
- To obtain new insights for sustainable development of mountainous regions.

1.3 Structure of the Study

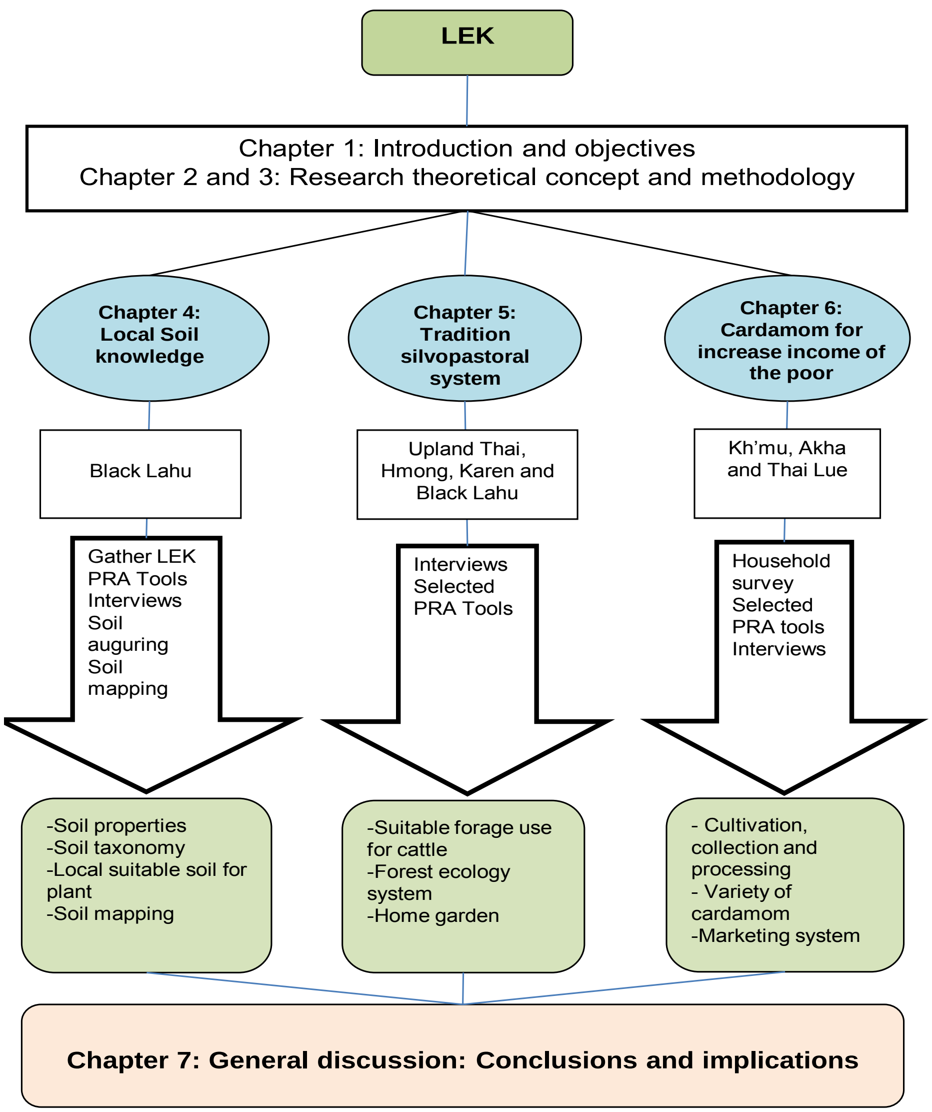
This thesis consists of seven chapters: 1) Introduction and objectives of the study; 2 and 3) Theoretical concept and methodology; 4) Local soil knowledge; 5) Ethnic farmers' perception of traditional silvopastoral systems in Northern Thailand and Laos; 6) Income options for the poorest of the poor: The case of cardamom in Northern Laos; 7) Conclusion and recommendations. The conceptualization of the study is presented in Figure 3.

[3] This software was created by theUniversity of Wales, Bangor, UK

Chapter 1 provides a brief overview of the background of the study, including the objectives and scope of study.

Chapter 2 defines some concepts and central terms used in this study. It is looking into the theory of knowledge, knowledge definition, types of knowledge, knowledge management, local ecological knowledge, concept of a local knowledge framework, local ecological knowledge on sustainable resource management as well as participatory management for promotion of local knowledge construction and innovations.

Figure 3: Overview of the conceptualization of the stud



Chapter 3 describes the general background and characteristics of the study areas, the research procedures and methodologies, the research strategies in order to stimulate and improve local knowledge, the qualitative research approach, PRA methods applied

quantitative research methods, data compilation and analysis, and finally a discussion of the limitations of the study and a critical appraisal of the applied methods.

Chapter 4 presents local knowledge on soil mapping for land-use planning in a karst area of Northern Thailand. This article looks on the perception of farmers about soil classification, soil fertility and soil suitability for cropping which could be confirmed by analytical soil data. We found that integrating local soil knowledge, petro-graphic information, and knowledge of local cropping practices allows for more rapid compilation of information for land evaluation purposes at watershed level. In cooperation with a PhD student from the field of soil science, soil maps on watershed level were evaluated with regard to their suitability for agricultural land use planning. Moreover, in addition to general scientific methods underlying the WRB classification, participatory methods were used to assess local knowledge about soils and to document it in a local soil map.

Chapter 5 presents farmers' perception of traditional silvopastoral systems in Northern Thailand and Northern Laos. The two countries have remarkably different forestry policy frameworks. This study shows that local knowledge can offer proven alternatives and complementary explanations of ecological cause-and-effect relationships which may need further scientific investigation. The findings underline that local knowledge can provide useful resources for striving towards more sustainable highland agro-ecosystems if it is integrated into scientific analysis and policy advice. One of the keys is to encourage the awareness among farmers about the need to enhance collective action and to establish positive incentives for it.

Chapter 6 looks on the topic of income options for the poorest of the poor by studying the case of cardamom in Northern Laos. It seeks to interpret the finding from this case study and concentrates on selling cardamom and other NTFPs collected from the wild. A threat for this resource is that the forest area has become increasingly converted into monoculture plantations (primarily rubber) and that the amount of secondary forest area is constantly decreasing. Even though, cardamom collection remains an important economic opportunity, for collectors and growers especially among poor people. Increasing demand in neighbouring countries like China offers some motivating income opportunities for all actors in the cardamom supply chain, while forest and agricultural policies would need to provide an appropriate framework for sustaining such NTFP value chains.

Chapter 7 presents a discussion and highlights some important lessons learned. From the conclusions some implications and recommendations are developed and presented.

2 Theoretical Background

Theories of knowledge have been developed and discussed from many perspectives. In this chapter I introduce some selected theoretical concepts associated with the practice of knowledge acquisition and utilization. The chapter aims to bring together basic theories and concepts to form the background and baseline of the study. Since epistemology is at the roots of any theory of knowledge, questions of the meaning of knowledge are crucial and several definitions were cited. The chapter also presents the concepts of local knowledge including local classification systems which may vary both in the characteristics used and in the detail and depth of classification. In some cases the classification relates closely to the practical use. The last part of the chapter concludes by presenting the local knowledge base framework and participatory management for the promotion of local knowledge and the adoption of innovations.

2.1 Definitions of Knowledge

HAVELOCK (1986, 14) defines it as "*all facts, concepts, theories, and artifacts that are passed from one generation to another*". This lays a focus on the historical and social focus of knowledge. But even when it is not passed on, when only held in one individual brain, where it assists in decision making and action, nobody would deny, that it is knowledge. This is a focus on the individual aspect of knowledge.

From Greek philosophers we got the basic philosophical questions, as Ontology, the philosophy of being and Epistemology, the philosophy of knowledge and recognition. Epistemology or theory of knowledge is the part of philosophy that studies about the nature and definitions of knowledge. The term "epistemology" is based on the Greek words " *episteme*" (knowledge) and "*logos*" (explanation); it is thought to have been coined by the Scottish philosopher James Frederick Ferrier (1808 - 1864). This field has focused on analyzing the nature of knowledge by placing the knower at the center of knowledge. In other words, epistemology primarily follows the questions: *"What is knowledge?", "How is knowledge acquired?", "What do people know?" and "How do people know?"* (WIKIPEDIA, accessed 14.7.2013).

It is convenient to think of knowledge as separated into indirect or direct types. The former has been called knowledge by acquaintance (LINDA, 1999). Although approaches to answer any one of the questions above frequently involve theories that are connected to others, there is enough particular content that they may be examined separately (GRECO, SOSA, 1999). There are many different topics, stances, and arguments in the field of epistemology. Recent studies have dramatically challenged centuries-old assumptions, and the discipline therefore continues to be vibrant and dynamic. In addition, the definition of knowledge is a debate for philosophers that adhere to different epistemologies. The definition, as given by Plato, with its three criteria to be fulfilled (justified, true, and believed), has been challenged by contemporary philosophers. Some claims of these conditions are not sufficient, as GETTIER'S (1963) case examples demonstrated. There are a number of alternatives proposed, including NOZICK's (1981) arguments for the requirement that knowledge tracks the truth and BLACKBURN's (1999) additional requirement that those who meet any of these conditions through a defect, flaw, or failure cannot claim to have knowledge. KIRKHAM (1984) suggests that our definition of knowledge requires that the believer's evidence is such that it logically necessitates the truth of the belief. DAVENPORT et al. (1998) hold that knowledge is information combined with experience, context, interpretation, and reflection. It is thus considered a high-value form of information that is ready to be applied to decisions and actions. NONAKA (1994) stated that explicit or codified knowledge refers to knowledge that is transmittable in formal, systematic language. On the other hand, implicit knowledge has a personal quality, which makes it hard to formalize and communicate it. Knowledge is seen as the human expertise stored in a person's mind, gained through experience and interaction with the person's environment. Moreover, knowledge is a physical, mental or electronic record of relationships believed to exist between real or imaginary entities, forces and phenomena (WORTHINGTON, 2005).

Knowledge is not easily measured or audited, so organizations must manage knowledge effectively in order to take full advantage of the skills and experience inherent in their systems and structures as well as the implicit knowledge belonging to the employees of the firm. In fact, organizations assume a shared worldview – we have an organizational knowledge – teaching children at school and train them to understand the world – if this understanding chimes with their worldview then they will pass this knowledge on. Knowledge management is a managerial activity which develops transfers, transmits stores and applies knowledge, as well as providing the members of the organization with real information to react and make the right decisions, in order to attain the organization's goals. For example, a school is an organization whose primary function is to pass on relevant knowledge of the world (KANAGASABAPATHY, RADHAKRISHNAN, 2006).

2.1.1 The problem of Defining Knowledge

For a long period of philosophical history, "knowledge" was taken to mean belief that was justified as true to an absolute certainty. Any less justified beliefs were called mere "probable opinion". This viewpoint still prevailed at least until the publication of Bertrand Russell's early 20th century book '*The Problems of Philosophy*'. In the decades that followed, however, philosophers came to think of knowledge as meaning "justified true belief", and the notion that the belief had to be justified to a certainty was forgotten. GETTIER (1963) criticized this definition of knowledge by pointing out situations in which a believer has a true belief justified to a reasonable degree, but not to a certainty, and yet in the situations in question, everyone would agree that the believer does not have knowledge (KIRKHAM, 1984). The problems show that there are situations in which a belief may be justified and true, and would not be knowledge. Although being justified, while true belief is necessary for a definition of knowledge, it is not sufficient. At least, the set of our justified true beliefs contains things that we would not say that we know. Some epistemologists have attempted to find strengthened criteria for knowledge that are not subject to the sorts of counterexamples GETTIER and his many successors have produced. Most of these attempts involve adding conditions or placing restrictions on the kind or degree of justification suitable to produce knowledge. None of these concepts has yet gained widespread acceptance. KIRKHAM (1984) has argued that this is because the only definition that could ever be immune to all such counterexamples is the original one that prevailed from ancient times through Russell: To qualify as an item of knowledge, a belief must not only be true and justified, the evidence for the belief must necessitate its truth (LEVINSON, 2010).

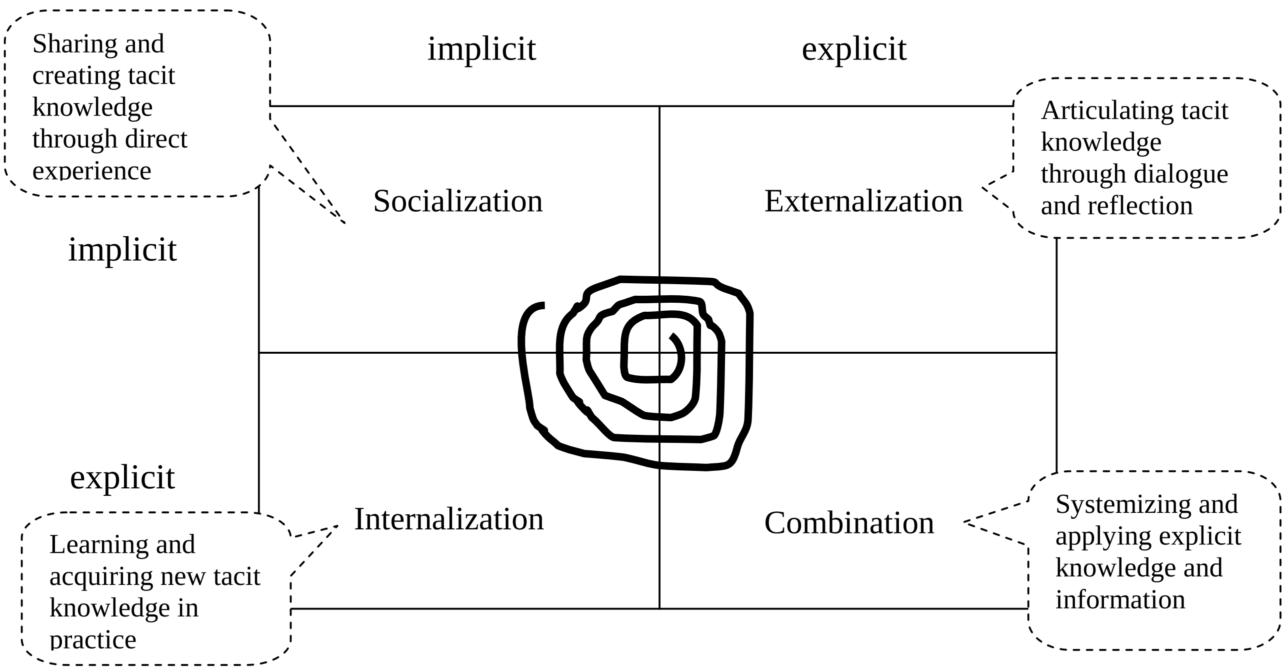
2.1.2 Two Kinds of Knowledge

In addition to these observations about knowledge, there are two different *kinds* of knowledge. When talking about knowledge management, it is clear that we are dealing with a set of complex issues that are interrelated and cannot be segmented. This is because much of the knowledge creation activities are products of people interacting with people, people interacting with information, people interacting with systems, and people interacting with the environment in which they operate. The two different types of knowledge that knowledge management is concerned with are explicit knowledge, and implicit knowledge. Concepts of "explicit" and "implicit" knowledge are meant to get at the fact that knowledge is a deeply rooted human process that lives within the private world of the individual and cannot simply be reduced to information processing and software automation, but also involves a great deal of tacit knowledge. While this knowledge is not unique to the individual and can be shared, it is hard to represent formally. At the same time, the human process lives in the public domain of communication and language, culture and representation that generates knowledge artifacts. These artifacts can be powerfully enhanced through software automation. The explicit knowledge is expressed by a language and hence it is declarative knowledge. The implicit knowledge is undeclared knowledge. In the field of artificial intelligence, knowledge is classified as declarative and procedural knowledge (FUKUZAWA, 2004). The implicit knowledge is further divided into two types in this paper; pseudo-tacit knowledge and real-tacit knowledge. Then the following might be said for each kind of knowledge (Cited in HOFFMANN et al., 2009, 92): "*Knowledge gained by experience and practices is implicit knowledge which is very complicated to transfer as it cannot be described explicitly. Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of the knower*". NONAKA, TAKEUCHI (1995), cited by HOFFMANN et al. (2009, 92), referred to this when they talked about how to convert implicit knowledge to explicit knowledge. According to them knowledge conversion is about the interactions between explicit and implicit knowledge in a continuous and spiral manner (Figure 4).

2.1.2.1 Explicit Knowledge: Management of explicit-knowledge is to manage a systematic framework that promotes and supports the comprehension of explicit information- mostly in the form of documents, based on data and composed by signs.

It is found in databases and files such as manuals, documents and orally communicated knowledge. Explicit knowledge is easy to document and share in the form of textbooks, written notes, research papers, presentations, and journals. In the creative field such as technical development, the management of explicit knowledge is capable to induce creativity due to comprehension-sharing between different experts in different special fields. The management of explicit-knowledge is also capable to work as an educational tool to transfer information from experts to novices as well as a communication tool between experts and common people, since the management aims at promotion and support of common comprehension. Explicit knowledge is representational and can live and be manipulated within the digital domain. Converting data-to-information and information-to-knowledge describes a value continuum of explicit knowledge. The tools and business processes of knowledge management are intended to enhance this continuum of value (cf. NONAKA, TAKEUCHI, 1995; cf. HOFFMANN et al., 2007).

Figure 4: Transforming knowledge (modified from NONAKA and TAKEUCHI, 1995, 85)



Source: HOFFMANN et al., 2009, 92.

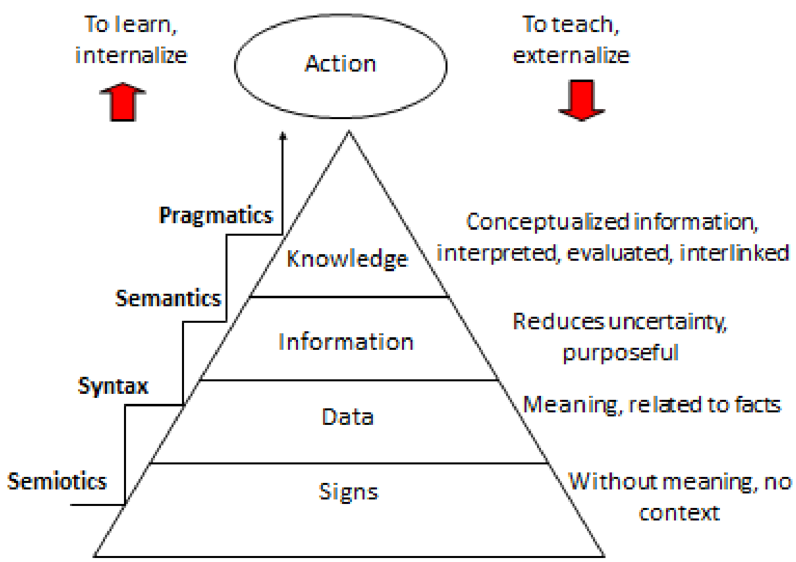
2.1.2.2 Implicit Knowledge

Implicit knowledge was originally defined by Polanyi in 1966. It is sometimes referred to as know-how (BROWN, DUGUID, 1998) and refers to intuitive, hard-to-define knowledge that is largely experience-based. Because of this, it is often context-dependent and personal in nature. It is hard to communicate and deeply rooted in action, commitment, and involvement (cf. NONAKA, 1994). "*Implicit knowledge is practical, action-oriented knowledge or ''know-how'' based on practice, acquired by* *personal experience, infrequently expressed openly, often resembles intuition*" (SMITH, 2001, 314).

Professional research can serve local needs if the researchers understand what local people already know the priority areas where new knowledge is required and if they are then able to communicate (SINCLAIR, JOSHI, 2000). In addition, implicit knowledge is found in people's heads and is often inaccessible, example of this being judgment, know-how, or intuition. This knowledge is informal, experimental, and difficult to capture or share. Implicit knowledge is made up of best practices, experience, wisdom and unrecordable intellectual property that live within individuals and teams. Since implicit knowledge exists within minds, it cannot be reduced to the digital domain as a material asset, or be manipulated directly. However, it is expressed in the social domain as the response ability of individuals and teams.

Since explicit knowledge can be acquired by such means as purchasing online, training courses or sharing manuals and organizational procedures, it is not relatively easy to produce and share. But implicit knowledge is exclusively in the minds of individuals and requires interaction with the knower to tap into their knowledge. Often people are unaware of their knowledge or how it can be valuable to others. HAWAMDEH (2002) stated that 80% of our knowledge is nowhere than in our heads, therefore we need to find ways to codify or transfer as much of this inaccessible knowledge so others can benefit from what we know. Moreover, as HOFFMANN et al. (2009) explained, knowledge can be indirect and stored as information. This means that information can be seen as externalized knowledge and processed data which serve a purpose or reduce uncertainty as shown in Figure 5. Understanding implicit knowledge is essential to the development of an effective approach to knowledge management (HOFFMANN et al., 2007).

Figure 5: The extended knowledge pyramid



Source: HOFFMANN et al., 2009, 90

2.2 Local Knowledge (LK)

2.2.1 What is Local Knowledge?

Local Knowledge is a broad concept, which refers to knowledge possessed by a group of people living in a particular area for a long period of time (LANGILL, LANDON, 1998). Local knowledge is a more or less systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments, and intimate understanding of the environment in a given culture (RAJASEKARAN, 1993). Meanwhile many authors from different disciplines contributed to the body of knowledge around local or indigenous knowledge (e.g. BROKENSHA et al. 1980, DUPRÉ, 1991, MCCORKLE 1989, ORLOVE, BRUSH 1991, RICHARDS 1985, WARREN 1991, WARREN et al. 1989, SILLITOE 1998b). The various definitions of local knowledge developed by academia and some institutions have not led to a unanimous perception of the concept of local knowledge. None of the definitions is essentially contradictory; they overlap in many aspects as suggested by WARREN (1991). Local knowledge is a term with many meanings depending on context, but it is generally related to communication, representation, learning, and experience. According to HAVERKORT, ZEEUW (1992) local knowledge is the knowledge of a given population that reflects the long-term, i.e. traditional, experiences and includes more recent experiences with modern technologies. In this sense, local knowledge includes the complexity of practices and decisions made by local people which are based on experience (OUDWATER, MARTIN, 2003). Local ecological knowledge (LEK) refers to knowledge held by local stakeholders (such as farmers and resource users) that is derived from their daily interactions with their natural environment, in effect based on experience and observation (SINCLAIR, JOSHI, 2000).

But there is no reason to idealize or romanticize local knowledge, "*just like scientific knowledge, local knowledge is always fragmented, partial and provisional in nature*". (THOMPSON, SCOONES, 1994, 64). "*It is never integrated in terms of an underlaying cultural logic or system of classification*." (THOMPSON, SCOONES, 1994, 60).
"*It is difficult to decide weather a certan technology or practice is indeed indigenous or from outside, as it can be a blend of both local and external components*." …"*Therefore local knowledge, indigenous knowledge and rural people's knowledge are used in this study as synonyms*."(DAIQ, 2005, 21).

2.2.2 Why is Local Knowledge Important?

Recently, many forms of local knowledge are at risk of becoming obsolete and extinct, because of rapid changes of the natural environment as well as economic, political, and cultural changes on both global and local scale. AGRAWAL (1995a, 1995b) describes attitudes of local knowledge during the 1950s and 1960s when it was viewed as disorganized, of lower value as compared to scientific knowledge, and as an absolute obstacle to development approaches to communities. However, local knowledge increasingly became recognized as a valuable and under-utilized resource of importance, owning communities and the development process in a similar way. In short, the development process might have achieved better results by including the knowledge of local people.

Local knowledge consists of factual knowledge, skills, and capabilities, most of which have some empirical grounding. It is culturally situated and is best understood as a social product. During extensive field studies many types of local knowledge were found that were based on farmers' experience. Such knowledge has been used for agricultural practices and gained high importance for improving rural livelihoods. Local knowledge is the main asset rural people invest in the struggle for survival, to produce food, provide for protection or achieve control of their own lives. Significantly, local knowledge has also made contributions to global knowledge, when local people have shared their knowledge of traditional human and veterinary medicine. Local knowledge is developed and adapted continuously to a gradually changing environment. It is passed down from generation to generation and closely interwoven with people's cultural values. In the emerging global knowledge economy, a country's ability to build and mobilize knowledge capital is as essential to sustainable development as the availability of physical and financial capital. The basic component of any country's or society's knowledge system is its local knowledge. This encompasses the skills, experiences and insights of people, applied to maintain or improve their livelyhood.

The tragedy of the impending disappearance of local knowledge is most obvious to those who have developed and make their living from it. Moreover, the implication for others may also be detrimental, when skills, technologies, artifacts, problem-solving strategies and knowledge are lost. Local knowledge is a part of people's lives. Especially, the poor depend, almost entirely, for their livelihoods on specific skills and knowledge essential to their survival. Recurrently, local knowledge is identified as an important component in sustainable farm development. The promotion of viewpoints that cross knowledge boundaries may provide a suitable approach to management (MEEHAN 1980; OUDWATER, MARTIN 2003; RIST, DAHDOUH-GUEBAS 2006). Consequently, local knowledge is dynamic, changing through local mechanisms of creativity and innovativeness as well as through contact with other local and international knowledge systems (WARREN, 1991). These knowledge systems may appear simple to outsiders, but they represent complex mechanisms to ensure the livelihoods for local people under adverse and often marginal conditions. Local knowledge systems often are elaborate, and they are adapted to local cultural and environmental conditions. Local knowledge systems are tuned to the needs of local people and the quality and quantity of available resources (PRETTY, SANDBROOK, 1991). They pertain to various cultural norms, social roles, or physical conditions. Yet their efficiency and sustainability lies in the capacity to adapt to changing circumstances. According to NORGAARD (1984, 7) local knowledge has been alternatively viewed as part of a romantic past, as the major obstacle to development, as a necessary starting point, and as a critical component of a cultural alternative to modernization which also contributes to our understanding of agricultural production and the maintenance and use of environmental systems.

2.3 Local Ecological Knowledge (LEK)

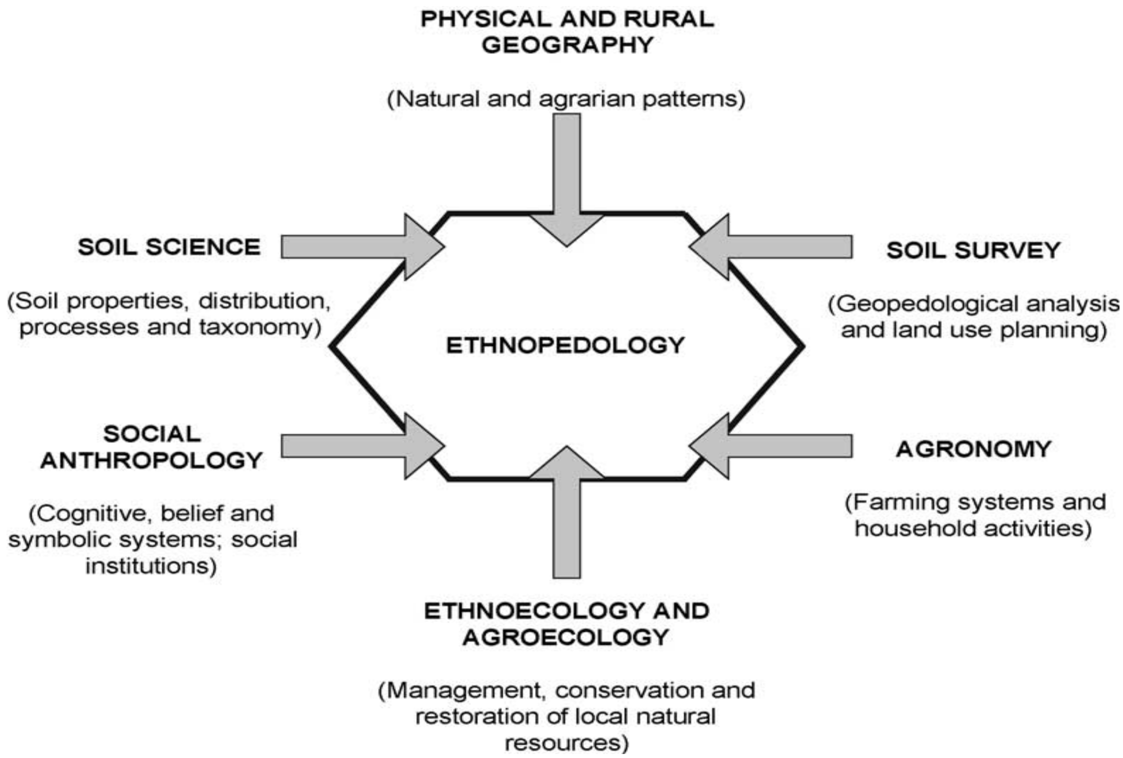
Local ecological knowledge refers to ecology as a natural science and includes a person's general knowledge of nature and a more specific localized knowledge. The concept can also be understood as experiential ecological knowledge, which can be a blend of learned scientific knowledge and knowledge based on a resident's own observations and experiences from surrounding nature. As such, by definition, Local Ecological Knowledge is usually a hybrid form of knowledge and thus not strictly local or traditional (CLARK, MURDOCH, 1997; NYGREN, 2005). For instance, OLSSON, FOLKE (2004) defined LEK in rural conditions as knowledge held by a specific group of people about their local ecosystem and a mix of scientific and practical knowledge, being site-specific and often involving a strong belief component. Furthermore, all LEK is contextualized and is a product of a social process. Finally, LEK is usually strongly contextualized; containing elements such as experiences, beliefs, and justification that are dependent on the actors' roles in time and space and the specific environmental context. On the other hand, it should also be kept in mind that all ecological research is site-specific, and scientific data cannot easily be contextualized. Contrasting ecological research information includes precise scientific knowledge about species composition, diversity, habitat requirements and characteristics, and population sizes (YLI-PELKONEN, NIEMEL, 2005). LEK is not a result of a systematic scientific study; its strength is to be based on a lengthy series of local observations. "*Intellectuals, development agencies and governments have all pursued environmental management problems at too high a level of abstractionand generalization. Many environmental problems are, in fact, localized and specific, and require local, ecologically particular, responses. The issue becomes how to stimulate such situation-specific responses. One of the answers explored below is through mobilizing and building upon existing local skills and initiatives. Everything should be done – so the argument runs – to stimulate vigorous 'indigenous science' and 'indigenous technology'*." (RICHARDS, 1985, 12)

It is essential to incorporate this type of knowledge in planning through participation (CHRISTINCK, 2002, 11ff.). This has been the aim of the field of ethnoecology. Ethnobotany (GEORGIADIS, 2008, 10f.) and ethnopedology (FRY, 2001) are sub-branches of ethnoecology, which is the study of indigenous environmental knowledge. Hence, ethnopedology can be considered as a hybrid discipline structured from the combination of natural and social sciences, such as soil science and geopedological survey, social anthropology, rural geography, agronomy and agro-ecology (Figure 6) (BARRERA-BASSOLS, ZINCK, 2003).

2.4 LEK in Natural Resource Management (NRM)

Local Ecological Knowledge is knowledge held by people in particular localities that use natural resources. There are many dimensions to the knowledge that natural and forest resource users have and many ways to go about describing it. We are concerned here with local knowledge, which in this context can be distinguished from 'indigenous'. Indigenous knowledge implies knowledge that is culturally specific

Figure 6: Ethnopedology as a hybrid discipline

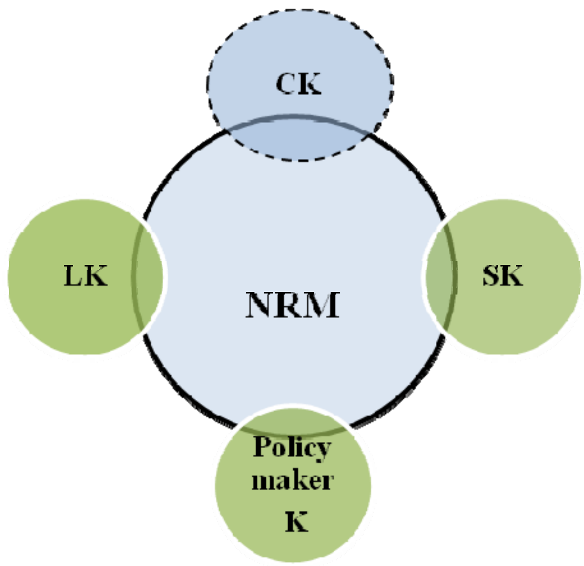


Source: adapted from BARRERA-BASSOLS, ZINCK, 2003

(SILLITOE, 1998a), whereas the concern here is with knowledge about resources and the environment that is locally derived through observation and experience. The significance of this distinction is that the local knowledge systems from geographically distant and ethnically different locations but with a similar agro ecological context show remarkable similarities. Local people most often depend heavily upon natural resources for their livelihood. Local knowledge in agroforestry research is defined as the general explanatory ecological knowledge encompassing all the practical skills, know-how and wisdom developed through the understanding of observations, experience and experimentation held by a person or a community in a particular environment (WALKER, SINCLAIR, 1998; FORSYTH, WALKER, 2008). Farmers and rural people who secure their livelihoods directly from the use of land or natural resources have a very intimate knowledge of their environment. Through daily observations, experimentation, experience and perceptions they build an understanding of ecological processes and change (BROOK, MCLACHLAN, 2008).

Knowledge construction is a way to think about the relationship between constructing artifacts and constructing shared understanding among people (OSTWALD, 1996). Knowledge alone does not lead to action; conditions and constraints due to cultural regulars, religious obligations, and economic and political circumstances can all influence farmers' decisions, forcing them to act in an ecologically irrational manner.

Figure 7: The interaction between knowledge systems about NRM.



Source; modified from JOSHI et al., 2004

(SK is scientific knowledge representing the multiple disciplines. CK is the construction of knowledge. LK is local knowledge. The black line indicates knowledge exchange for successful NRM

Moreover, farmers construct their knowledge on agricultural practice that generally unfolds over time (during a season, off season or over several years in the case of perennial crops). There are four weakly connected major knowledge systems (Figure 7) so that farmers may make many separate decisions about the cultivation, tending and harvesting of crops, each of which would be contingent upon the circumstances extant at the time that it is made. These build up a complex agricultural practice, in which it is difficult to disentangle ecological knowledge from other social and economic constraints by simply observing the result (RICHARDS, 1989). ORMROD (2008) stated that learning involves constructing one's own knowledge from one's experiences. Moreover, current human knowledge influences what we learned, what we expect to learn, what we can store, and what we can retrieve. From the case study explained that the gap between LK and SK is CK which the LEK itself has constructed their knowledge during practicing their agricultural system. Thus, the usefulness of the four aspects is building on local practice for recognizing sophistication of local knowledge for effective communication and realizing its limitations and windows for improvement. While this section has stressed the local understanding of ecological processes, it is also clear that there is a lot that local people may not know (e.g. how agrochemical residues move in soil and water) and that this often constrains their practice. Limits to what resource users can observe often determine limits to their knowledge.

2.5 The Concept of the Local Knowledge Base Framework

A knowledge base is a store of knowledge that consists of a collection of statements and locally defined taxonomic relationships, created using AKT5 software. Each statement is tagged (referenced) with its source of knowledge (either a singular person, a number of people if it came from a group interview or a document). Creating a knowledge base involves a significant investment of time – particularly when many people have to be interviewed. The product, therefore, should be a resource that is suitable for many purposes. Preparation before actually developing a knowledge base involves two crucial activities: (1) Specifying objectives of creating a knowledge base and (2) Defining scope and boundary of the knowledge base (DIXON et al., 2001).

2.5.1 LK and Knowledge Based Systems (KBS) Approaches

There is an increasing awareness that local knowledge and practices should be considered when developing initiatives expected at sustaining and improving the livelihoods of farming communities and the environment (JOSHI et al., 2004). Interest amongst institutions involved in research, education and development in investigation and documentation of local knowledge has grown significantly over the last few years NATHAN et al., 2007). Bangor University is a leading institution in the development of a knowledge-based system (KBS) methodology to acquire and use local knowledge in research and development. The university spearheaded the development of this novel approach to acquire, store and use local ecological knowledge about agro-ecosystems in collaboration with various national and international research institutions in Asia, Africa and Central America. It promotes systematic collection and collation of ecological knowledge from farmers and development professionals. The Agro-ecological Knowledge Toolkit (AKT5) is a tailor-made computer software package that enables representation of knowledge in a computer readable form facilitating exploration of local ecological knowledge using computer based search and reasoning facilities. Work so far has revealed that rural people often have sophisticated knowledge of ecological processes occurring in their environment and that local knowledge is largely complementary to scientific knowledge, but is often not taken seriously into account when planning research (SINCLAIR, WALKER, 1998; DIXON, et al., 2001). While knowledge may differ to some extent between communities living in the same geographical region, common frameworks and terminology can occur across large distances and consistencies have been identified between people from similar agro-ecological zones despite different geographical and cultural contexts (BERLIN, 1992).

2.5.1.1 Consulting Knowledge Bases

Local knowledge can help researchers and development workers to explain the rationale behind farmers' actions and can contribute towards more effective decision making in developing appropriate strategies for particular development issues. Knowledge bases can be consulted by:

- Viewing sets of *statements* that fall under specific *topics*,
- Using search facilities within AKT to find out the details of particular *terms* (words), Formal terms in AKT are either:
  - objects (e.g. 'pests', 'crops', and 'field')
  - processes (e.g. 'erosion', 'infiltration', 'growth')
  - actions (e.g. 'pruning, 'harvesting', 'planting')
  - attributes (e.g. 'rate of erosion', 'pest population size', 'tree height')
  - values (e.g. '3 m', '10 t/ha', 'high', 'low')
  - links (user defined) (e.g. 'eat' as in 'cows eat grasses)
- Generating *diagrams* from *statements* and using these to investigate causal relationships, and using customized *tools* (small computer programs that are incorporated into AKT5 that interrogate and reason with the knowledge base) (DIXON, et al., 2001)

2.5.1.2 The Agro-ecological Knowledge Toolkit (AKT5)

AKT5 is a methodology and software that enables the user to create a knowledge base about a chosen domain which is shaped by the topic of the knowledge base, the research area and the people chosen to be interviewed. A knowledge base is built up by collating knowledge about a chosen topic from a variety of sources (usually farmers, scientists, extension workers and scientific literature). So far, AKT5 has been used primarily as an analytical research tool to explore the extent and nature of agro-ecological knowledge at a wide range of localities. This has led to profound changes in the way that research and extension are planned in areas of Africa (Kenya, Tanzania, Ghana and Cameroon), Asia (Nepal, Thailand, Sri Lanka and Indonesia) and Latin America (Colombia, Costa Rica and Nicaragua), as well as forming the basis for successful participatory crop improvement and the development of decision support tools for the production of extension materials tailored to farmer circumstances (MOSS et al., 2001; JOSHI, SINCLAIR, 1997; DIXON et al., 2001). Hence, local knowledge is explicitly stored within a knowledge base; it can be consulted by natural resource scientists, policy makers and development workers in a variety of ways to help them meet their own objectives.

2.5.2 Knowledge Base (KB) Creation

Creating a KB involves four stages; knowledge elicitation from appropriate sources, converting the knowledge into simple unambiguous statements and input of those statements into special software as depicted in Figure 8.

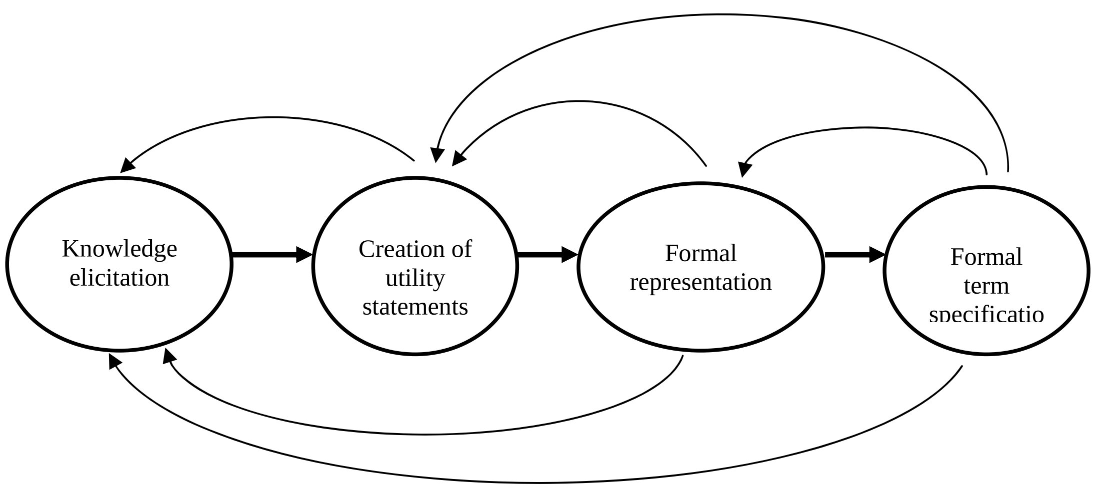
Knowledge elicitation is the process where selected informants are encouraged to articulate their knowledge by repeated interview with farmers.

Creation of utility statements is the process of extracting knowledge from the interview material and creating simple statements each containing one unit of knowledge.

Formal representation is the process of coding knowledge for input into a computer by analysis of formal grammar statements.

Formal term specification is the process of identifying and organizing key components of knowledge.

Figure 8: The creation process of a KB



Source: Applied from DIXON et al. (2001)

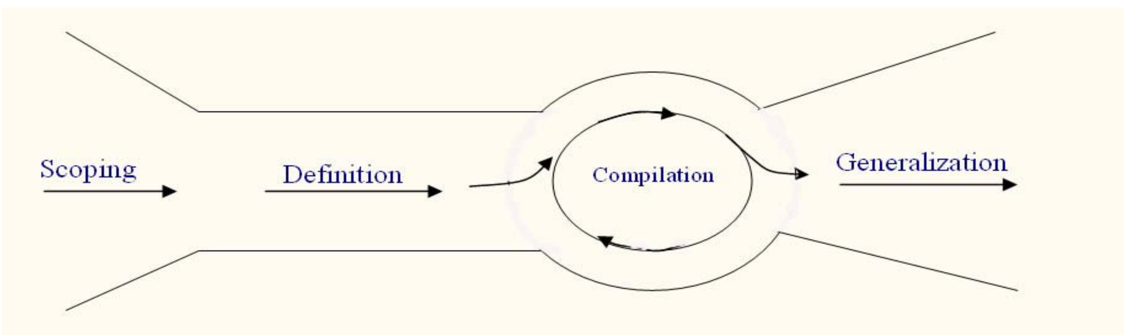
There are four principle activities in the creation of a KB, as shown in Figure 8. These occur in sequence (bold arrows), but evaluation during the creation of a KB and consequent return to previous activities (fine arrows) means that the process is in fact a series in a cycle.

2.5.3 Knowledge Elicitation

Before we can begin to design and implement our expert system, the process of knowledge elicitation has to be undertaken. Knowledge elicitation can be described as acquiring knowledge from human experts and learning from data. Eliciting knowledge is the approach to gather as much knowledge as possible which is in the heads of experts or the key informants. Experts may have a great share of tacit knowledge as they are not aware of all that they know and use. Tacit knowledge is hard (impracticable) to describe. Experts can be a scarce and valuable resource. Techniques of PRA should help to take experts off the job for short time periods. Focus on the essential knowledge, tolerate knowledge to be collated from different experts and allow knowledge to be validated and maintained (BECHHOFER, 2006)

Figure 9 describes the framework of knowledge elicitation by a manual knowledge elicitation process which consists of interviewing individuals and eliciting their knowledge via several semi-structured questions and face-to-face group discussions. Sources as key informants are the farmers or other types of resource managers. The data or information derived from the answers is integrated into the knowledge base (DIXON et al., 2001). In short, knowledge elicitation techniques are capable of providing rich information regarding the concepts, relations, facts, rules, and strategies relevant to the domain in question. The techniques differ in terms of their procedures,

Figure 9: Knowledge elicitation framework



To refine knowledge acquisition	To generate understanding with selected key informants	To create a coherent and comprehensive KB	To test how representative the KB is of farmers generally

Source; Applied from DIXON et al., 2001

as well as their emphases on one type of knowledge or another. No technique is guaranteed to result in a complete and accurate representation of an expert's knowledge.

2.6 Participatory Management for Promotion of Local Knowledge and Adoption of Innovations

A wide array of experiences in participation at different stages of the project cycle can be found in the three case studies undertaken and documented in chapters 4-6. These cases have demonstrated innovative features and a range of possibilities that can be replicated elsewhere. Participatory management is one dimension that needs to be much better addressed in all projects. In fact, there is need to develop a comprehensive framework on participation, where participation is considered a partnership among key stakeholders and include, among other aspects, the provision of adequate time to build participation, and capacity building to promote and monitor peoples participation.

The concerns relating to the use and promotion of local knowledge require also to be translated into an essential facilitation processes in the case study design, which should be reviewed and monitored regularly. In larger projects, developing appropriate facilitation processes and their systematization is important. Further, sensitizing the case study facilitators and managers on the relevance of the local knowledge systems and building their capabilities is the basic foundation upon which the participatory processes for generation of new knowledge is built upon. Similarly, experimentation and validation through experience is a key to adoption and development of local knowledge systems. External ideas or solutions should also necessarily go through such a process of validation. Processes relating to documentation and communication strategies which help in sharing of knowledge and innovations in between communities are important elements in this facilitation process. If local knowledge is to be used in a respectful way that recognizes its inherent and use-value, community members should be meaningfully involved in most, if not all, aspects of a study, especially when making linkages between LEK and science.

The importance of LEK for supporting local adoption processes is exemplified by the factors for adopting cardamom plantations, actively promoted by development projects and the government among ethnic minority groups in Northern Laos (cf. chapter 6). The relative advantage of the farmers is that they are able to establish cardamom plantations quickly since it does not require fundamental changes to the farm management. Based on the collection of wild cardamom, farmers have already acquired the necessary local ecological knowledge related to plant physiology, specific management requirements and harvesting periods. During the trialability stage, farmers usually plant cardamom in one part of their field or in the forest as it has a higher productivity rate when grown in the shade. The farmers do not need to search for new cultivation areas, they are still able to plant their main crops and augment the income with a crop that does not require complex measures. Villagers do not have to add fertilizer, spend little time on cardamom and the rest of the time they are able to tend to other crops since the cardamom harvest occurs only once per year. Meanwhile, the farmers grow other crops which are promoted by the Laos's government and Chinese companies, such as commercial products like rubber, watermelon and sugar cane.

3 Methodology

This chapter presents the methodology employed to motivate local people to assess their own situations and to communicate their knowledge to the researcher or research team. Qualitative and participatory research methods were primarily used to enable local people to describe and discuss their everyday knowledge and natural resource management practices to sustain their livelihoods. Because the research involved an emphasis on local people's own knowledge and practices and was taking place within the community, the use of such an approach could yield many insights into local knowledge. For local knowledge elicitation to be useful as a valuable source of information and a basis for improved natural resource management, the process of data collection and analysis needed to be systematic and accurate. The various methods used to derive local knowledge in this study are described in detail below.

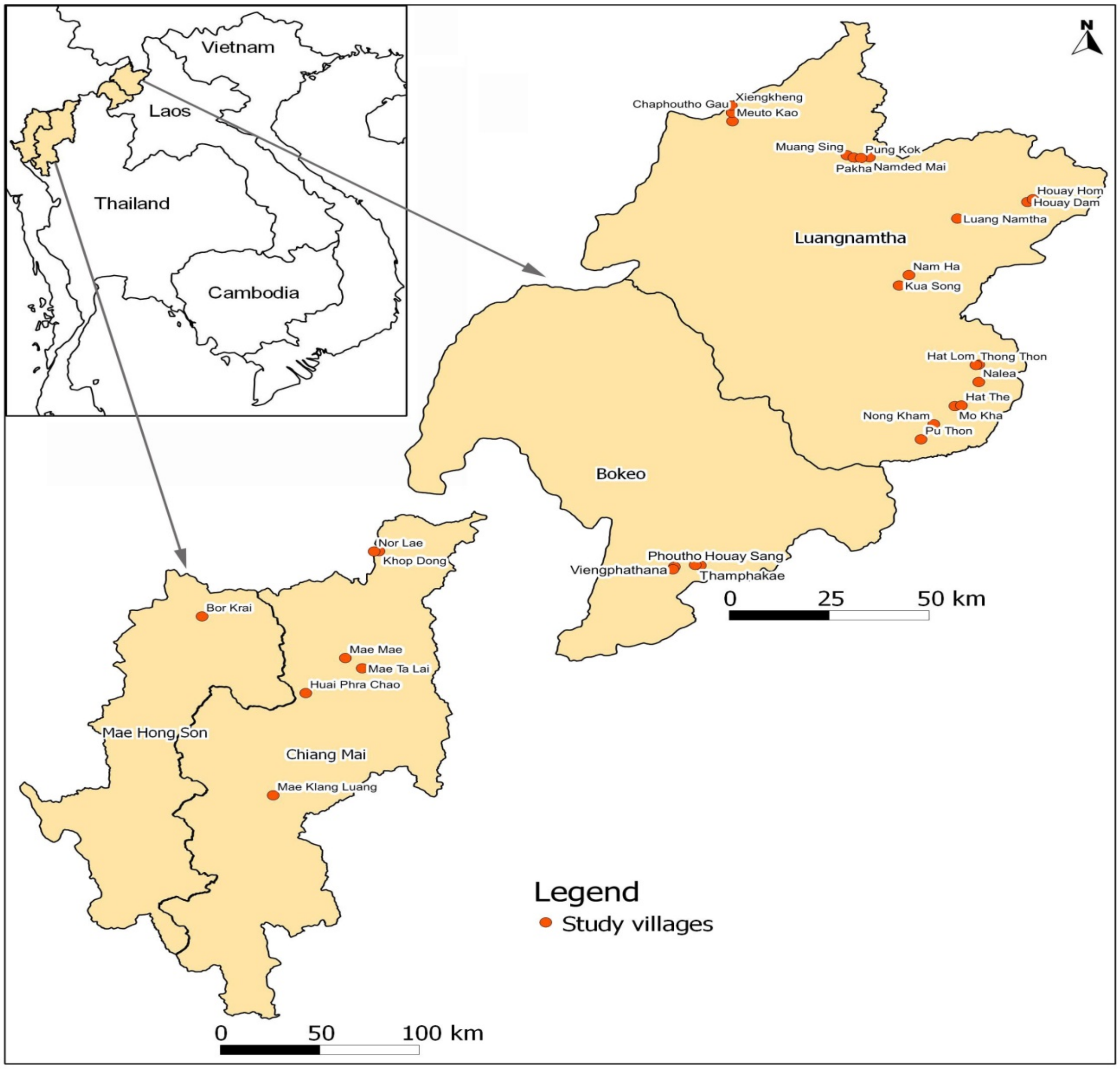
3.1 Study Areas

The selection of the research area followed the framework of the Uplands Program. The Thailand component of the Upland Program "Research for Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia**"** (2000-2012) (SFB 564) was long-term research collaboration between the University of Hohenheim and several Thai universities in South East Asia (Kasetsart University, Silpakorn University, Mae Jo University and Chiang Mai University). My main interest in this study was the comparison between Northern Thailand and Northern Laos, as they are located in the similar climate and landscape, while there are different ethnic minorities that have been developing their distinct agricultural practices (Figure 10). In total, 28 villages were selected for the study, comprising eight ethnic minority groups. Table 1 below shows the names, administrative affiliation and ethic composition of the villages in detail.

3.2 Research Procedure and Methods

The data collection focused on local ecological knowledge held by local people. Knowledge was gathered using selected participatory research tools developed for Participatory Rural Appraisals (PRA). CHAMBERS, 1998 stated that "*A growing and evolving family of approachesand methods, continuously discovered, invented, rediscovered, reinvented, and always experienced, variously known as PRA*". PRA evolved from Rapid Rural Appraisal (RRA) - a set of informal techniques used by development practitioners in rural areas to collect and analyse data. RRAs were the first attempts to bring local considerations into decision making by project planners. Rapid Rural Appraisals were developed in the 1970s and 1980s in response to the perceived problems of outsiders missing or miscommunicating with local people. In the context of development work the PRA approach was developed in the early 1990s, and is associated with a considerable shift in paradigm, from a top-down to a bottom-up approach. In PRA, data collection and analysis are undertaken by researchers as fa-

Figure 10: Research area



Map provided by ELSTNER, 2011

Table 1: List of villages

Village	District	Country	Ethnicity	N
Mae Klang Luang	Jom Tong	Thailand	Karen	1
Mae Ta Lai	Mae Tang	Thailand	Thai	2
Mae Mae	Chiang Dao	Thailand	Thai	3
Nor Lae	Fang	Thailand	Palong	4

Village	District	Country	Ethnicity	N
Kob Dong	Fang	Thailand	Black Lahu	5
Bor Krai	Pang Ma Pha	Thailand	Black Lahu	6
Huai Pro Jao	Mae Tang	Thailand	Karen	7
Viang Patthana	Bo keo	Laos	Hmong	8
Thamphakae	Bo keo	Laos	Hmong, Laotian	9
Phuto	Bo keo	Laos	K'hmu	10
Huai Sang	Bo keo	Laos	K'hmu	11
Namded Mai	Muang Sing	Laos	Akha	12
Pakha	Muang Sing	Laos	Akha	13
Pung Kok	Muang Sing	Laos	Akha	14
Thung Thon	Nalae	Laos	K'hmu	15
Hat Lom	Nalae	Laos	Thai Lue	16
Hat The	Nalae	Laos	Thai Lue	17
Mo Kah	Nalae	Laos	K'hmu	18
Nalae	Nalae	Laos	Thai Lue	19
Nong Kham	Nalae	Laos	Thai Lue	20
Pu Thon	Nalae	Laos	K'hmu	21
Chaputhon Gau	Muang Sing (Xiengkhaeng)	Laos	Akha	22
Xiengkhaeng	Muang Sing	Laos	Thai Lue	23
Meuto Kao	Muang Sing (Xiengkhaeng)	Laos	Akha	24
Kua Song	Luang Namtha	Laos	K'hmu	25
Nam Ha	Luang Namtha	Laos	K'hmu	26
Houay Dam	Luang Namtha	Laos	K'hmu	27
Houay Hom	Luang Namtha	Laos	K'hmu	28

Source: Based on data collection 2004-2010

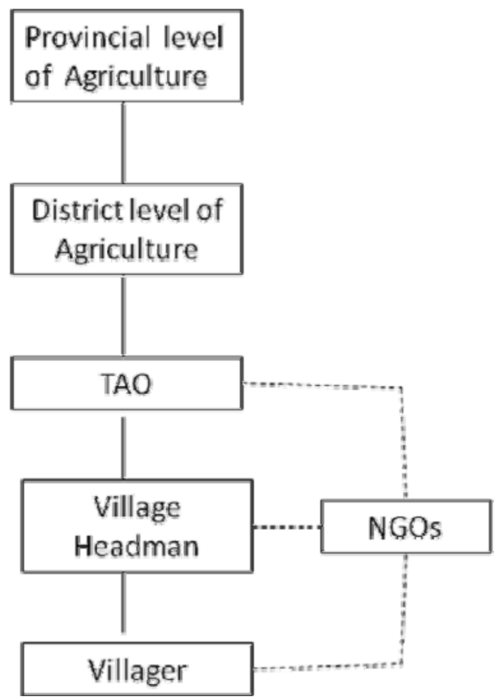
cilitators in close collaboration with local people. Although originally developed for use in rural areas, PRA techniques are equally applicable in urban settings and are not limited to assessment only - PRA extends into analysis, planning and action (CHAMBERS, 1990, 1992, 1994; CAVESTRO, 2003 and BHANDARI, 2003). While originally developed as a set of tools to support rural development work, the selected use of PRA tools in agro-ecological research has proven to be a valuable complement to more formalized research methods.

3.2.1 Research Strategies in Order to Create and Improve LEK

To initiate the various stages of data collection when starting the field work, the following steps were required at various levels.

Governmental level: Official acceptance is the first priority of working in a sensitive mountain environment, which is not completely open for research and requires presentation and approval of the research topic. In Northern Laos, research is not denied by the governmental officer, but one official must participate in the fieldwork as observer of the work progress. In Northern Thailand, the first contact was made with the provincial extension service and then the approval process was passed on to the district and village levels (Figure 11).

Figure 11: The structure of the provincial extension service

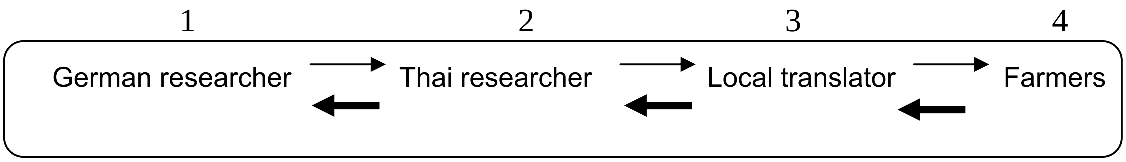


Government officials are essential in official work for the first contact and introduction of research topic. The main statistical information on the study area is also often presented in some detail in official meetings with government representatives.

The most important consideration is that direct contact to villagers cannot be done without permission from the government agencies. In the case of Northern Laos, the Lao-German development project was already involved in field work, meaning they were already familiar with the farmers. It has been the experience that less working time will be lost by working with development projects or NGO teams.

Local translator assistance: Those people are useful for the researchers, who do not understand the local language. However, one must accept that some information can be lost in translation, see Figure 12.

Figure 12: Translation process



In Figure 12, the communication channels are presented. As can be assumed, the returning of the message from 4 to 3 to 2 to 1 is time-consuming and is not comparable with direct communication. Fortunately, during the work in all study sites in Thailand and Laos direct communication was nearly always possible, as I am familiar with both the Thai and Lao language.

Village guides: They are most useful in detailed work and there were three benefits of using them. First, he or she was able to lead directly to the target person or resource person who are expert in the research topic such as expert on local soil knowledge, traditional silvopastoral and cultivated cardamom. This method, i.e. using local "gatekeepers", reduces the time required, as he or she will know which people are available in the village or going to somewhere and it will be easier to make appointments in case that person is not present.

Villagers or key informants: They are the main persons in the study area who have broader knowledge and are willing and able to express their knowledge expertise related to the topic and highly knowledgeable in identification of farmers and in presenting to local stakeholders the aims of the study. By using key informants less time is needed to conduct the research and a greater depth of information is achieved as they are familiar with the area. This allows local communities to be approached from an insider view – or "emic view" in the language of the anthropologist. Key informants can also give advice in deeper detail and thus the researcher benefits from their relationship to find the next key informant or other stakeholder in a chain sampling or snowball sampling approach. However, it requires time to find the key informant, information may be injected from their own bias and impression and social conflicts may arise during group discussions.

3.2.2 Qualitative Research Methods

In this section the major qualitative methods employed during the study period are described. All methods were based on the author's long-standing experience with field work in ethnically and culturally diverse contexts.

These included **Observation** (corresponding to Chapter 6): This method was useful during the formative phase and evaluation as it provided direct information on the behaviour of the farmers and helped to understand their situation; it is a natural, unstructured and flexible method. On the other hand, it is time-consuming and requires a well-qualified and highly-trained observer.

Interviews (corresponding to Chapter 4, 5 and 6): Two types of interviews were used in this research: The Semi-Structured Interview (SSI) is one of the most common techniques applied in qualitative research and has also been increasingly adopted by PRA practitioners. In the SSI, the general thread, idea of what information needs to be collected is pre-determined by the researcher or the research team beforehand. Semi-structured interviews were conducted with purposively selected villagers. During this process, selected informants were encouraged to articulate their knowledge on specific topics through discussion. It was found that semi-structured interviews are best performed with one informant; if more than one person participates, the information can be biased, because LEK tends to be site-specific and informed by local people's individual observations and experiences, for example, where one farmer cultivates a distinct soil type.

A particular form of semi-structured interviews was **market interviews** conducted in Laos (corresponding to Chapter 6): Market interviews were done in the main market of Luang Nam Tha. The interviews focussed on economic attributes, such as the price of wild plants, the sold quantities and the season when they are sold to get an idea about the revenue. Also information about the wild plant was of interest, its origin, and the plants part of value, its use and the condition of the plant. The position of the seller was asked as well, e.g. if she collects the plant by herself or functions as a trader.

In-depth interviews - the second type of interview employed in this study - are a dialogue between a skilled interviewer and an interviewee. It allows the interviewer and interviewee the greatest flexibility in asking and answering questions. Disadvantages are the long duration and the large amount of data collected which is demanding for subsequent analysis. Based on the author's experience, the suitable time for conducting an individual interview should not be longer than 1.5-2 hours to avoid exhausting the concentration of farmers.

Group discussions (corresponding to Chapter 4, 5 and 6): The group discussion is the explicit use of group interaction to generate data. The suitable number of participants ranges from 4-8, depending on the topic to be discussed. Group discussions are of limited utility when one person dominates the meeting (such as a village headman or village committee). Therefore, the interviewer has to acknowledge this and make sure that no one is able to dominate the discussion (CHAMBERS, 1994). An important aspect of conducting the group discussion is the topic guide line. The list of topics and questions is similar to a road map to remind the interviewer of the aim of group session.

3.2.3 Participatory Rural Appraisal (PRA) Tools and Techniques

Emphasis in many past Participatory Rural Appraisals (PRAs) has been placed on the doing aspect, with limited attention to the theoretical or conceptual underpinnings to process design stated by WEBBER and ISON, 1995. In this study, conceptual and process issues relating to design are applied, discussed and combined, using a range of PRA tools according to the author's long year's experience. (More information about the different methods can be found in the literature (BECKER et al. 2009, BHANDARI 2003, CAVESTRO 2003, CHAMBERS 1980, 1990, 1992, 1994 KUMAR, 1993, PRETTY et al. 1995, SCHÖNHUT, KIEVELITZ 1994, SRINIVASAN, 1990). The set of methods presented in the following were applied in slightly modified forms corresponding to Chapter 4, 5 and 6.

Transect walks and guided field walks: The researcher and key informants conducted a walking tour through areas of interest to observe, to listen, to identify different zones or conditions, and to ask questions to identify problems and possible solutions. With this method, I could get information about topography, soils, land use, forests, watersheds, and community assets.

Resource flow: A resource flow analysis aims to provide a qualitative view of the flows of and linkages between resources at the village scale. Resource flow analysis guidelines presented in the land-use and resource diagrams were drawn by the villagers themselves without a given scale. These diagrams were designed in group discussions that focused on how farmers utilized and managed their own resources. This method allows identification and visualization of 'hidden' resource flows, which are supplies extracted from nature.

Village mapping: This is a method to identify the area, the resources and their importance for land use or agricultural practices. The selected villagers draw their houses, school, fields, animal raising area, forest, streams, streets, and markets on large paper. This gives an overview about the natural prosperity of their area, location of protected areas, areas that are most used and the distance of homesteads to natural resources. Moreover, village mapping can give a broad overview of the evolution of community land use in each village. In general, this tool was used in the beginning of the study, mainly in connection with group interviews. It proved to be less time consuming than other information gathering tools as many different interventions could be identified using one tool only. Communities could analyze the linkages, patterns and interrelationships of land use. Drawing a village map is a visual process in which people are given the chance to relate physical and/or social information in a simple and easily understood format. Even people who have had access to formal education often cannot read professionally drawn maps. Visualizations are therefore intuitive and not necessarily accurate in scale - but the key issue with these methods is that the process of developing the maps provides as much or even more information as the final map itself. When villagers developed the map, they could use symbols and materials that have meaning and relevance for them. Often this means that the map was drawn on the ground using sticks to make the lines and locally available materials as symbols (leaves, stem, and fruits). To maintain a record of the information I needed to redraw the map on paper as accurately a possible - always showing it to the participants for cross-checking and support -, while the original stayed with the –villagers who usually gave their permission to make a copy.

Livelihood and land use diagrams: This tool was used to identify land use patterns, paddy rice areas, bamboo plantations, and land tenure systems. In addition, information on the use of labour, such as hired labour or family labor, income generating activities, such as livestock, honey and other non-timber forest products, could be collected in a diagrammatic form.

Agricultural calendar: An agricultural or seasonal calendar is a PRA method that determines patterns and trends throughout the year in a certain village. In this study, it was used to get an impression about agricultural and forest product utilization, important upland crops and changes in livelihoods over the year.

Informal conversation: Conducting discussions with villagers through meals was an important way of engaging them in informal conversations. This had the benefits that informants felt comfortable in a familiar setting, could relax, and were then able to provide clearer and more reliable answers than in formal interview settings. In Laos where there were no local shops for buying food, providing food from outside was a helpful way of bringing people together. For interviews at night time, providing food encouraged good cooperation for conducting group discussions.

Corresponding to Chapter 5 and 6, the following PRA tools were used to gather information:

Timelines: In the context of this study this tool was used to get information on historical community events. Important changes were dated and listed in some villages to estimate the development of the situation or problems over the last 10 years.

Matrix ranking and scoring: Direct-matrix ranking and scoring was used to discover local attitudes on various topics. People ranked and compared individual items, using their own categories and criteria, by raising hands or placing numbers on a sheet of paper. For example, twenty different wild plants could be ranked from best to worst with regard to their value as fuel, fodder, growth rate and erosion-control attributes. Other resources could be ranked in terms of taste or marketability.

The advantage of these applied methods was to provide respondents with a flexible, familiar and understandable basis for the research work. Exchanged and shared knowledge during the conversations also lead some of them to improve their agricultural activities. For the researcher, the type of information obtained by farmers becomes more comprehensive. It helped the researcher and the research team to develop a priorities framework and provided alternative and complementary sources of information in the study.

3.2.4 Quantitative Research Methods and Data Analysis

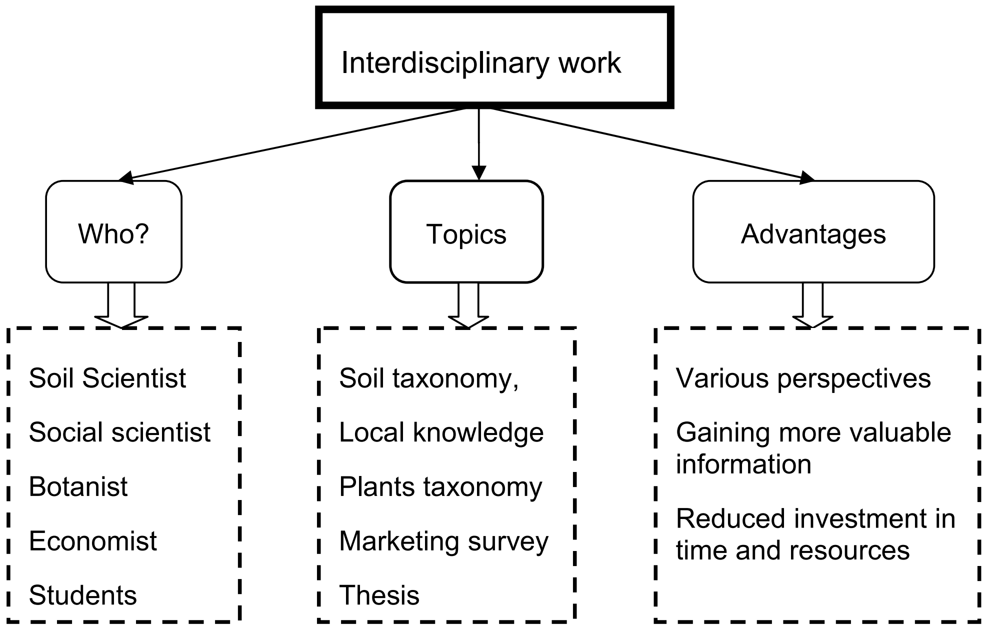
Quantitative methods of data collection were conducted in the case of the cardamom study (corresponding to Chapter 6). The quantitative survey was conducted in Laos in twenty-one villages proposed by staff from a Lao-German development project (the RDMA project). In these villages, cultivation or collection of cardamom already took place (cf. Table 1). The purpose of the survey was to identify the strengths and constraints of the cardamom business and to determine how the poor were affected by the cardamom supply chain. Standardized questionnaires were administered to individual respondents and to farmer groups in face-to-face interviews to identify the scale of the cardamom business and its impact on the livelihoods of both cultivators of domesticated cardamom and collectors of wild cardamom. In general, interviewees assessed the cardamom business as a positive contributing factor to their livelihoods. After data collection, cardamom suppliers, producers and collectors were grouped based on income categories, generated by the sale of cardamom. To determine the dependence of the groups on the sale of cardamom, a one-way analysis of variance (ANOVA) was performed. Least significant difference (LSD) was used for means comparison ($p=0.05$) and procedures were performed using the SAS® 9.2 statistical software packages.

3.2.5 Working in interdisciplinary teams

Interdisciplinary research has been identified as the most suitable approach for social-ecological research. When working together as a team, researchers must balance responsibilities, values, knowledge, and skills. This Ph.D. research involved a great deal of research team work conducted both in Northern Thailand and Laos.

As depicted in Figure 13, the interdisciplinary teams consisted of a soil scientist for soil classification, me as a social scientist for local knowledge and participatory research, a junior economist for analysis of value chains and students from the University of Hohenheim (Germany) with diverse disciplinary and cultural back-grounds (corresponding to Chapter 6). The interdisciplinary delivery model requires that participants share a common goal, bring in their various perspectives and find a commonly accepted mode of communication. Sometimes members of the team may differ with regard to the research approach emphasizing their individual interests and perspectives at the expense of collective interests and approaches. However, in this study we found that the interdisciplinary team-based approach contributed to gaining more valuable information, reduced investment in time and resources, and created an atmosphere where productive and innovative exchange among researchers was possible. For example, our joint research on scientific and local soil classification created a **Geographical Information System of each study site and scientific soil maps** (In Chapter 4: together with a PhD student from Hohenheim): This enabled a comprehensive land use evaluation by using interpretation of most recent aerial photographs and by conducting field surveys and interviews with local residents to verify the accuracy of land use data. Furthermore, data was available from published articles from previous surveys. Plant diversity surveys, using transects across different land use types and based on information from the farmers and own observation created complementary data for the soil survey. This study was particularly demanding, as the team members had very different disciplinary backgrounds but the results were good due to identifying common ground and mutual understanding (cf HAGEL et al. 2013).

Figure 13: Interdisciplinary teams



Collection of Specimen and Taxonomic Classification (In Chapter 5 and conducted with a senior biologist from Chiang Mai University and a student from Hohenheim): Specimen of wild plants was collected in the forest area of villages. Fresh leaves were pressed in newspapers, and dried fruits and bark were collected, although not every species mentioned by the villagers could be found. Taxonomic identification of the specimens was done by the botanist of Chiang Mai University.

3.2.6 Data Compilation and Qualitative Data Analysis

The **Agro-ecological Knowledge Tool Kit** (AKT5) created by University of Wales, Bangor, UK, and the guidebook for easily using a knowledge base was employed to compile and analyze the collected local ecological knowledge concerning ecological functions. This comprised two integrated programs: for knowledge acquisition and for reasoning with the acquired knowledge (DIXON et al., 2001). The knowledge base system was created and presented in Chapter 5. The process of formalisation involved computer coding of the knowledge by creation of statements written in the restricted syntax of a formal grammar. The structure of AKT5 was created under the formal statements, which may be conditional and include five fundamental elements: 1) objects, which are physical items e.g. forest trees, tea, rain; 2) processes, that are natural changes, e.g. erosion, grazing, burning; 3) actions, which are human induced changes, e.g. making, weeding, picking; 4) attributes, which are properties of objects or processes; e.g. growth rate of tea, height of forest trees, or intensity of forest fire; 5) values, which are the measurable state of an attribute may be qualitative (e.g. high, low and medium) as well as quantitative (5 cm, 2 m and 4 t $^{ha-1\ a-1}$) and may refer to a range (e.g. 3 to 4 cm, 5 to10 m) (applied statement base on DIXON et al., 2001). Because of the uncertainty and complexity inherent in language, accurate interpretation of unitary statements in unrestricted natural language may often be complicated. The meaning of natural language statements were often specific to the context in which articulation occurred, therefore it cannot be clearly assumed that the contextual meaning of a unitary statement will still be understood by the user, if it remains implicit (WALKER et al. 1994, 1995).

Supply chain mapping (corresponding to Chapter 6: Conducted with a master student from Hohenheim): The supply chain is a network of organizations that are involved, through upstream and downstream linkages, in different processes and activities that produce value in the form of products and services delivered to the ultimate customer (CHRISTOPHER, 1992). It involves the management of the relationship between the stakeholders to produce efficiently and supply the product into the market as well as to meet the requirements of the consumers regarding quantity, quality and price (WOODS, 2004). These statements can also be applied to the supply chain of cardamom in Northern Lao PDR. The value-links methodology (described by SPRINGER-HEINZE 2007) was used to map the supply chain of cardamom. This methodology allows business operations (production, packing, trade and export) to be identified, in addition to the operators (producers, collectors, traders, middlemen) and the relationship between the operators. A supply chain map is defined as a network of entities responsible for obtaining, producing, processing, distribution and consumption of cardamom was constructed.

3.3 Limitations of the Study and Critical Review of the Applied Methods

In this section, the constraints and obstacles that occurred during the research process are summarized and factors are considered that might influence the outcomes of the study. Additionally, the applied methods are reviewed to estimate whether the way of employing them was appropriate for the principles and objectives of the study. The data used for this study reflects the situation in the selected villages at the time of the survey and is not attempting to provide general conclusions on the situation in the entire region of Northern Thailand and Northern Lao PDR. Overall the applied qualitative research methods and PRA tools worked well and generated a wealth of information. The participants were motivated to participate, as long as the interviews and discussions did not interfere with their work on the farm or other important activities. The interpretation of information was one important issue that needed to be considered. During qualitative fieldwork, finding a common language is important, as some information can be lost and misunderstandings can occur. Therefore, the approach has to be flexible and methods need to be triangulated to gain complete information and minimize communication failures. Most farmers prefer talking in their local language which made them confident to talk and to provide more detailed information. While group discussion interviews helped to gain information in case of time limitations, individual information was possibly not disclosed by all of the interviewees. I avoided touching sensitive political or cultural issues, as in different villages and ethnic minority groups, people have their own beliefs and cultural norms.

Estimating rural people's monthly or annual income and amount of harvested products proved difficult, because they usually do not take notes of their revenues and expenses. Long recall periods also needed to be avoided, as information relating to several years in the past could often not easily be recalled. The other problem is that most villagers do not have a regular income, but are prone to seasonal fluctuation and depend on occasional sales of agricultural products. Many respondents were subsistence farmers, using only their memory to tell figures related to prices, income, and amount of products, for example in the case of harvested and sold amounts of cardamom and wild plants. With this in mind, it is possible that the numbers presented do not exactly reflect the reality. Assigning the correct scientific name to plants was also hard as farmers mentioned only the local name. The best way was to collect a sample of the plant, which then needed to be classified by an experienced botanist. Moreover, the fact that some plants are only available in certain seasons made the data collection process time-consuming.

4 Soil Mapping for Land-use Planning in a Karst Area of N Thailand with Due Consideration of Local Knowledge*

4.1 Abstract

For the development of sustainable land-management systems in the highlands of N Thailand, detailed knowledge about soil distribution and soil properties is a prerequisite. Yet to date, there are hardly any detailed soil maps available on a watershed scale. In this study, soil maps on watershed level were evaluated with regard to their suitability for agricultural land-use planning. In addition to common scientific methods (as underlying the WRB classification), participatory methods were used to exploit local knowledge about soils and to document it in a "Local Soil Map". Where the WRB classification identified eight soil units, the farmers distinguished only five on the basis of soil color and "hardness". The "Local Soil Map" shows little resemblance with the detailed, patchy pattern of the WRB-based soil map. On the contrary, the "Local Soil Map" is fairly similar to the petrographic map suggesting that soil color is directly related to parent material. The farmers' perception about soil fertility and soil suitability for cropping could be confirmed by analytical data. We conclude that integrating local soil knowledge, petrographic information, and knowledge of local cropping practices allows for a rapid compilation of information for land-evaluation purposes at watershed level. It is the most efficient way to build a base for regional land-use planning.

Key words: Local soil knowledge / petrography / participatory and scientific soil mapping / SE Asia

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4.2 Introduction

The pressure on land and water resources in the highlands of Northern Thailand is increasing due to rapid population growth and commercialization of agriculture. Sound information on environmental qualities including soil characteristics is necessary for the development of new management techniques in these areas. Many numeric models used in scenario development, e.g. FALLOW (VAN NOORDWIJK, 2002), CATCHS-CAPE (BECU et al., 2003), CATCHCROP (PEREZ et al., 2001) need detailed soil data which are scarce in Northern Thailand. The sloping lands, in particular, are represented as one undifferentiated "slope complex" on the Soil Map of Thailand (VIJARNSORN, ESWARAN, 2002).

Given this lack of soil information, the question arises how to collect the necessary soil data in an efficient way. Conventional soil mapping approaches rely on grid or transect observations augmented by reference profile descriptions and laboratory analyses (SCHLICHTING et al., 1995). The scale of the soil map dictates the number of field observations that are required. In practice, soil mapping is arduous and time consuming, and the soil information collected is often precise but not always relevant (BARRIOS, TREJO, 2003), particularly in the developing world. Other mapping efforts in the region proved also of limited use; geological maps, for instance, are insufficiently detailed to provide information on potential soil variability (SCHULER et al., 2004).

The challenge is therefore to collect coherent, useful and sufficiently detailed soil information at watershed level in a reasonable time and to present this information in a format that the local population can understand and use.

The use of local knowledge in soil appraisal has received increasing attention in the past decades (e.g. REIJ et al., 1996) because there is overwhelming evidence that farmers can provide valuable information on changes in land cover and land management practices. Several authors suggest that local knowledge should be blended with conventionally collected soil information (WINKLERPRINS, 1999; ALI, 2003; ERKOSSA et al., 2004).

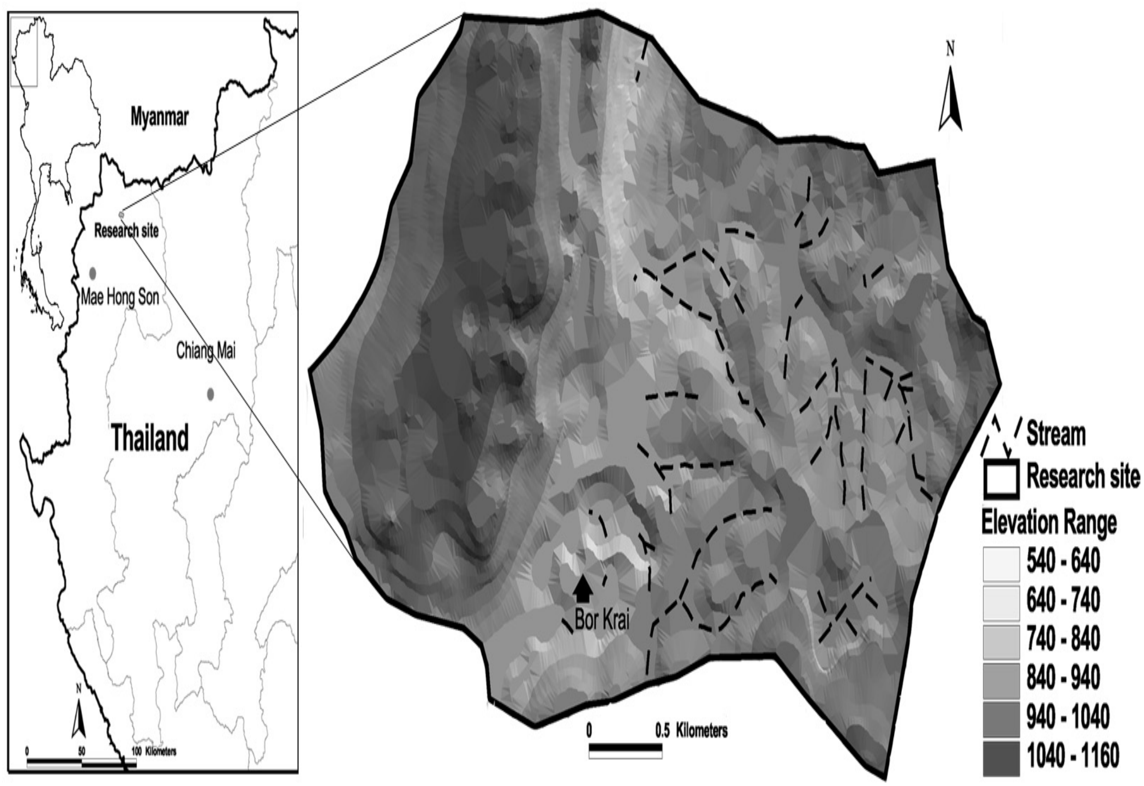
Many studies use participatory approaches to evaluate local soil maps (e.g. OUDWATER, MARTIN, 2003) but only few combined so-called scientific analysis and local knowledge (e.g. KEIICHI, TOSHIYUKI, 2002). The present study compares local soil classification and local soil maps with conventionally collected soil information. The results suggest that incorporating local soil information in soil maps is cost-effective and produces maps that are more relevant and easily understood by local farmers (KRASILNIKOV, TABOR, 2003), which is conducive to (more) sustainable land management.

4.3 Materials and Methods

4.3.1 Research Site

The research site is situated in a Permian limestone area (GERMAN GEOLOGICAL MISSION, 1979) in Pang Ma Pha district, Mae Hong Son province, in mountainous Northern Thailand (Figure 14). This area includes the village of Bor Krai and parts of the neighbouring village of Jabo (Figure 14).

Figure 14: Location of the Bor Krai research site in Northern Thailand.



Source: SCHULER, 2006

The Bor Krai research site lies between 540 m asl and 1020 m asl. The landscape is characterized by steep, cone-shaped limestone mountains separated by karstic depressions. Within the depressions occur some smoother hills that consist largely of sand-, silt- and claystone. The vegetation is mainly mixed deciduous forest with small patches of dry evergreen forest. In 2004, the mean temperature was found to be 19.9°C and precipitation amounted to 935 mm. The local monsoon climate has three distinct seasons: a rainy season from May to October, a cool dry season from November to February and a hot and dry season from March to May.

The local people belong to the Black Lahu ethnic minority group; they moved from Myanmar to Pang Ma Pha district some 40 years ago. Most villagers are farmers who generate income from livestock (pigs, cattle and buffalos) and crop production (uplandrice, corn, beans, cucumbers).

A first soil survey in the highlands of Northern Thailand was conducted by HENDRICKS (1981) who reports that soil variability in the uplands depends largely on soil parent material, climate and vegetation. VLASSAK et al. (1992) classified most soils on granite and soils on crest positions (with various parent materials) as deeply weathered Acrisols. Shallow and stony Regosols are dominant in slope positions on sedimentary and metamorphic rocks. Soils of valley floors are mostly shallow Regosols or water saturated Gleysols/Fluvisols. The physical and chemical properties of soils of the Jabo research station, located in the limestone part of the Bor Krai area, were determined by the “Soil Fertility Conservation project – SFC” (VLASSAK et al., 1992). The soil of Jabo research station was classified as a Humic Ferralsol. In a transect study close to the station SEREKE (2002) classified three soil profiles as Rhodic Nitisols. However additional chemical and mineralogical analyses suggest that these soils are Acri-Gibbsic Ferralsols and Humi-Umbric Acrisols. In his ethno-pedological soil survey, TINOCO-ORDÓNEZ (2003) described eight soil profiles as Luvisols and Cambisols.

4.3.2 Geographical Information

The topographic map (ROYAL THAI SURVEY DEPARTMENT, 1976), at scale of 1:50.000 and contour lines interval of 20 m resolution and the geological map at scale of 1:250.000 (GERMAN GEOLOGICAL MISSION, 1979) were digitized. A GPS was used to obtain coordinates of the research points.

4.3.3 Soil and Petrography Mapping

In a first approach, soils were studied along transect lines and at 118 random points. Rugged, steep and partly inaccessible terrain in the limestone area was surveyed along trails with the help of a local guide. Where there were insufficient trails to obtain adequate information, additional points were described and sampled. Reference soil profiles were described for the dominant soil units and analyzed in the laboratory. In total, 341 augerholes and 22 soil profile descriptions - according to WRB and SOTER guidelines (VAN ENGELEN, WEN 1995; FAO 1998, 2001 ;) - were collected in an area of approximately 8.5 km^2 with a mapping scale of 1:10000. Most rock types could be determined directly in the field. The rocks were classified according to DUNHAM (1962), MATTHES (1996); and TUCKER (1985). Selected rock samples were taken for X-ray diffraction analysis. After the field survey the collected information was used to compile a petrographic map.

4.3.4 Local Soil Classification and Mapping

The evaluation of farmers’ soil knowledge was based on a “Participatory Rural Appraisal”, or PRA (CHAMBERS, 1992). It used semi-structured interviews, field and key informant interviews, participatory mapping, and group discussions. The survey was conducted by a multidisciplinary group of scientists – representing soil science, agricultural extension, farming systems and rural sociology – during the dry season (October to May) of 2004/2005.

The first step was to identify farmers with longterm practical experience. Next, key informants were asked which soil types they distinguish and by which differentiating criteria. Soil classification was further refined during field walks with farmers. Soils on the sites chosen by the farmers were described according to local perceptions and the WRB and SOTER system (VAN ENGELEN, WEN 1995, FAO 1998, 2001 ;) and samples were taken.

The key informants ranked different soil properties and developed a local soil classification and a local soil map. The topics for ranking, e.g. suitability for crop production, fertility, infiltration rate, available water capacity, erodibility and stickiness were suggested by us. In a final step the farmers showed the distribution of the local soil units on a printout of the topographic map.

4.3.5 Soil Analysis

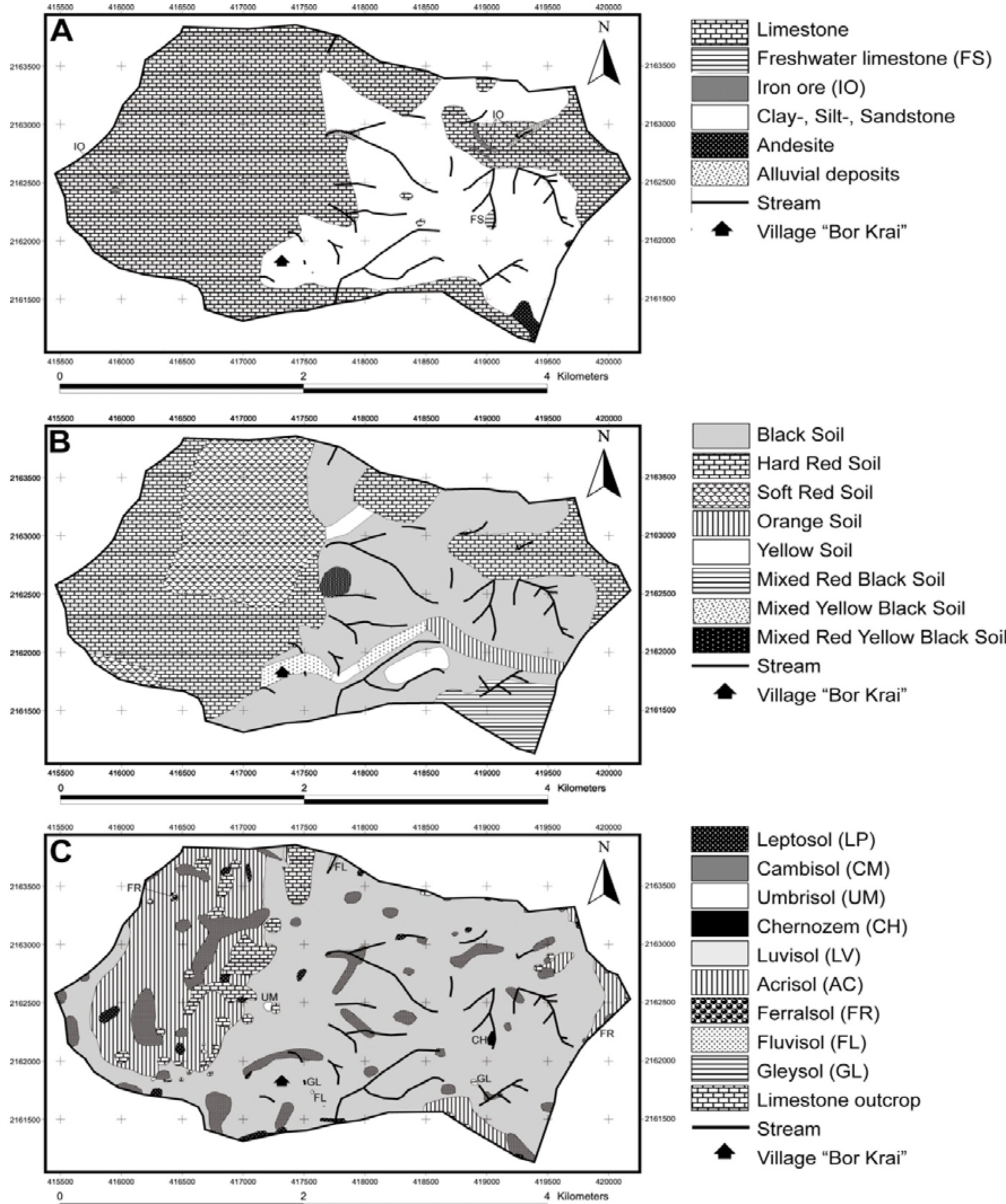
Laboratory analyses were done at the University of Hohenheim, Germany, and Chiang Mai University, Thailand. The soils were analyzed according to KLUTE, 1986; VDLUFA, 1991; SCHLICHTING et al., 1995; BLUME et al., 2000; and HERRMANN, 2005. The analyses comprised texture, total carbonate content, cation exchange capacity, effective cation exchange capacity, exchangeable cations, organic carbon, total nitrogen content, X-ray diffraction, pH in water and KCl, DCB and oxalate extractable iron contents, water-dispersible clay content, and levels of “available” phosphorus and potassium.

4.4 Results and Discussion

4.4.1 Petrography

The petrographic mapping revealed that the area consists for 60% of limestone and 39% of clay-, silt-, and sandstone. The remaining 1% are alluvial deposits, dolomite, freshwater limestone, iron ore and andesite (see Figure 15). The limestone was crystalline and mostly massive, only at some places a layering was visible. Occasionally dolomite intercalation within the limestone formation was observed. Freshwater limestone was found around karst springs. The claystone had a yellow weathering colour; dark grey coloured claystone was found only at a few sites along creeks. In places layers of silt- and sandstone are intercalated in the claystone. Andesite was found in the southeastern part of the research area.

Figure 15: (A) Petrographic Map of the Bor Krai karst area (B) Local Soil Map; (C) Soil Map according to the WRB classification – soil group level



Source; Schuler, 2006

4.4.2 Soil Mapping According to WRB

Soil mapping according to WRB rules revealed that the area consists of approximately 69% Luvisols, 21% Acrisols, 9% Cambisols and 1% Leptosols. Umbrisols, Ferralsols, Fluvisols, Chernozems each occurred on less than 0.1% of the area (see Figure 15C).

Luvisols are found at stable positions in the landscape. Their extension on clay-, silt and sandstone was found to be independent of elevation. Luvisols on limestone are exclusive to sites below 800 m asl. Acrisols are found only on stable limestone above 800 m asl. Ferralsols occur at very stable positions in the limestone area. Cambisols are typical of unstable landscape positions, either affected by erosion or by deposition of eroded soil material. An Umbrisol was identified in a karst depression; it contained charcoal down to a depth of at least 200 cm which accords with the colluvial character of the soil parent material. Chernozems are restricted to the surroundings of karst springs. A Gleysol was found in a karst depression with a sealed underground. Fluvisols are restricted to valleys and stream beds. Leptosols occur in the vicinity of limestone and iron ore outcrops. The use of cation exchange capacity as a differrentiating feature between Luvisols and Acrisols on the one hand and Cambisols and Ferralsols on the other hand proved to be a source of insecurity. The WRB classification system stipulates that Luvisols are characterized by an Argic horizon with a cation exchange capacity (in 1 M NH_4OAc buffered to pH 7.0) equal to or greater than 24 cmol(+) kg^{-1} clay, and without any Alic properties. In contrast Acrisols are characterized by an Argic horizon with less than 24 cmol(+) kg^{-1} clay in some parts. The differentiation of the Luvisols and Acrisol is mainly based on the analysis of nine soil profiles; therefore their real distribution remains somewhat unclear. Only one Ferralsol was found, but it can be expected that more Ferralsols exist than the current soil map suggests. The WRB map was compiled based on 22 analyzed soil profiles, 341 augerings, information from the topographic map and observations during the field survey. The WRB soil map shows two large homogeneous units of Acrisols and Luvisols which are riddled with inclusions of other soils and limestone outcrops. Especially the Cambisol spots trace back to the land use in this area, responsible for dislocation of soil material. It is expected that the areas of Cambisols, Leptosols and limestone outcrops will increase in the future at the expense of Luvisols and Acrisols.

4.4.3 Local Soil Map

Farmers in the area differentiate soils according to observable morphological parameters mainly topsoil colour. At first the farmers distinguished only between two soil types: Black Soil and Red Soil. A minority also mentioned texture and water drainage. However, farmers were well aware of more complex soil parameters, like fertility status, suitability for certain crops and workability.

During the field trips the classification according to colour two additional soil colours were added: Yellow and orange. The farmers identified five to seven soil types, using texture as an additional criterion to differentiate within the colour classes. Local soil classification is not always consistent which was also reported by others (e.g. OUDWATER, MARTIN, 2003). This explains the disparity between our results and findings by TINOCO-ORDÓNEZ (2003) who – in the same village – identified five major classes according to colour (red, black, yellow, yellow mottled and grey) and six classes according to texture.

In the second group discussion the farmers were asked to present a common soil classification. This was established by asking farmers to sort soil samples according to soil properties. During this ranking process it became clear that farmers relate soil properties primarily to soil colour. Hence we focused on colour in the common classification. Farmers distinguish four main soil types, namely Black, Red, Orange and Yellow Soils, which together make up more than 90 % of the preliminary Local Soil Map. Mixed local soil units occurred as well. The use of colour as a first criterion is very common in local soil classifications (cf. ETTEMA, 1994; TALAWAR, RHOADES, 1998). The comprehensive study on ethnopedology by BARRERA-BASSOLS, ZINCK (2003) concluded that all local soil classifications reviewed used colour as a parameter because it is the most obvious and easily distinguishable property of soils. Further interviews revealed the necessity to divide the Red Soil group into Hard Red Soils and Soft Red Soils. The "Local Soil Map" was updated accordingly with the help of experienced farmers whereby the preliminary local soil map and the topographic map were the main communication tools. Once this map was made, farmers were asked for more "Local Soil Unit" properties. In our final Local Soil Map (see Figure 15B) Black Soil covers 38% of the map area, followed by Hard Red Soil (34%), Soft Red Soil (18%), Orange Soil (2%), Yellow Soil (2%) and Mixed Soils (7%).

4.4.4 Comparison of Soil Properties

The semi-structured interviews revealed that the farmers are able to relate a range of soil properties, like infiltration, stickiness, erodibility and crop suitability to the local soil types (Table 2). Black Soil was considered to have the highest inherent fertility, followed by Hard Red Soil and Soft Red Soil. In comparison to these soils, the fertility status of Orange Soil and Yellow Soil was considered as low. Black Soil is characterized by high infiltration rates, erodibility, soil stickiness and weeds infestation. Hard Red Soil is characterized by low infiltration rates, soil stickiness and weeds infestation; its resistance to erosion is considered to be medium. Soft Red Soil has a low bulk density, high infiltration rate, negligible erosion hazard and moderate soil stickiness. The difference between Orange Soil and Yellow Soil is solely the colour. Both these local soil types are characterized by low infiltration rates, low weed pressure and high erodibility. Soil stickiness is low. Own analyses of several soil fertility parameters confirmed the perceived soil fertility status of four of the five local soil types. Farmers pronounced Soft Red Soil clearly more fertile than Orange and Yellow Soils but all measured fertility parameters indicated that Soft Red Soil, Orange Soil and Yellow Soil have a similar low fertility status (Figure 16). Laboratory analysis confirmed the comparatively high fertility level of Black Soil, manifest from the highest values for cation exchange capacity of clay, base saturation, organic matter content and nitrogen content. Hard Red Soil also has high base saturation and organic matter and nitrogen contents but the cation exchange capacity of the clay is extremely low. The fertility parameters of Soft Red Soil are similar to those of the Yellow – and Orange Soils.

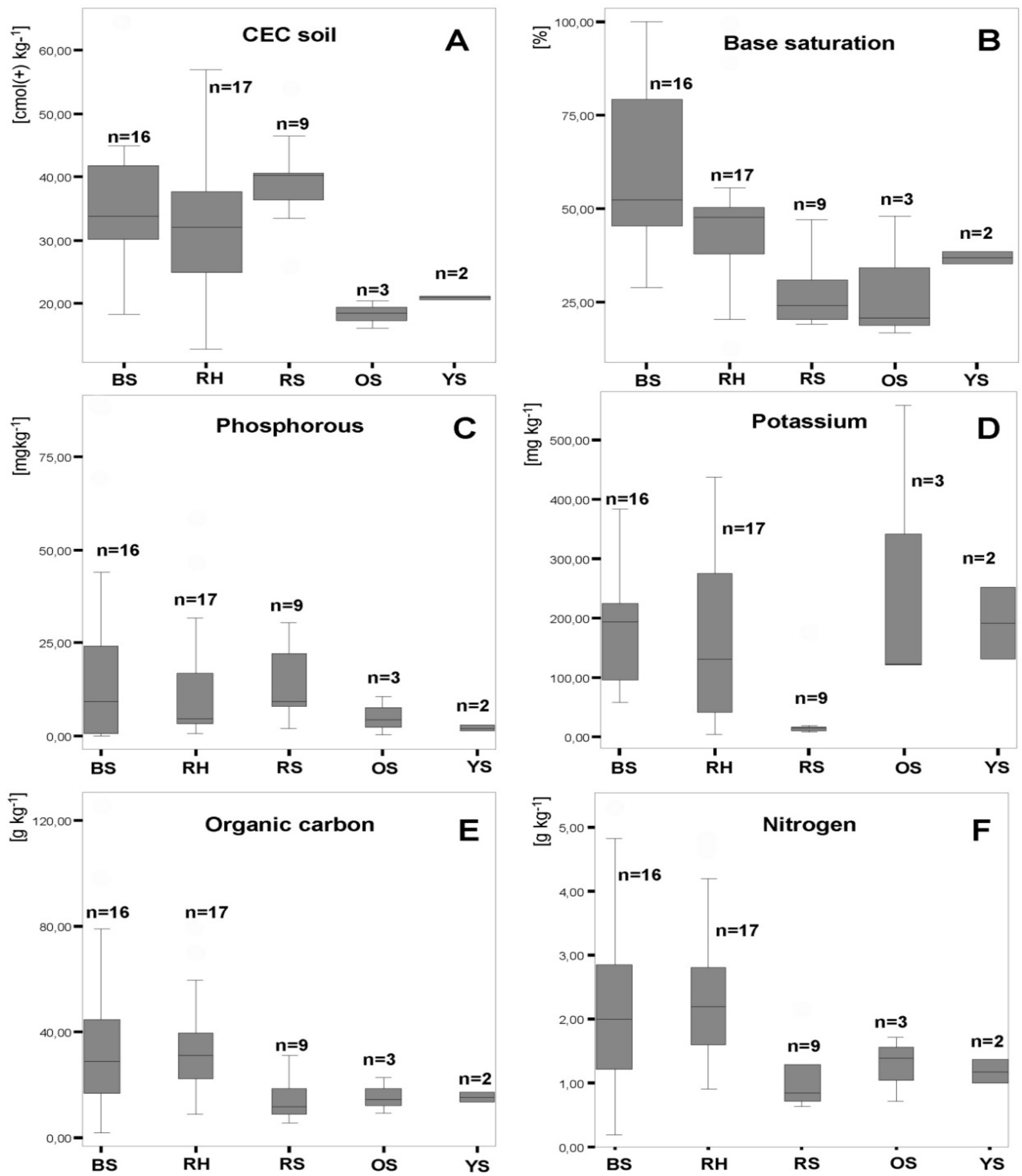
Many factors influence soil fertility; therefore the analysis of topsoil samples can only provide a general impression. The evaluation of the analysis results followed Landon (1991). Cation exchange capacity is high in Black Soil, Hard Red Soil and Soft Red Soil and moderate in Orange Soil and Yellow Soil. These tallies with their median clay content values, with > 35 % in Black Soil, Hard Red Soil and Soft Red Soil, and < 35 % in Orange Soil and Yellow Soil. Black Soil has the highest base saturation median values (> 50%; see Figure 3A), followed by Hard Red Soil (48%), Yellow Soil (37%), Soft Red Soil (23%) and Orange Soil (21%). The pH values of all local soils are medium; those of Black Soil and Red Soil are around 6.5, whereas Orange Soil and

Table 2: Petrographic units and Reference Soil Groups as components of Local Soil units.

Local soil units	Black Soil [%]	Hard Red Soil [%]	Soft Red Soil [%]	Orange Soil [%]	Yellow Soil [%]	Mixed Red Black Soil [%]	Mixed Yellow Black Soil [%]	Mixed Red Yellow Black Soil [%]
Petrographic units								
Alluvium	1	1	0	0	0	0	0	< 1
Andesite	< 1	0	0	0	0	11	0	0
Clay-, silt-, sandstone	**75**	< 1	< 1	**100**	**100**	**54**	**99**	6
Dolomite	0	< 1	0	0	0	0	0	0
Freshwater limestone	< 1	0	< 1	0	0	0	0	0
Iron ore	0	1	0	0	0	0	0	0
Limestone	**24**	**98**	**100**	0	< 1	**34**	1	**94**
Reference Soil Groups								
Acrisols	< 1	**39**	**44**	< 1	0	**25**	0	0
Cambisols	5	**11**	**14**	1	< 1	**12**	4	**17**
Chernozems	< 1	0	0	< 1	0	0	0	0
Ferralsols	0	< 1	0	< 1	0	0	0	0
Fluvisols	< 1	0	0	< 1	0	0	0	0
Gleysols	< 1	0	0	< 1	0	0	< 1	0
Leptosols	1	1	2	< 1	0	1	0	0
Luvisols	**93**	**49**	**40**	**99**	**100**	**63**	**96**	**83**
Umbrisol	0	0	< 1	< 1	0	0	0	0

Yellow Soil have values around 6.0. The unifying factor is that nearly all soils are decalcified. Only one Chernozem and one Gleysol with measurable carbonate content were found. The median values for “plant available” phosphorus are only marginal (6.5 -13 mg kg^{-1}) for Black Soil and Soft Red Soil, deficient (3 – 6.5 mg kg^{-1}) for Hard Red Soil and Orange Soil and acutely deficient (< 3 mg kg^{-1}) for Yellow Soil (see Figure 16c). The average pH values suggest low “available” phosphorous levels in the soil parent material as the main reason for the low values found. Median values for plant “available” potassium are adequate (117 – 196 ppm) for Black Soil and Yellow Soil; Hard Red Soil and Orange Soil have marginal (59 – 117 mg kg^{-1}) “available” potassium median values (see Figure 16D). Soft Red Soil is deficient in “available” potassium (< 59 mg kg^{-1}). The comparably low potassium levels of Red Soils might be explained by the low potassium content of residual clay minerals from limestone weathering. Organic carbon contents of Black Soil and Hard Red Soil are low with around 30 g kg^{-1}. Those of Soft Red Soil, Orange Soil and Yellow Soil are very low with values below 20 g kg^{-1}. The nitrogen contents of Black Soil and Hard Red Soil are medium to low; Soft Red Soil, Orange Soil and Yellow Soil have clearly lower nitrogen contents (see Figure 16E). The highest infiltration rates were measured on Soft Red Soil, with >200 cm h-1, followed by Black Soil (11 cm h-1), Hard Red Soil (10 cm h-1), Orange Soil (6 cm h-1) and Yellow Soil (< 1 cm h-1).

Figure 16: (A) Cation exchange capacity [cmol(+) kg^{-1}], (B) Base saturation [%], (C) Plant available phosphorous [mg kg^{-1}], (D) Plant available potassium [mg kg^{-1}], (E) Organic carbon [% m], (F) Nitrogen [% m] of topsoils from different local soil units. BS = Black Soil; RH = Hard Red Soil; RS = Soft Red Soil; OS = Orange Soil; YS = Yellow Soil

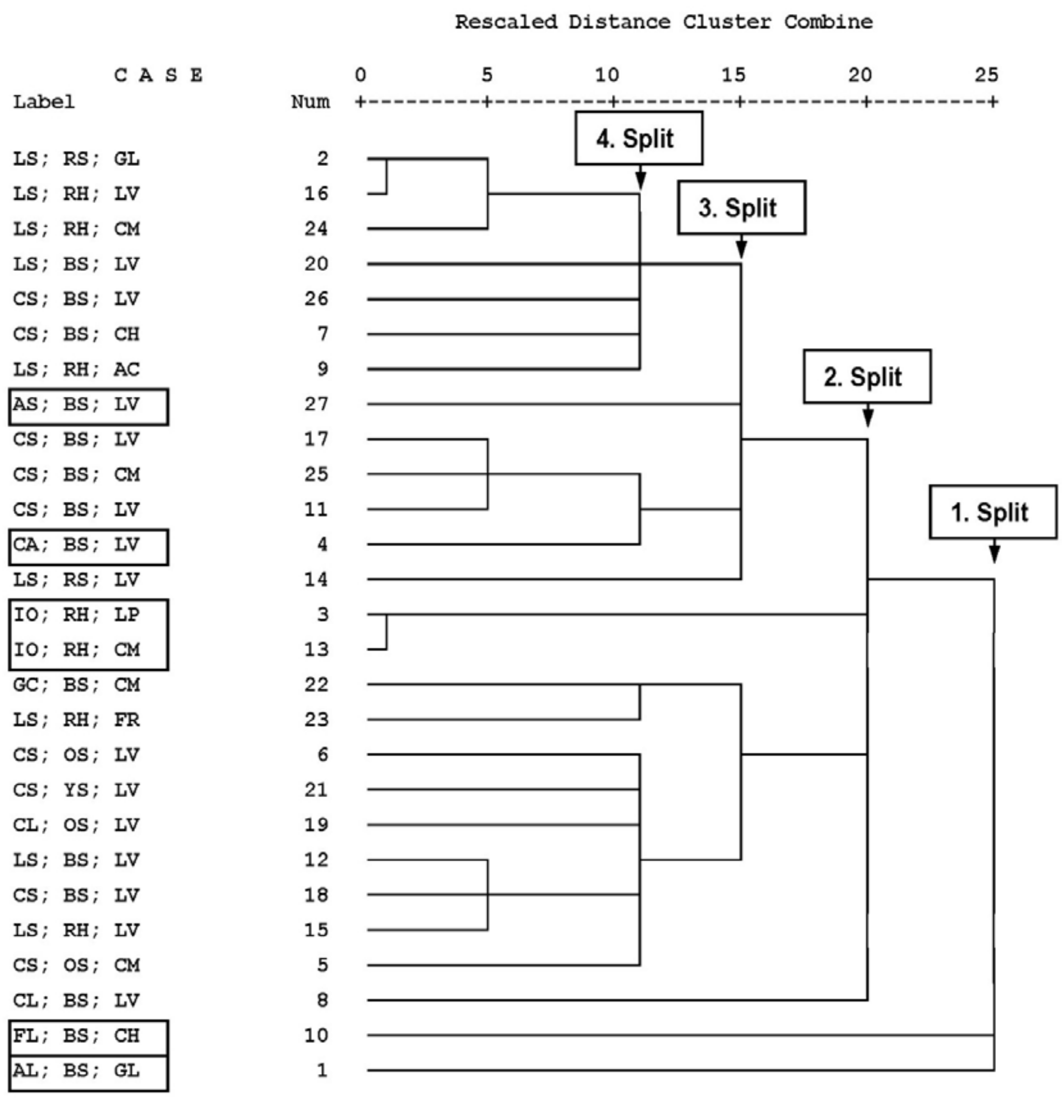


4.4.5 Comparison of ‘Conventional Soil Map’ and ‘Local Soil Map’

The pattern of the Local Soil Map is similar to that of the Petrographic Map (see Figure 16A, B), whereas the WRB soil map appears totally different. Poor correlation between WRB-based soil maps and Local Soil Maps was also reported by others, e.g., PAYTON et al. (2003) and ALI (2003). The main reason cited are the differences in the conceptual bases of the soil classification systems used (NIEMEIJER, MAZZUCATO, 2003). The WRB classification system considers essential chemical soil parameters (e.g. cation exchange capacity) and/or properties below the soil surface (e.g. mottles) that are invisible to farmers whereas the local soil types are solely based on visible soil colour and soil structure. Black Soil covers all areas with preserved dark topsoil; the other local soil types are predominantly marked by subsoil colour as surface soils were eroded away. Strong correlation between local soil map units and petrographic map units is found in more than 55% of the area, where the dark topsoil is strongly degraded and the subsoil colour is exposed at the surface. There, Red Soils cover more than 98% of the limestone area and Orange and Yellow Soils cover more than 99% of the petrographic clay-, silt-, and sandstone unit (Table 1). The total area of Red Soils is composed of some 40% Acrisols, 46% Luvisols, 12% Cambisols and 2% other reference soil groups. Hard Red Soil, Soft Red Soil and Mixed Black Red Soil units include a considerable component of Acrisols. The highest proportion of Cambisols can be found within Red Soil units.

Black Soil, Orange Soil, Yellow Soil and Mixed Red Yellow Black Soil units consist for more than 80% of Luvisols. The dominance of soils with clay illuviation (Acrisols and Luvisols) is explained by the low surface soil-pH which is conducive to clay dispersion, and the seasonal climate with heavy rain showers that enable mechanical transport of clay down to the argic accumulation horizon. Subsoil colour is largely dictated by the mineral composition of iron oxides. Hematite accounts for the red colour of soils on andesite and limestone; goethite causes the yellow subsoil colour of soils in clay-, silt- and sandstone weathering. Hematite mottles (‘ferric properties’ in the WRB system) in the yellow soil matrix of clay-, silt- and sandstone weathering produces an orange subsurface soil. Small quantities of hematite can already change the soil colour to red. Our results suggest that local climate, high subsoil drainage, low organic matter content of the subsoil, limestone, and probably accumulation of residual iron all favour the development of hematite. X-ray analyses revealed around 9% hematite in weathered andesite and some 10% in iron. Hematite development seems to be suppressed on clay-, silt- and sandstone, probably because of impeded drainage. The ‘local soil map’ reveals strong correlation between parent material and local soil units. To test the influence of the parent material on essential soil properties, cluster analysis with the ‘nearest neighbour method’ was applied considering farmers’ rankings of erodibility, water infiltration rate, available water capacity, soil stickiness, nutrient content, nutrient absorption, and soil hue (see Figure 17) infiltration rate, available water capacity, soil stickiness, nutrient content, nutrient absorption, and hue. (Cluster method: Nearest neighbour. Measure interval: Squared Euclidean distance on the dendrogram of the hierarchical cluster analysis, the first split at Squared Euclidian distance 25 (see Figure 17 scale bar) leads to three different clusters. The upper cluster comprises all mapping units with the exception of alluvial deposits and freshwater limestone. The central cluster represents freshwater limestone; the lower cluster alluvial deposits. In a second split at Squared Euclidian distance 20 iron ores build their own cluster. Andesite forms a single cluster after the third split Squared Euclidian distance 15. After the fourth split, parent material still causes the clearest cluster groups. We conclude that the cluster analysis accords with farmers' perception that parent rock dictates soil properties.

Figure 17: Hierarchical cluster analysis based on farmers' ranking of erodibility, water



Column 1: AL = Alluvial deposits; AS = Andesite; CA = Clay stone with some Andesite; CS = Clay-, Silt-; Sandstone; FL = Freshwater limestone; GC = Glauconite bearing Limestone; IO = Iron ore; LS = Limestone.
Column 2: BS = Black Soil; OS = Orange Soil; RH = Hard Red Soil RS = Soft Red Soil; YS = Yellow Soil.
Column 3: AC = Acrisol; CH = Chernozem; CM = Cambisol; FR = Ferralsol; GL = Gleysol; LV = Luvisol

We could not find any similar case of correspondence between local soil map and petrographic map in literature.

4.5 Conclusions and Outlook

The Local Soil Map and the WRB-based soil map of the Bor Krai study site are strongly dissimilar. While the Local Soil Map to a large extent corresponds with the Petrographic map – with exception of the Black Soil, the WRB map is more or less independent from the parent material, because Luvisols and Cambisols occur irrespective of parent material. Due to the dominance of limestone above 800 m asl the independency of Acrisols and Ferralsols could not be proven.

Farmers, on the other hand, classify their soils according to colour which first and foremost reflects the parent material that was subject to various degrees of weathering and subsequent erosion. It is expected that population increase and intensification of agriculture in the Bor Krai area will accelerate soil erosion. With the loss of the topsoils the similarity between the local soil map and the petrographic map is likely to increase. This study confirms that predominant local soil types, their properties and features can be efficiently identified on the basis of participatory soil mapping (PSM). Although PSM certainly cannot replace conventional soil mapping, it can reduce fieldwork to some extent. It facilitates the first step of getting acquainted with the terrain under study. An important prerequisite is that surveyors are able to communicate with the rural population in personal interviews and group discussions, which can be facilitated through cooperation with social scientists. A further advantage of participatory soil mapping (PSM) is that the local soil maps produced are a base for knowledge exchange between farmers and surveyors. Both have their own ways of acquiring knowledge; fruitful synergies are anticipated if the expertise of both groups is brought together. Other disciplines (e.g. policy makers and extension workers) can also benefit from the unveiled local knowledge (cf. BIRMINGHAM, 2003; ERICKSEN and ARDON, 2003; RYDER, 2003). Finally, Local Soil Maps can help to integrate the views of local people into land use planning and perhaps avert problems which confront local communities if their interests are overlooked.

It is to be expected that local soil classification systems in Northern Thailand differ between environments and ethnic groups. If our results are confirmed elsewhere, integration of local and foreign soil knowledge can be attempted at the landscape and regional levels.

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5. Agrosilvopastoral Systems in Northern Thailand and Northern Laos: Minority Peoples' Knowledge versus Government Policy*

5.1 Abstract

Traditional agrosilvopastoral systems have been an important component of the farming systems and livelihoods of thousands of ethnic minority people in the uplands of Mainland Southeast Asia. Drawing on a combination of qualitative and participatory inquiries in nine ethnic minority communities, this study emphasizes the complex articulation of local farmers' knowledge which has been so far excluded from governmental development and conservation policies in the Northern uplands of Thailand and Laos. Qualitative analysis of local knowledge systems is performed using the Agroecological Knowledge Toolkit (AKT5) software. Results show that ethnic minorities in the two countries perceive large ruminants to be a highly positive component of local forest agro-ecosystems due to their contribution to nutrient cycling, forest fire control, water retention, and leaf-litter dispersal. The knowledge and perceptions of agrosilvopastoral farmers are then contrasted with the remarkably different forestry policy frameworks of the two countries. We find that the knowledge and diversity of practices exercised by ethnic minority groups contrasts with the current simplified and negative image that government officials tend to construct of agrosilvopastoral systems. We conclude that local knowledge of forest-livestock systems can offer alternative or complementary explanations on ecological cause-and-effect relationships which may need further scientific investigation and validation.

Keywords: local ecological knowledge; ethnic minority groups; forest-dependent people; conservation policy; Southeast Asia

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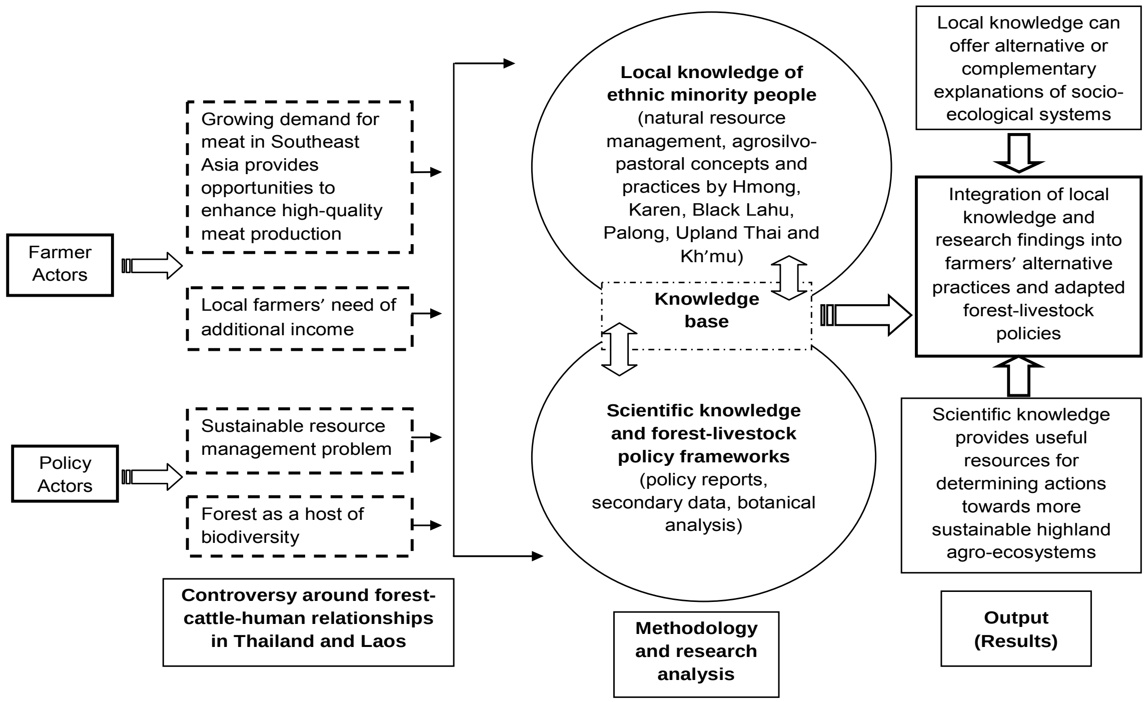
5.2 Introduction

Traditional agroforestry systems in Southeast Asia – and agrosilvopastoral systems in particular – are transforming rapidly under pressure from the transition of farming systems towards increasingly larger scales, from enhanced forest conservation efforts, from large-scale land investments, and the constrained availability of arable land. Under these pressures many swidden and rotational practices have been abandoned in favor of more permanent cultivation (RERKASEM, 1997 and NEEF et al., 2006). This is also the case in the highland areas of Northern Thailand and Northern Laos, where most rural people were, until relatively recently, practicing swidden cultivation in various forms and with varying impacts on the forest ecosystems. Traditionally, forest-dependent people have cultivated upland rice in combination with other subsistence crops, such as pumpkin, cassava or taro (RERKASEM, 1997), and practiced extensive cattle rearing in the surrounding forest areas for a variety of reasons, including provision of draught power, transportation, and capital saving (CARSON, 1997 and HORNE, 2007). Both the Thai and Lao governments have maintained a negative view on upland farmers who have traditionally lived in the forest, regarding them as destroyers of the forest, an attitude that is also evident in other Southeast Asian countries with ethnic minorities (BUERGIN, 2000 and FOX et al., 2009). Yet the policies towards livestock rearing in upland areas show some significant differences between the two countries. While the Thai government has discouraged cattle farming in forested upland areas due to its perceived negative ecological impact, the Lao government has promoted the production of livestock, including cattle, among upland minority groups as a strategy of poverty alleviation (BOUAHOM, 1998).

Cattle have traditionally been the main animals raised by upland farmers in Southeast Asian countries due to their multifunctional roles in the farming system. This trend has decreased in recent years as a result of external pressures and shifts in farmers' priorities. The major purpose of animal husbandry was formerly for agricultural work, transportation and manure provision as well as for consumption. As new agricultural technologies have become more widely available and machines have replaced cattle in labor functions, Southeast Asian upland farmers now invest less time and capital on cattle. However, cattle still continue to play an important role in terms of local food supply - particular the provision of protein - and for ceremonial purposes. There is also an increasing demand for high-quality meat from animals raised under more natural, i.e. less intensive conditions, connected with an increasingly affluent and expanding middle class in Asia (DEVENDRA, 2002). At the same time, systematic research on the role of large ruminants in upland swidden systems remains scant, and knowledge of the potential of cattle-forest interactions and sustainable livestock intensification in a dynamic upland environment is sketchy at best (RAMBO, 2007).

This article aims to elucidate the role of cattle in sustainable agroforestry systems in upland areas of Thailand and Laos, juxtaposing the assessment of the controversial role of large ruminants by government officials with local perceptions of its largely positive agro-ecological and socio-economic functions. The conceptual framework of the study as a main approach to reach the objectives is presented in Figure 18. The specific objectives are (i) to explain the different concepts of animal husbandry promotion and policies towards local agrosilvopastoral systems, (ii) to describe the basis of historical conditions where animal husbandry has played an essential role for the sustainability of the existing farming concepts, particularly in mixed crop-animal husbandry systems, (iii) to draw conclusions regarding the possibility of integrating local knowledge and research findings into alternative forest-livestock policies and farmers' practices.

Figure 18: Conceptual framework to assess local knowledge on the traditional agrosilvopastoral systems of upland people in Northern Thailand and Northern Laos.



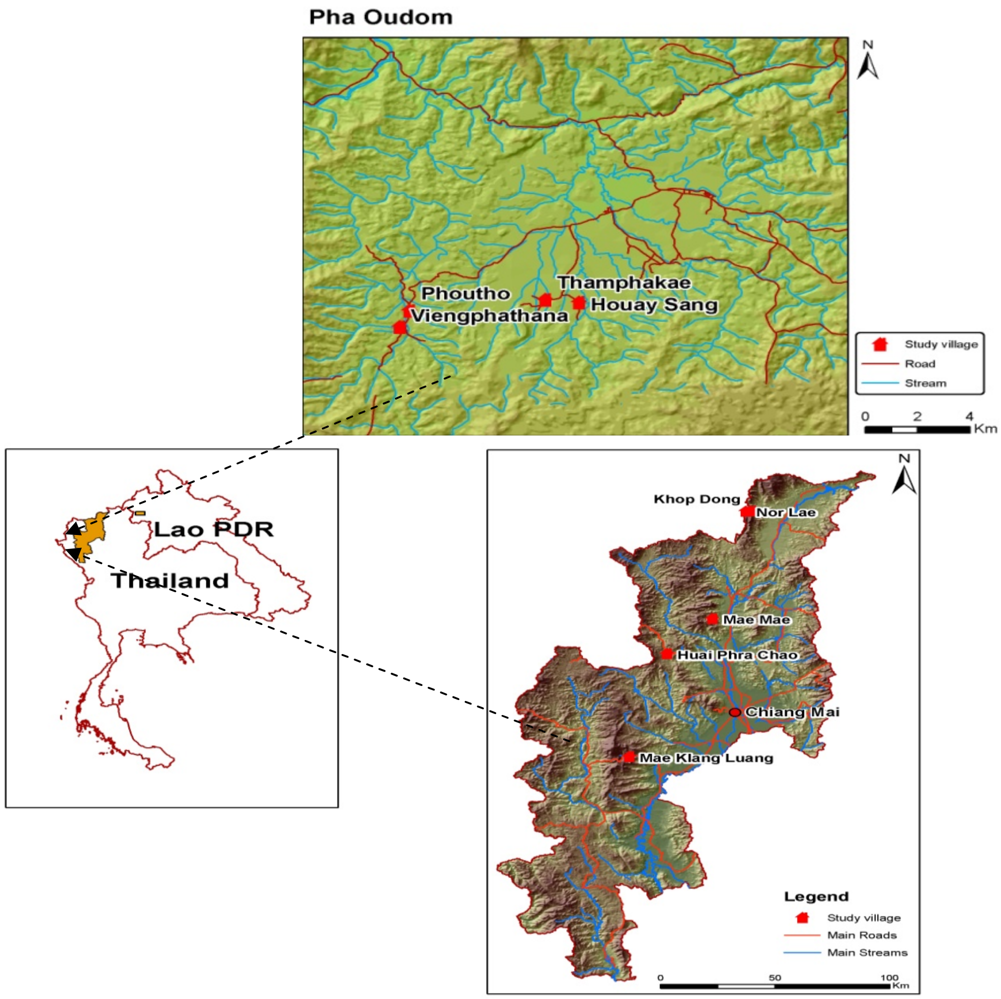
5.3 Research Methodology

5.3.1 Study Region

The study was carried out in Northern parts of Thailand and Laos in areas composed of lowlands and hills (Figure 19). The climate is of the tropical monsoon type with two distinct seasons: Rainy (May-October) and dry (November-March). **In Thailand**: The first village (Mae Klang Luang) is located in the Doi Inthanon National Park, southern Chiang Mai province, situated at an elevation of approximately 1200 masl. Mae Klang Luang has approximately 500 Karen inhabitants comprising 63 households whose primary economic activities include the cultivation of upland rice, maize, soybean, cabbage and livestock production based on rotational swidden systems. The second village is Huai Phra Chao village, situated in a wildlife conservation zone, located at

1250 masl. The village has a population of 133 predominantly Karen inhabitants who have paddy fields and practice shifting cultivation, producing '*miang* tea', upland rice and non-timber forest products. The third village is Ban Mae Mae, sited in a wildlife conservation area, located at 900 masl. The village has a Thai population who has lived in the upland area for more than 50 years and depends on the resources from a dry dipterocarp forest. The fourth village has two parts (Ban Nor Lae and Ban Khop Dong) located 1800 masl at the Thai-Myanmar border region in the northwestern part of Thailand and belongs to the target villages of the Ang Khang Royal Project Station. There are Black Lahu and Palong populations in the villages, which have 188 and 279 inhabitants, respectively.

Figure 19: Research areas and location of study villages in Northern Thailand and northern Lao PDR.



Source: Maps provided by Peter ELSTNER

In Laos: The first two villages, Viengphathana and Thamphakae, are Hmong communities and have populations of 1,072 and 663 people, respectively. Viengphathana is located at an altitude of about 600 masl, is relatively rich in surrounding forest resources and has a particularly large cattle population. Thamphakae – located at 500 masl – has much scarcer forest and land resources, restricting the number of cattle that can be kept per household. The other two villages, Phoutho and Houay Sang, are of the Kh'mu ethnic group, are located at altitudes of 600 and 450 masl and have populations of 339 and 663 people, respectively. Cattle are raised at a much smaller scale than in the neighboring Hmong communities. All four villages are located in Pha Oudom District, Bokeo Province, Laos (see Figure 19). They have been relocated from upland forests to the midlands and lowlands. In all four communities, villagers practice subsistence cultivation of both paddy rice and upland rice and produce maize for sale and as animal feed and sesame and peanuts for sale. Women collect a variety of non-timber forest products, with paper mulberry *(Broussonetia papyrifera)* being a particularly important source of cash income. Rubber cultivation has been strongly promoted in all four villages as an alternative to upland swidden agriculture by government agencies in conjunction with Chinese investors.

5.3.2 Field Research Methods

To collect data on the traditional agrosilvopastoral systems, a mixed-method approach was applied in both Thailand and Laos. Selected Participatory Rural Appraisal (PRA) tools were used for the collection of primary data such as mapping, in order to learn about the locations of the village area, agricultural fields as well as the animal husbandry systems. An agricultural calendar was used to get an impression of current modes of agriculture and forest product utilization. Resource flow diagrams were used in order to represent the utilization of resources and how the concerned farmers use the land. Transect walks were used to observe the area and describe its structure and vegetation. Observation was used in order to investigate unstructured conditions and situations which occurred during field work. Semi-structured interviews with purposively selected key informants with local expert knowledge of traditional agrosilvopastoral systems were also conducted. Focus group discussions and semi-structured interviews were conducted with women specializing in fodder collection, as well as men taking care of the cattle while browsing the forests. Vegetation samples were collected as herbarium specimens from the animal husbandry areas and nearby forests for species identification.

5.3.3 Data Analysis

Data analysis was performed using the Agroecological Knowledge Tool Kits (AKT5) software, developed by the University of Wales (Bangor, UK) in collaboration with the Department of Artificial Intelligence at Edinburgh University. AKT5 is a toolkit that provides an environment for qualitative and quantitative data on local knowledge to be stored and subsequently retrieved and analyzed in a systematic way through the medium of 'Knowledge Bases' (KB), where KB can be conceptualized in the form of multifunctional databases. The four main stages of KB creation and the key characteristics of the software were taken from the manual for the use and development of KB using AKT5 (DIXON et al., 2001)The use of the knowledge-based systems approach for acquiring local knowledge has been reviewed and justified by WALKER et al. (1995).

5.4 Agrosilvopastoral Systems in the Uplands of Thailand and Laos: A Comparative Review of Policies, Features and Conflicts

5.4.1 Forest and Livestock Policies in Northern Thailand and Northern Laos

The Northern parts of Thailand and Laos represent a subtropical mountainous region possessing a variety of forested landscapes with rich and highly valuable biodiversity. At the same time, the area features a very rich cultural heritage due to the presence of many ethnic minority groups which are renowned for their indigenous knowledge of highland agro-ecosystems. Deforestation in these areas has been identified by a variety of actors as a major environmental threat, reducing genetic diversity within populations or even driving entire populations of endemic plants and animals to extinction. As a response, large areas in Northern Thailand have been declared as national parks, wildlife sanctuaries, watershed conservation zones and forest reserves, while ethnic minority groups and their swidden agricultural practices – often dubbed with the pejorative terms 'nomadic people', 'forest destroyers' and 'slash-and-burn' – have been targeted as the main culprits of forest destruction and watershed degradation (BUERGIN, 2000; FORSYTH, WALKER, 2008; KAMPE, 1997 and DELANG, 2005). The counter-narrative that has been constructed by social science scholars, human rights organizations and indigenous people's networks is that ethnic minority groups have long since depended on forest resources for their livelihoods and developed sophisticated forest classification systems and forest conservation measures alongside their swidden practices (LAUNGARAMSRI, 2001 and HARE, 2009). Ethnic minority people have argued that secondary forest and swidden cultivation rotation involves moving their fields rather than their villages. The land would be farmed for only a short time and left fallow for several years to allow the forest to regenerate. Sensitive head watersheds would often be protected by sacred forests, declared off-limits for villagers and outsiders, with the exception of annual ceremonies.

In Thailand, the Royal Forestry Department (RFD) and local governmental agencies have depicted livestock raising practices as having negative direct and indirect effects on the local ecosystems. They hold that forest browsing by large ruminants increases the incidence of forest fires and damages plant seedlings and saplings, especially in newly reforested areas (PREECHAPANYA, JIRASOOKTAWEEKUL, 1999). It is also widely believed that keeping large ruminants in the forest causes a decrease in total forest cover and tree density, with consequent impacts on the populations and diversity of wild plant and animal species as well as causing risks of soil erosion and landslides. Therefore, rearing cattle is strictly forbidden in conservation areas that belong to national parks and wildlife sanctuaries. Thus, in effect, both cropping and animal husbandry systems are severely restricted by the Thai forest and watershed conservation policy, which puts the viability of traditional agrosilvopastoral systems at risk and adversely affects the livelihoods of thousands of local farmers living in protected areas. In the past, livestock keeping in upland communities was promoted by a number of international and bilateral highland development projects, often in connection with opium substitution programs, although these programs had a much stronger focus on permanent crop production (CARSON, 1998 and CHEVA-ISARAKUL, 1998). Attempts to intensify large ruminant production by means of improved and enclosed pastures mostly failed in Northern Thailand, but the importance of livestock for households' cash economy remained high, accounting on average for nearly the same cash revenues as crop production, which is much more demanding in terms of labor than extensive livestock systems in the uplands (CARSON, 1998). Meanwhile, in the Thai lowlands, large-scale commercial pig production has shown particularly high growth rates, and the expanding feed industry has triggered a corn boom in several Northern provinces, particularly in Nan and parts of Chiang Mai province, where large tracts of forestland have been cleared for intensive hybrid corn production with support from Thai government agencies and large corporations. The practice of promoting these ecologically damaging crop-livestock systems, while vilifying extensive agrosilvopastoral systems in the uplands reflects the innate inconsistencies and contradictions in the Thai land, forest and agricultural policy framework.

In Northern Laos, large forested areas in the uplands have remained intact until very recently and are still inhabited by numerous communities. Like in Thailand, upland people's swidden cultivation has been considered by government officials to be an inefficient and environmentally destructive land use system in upland areas (DUCOURTIEUX et al., 2005 and FRIEDERICHSEN, NEEF, 2010). Hence, the Lao government has implemented a strict policy of eliminating 'slash-and-burn agriculture' and of protecting forest ecosystems, which has gone hand in hand with massive relocation of ethnic minority communities from upland forest areas to the midlands and lowlands (FRIEDERICHSEN, NEEF, 2010 and BAIRD, SHOEMAKER, 2007)Yet, in contrast to the Thai government approach of zero tolerance towards keeping large ruminants in the forest, the Lao government has encouraged animal husbandry as a means to 'stabilize' swidden farmers and to alleviate rural poverty (HORNE, 2007 and BOUAHOM, 1998). Livestock policies have been geared towards improving the productivity and expanding marketing opportunities of livestock for upland smallholders due to rising demand for animal products in the country and improved market access of more remote upland areas (HANSEN, 1998 and BOUAHOM, 1998). Substantial efforts have been made by national agencies and international projects to incorporate a range of forage species into existing swidden cultivation systems (HORNE, 2007; HORNE, 1998 and STÜR et al., 2002). However, there is an inherent conflict between the land, forest and livestock policies of the Lao government. The current land and forest policy framework favors the implementation of both small- and large-scale tree plantations, particularly rubber and teak (FOX et al., 2009; FRIEDERICHSEN, NEEF, 2010). Especially during the implementation phase, conflicts between plantation owners and keepers of large ruminants are common, as will be discussed in detail in section 3.2.

Notwithstanding the ambiguities of forest and livestock policies in Thailand and Laos, a further increase in the demand for livestock products is expected in both countries and the entire ASEAN region, triggered by a combination of factors, such as population growth rates, urbanization, increased per capita income and shifts in consumer preferences (DEVENDRA, 2006). This presents the Thai and Lao governments with tough choices on whether they should focus their support only on high-input, high-output livestock systems in the lowlands or whether they should also encourage more diversified and integrated low-input, low-output agrosilvopastoral practices in the uplands of their countries.

5.4.2 General Features of Agrosilvopastoral Systems in the Uplands of Thailand and Laos

5.4.2.1 Socio-Economic Benefits, Cultural Traditions and Agro-Ecological Constraints

Livestock have been an integral component of traditional swidden systems practiced in the uplands of Northern Thailand and Northern Laos. Rearing of cattle (and buffaloes) has been integrated with upland crops, paddy fields, fallow areas, forest trees and non-timber forest products. With a low level of technological development, low use of external inputs, and good adaptation to less favorable and changeable local environmental conditions, cattle have played a major role in the farm economy. The major benefits of the integration of cattle into upland swidden systems can be summarized as follows:

(i) Multifunctional use as draught animals, for transportation and for consumption (CHEVA-ISARAKUL, 1998);

(ii) Use of feed resources that do not have any other productive purpose, such as grasses, shrubs and crop residues (HANSEN, 1998; HORNE, 2007 and HORNE, 1998);

(iii) Cultural functions, e.g. ritual offerings to ensure a safe harvest (HANSEN, 1998 and CHEVA-ISARAKUL, 1997);relatively stable market demand and high profit for very little labor input (CARSON, 1998; HORNE, 2007 and HORNE, 1998);low dependency on road infrastructure, i.e. cattle can be walked to the market over long distances (HORNE, 2007 and HORNE, 1998);

(iv) Provision of soil fertility enhancing manure (HORNE, 2007 and HORNE, 1998);

(v) Risk diversification, i.e. cattle can be sold in times of crop failures or major shocks to the household economy (HANSEN, 1998 and CHEVA-ISARAKUL, 1998);

(vi) Capital saving and wealth accumulation (HANSEN, 1998; HORNE, 2007).

While most authors find common ground regarding these benefits for the local economy, the impact of cattle on upland forest ecosystems remains a much more contentious issue. Some have argued that cattle rearing can actually decrease the competition between agricultural and forest land use because it lowers the risk of income losses in times of crop failure. Scholars and practitioners in Thailand have identified a lack of integration between crop and livestock systems, uncontrolled grazing patterns, and overstocking in agrosilvopastoral systems as major threats to the local ecosystem (CARSON, 1998 and CHEVA-ISARAKUL, 1998).In Laos, the main constraints identified by various authors for the further development of ecologically sustainable agrosilvopastoral systems were the burning of grazing areas to favor grass production, the lack of fodder during the dry season, animal diseases, and free-range grazing in ecologically sensitive and biodiversity-rich areas (HANSEN, 1998 and FAHRNEY et al., 1998).

5.4.2.2 Recent Dynamics and Conflicts

Animal husbandry systems in upland areas of Thailand and Laos have undergone significant changes over the past 40 years, mainly evidenced by a reduction in grazing areas and the adoption of supplemental feed, including vitamin and mineral inputs. More recently, agricultural practices related to both traditional cropping and silvo-pastoral systems have experienced a series of further changes. Aiming to increase the expanse of conservation areas and to protect their natural resources, both the Governments of Thailand and Laos have made significant efforts to reduce shifting cultivation in highland areas and to separate the local people from the forest. In addition, greater income opportunities in urban centers now motivate and attract younger people for study and work, hence reducing the labor force available for agricultural work.

In Thailand, numerous conflicts have been created between local communities and forest authorities – namely the Royal Forestry Department and the Department of National Parks, Wildlife and Plant Conservation – since the strict implementation of policies for the expansion of conservation areas has come into effect in Thailand. While the Thai government has decentralized power to regional authorities and delegated more management rights of natural resources to local communities under its decentralization act of 1999, conflicts between governmental agencies and local people are still common. Forest communities are limited by policy makers through strict control of agricultural land and forest boundaries and the lack of alternatives to traditional animal husbandry practices. Agrosilvopastoral practices tend to be promoted among some rotational swidden farmers who maintain terraced paddy rice fields, but are generally prohibited in protected areas. A recent agricultural strategy in Thailand encourages small-scale farmers cultivating areas of not more than 5 *rai* (0.8 ha) to use buffaloes instead of agricultural machinery for the cultivation of paddy fields, as a response to increasing diesel prices. This strategy puts to the test the tolerance level among forest officials that undertake the task of controlling animal numbers inside forest conservation areas.

In Laos, the ongoing resettlement of upland communities from forest areas in the context of the government policy to eradicate swidden cultivation and to expand rubber and teak plantations has become a major threat to traditional agrosilvopastoral practices. Several studies report that resettled communities had to sell their cattle and buffaloes due to lack of pasture land and growing food insecurity (BAIRD, SHOE-

MAKER, 2007; EVRARD, GOUDINEAU, 2004). The indiscriminate expansion of large- and small-scale rubber and teak plantations in Northern Laos also severely constrains the rearing of cattle and buffaloes. In several provinces, upland farmers have sold their large ruminants or plan to reduce their herds, as they fear the imposition of fines if their animals destroy plantations of other farmers (FRIEDERICHSEN, NEEF, 2010).

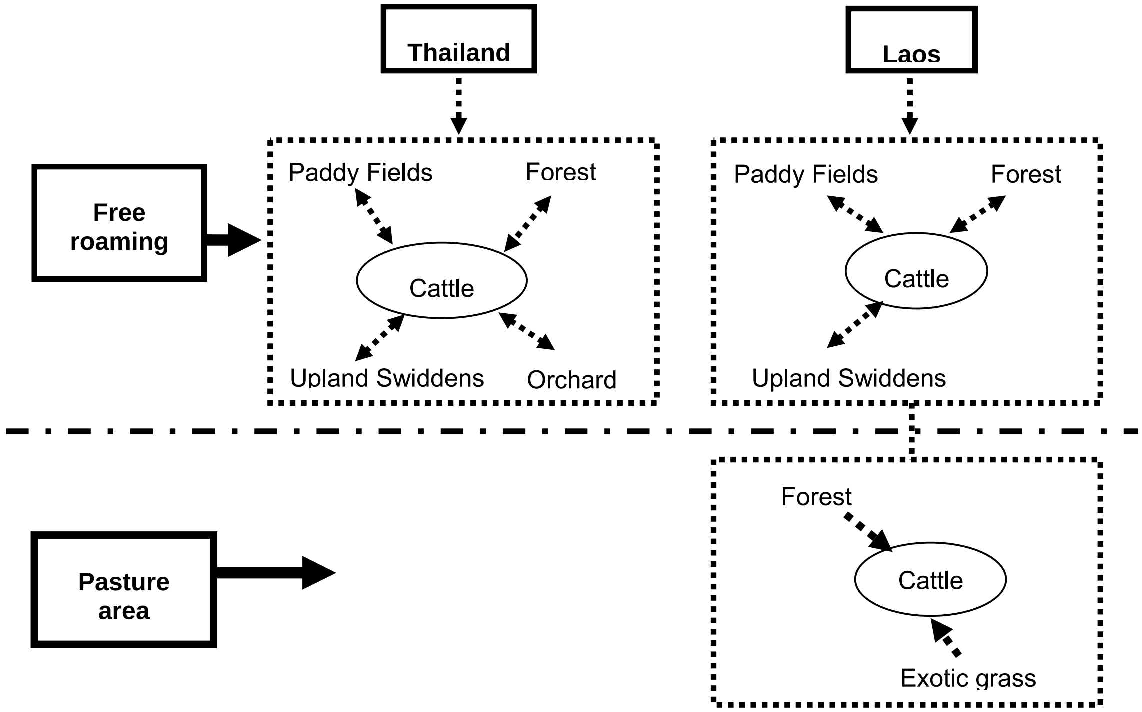
5.5 Results from the Case Studies

5.5.1 Agrosilvopastoral Systems as Practiced in the Study Villages

Several patterns of agrosilvopastoral systems can be observed in the upland areas of both Thailand and Laos. Figure 20 shows that the agrosilvopastoral systems in Thailand encompass forests, upland swiddens, orchards and paddy fields. Orchards do not play a role in animal husbandry in Laos while exotic grasses are absent from the agrosilvopastoral systems in Thailand.

Highland farmers skillfully combine the management of natural and secondary vegetation and domestic animals for serving various functions. Vegetation plays a major role in both enhancing and measuring productivity, while animals optimize the system by consuming unutilized plant resources. In addition, animals enhance the role of decomposers in fertilization with the production of manure and urine. Mixed agricultural systems have been introduced and integrated with these functions, taking into account that cattle support sustainable systems in the long term. Raising cattle has been essential for sustaining crop yields and has been crucial in agroforestry practices of silvopastoralists including the Thai, Karen, Palong, Black Lahu, Hmong and Kh'mu peoples. Among the diversity of agroforestry systems, the ones employed by the Karen and Black Lahu groups show the most similarities with respect to their traditional animal husbandry practices. The Karen people, in particular, regard the forest as an essential part of their lives (PREECHAPANYA, JIRASOOKTAWEEKUL, 1999). They have learned over generations how to be closely connected with the forest and how to lead a sustainable life through continuous interaction with it. This knowledge is still present in many communities, although it cannot always be put into practice due to changing demographic and institutional conditions. The expansion of protected areas in Thailand, in particular, has limited the resource management options of upland people. This phenomenon can be examined with the Karen in Mae Klang Luang, the Palong in Nor Lae and Black Lahu from Ban Khob Dong who are located inside national park boundaries in Thailand. In these communities, the number and size of farms have decreased, despite the promotion of commercial crop production by locally operating development organizations. Permanent and intensive farming of fruit and vegetables for market-oriented production was imposed on many upland farming communities under the auspices of the Royal Project Foundation and other development organizations that have portrayed swidden farming as culturally undesirable and ecologically dysfunctional. Meanwhile, the Karen in Huai Pra Jao still maintains their traditional agrosilvopastoral system of raising cattle in the forest as well as in agricultural areas.

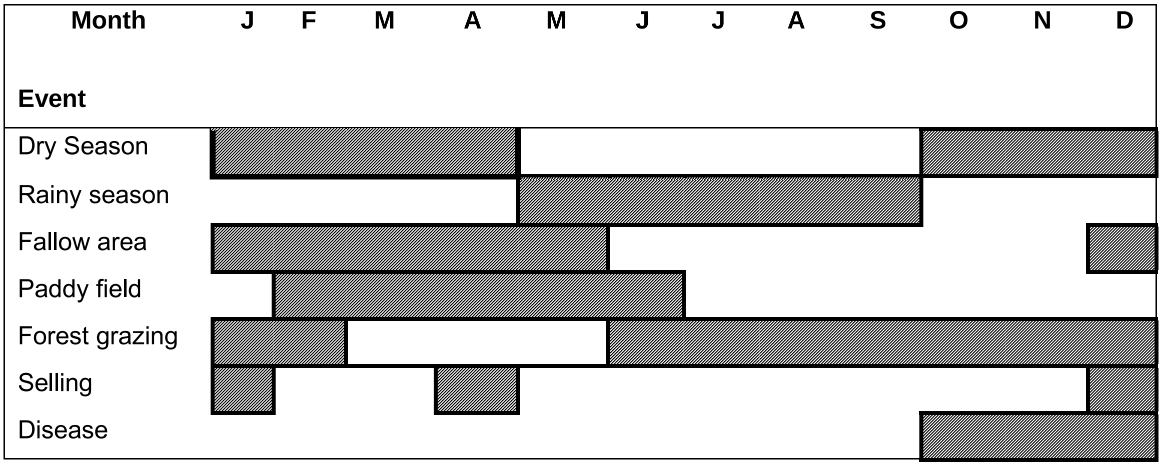
Figure 20: Different areas of occurrence of traditional agrosilvopastoral systems in Thailand and Laos.



Source: Group discussions

In Laos, one of the main plans of the central government involves the use of current animal husbandry practices in fallow areas, paddy fields, forests and holding areas (Figure 21). Farmers in Laos keep their animals in the respective areas depending on the period of planting and harvesting. The temporal patterns of silvopastoral systems present in Laos correspond to three periods: Leaving the cattle in the forest (original pattern), setting up an area and leaving the cattle inside it (present pattern) and setting up an area for permanent animal husbandry (future pattern). At present, there are strong interconnections between the main agrosilvopastoral components in Northern Thailand and Northern Laos. Yet the traditional patterns from both areas are different, for example most of the cattle raising area correspond with forests in Thailand, while in Laos it takes place inside upland and paddy rice fields. According to this pattern, the main reasons that motivate farmers to leave ruminants in those areas are the large amount of fodder available and the relative ease of taking care of the animals.

Figure 21: Events relevant for animal husbandry practices along the seasons.



Source: Seasonal calendar elaborated in a participatory group discussion in Viengphathana (Laos)

In the uplands of Laos, people depend on livestock which contributes to more than 50 percent of their household income, a much higher percentage than in most upland areas of Northern Thailand. More than 95% of livestock production stems from small-scale husbandry systems, with relatively poor herd management (STÜR et al., 2002). In our study we found that every Hmong household in both Viengpathana and Thamphakae raised cattle, which provide the main contribution to annual income. At the time of our study, farmers in Viengpathana kept about 1,220 heads of cattle. Neighboring Kh'mu farmers, in contrast, derived their main income from crops and only few households owned cattle. Furthermore, the Kh'mu had great expectations from rubber production, with respect to income generation in the future, which cannot be well integrated with animal husbandry practices. We found little or no provision for improved animal health care and nutrition as well as breed improvement, resulting in rather low performance in terms of animal productivity.

5.5.2 Local Knowledge and Perceptions of the Role of Agrosilvopastoral Systems in Forest and Ecosystem Management

5.5.2.1 Impacts on Nutrient Cycling

Ethnic minority farmers in both Thailand and Laos maintain local perceptions about factors associated with nutrient cycling in traditional agroforestry systems. They believe that cattle are an important agro-ecological component of such systems. Table 1 illustrates the local perceptions regarding ecological systems associated with the cause-and-effect relationship of nutrient cycling. Upland farmers have acquired detailed knowledge through observations of the nutrients present in the top soil, produced by decomposition of the litter and manure derived from cattle. They state that the deposition of manure increases the growth rate of trees, which justifies the key role of cattle in functions related to nutrient cycling.

Government officials tend to argue that an increase in the rate of trampling by cattle causes an increase in the degree of soil compaction, resulting in surface runoff that increases soil erosion and decreases fertility. In contrast, upland farmers argue that trampling decreases the intensity of forest fires through leaf scattering while enhancing water retention in hoof-prints and the production and distribution of manure.

5.5.2.2 Forest Fire Control and Leaf-litter Dispersal

The Karen people have particularly strong perceptions and complex ecological knowledge related to forest fire control and leaf litter dispersal. This can be explained by the fact that the Karen people have a particularly long history of having their cattle browse in the forest. Karen respondents reported that their cattle scatter leaf-litter in a way that allows it to decompose quicker, therefore decreasing the risks of forest fire. According to their perspective, although fires occur when litter is scattered, their intensity is not high enough to cause severe damage to trees (Figure 22; Table 3).

Palong farmers have observed that trampling creates shallow holes on the ground that serve to store water and consequently decrease surface runoff.Hence, the impact of raising animals on sloping land remains a contested issue requiring further study to fully capture the cause and effect relationships of animal husbandry in upland areas. Perceptions of local farmers on factors related to nutrient cycling in traditional agroforestry also suggest that cattle are important components of such systems. For example, forest fire control and leaf-litter dispersal implies that an increase in the numbers of cattle walking increases the rate of trampling, followed by a drop in forest fire intensity. Farmers of Mae Mae in Thailand claimed that if the number of cattle decreases in a forest, the number of forest fires increases and spreads over larger areas.

Table 3: Local statements regarding cause-and-effect relationships in nutrient cycling.

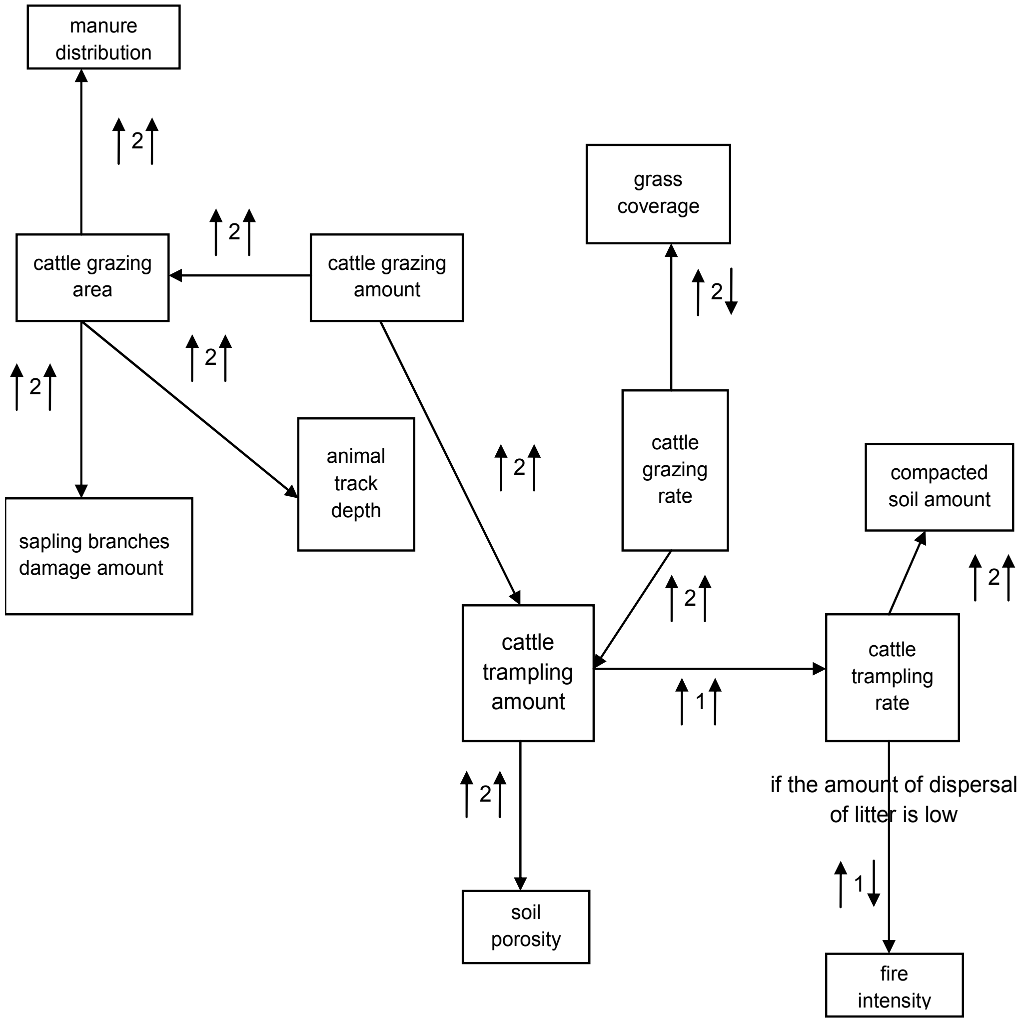
Cause	Effect
+ cattle trampling	+ soil compaction + water retention in hoof-print holes
+ cattle trampling	- forest fire intensity[1]
+ manure application	+ tree growth
+ leaf litter amount	+ leaf litter absorption + leaf litter decomposition + soil moisture[2]
+ leaf litter amount	- surface water run-off - stream depth
+ leaf litter decomposition	+ soil fertility[3]
- *Imperata cylindrica*	+ water availability
+ tree growth	- surface water run-off
+ surface water run-off	+ growth of rice + soil erosion
+ forest fire intensity	- *Imperata cylindrica*
+ soil compaction	- soil fertility
+ soil fertility	+ tree growth + forest density + growth of rice + growth of tea + growth of upland crops
+ surface water	+ leaf litter absorption
+ manure application	+ soil fertility
+ solar radiation	+ growth of rice + forest canopy transpiration
+ sedimentation	+ soil fertility[4]
+ forest transpiration	+ occurrence of dew
+ manure application	+ soil porosity
+ soil erosion	- soil porosity
+ leaf litter decomposition	+ soil porosity
+ ash content of the soil	+ soil fertility

1 if leaf litter dispersal is low; 2 if leaf litter absorption is high; 3 if rainfall is high; 4 if nutrient content of sedimentis high.

Source: Individual interviews with 12 farmers and focus group discussions in Mae Klang Luang and Huai Phra Chao, Northern Thailand.

Note: Cause-and-effect relationships have been generated through the AKT5 software from respondents' individual statements in interviews and focus groups. They have been grouped for better readability.

Figure 22: Karen and Palong farmers' perception of cause-and-effect relationships around forest fire control and leaf litter dispersal.



Source: Generated with AKT5, based on data from interviews and focus group discussions

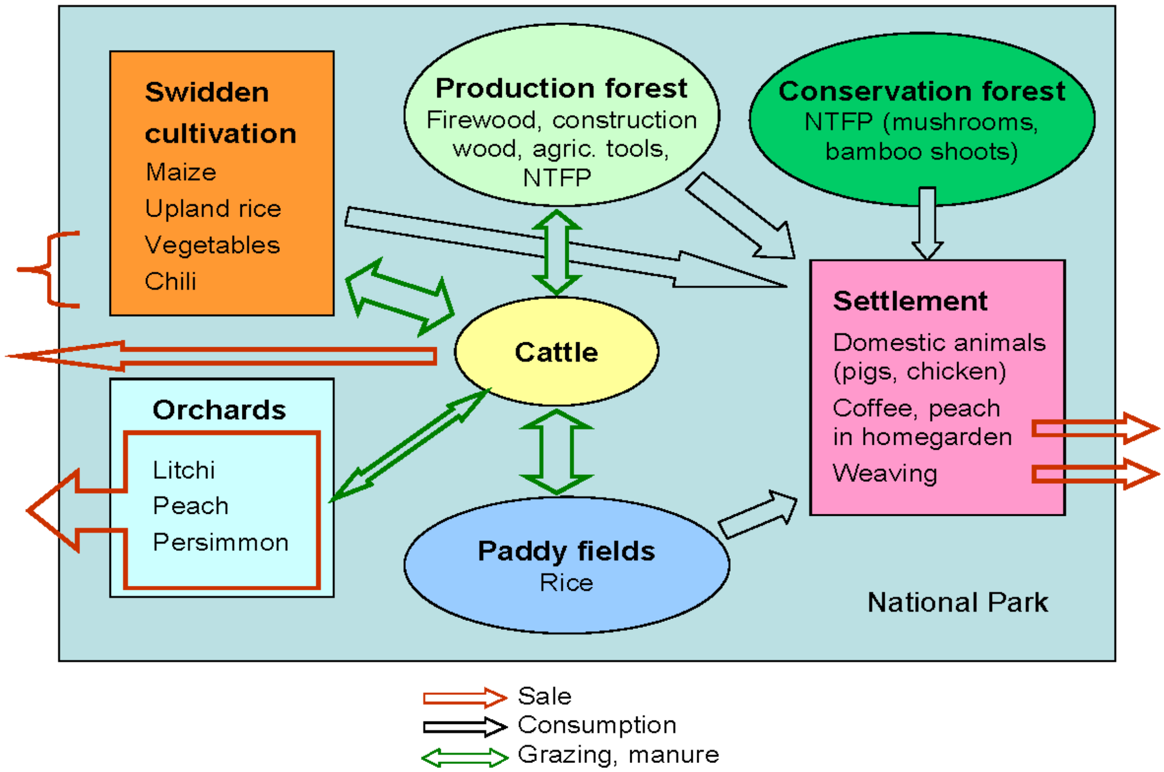
Note: Nodes (boxes) represent a named attribute of components of the agro-ecosystem. Arrows represent a causal influence by a node on another node (at the arrowhead of arc), as specified by the arrows and numerals. Small arrows represent the direction of change of values of the independent attribute (left-hand side) and the impacted attribute (right-hand side):↑ signifies an increase, ↓ signifies a decrease. Numerals specify 'symmetry': For example, '2' signifies that if ↑x causes ↑y, then ↓x causes ↓y; this does not apply for relationships marked with '1'. (DIXON et al., 2001).

5.5.2.3 Integration of livestock in orchards and tree plantations

Keeping large ruminants in orchards and tree plantations provides scope for a particularly integrated and intensified crop-tree-livestock system. Crop residues and manure serve as major inputs in such integrated resource cycles, while animals take advantage of the shade provided by the tree foliage and provide essential services in terms of fertilizer input and weed control. Karen farmers in Mae Klang Luang in the

Doi Inthanon National Park have developed a particularly sophisticated and well-integrated system as depicted in Figure 23.

Figure 23: Integration of cattle with orchards, swidden fields, forests and homegardens in the Karen community of Mae Klang Luang, Northern Thailand.



In Thailand, the case study of Palong and Black Lahu in Doi Ang Kang is presented as an alternative animal raising system which is limited by such factors as farm area and fodder availability. Although these people have long-standing experience with rearing cattle, they have limited opportunities for practical application of their knowledge.

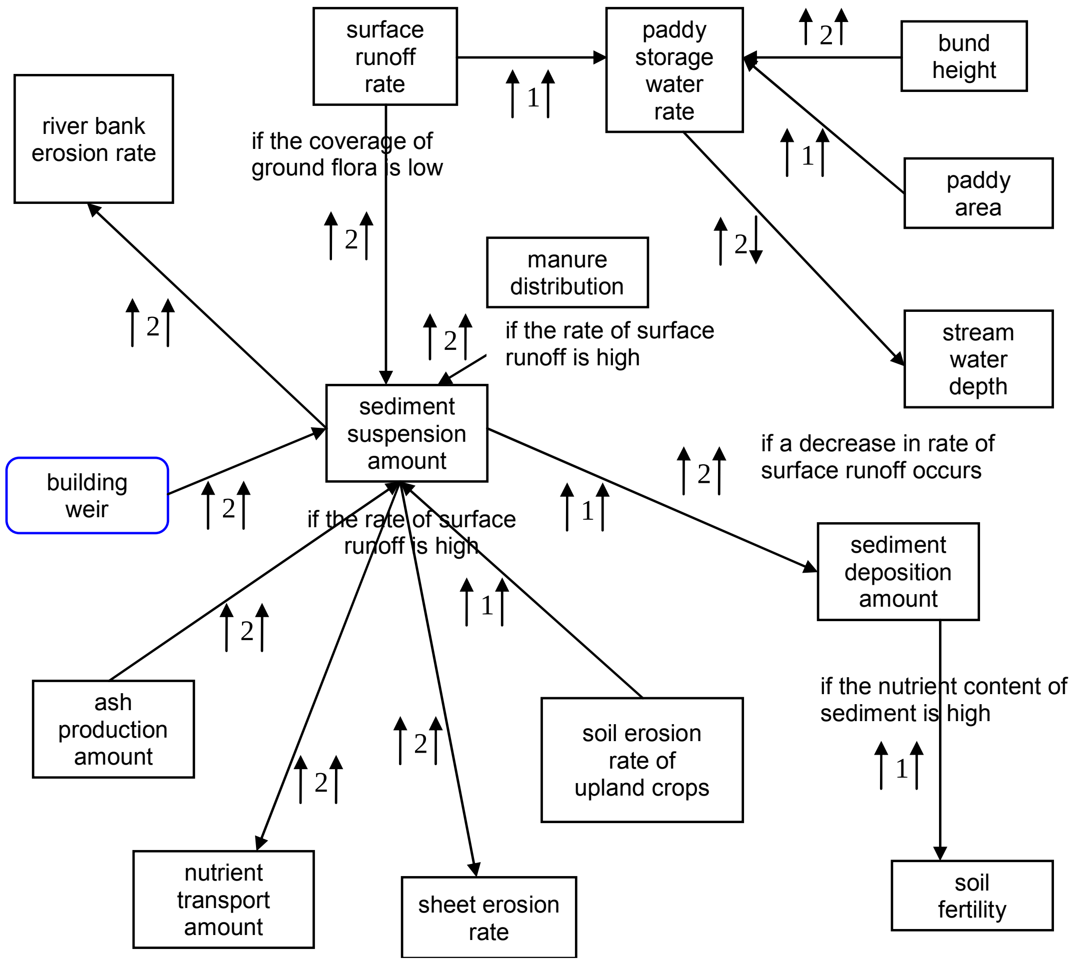
However, keeping animals in orchards is not promoted in Laos, mainly due to a lack of orchard areas, while keeping the cattle inside rubber plantations is not advisable. Moreover, cattle inside rubber areas graze the rubber leaves, leading to fines by the rubber plantation owners (FRIEDERICHSEN, NEEF, 2010).

5.5.2.4 Integration of livestock in paddy fields

Figure 24 illustrates the local perceptions of people who live in the upland areas and maintain integrated paddy-field-ruminant systems.

In paddy fields, cattle and buffalo graze during post-harvest periods. The paddy field system of the Karen people in Thailand occurs in terraces across hill slopes. The Karen in both Huai Pra Jao and Mae Klang Luang cultivate paddy and upland rice in close proximity to the local forest ecosystem. It has been claimed that such a system stores

Figure 24: Local perceptions of cause-effect relationships associated with integrated paddy-field-ruminant agroecosystem.



Source: Generated with AKT5, based on data from interviews and focus group discussions
Note: For explanations of nodes, arrows and numerals please refer to note under Fig. 5.

significant amounts of fertilizer in a similar way that a small dam holds water and sediment. This connection provides the main reasoning behind the belief that terraced paddy contributes to the conservation of soil and water resources by decreasing the rate of soil erosion and enhancing soil water storage. Moreover, terraces decelerate surface runoff and soil erosion, while the accumulated sediment leads to an increase in soil fertility.

However, not all upland people in Northern Thailand practice terraced wet-rice farming, often due to shifts from subsistence food production to commercial farming systems over the last 30 years. The Black Lahu people in Doi Ang Kang (Fang, Thailand), for instance, have abandoned their terraced paddy fields because they switched to modern cropping systems involving growing temperate vegetables and flowers under the supervision of the Royal Project Foundation. Similarly, most Hmong communities in the uplands of Thailand have shifted their focus on cash crops in recent years and have discontinued cattle or buffalo rearing in natural habitats or agricultural areas.

In Laos, paddy fields still occupy the main area in the lowlands, where cattle and buffaloes graze after harvesting. This is most prominent among the Hmong, who are well known for their knowledge and extensive use of the post-harvest period for feeding and taking care of their large ruminants.

5.5.3 Valuation and Management of Local Fodder Resources

Raising cattle in the forest is a land use which combines the use of trees, shrubs, pasture and animals, with a diversity of wild plant species contributing as fodder resources with various edible parts including flowers, leaves, fruits, pods, barks and roots. Farmers' knowledge on fodder quality is based on an understanding of the various attributes of plants, such as their nutritive value, availability and palatability (Table 4).

Feeding cattle poses enormous management challenges to the farmers, as he or she needs to consider a web of factors, such as seasonality, agro-ecological conditions, topography, proximity of grazing grounds, and nutritional values of the various fodder species. Tables 4 and 5 show that farmers are mainly concerned about fodder palatability and the contribution of fodder to improving the animal growth rate (body weight gain). Table 4 illustrates the local classification of the main plant species growing in the forest, paddy and upland fields used as fodder by the Karen and upland Thai farmers in Northern Thailand. Locals divide fodder species into three major groups, namely bamboos, grasses and trees. Their use follows a seasonal pattern, with grasses mainly used during the rainy season and bamboos together with trees (leaves and fruits) used during the dry season. Respondents in Northern Laos did not categorize the forage species into subgroups (bamboo, grass, tree), but did have an equally pronounced knowledge of their respective palatability as the respondents in Northern Thailand (Table 5).

Table 4: List of main forage species in upland areas of Northern Thailand with local classification, habitat types and palatability rating by ethnic minority groups.

Local Classification	Local Thai Name	Scientific Name	Habitat	Palatability Rating
Bamboo (*Pai*)	Rai	*Gigantochloa albociliata*	F,S	+++
	Bong	*Bambusa longispattha*	F,S	+++
	Sang	*Dendrocalamus strictus*	F,S	+++
Grass (*Yha*)	Tong gong	*Thysanolaena maxima*	UF,P	++
	Gay	*Eulalia siamensis*	UF,P	++
	Fak	*Themeda triandra*	UF,P	++
	Phank kwai	*Axonopus compressus*	UF,P	+++
	Kham	*Phragmites karka*	UF,P	+++
	Ka	*Imperata cylindrica*	UF,P	+++
	Yong kor lek	*Cyrtococcum pilipes*	UF,P	+++
	Nad lek	*Pluchea eupato*	UF,P	+
	Kom bang	*Corex indica*	UF,P	+++
	Dok Kham	*Gymura crepidoides*	UF,P	+++
	Rok krea	*Terminalia alata*	UF,P	++
Tree (*Ton Mai*)	Kra tin	*Leucaena leucocephala*	F	++
	Ma kok pha	*Spondias pinnata*	F	+++
	Dok tien	*Impatiena chinensis*	F	+++
	Ta lo	*Schima wallichii*	F	+++

Note: F= [Forest], P= [Paddy], UF= [Upland areas], S= [Stream]) and palatability rating (+++ [High], ++ [Medium], +[Low].
Source: Data obtained by individual interviews with 12 farmers and focus group discussions in Mae Klang Luang and Huai Phra Chao

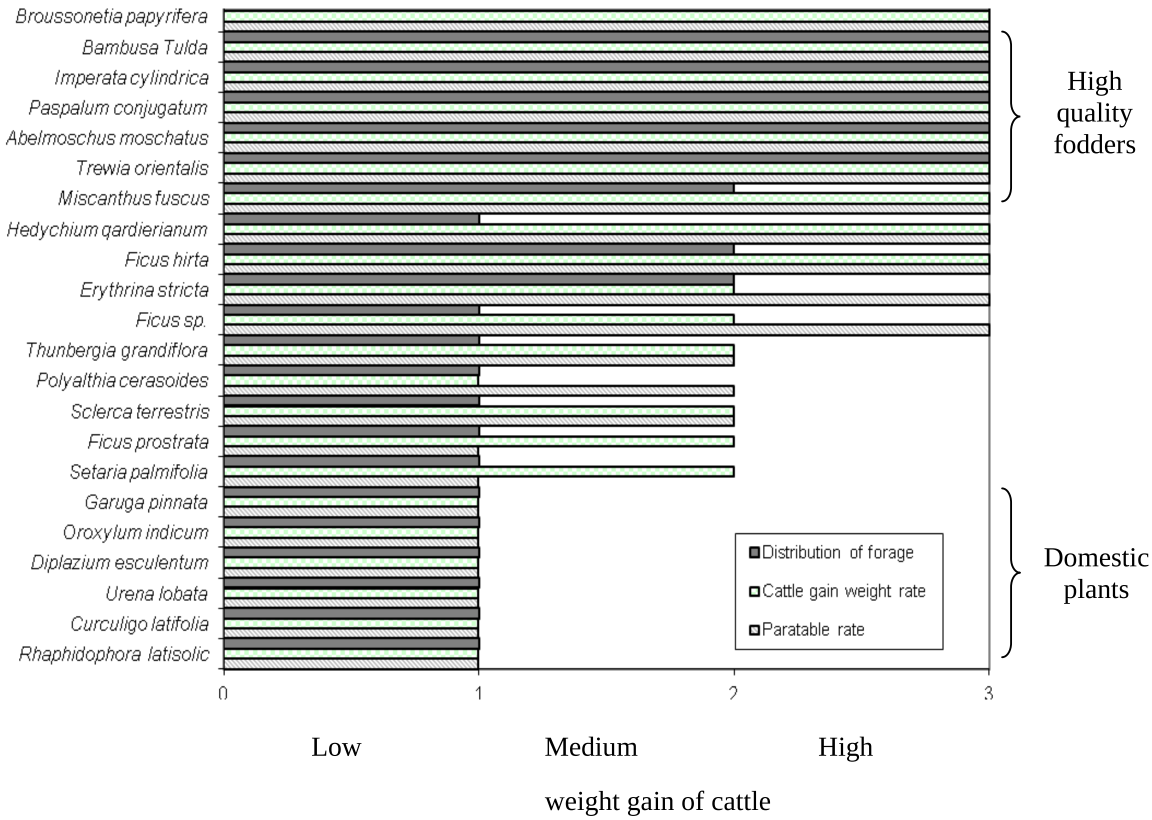
Table 5: List of the main forage species in upland areas of Northern Laos with habitat types and palatability rating by Hmong ethnic group.

Hmong Name	Lao Lum Name	Scientific Name	Habitat	Palatability Rating
Yor	Yha Kad	*Paspalum conjugatum*	P	+++
Kei	Yha Ka	*Imperata cylindrica*	UF, P	+++
Tua jea	Mai Bong	*Bambusa Tulda*	F, UF	+++
In Cha	Yha Kad	*Urena lobata*	P	+
Chur	Pak good	*Diplazium esculentum*	F, S	+
Blong ma	Lin fa	*Oroxylum indicum*	F	+
Jae	Deau pong	*Ficus hirta*	F	+++
Blong jao	Yha kom pang	*Scleria terrestris*	P	++
Jae tao	Unknown	*Polyalthia cerasoides*	S	++
Hua chee	Mak pod	*Garuga pinnata*	F	+
Ma mor lea	Keau sam hang	*Abelmoschus moschatus*	F	+++
Mha song	Keau pead	*Erythrina stricta*	F, UF	+++
Jae lao ter	Por sa	*Broussonetia papyrifera*	F	+++
Jae kong	Mak nod	*Ficus prostrata*	F	+
Pa gua	Keau tam nae	*Thunbergia grandiflora*	F	++
Ya Chee	Unknown	*Setaria palmifolia*	S	+
Tao gao tua	Kham	*Miscanthus fuscus*	F, P	+++
Kao	Kha kom	*Rhaphidophora latisolic*	F, S	+
Blong kai cha	Deau pa	*Curculigo latifolia*	F, S	+
Blong pao la	Deau pa	*Ficus hispida*	F	+
Jer	Kluay	*Hedychium qardnerianum*	S	+++
Dong ma	Por tab	*Trema orientalis*	F,S, UF	+++

Note: F= [Forest], P= [Paddy], UF= [Upland areas], S= [Stream]) and palatability rating (+++ [High], ++ [Medium], +[Low].
Source: Authors' survey in Viengphathana and Thamphakae

Figure 25 shows the most widely used fodder species in Northern Laos, among which *Broussonetia papyrifera, Bambusa tulda, Imperata cylindrica, Paspalum conjugatum, Abelmoschus moschatus* and *Trewia orientalis* are considered as having the highest value. These occur mostly in secondary forests, upland swiddens and fallow plots. Domestic plants, i.e. those found in permanent fields and homegardens, are considered as being of lower nutritional value. The high value of forage plants occurring 'in the wild' or as by-products of traditional swidden cultivation may be one of the reasons why there has been such a low adoption rate of improved forage technologies (STÜR et al., 2002).

Figure 25: Local assessment of fodder values among Hmong farmers in Viengphathana and Thamphakae villages (Laos).

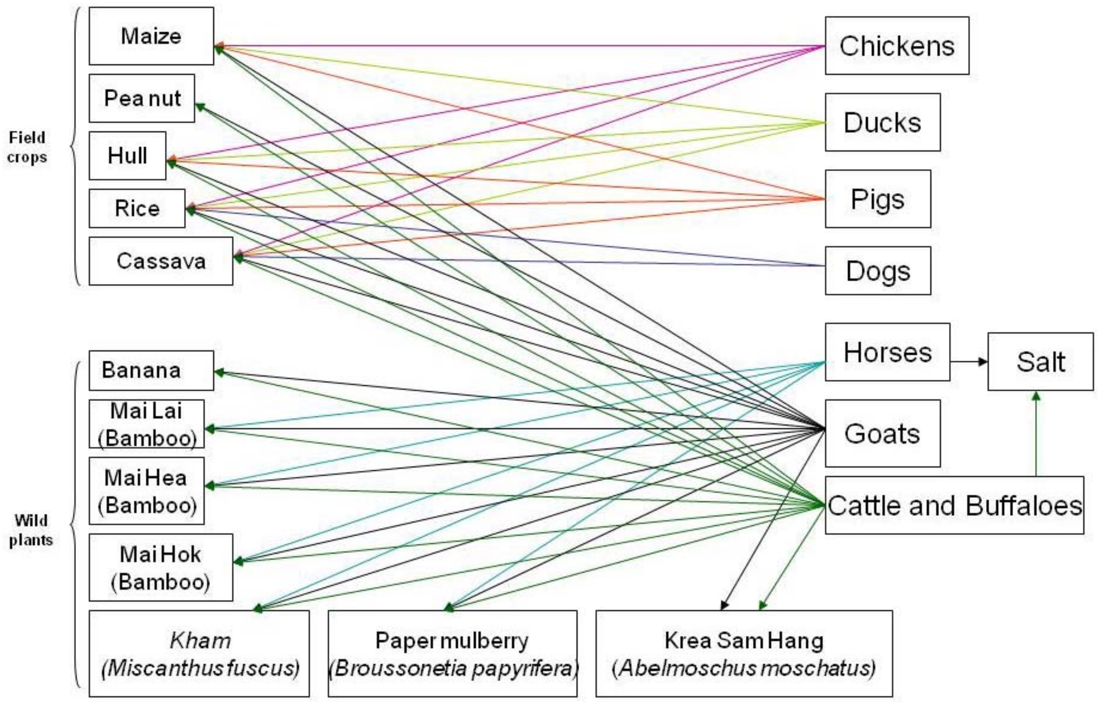


Source: Data obtained by focus group discussions

Table 5 and Figure 25 demonstrate that the Hmong in Laos have a sound local classification system which is reflected in a complex understanding of fodder values, for example enhanced weight gain of cattle through consumption of particular fodder species, such as 'Kham' (*Miscanthus fuscus*), 'Krea Sam Hang' (*Abelmoschus moschatus*) and 'Pai Bong' (*Bambusa tulda*). Simultaneously, they rely on modern production practices, e.g. medicines against parasites and vaccines provided by government veterinary services. Hence, the resource management practices of the Hmong make a combined use of traditional and modern knowledge systems.

Apart from the increasing resource constraints, the limited scope for intensification of traditional large-ruminant systems (e.g. through the introduction of cut-and-carry systems) is also due to the fact that cattle and other domestic animals often have similar preferences for fodder sources, as depicted in Figure 26. If cattle were to be raised permanently in the area around the homestead, this would lead to high competition for feeding and unstable fodder supply.

Figure 26: Local classification of the main forage species associated with domestic animals in the communities in Northern Laos.



Source: Data derived from focus group discussions

5.6 Discussion

Traditional agrosilvopastoral systems continue to make a significant contribution to food security and livelihood opportunities in Southeast Asian uplands. Ethnic minority farmers find that large ruminants are a positive and crucial component of local forest agro-ecosystems, due to their contribution to nutrient cycling, forest fire control, water retention, and leaf-litter dispersal, which partially supports the findings from studies on nutrient cycles and indigenous knowledge of fodder values in silvopastoral systems in Nepal (THAPA et al., 1997; THORNE, TANNER, 2002). However, the contribution of local knowledge in sustaining these highly adaptable systems has been hardly recognized, which raises concerns with regard to the future viability and sustainability of such systems. Similar observations on the discrepancies in appreciating local knowledge, perspectives and practices of agrosilvopastoralists have been noted by a number of scholars in the mid-1980s (e.g. DOVE, 1983 and OLOFSON, 1985)]. Our findings suggest that persistent negative perceptions regarding agrosilvopastoralist systems have prevented policy makers from considering viable strategies to strike a balance between rural livelihood opportunities and national forest conservation objectives.

The governments of Thailand and Laos have adopted markedly different policies for raising cattle in upland areas. In Thailand, strict forest-conservation policies that prevent cattle-raising in watershed areas are constraining ethnic minority highlanders' agrosilvopastoral practices and – when they disregard these policies – result in severe conflicts between local communities and government officials. Conversely, raising cattle in areas with natural and secondary forest vegetation is tolerated and even encouraged by the Lao government, but the indiscriminate expansion of rubber and teak plantations puts increasing pressure on local cattle owners (FRIEDERICHSEN, NEEF, 2010).While tree-based systems are likely to dominate the landscapes of Northern Laos, agrosilvopastoral systems may remain an important livelihood strategy in some communities, particularly in the more remote parts of the region.

At the same time, market demand for meat in Thailand, Laos and other Southeast Asian countries has been growing drastically over the last 20 years and this trend is predicted to continue. There is also renewed interest in meat from local breeds that are raised under more natural or even organic conditions, which may open up new market opportunities for agrosilvopastoralists in Northern Thailand and Northern Laos. Studies in Mexico, for instance, found that traditional silvopastoral systems can be easily transformed into organic meat production systems, due to their integrated nature and low reliance on external inputs (NAHED-TORAL et al., 2013).

Numerous plant species, currently used locally as forage, remain under-utilized and are neglected by research and conservation activities. Exotic forage species that have been promoted by external aid agencies and state-led extension services have not been taken up at the local level. In this context, the knowledge of upland farmers, particularly concerning quality attributes influencing fodder selection, needs to be reconsidered for the development of more suitable evaluation strategies for assessing the nutritive value and palatability of forages. Research by scientists from the Center for International Tropical Agriculture (CIAT) has demonstrated that farmer-developed forage management strategies can contribute to stabilizing swidden cultivation systems by enhancing their sustainable intensification (HORNE, 2007). Further research is required in order to investigate the possibility for potential synergies between scientific and traditional knowledge.

5.7 Conclusion

We conclude that the knowledge gathered and diversity of practices exercised by ethnic minority groups contrasts with the simplified, normative and mostly negative image that government officials and mainstream society tend to construct of traditional agrosilvopastoral systems. Our results suggest that local knowledge can offer alternative and/or complementary explanations on ecological cause-and-effect relationships which may need further scientific analysis, using experiences and methods from diverse perspectives and disciplinary backgrounds. The integration of local knowledge into scientific analysis and policy-making could provide useful resources for achieving sustainable highland agro-ecosystems. Yet, unfortunately, the ethnic minority groups of the region continue to be neglected in major decision-making processes regarding their resource management and are increasingly concerned about the sustainability of their agrosilvopastoral practices. Our findings call for policy action and new research agendas that focus on actively preserving valuable local knowledge through its investigation, documentation and validation.

In Laos, due consideration should be given to the integration of agrosilvopastoral systems into ongoing land and forest allocation processes in the Northern provinces, which have been scrutinized by various scholars for their lack of genuine community participation (FRIEDERICHSEN, NEEF, 2010 and LESTRELIN et al., 2012). This could be done, for instance, in the form of 'community-based forest-livestock concessions' in combination with the allocation of secure communal land rights. In Thailand, community-based land titling programs could be extended to groups of livestock keepers that adhere to commonly agreed standards of 'sustainable forest grazing' practices. Further research could inform and support such policy measures through quantifying the impact of agrosilvopastoral systems on household incomes, food security, resilience to external shocks and provision of ecosystem services.

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6 Income Options for the Poorest of the Poor: The Case of Cardamom in Northern Laos*

6.1 Abstract

This study examines the potential of cardamom for poverty alleviation and sustainable rural development under conditions of increased resource scarcity in the uplands of Northern Laos. Drawing on both qualitative and quantitative fieldwork in Luang Namtha province, the supply chain of cardamom is identified and the socio-economic opportunities for collectors and growers are examined. Rising demand in neighbouring countries, particularly China, provide sound income opportunities for all actors in the cardamom supply chain. Growing improved varieties has become a boon for farmers endowed with relatively large land areas with suitable agro-ecological conditions. However, land-poor and landless collectors of wild cardamom are facing increasing difficulties due to overharvesting, lower prices offered by middlemen, and the rapid conversion of remaining forests into monoculture plantations, especially rubber, which has reduced the natural habitat of cardamom and other non-timber forest products. The major policy implication is that protecting the remaining natural and secondary forests - for instance through making use of evolving international support mechanisms for community-based forest protection, including REDD-plus - will not only be of benefit for biodiversity conservation and climate change mitigation, but would also enhance the livelihoods of the poorest groups in the uplands of Northern Laos.

Keywords: Non-timber forest products, Supply chain, rural livelihoods, Poverty alleviation

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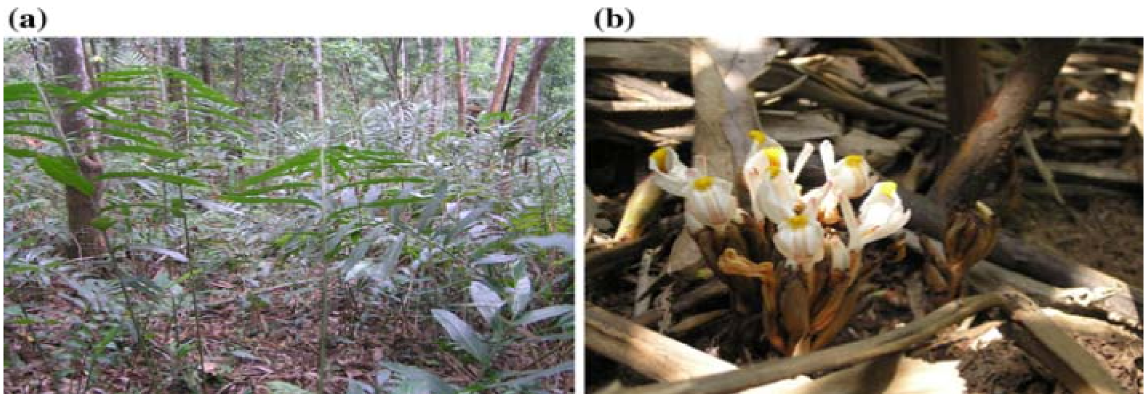
6.2 Introduction

Forests are rich sources of food and income for the upland population of Laos (WFP 2007). Collection and sale of non-timber forest products (NTFPs) accounts for up to 50 % of the annual cash income of upland rural communities in remote areas of Northern Laos (RIGG 2004). These are mostly ethnic minorities who depend on subsistence farming as their livelihood base (SEIDENBERG et al. 2003). NTFPs are particularly important for farmers with low cash incomes who are not specialized in the cultivation of any particular field crop and villagers suffering from seasonal food shortages (NEEF et al. 2010). However, the availability of NTFPs is threatened by over-exploitation and increasing deforestation and landscape degradation (ADB 2001; RAINTREE, SOYDARA 2001). The National Poverty Eradication Program of Laos aims to achieve its objectives by improving basic infrastructure and by relocating highland populations along roads in the midlands and lowlands (LESTRELIN 2010; NEEF et al. 2010; THONGMANIVONG, FUJITA 2006). The creation of these new economic zones is often accompanied by large-scale replacement of forestland and traditional swiddens by rubber and teak which have been aggressively promoted by private investors from neighbouring countries and the Lao government (cf. COHEN 2009; FRIEDERICHSEN, NEEF 2010; Neef et al. 2010; NEWBY et al. 2012). This threatens the livelihood base of many communities that depend on forests as sources for food, medicine, ecological services and incomes. The increasing challenges facing the major actors along NTFP value chains are exemplified in this study by the case of cardamom.

Cardamom (*Amomum spp*.) is one of the world's most expensive spices by weight (BUCKINGHAM, TIEP 2003; TUGAULT-LAFLEUR, TURNER 2009), and is an important component of traditional Chinese medicine (FOPPES, KETPHANH 2000). It is collected from forests and cultivated as a domesticated crop, and is the second biggest agroforestry export product of Laos after coffee. The capsules of cardamom contain essential oils, camphor, acetate, limonene and other esters (KVITVIK 2001; NAFRI 2007). Although the local market for cardamom in Laos is negligible, it has been collected for several centuries from native forests and swidden fallows for export, mainly to China and Thailand. The annual demand for cardamom by the Chinese market is estimated to be about 1,500 tons (AUBERTIN 2004). This demand is increasing and cannot currently be met by collectors and producers of cardamom (NAFRI 2007).

Cardamom is a perennial herb of the Zingiberaceae family, growing throughout Laos in elevations between 500 and 700 m in semi-shaded, moist habitats. The plant can reach a height of 2–3 m (Figure 27a) and develops a thick rootstock from which the inflorescences grow in pairs of white flowers (Figure 27b). In the wild, it is a characteristic element of plant communities in the understory of secondary mixed deciduous and evergreen forests. Two kinds of wild cardamom grow in the forests of Northern Laos. The wild red cardamom *Amomum microcarpum* C. F. Liang and D. Fang (syn. *A. villosum* Lour.) is locally known as maak naeng daeng. Green cardamom *A. ovideum* Pierre is known as maak naeng khiaw. The development of cardamom is favoured by a mean annual temperature between 19 and 22^0 C and annual rainfall between 1,200 and 2,400 mm. Cardamom depends on the availability of forestland and is associated with traditional slash-and-burn agricultural practices with long-rotation fallow periods (AUBERTIN 2004; LIU et al. 2006). In Luang Namtha province, cardamom is mainly marketed as dried capsules (NAFRI 2007), with the first yield occurring 3 years after planting. Weeding is necessary in the first 2 years, before the growth of cardamom starts suppressing weed growth (ZHOU 1993; DUCOURTIEUX et al. 2006).

Figure 27: a) Cardamom plants in the understory of a secondary forest; b) Inflorescence



Two cardamom varieties are grown under cultivation. The most widely grown is maak naeng 'khuang tung' (*A. xanthoides* Wall.), introduced from China in the mid-1990s and found in all three districts where this study took place (AUBERTIN 2004; DUCOURTIEUX et al. 2006; NAFRI 2007). The variety 'khuang tung' is cultivated on plots at the edges of forests that also contain wild cardamom populations. Another variety, known locally as maak naeng 'pak song', has only been cultivated since 2007. This variety grows in upland fields and does not require 50 % shade like the improved variety 'khuang tung' or the local varieties. There is no literature record to date on the cultivation of the 'pak song' variety. According to NAFRI (2007), a family is able to harvest on average 108 kg of fresh wild cardamom (corresponding to about 20 kg of dried cardamom) annually, with each family member collecting about 5 kg per day during the very short harvest period of only a few days in July or August.

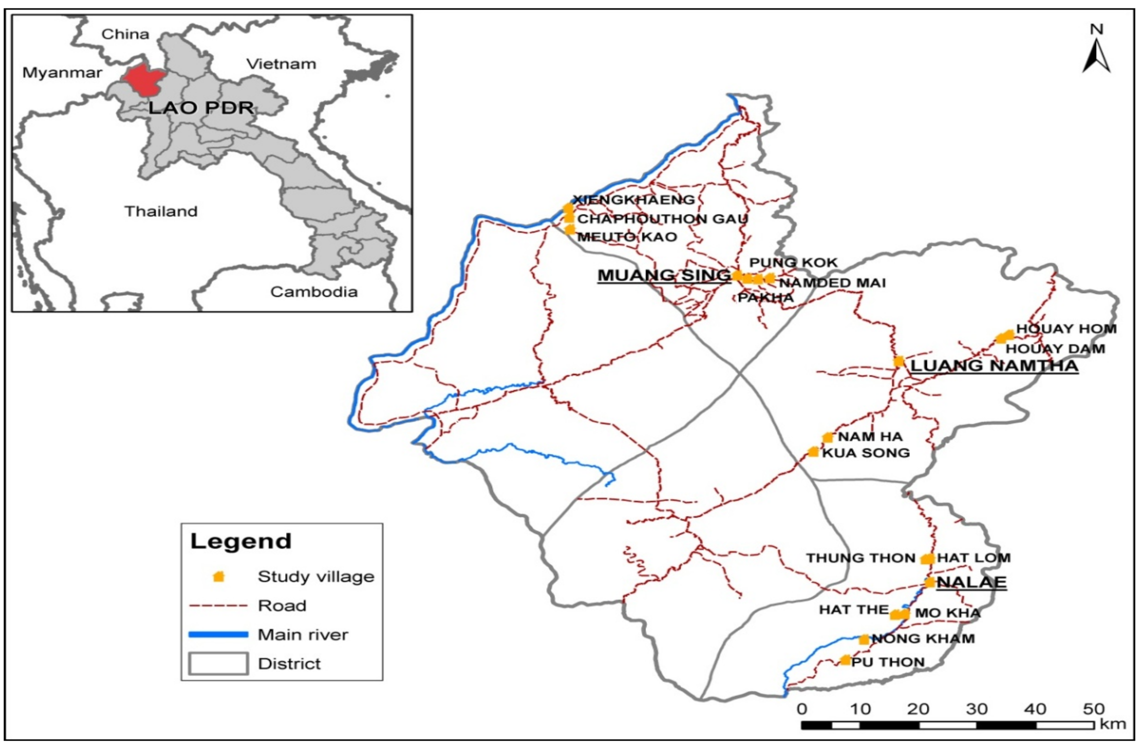
Since cardamom is produced nearly exclusively for export, and consumers demand high product quality and integrity, an integrated supply chain management from farm to retail outlet is necessary (WHEATLEY et al. 2004). Hence, the main objectives of this paper are to identify all steps in the existing supply chain of cardamom and its value as an income source and to evaluate whether promotion of this crop can improve the economic situation of rural populations, especially the poorest groups. The next section describes the study area and the research methods for data collection and analysis. The research results are then presented, with a focus on the economic characteristics of collection versus cultivation of cardamom, analysis of the supply chain and distribution of benefits among the various stakeholders. The potential of the cardamom business in Northern Laos for alleviating poverty is then examined, and policy implycations and avenues for further research are discussed.

6.3 Study Area and Research Methodology

6.3.1 Characteristics of the Study Area

The study area is the Northern Province Luang Namtha, one of the poorest regions in Laos and home to one of the most ethnically diverse populations of Southeast Asia (Figure 28). At least 11 from the 47 ethnic groups of Laos live in the region and are classified according to their language families into Lao Tai, Mon-Khmer, Chinese-Tibetan and Hmong-Mien. They have long been engaged in swidden cultivation of upland rice and other cash crops including maize, peanuts, cassava, ginger and soybeans. In an attempt to phase out swidden cultivation, the provincial government has actively promoted industrial tree plantations including teak, eucalyptus and rubber for several years.

Figure 28: Map of the research area.



Source; Prepared by ELSTNER (2009)

The location of Luang Namtha favours ground transportation of cardamom to China, a market which absorbs most of the harvested produce. This transport takes place either by road or by boat, the province being partly located along the eastern bank of the Mekong River which forms the natural border of Laos with Myanmar in the west. Fieldwork for this study was conducted from March to May 2008 in 18 villages in three of the five administrative districts of the province: Muang Sing, Luang Namtha and Nalae. Research sites were selected on the basis of available information at the district offices, from a German-Lao development project and from local informants who knew about the involvement of village communities in the cardamom enterprise. Additional criteria were accessibility of the villages and ethnicity. The Thai Lue (6 villages) are among the politically and economically most dominant ethnic groups in the province, having occupied the more favourite lowland locations with good access to roads and other infrastructure. The Akha (5 villages) are at a lower scale of the ethnic hierarchy and tended to be economically marginalized in the past, but have recently benefitted from their transboundary social networks and increased cross-border economic exchange, e.g. by selling sugarcane and - most recently - rubber to Chinese traders (cf. STURGEON 2010). The indigenous Khmu (7 villages) are the most marginalized ethnic group in the province and have been most adversely affected by relocation from upland forest areas and the government policy of eradicating swidden cultivation (cf. FRIEDERICHSEN, NEEF 2010; YOKOYAMA 2010).

6.3.2 Research Methods and Concepts

Qualitative data were collected by means of semi-structured interviews with 36 individual growers, 32 collectors and seven traders of cardamom as well as two representatives of export companies and three government officials involved in various steps of the supply chain. Respondents were selected purposively through chain or snowball sampling. Additional information was sought through focus group discussions after the household surveys. Group discussions were usually composed of 4–8 key informants and encompassed traders, growers and collectors to provide a rich and detailed picture of the various key actors and activities along the value chain. Various interactive methods with visualizing tools, such as cropping calendars and timelines known from Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA), were applied in the group discussions. The sessions were facilitated by research assistants and moderated by the first author who is fluent in the Lao language without being part of the local setting. Session records were analyzed based on the salience of the issues discussed.

Data obtained from qualitative methods were complemented by quantitative data on the incomes and economic status of collectors and growers. The combination of the two types of data generates a broad understanding of the importance of cardamom as a cash crop and as a potentially viable income source for the poor. The supply chain of cardamom was mapped using the value-link methodology described by SPRINGER-HEINZE (2007). This allows visualization and description of the flow of cardamom from raw material to the end product. It also illustrates the main processes in place, including business operations (production, packing, domestic trade, and export) as well as the operators (producers, collectors, traders, middlemen) and the relationships between them. For statistical analysis, cardamom suppliers, i.e. producers and collectors, were grouped on a cash income basis. To determine the dependence of the groups on the sale of cardamom, a one-way analysis of variance (ANOVA) was conducted using SAS9.2. The least significant difference (LSD) was used for pair wise comparison of means, at the 5 % significance level.

Poverty is used in our study as a relative concept, based primarily on the level of resource endowment and cash income. The subsistence economy in Northern Laos is difficult to capture in one-shot interviews since local people do not keep records on yields of staple crops (e.g. upland rice) and their home consumption. The scope of the study also did not allow considering an endogenous or emic perspective on poverty, and we believe that such a perspective may also have entailed differences between the villages, making comparisons across the sample difficult.

6.4 Results

6.4.1 Status of the Cardamom Enterprise in Northern Laos

The major share of cardamom produced as a cash crop in the study region is traded as dried capsules (Figure 29). Marketing of the fresh produce prevents loss of weight per volume which occurs during the drying process. However, the perishable nature of the capsules allows trading of fresh material only in places with good road access. Irrespective of the cardamom variety traded, cardamom is brought to the market by motorbikes, cars, trucks or boat.

Figure 29: Dried capsules of cardamom

Cardamom is usually harvested in the rainy season, when the moist climate makes it difficult for producers and collectors to comply with the quality requirements specified by traders. High quality cardamom capsules should be low in moisture content, clean and intact (NAFRI 2007). Traders check for high quality simply by pressing the fruits with their fingers. Another crude method for assessing the moisture content is placing one arm down a full sack of cardamom capsules. If the trader’s hand is dry after removing it from the sack, then the product is dry enough to meet the quality standards. Suppliers were not fully aware of the properties of the crop that need to be preserved during and after harvesting or the quality requirements, because there is little local use[4] of cardamom. The lack of attention paid to quality improvement is in line with the findings of other researchers for the case of cardamom (AUBERTIN 2004; DUCOURTIEUX et al. 2006) and for other NTFPs (e.g. NEEF et al. (2010) for the case of paper mulberry) and may be due to a lack of marketing extension, since NTFPs tend to be neglected by Lao government agencies.

6.4.2 Collection from the Wild Versus Cultivation of Improved Varieties

As indicated in Table 6 some cardamom enterprise activities vary between villages. In most places, people who cultivate cardamom also collect it from the wild. In the three Khmu study villages of Nalae district, only collection is practised, although people in one of the villages are also involved in the trade of cardamom.

Table 6: Activities in the cardamom enterprise in the study villages

District	Village	Collection	Cultivation	Trade
Muang Sing	Namded Mai	x	x	
	Pakha		x	
	Pung Kok		x	
	Chaputon Gau	x	x	x
	Xiengkhaeng	x	x	x
	Meuto Kao	x	x	
Nalae	Thung Thon	x		
	Hat Lom	x	a	
	Hat The	x	x	
	Mo Kah	x		x
	Nalae			x
	Nong Kham			x
	Nalae village			x
	Pu Thon	x		
Luang Namtha	Kua Song	x	x	
	Nam Ha	x	x	
	Houay Dam	x	x	
	Houay Hom	x	x	x

x: This activity was carried out in this village;
a: Cultivation was abandoned due to low productivity

[4] Only in one village, a cardamom capsule was found in an alcoholic beverage. None of the respondents in the interviews stated that cardamom was used locally. This corresponds with the findings of YOKOYAMA (2004) in his study of various NTFPs (including cardamom) in Luang Prabang province.

In Hat The, a Thai Lue village, a higher share of income is generated by the sale of wild cardamom. In three of the Thai Lue villages people only concentrate on trading cardamom and other NTFPs without being involved in the production or collection of cardamom. These findings reflect the commercial dominance of the Thai Lue people in this province. Adoption of cultivation of improved varieties is strongly influenced by the availability of suitable plantation sites that provide adequate growing conditions for cardamom, namely moist areas near streams and forest edges. During and after harvesting, capsules of wild and cultivated cardamom are usually mixed together and sold after drying. Only farmers of the pak song variety reported they could sell the capsules in a fresh form.

Table 7: Key differences between wild and domesticated cardamom

Feature	Collected from the wild	Cultivated as domesticated crop
Ecology	Collection areas often distant from the village. Access to the collection sites is time-consuming	Plantations are usually nearby or within walking distance to the village
	Wild varieties produce smaller capsules	Improved varieties produce larger capsules, leading to higher yields in smaller plots
	Individual plants distributed over large forest areas	High planting densities generate higher yields
	Dependency on the availability of forest land, which is in decline in Laos	Plantations within production forests
Resource tenure	Undefined tenure rights in collection areas lead to increased competition and premature harvesting	Only the owner of the plot has harvesting rights
Production volumes	Annual fluctuation in harvested amounts	Production volumes are predictable, depending on the season
Market forces	Lower prices paid by traders	Higher prices paid by traders for improved varieties

Both wild cardamom and the improved varieties introduced from China are purchased by the same network of traders and middlemen.[5] Farmers who sell unadulterated cultivated cardamom can obtain higher prices compared to those that mix cultivated

[5] The use of the term "middlemen" here and throughout the paper is deliberate, since we did not encounter any female market intermediaries for the cardamom trade during our field survey. This contrasts with the study of WALKER (1999) who found a strong role of women traders in long-distance commodity trade (cf. YOKOYAMA 2010).

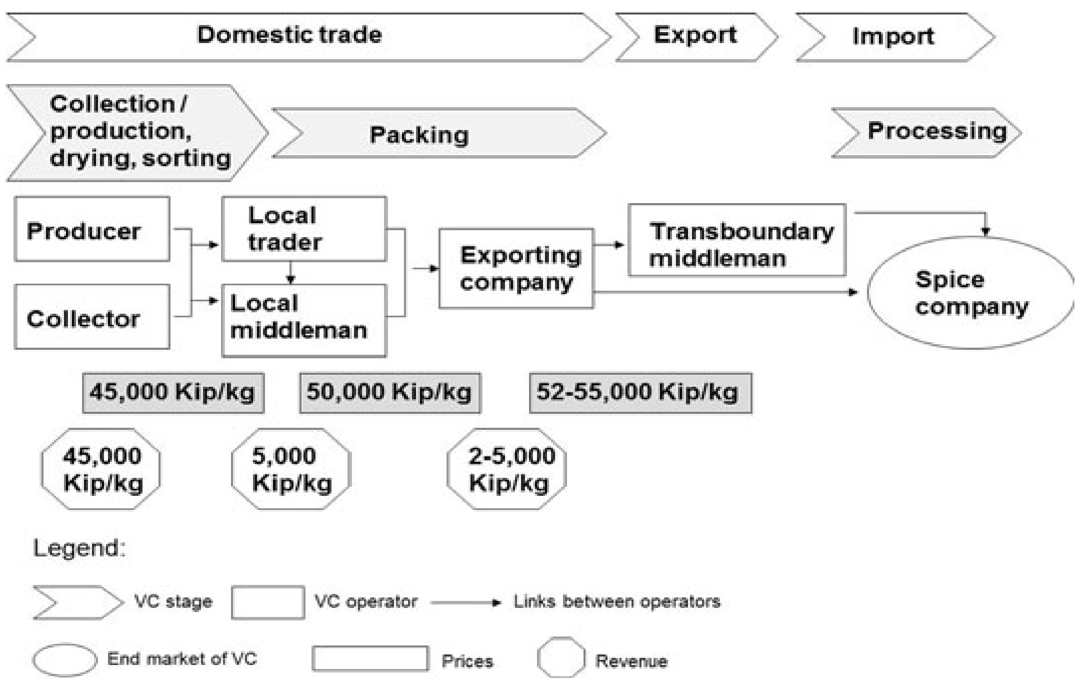
with wild yields, inducing a shift of farmers' preference towards the improved varieties. In the plantations visited during this study, only improved varieties are currently in cultivation and mostly the 'khuang tung' variety. No evidence was found of continuing domestication of wild varieties growing in the local forests.

Both advantages and disadvantages can be observed for the harvesting and trading of wild versus cultivated cardamom (Table 7). Improved varieties growing on plots that are closer to villages have higher yields, and production volumes are more predictable. This allows individual farmers to agree with traders on the amounts to be delivered, by means of contract farming. Cultivation of cardamom is more profitable than collection from the wild and provides exclusive ownership and use rights.

6.4.3 Major Stakeholders Involved in the Cardamom Enterprise

The supply chain of cardamom in Northern Laos involves seven groups of stakeholders. Figure 30 depicts the various steps and activities during the product flow from production to processing. The potentials and vulnerabilities encountered in each step of the supply chain are explained in this section.

Figure 30: Sub-sector map of cardamom in Northern Lao PDR



(Prices based on 2007 data). VC value chain; kip = Lao local currency.

Source; Adapted from SPRINGER-HEINZE (2007)

6.4.4 Sources of Improved Planting Material

Recently, development agencies and non-governmental organizations have distributed seedlings of the improved variety 'khuang tung'. However, no nurseries have been established in the target villages to date, except for one near the provincial centre Luang Namtha. Therefore, access to high-quality seedlings is presently not ensured for farmers. Local farmers who are already growing improved cardamom varieties could be sources of seedling stock for farmers wishing to start new plantations for enhancing their incomes.

6.4.4.1 Collectors of Wild Cardamom

Wild cardamom is collected in forest areas surrounding the villages in an expanse of 15–200 ha. The walk to wild populations can take up to 2 h. Everyone is permitted to collect NTFPs for own use or sale and, in most cases, the entire family goes to the forest to gather wild cardamom in order to ensure a maximum share of the benefits from this increasingly scarce plant. The classification of forests into protection, conservation and production zones is determined by the Forest Law (DOIN 2007), but not always recognized by the rural population. Villagers often classify the collection sites simply as 'forest'. Since property and use rights in the collection areas are not clarified, people from different villages harvest repeatedly at the same known locations. This increases competition over the resource, leading to overharvesting or harvesting of immature capsules that do not meet the desired quality.[6]

6.4.4.2 Producers of Cardamom Cultivars

Producers cultivate cardamom in plots at forest edges with an average size of 0.3 ha per family. These plots are usually located within a walking distance of up to 30 min from the village. Land owners are the only ones allowed to plant, harvest and sell the cardamom.[7] Unlike maize and rice, cardamom is easy to handle, does not need external inputs and requires little labour, as also reported from Northern Vietnam (TUGAULT-LAFLEUR, TURNER 2009). In the case of the 'khuang tung' variety which can be cultivated in plots inside the forest, there are additional benefits stemming from the preservation of forest land, namely conservation of biodiversity, and maintenance of soil structure and fertility.

Various problems before and after harvesting were reported by growers. While the plants are not susceptible to insects, yield losses sometimes occur due to rodents feeding on the ripe capsules. Further, because the cultivation areas are not fenced, young plants are in danger of trampling and browsing by cattle and buffaloes which are allowed to graze inside the forest. Losses also occur due to poor post-harvest handling. As cardamom is harvested during the rainy season, where sunny periods are

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[6] NEEF et al. (2010) found for the case of naturally occurring paper mulberry in Bokeo province that regulations concerning harvesting rights evolved as a consequence of increasing resource scarcity and competition. However, we could not identify any emerging common property rules for collection of wild cardamom in our study villages.

[7] Since cardamom is a perennial crop, tenants or landless people are not allowed to grow it, as this could lead to a claim of land ownership rights.

usually short and do not suffice to adequately sun-dry the capsules, it is susceptible to mould. Hence, the fruits are often placed on trays over open fires inside the houses to accelerate drying, which reduce product quality.

For the poorest groups in the communities, i.e. landless and land-poor households, shifting from collection to cultivation of cardamom is constrained by lack of land. Yet even for owners of large land areas the expansion of cardamom cultivation is difficult, mainly due to limited availability of shaded, moist habitats suitable for the establishment of plantations inside the forests. This is exacerbated by the fact that the nationnal government and private investors from neighbouring countries - particularly China - are aggressively promoting rubber plantation monocultures,[8] which are known for inducing widespread deforestation (COHEN 2009; FRIEDERICHSEN, NEEF 2010; NEEF et al. 2010). Furthermore, due to high transaction costs linked to poor infrastructure, farmers do not have access to information about demand and prices in the cardamom market.

6.4.4.3 Local Traders and Middlemen

Local traders live in the villages where collection and/or production occur and, in most cases, they also collect or produce cardamom. They buy dried cardamom from villages in their vicinity, often together with other NTFPs such as incense bark, broom grass, bamboo shoots and the rhizomes of galangal (*Alpinia galanga* Willd.), depending on demand and seasonal availability. The produce is then sold to one or more Laotian or Chinese middlemen. Because the harvested cardamom is mainly destined for export to China, Chinese middlemen usually offer higher prices for the purchased amounts.

Middlemen operate in larger villages or district centres. They have better access to infrastructure for transport and trading, either by road or river, in contrast to collectors and producers in villages which are connected only by unsealed roads or roads under construction. In general, middlemen are not involved in collection or in cultivation of cardamom, but buy and sell cardamom together with other NTFPs which follow similar marketing patterns. Cardamom is then sold to exporters or other traders who are based in the district centre Muang Sing or the provincial centre Luang Namtha.

Fees and taxes have to be paid in the various steps of the supply chain, since cardamom is produced only for exports. In most cases, collectors and producers who sell to local traders in their villages do not have to pay any fees or taxes, because the trade is informal, and amounts are generally not registered. Traders who sell cardamom to local middlemen within the same district also escape having to pay fees and taxes.

[8] Rubber was first introduced to Luang Namtha province by Hmong refugees from China in Hadyao village in the mid-1990 s (cf. MANIVONG, CRAMB 2008; COHEN 2009). Rapidly growing demand in China in conjunction with the search of Laotian officials for permanent alternatives to swidden farming and opium poppy cultivation has induced a rubber boom since the early 2000s that has dramatically transformed the rural landscapes and reshaped livelihoods of ethnic minority people northern Laos (THONGMANIVONG et al. 2009; FRIEDERICHSEN, NEEF 2010).

Dues have to be paid only when the produce crosses district and provincial boundaries or the national border. Local middlemen report that for the transport of one ton of cardamom from Nalae to the provincial capital Luang Namtha, a fee of 2,000–3,000 Kip/kg has to be paid to the customs in Nalae. A 5 % general tax, a 10 % income tax and a fixed fee of US$ 1 per ton has to be paid by exporters when the product crosses the national border.

6.4.4.4 Exporters, Industry and Final Markets

The final actors in the domestic part of the supply chain are local and Chinese export companies, which are based in the provincial centre Luang Namtha. In the last decade, they have marketed various NTFPs - including cardamom, incense bark, orchids, galangal and sugar-palm fruit - to China, Thailand, Vietnam and Korea. These companies have established a network of trading units in various villages in the Northern districts, where local middlemen and traders store the cardamom harvest every year. During the harvesting season, sales agents visit the trading units, collect the cardamom and bring it to the companies' headquarters in Luang Namtha, where the produce is collected by transboundary middlemen and then sold to spice companies in various countries.

Transboundary middlemen contact the export companies before the harvesting season to negotiate the desired amounts and fix the price. They receive advance payment of 40 % from the export companies, the balance to be paid upon delivery of the agreed amount. Subsequently, the sales agent of the export companies visit the collection and production villages and offer the price they are willing to pay per kg. Transboundary middlemen and sales agents from the spice companies collect the cardamom from Luang Namtha and transport it across the border into China by truck. This trading structure is well developed and contacts between the various levels of the supply chain are established, although details were not disclosed to the research team. Last in the supply chain are spice companies, but exporters interviewed in this study did not disclose the amounts traded or the names and locations of the final destination. Exports to Thailand, Korea and Vietnam are also difficult to track.

6.5 Evaluation of the Supply Chain

6.5.1 Stakeholders' Perceptions

There are various factors that influence the views on cardamom as a cash crop, as well as the activities of the various stakeholders involved in its supply chain. In general, the involved groups of actors assign positive attributes to cardamom as an enterprise (Table 8). They state that it is an easy crop to handle, without major production and marketing risks and generating profit at all levels of the supply chain.

Table 8: Evaluation of the cardamom business by the three main stakeholder groups

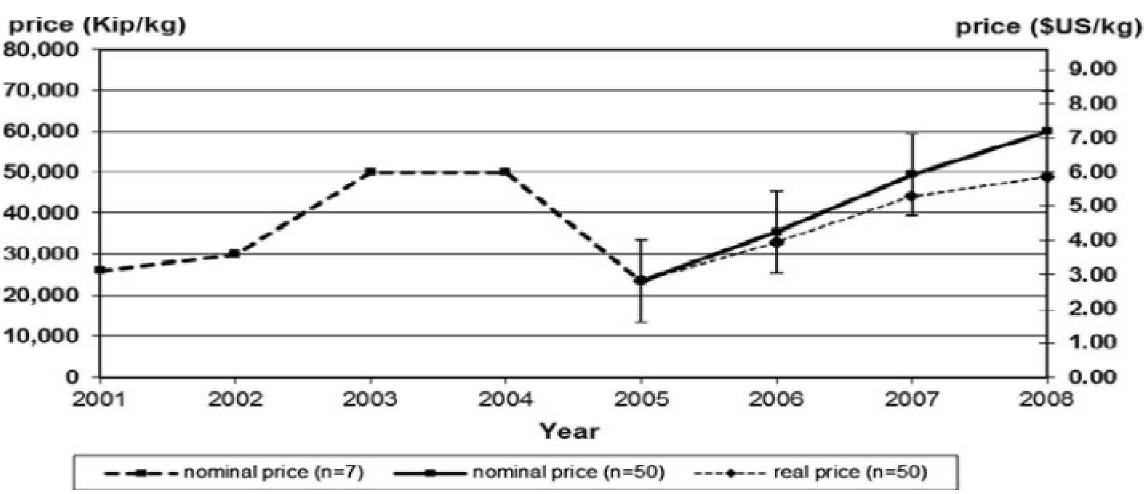
Feature	Collectors	Producers	Traders
Costs		Low investment costs (ca. 1000 Kip per seedling).Access to planting material is ensured	
Labour	No need for re-planting. Harvest in the season where labour is available.	Low labour demand. No weeding and fertilization needed.	Easy handling of the product (acquired from villagers or middlemen).
	The entire family can involve in collection from the wild.	Harvesting between rice planting and harvest (labour is abundant)	High value per weight compared to other crops.
Inputs	The crop is growing as a natural resource inside protected forests.	Plantations expand after initial planting and can be harvested for up to 40 years. No re-planting is required, nor further inputs after initial investment.	Acquired from villages together with other crops and NTFPs

6.5.2 Market Demand

High demand, which exceeds current supply, is the main driver for adoption of cardamom production. Accordingly, prices have trended upwards in recent years, particularly due to rising demand in the Chinese market (Figure 31).

Table 9 presents the prices achieved through sales of dried cardamom in the research villages of the three districts studied.

Figure 31: Trends of farm-gate price development for cardamom from 2001–2008.



Note: Dotted line 2001–2005: n = 7, 2005–2008: n = 50). Real prices on the basis of 2005 reflect the inflation rate of 2006: 6.81 %; 2007: 4.51 % (Bank of the Lao PDR 2007) and 2008: 8.6 (CIA 2009). Influences due to price fluctuations within the season and price differences between varieties marketed are not considered. Exchange rate: 1 US-$ = 8,719.60 Lao kip; n refers to the number of observations are influenced by the location of the collection/production villages and their connection to the national road network.

Table 9: Prices paid by traders to producers and collectors of dried cardamom (2008)

Type of supplier	Village	Ethnic group	Price(Kip/kg)	District
Producers	Chaputon Gau	Akha	72,000	Muang Sing
	Pung Kok	Akha	70,000	
	Meuto Kao	Akha	65,000	
	Namded Mai	Akha	60,000	
	Pakha	Akha	60,000	
	Xiengkhaeng	Thai Lue	58,000	
	Nam Ha	Khmu	50,000	Luang Namtha
	Houay Hom	Khmu	40,000	
Collectors	Thung Thon	Khmu	40,000	Nalae
	Hat The	Thai Lue	40,000	
	Hat Lom	Thai Lue	35,000	
	Mo Kah	Khmu	30,000	

6.5.3 Access to Markets and Infrastructure

Since the mid-2000s, local transportation of commodities in Northern Laos has been enhanced by the creation of the Greater Mekong Sub-region's economic corridor, particularly the North-South corridor, linking Northern Thailand with Yunnan province in south-western China. As a consequence, the volume and speed of exports of NTFPs has been increasing (THONGMANIVONG, FUJITA 2006). Marked price differences for Cardamom were observed in the three districts. The highest prices were paid in Muang Sing, which is closest to China, indicating that proximity to the country of export is influencing the price positively. Little cardamom is collected from the wild in this district, and most sales refer to improved cultivated varieties.

The lowest prices for cardamom are offered in the remote Nalae district. Most of the cardamom marketed from this district comes from the wild. It is located farther away from China, making access by traders more difficult, consequently raising transportation costs. However, new roads are under construction in this district, and the new infrastructure will open more marketing channels to Thailand via Bokeo province. Provided that there is demand in Thailand, as reported by YOKOYAMA (2010), a new marketing infrastructure could be developed, involving traders other than the ones engaged with exports to China.

6.6 Beneficiaries of the Cardamom Enterprise

6.6.1 Contribution of Cardamom to Household Income

Sales of surplus upland rice and major cash crops, livestock and a variety of NTFPs form the income base of the rural communities in Northern Laos (Table 11). These sources usually vary between villages but not within villages.

Producers and collectors were divided into quartiles based on their cash income. Analysis of the income quartiles revealed the groups that benefitted most from the sale of cardamom and the percentage of their income earned from it. The highest and lowest quartiles of both groups are indicated in Table 10. Findings suggest that relatively lower incomes correlate with collection of cardamom from the wild.

One-way analysis of variance (ANOVA) determined the dependence of the income groups on direct sales of cardamom. Annual revenues were compared to those generated by the sale of other products, in order to evaluate the percentage contribution of cardamom to the annual income for year 2008 (Figure 32). The highest share of cardamom in total cash income is found among both producers and collectors of the lower income quartile. No statistical differences could be observed between producers in the high and low income class. High income producers depend to a lower share on cardamom than the high income collectors. Low income collectors obtain a significantly higher percentage of their income from cardamom than the other income classes ($p = 0.05$).

6.6.2 Benefits in Areas Where Cultivation of Cardamom Predominates

To determine the importance of cultivated cardamom for income generation compared to other income sources, two fairly dissimilar villages in terms of wealth were chosen, Pung Kok (Muang Sing district) and Kua Song (Luang Namtha district). The average household cash income and its sources are depicted in Table 12.

Pung Kok ranks the highest in average household income out of the producing villages. In this relatively wealthy village, cash income sources are less diverse and people rely only on the sale of cash crops, including cardamom, as well as the sale of livestock. The highest share of income is generated by the sale of sugarcane, followed by large ruminants (buffalo/cattle) and rice. Cardamom contributes only about 8 % of the total annual cash income.

Kua Song is one of the producing villages with the lowest income. In this village, household income is generated from a wider diversity of sources. Cardamom accounts for about 14 % of the total income, approximately the same as wild broom grass, while tree bark and galangal together contribute about 8 %. Hence, the collection and sale of NTFPs contributes more than one third of the annual income, with the remainder generated by the sale of livestock including pigs and large ruminants. While the relative share of income generated by cardamom in Pung Kok is lower than in Kua Song, in absolute terms it is more than three times as high.

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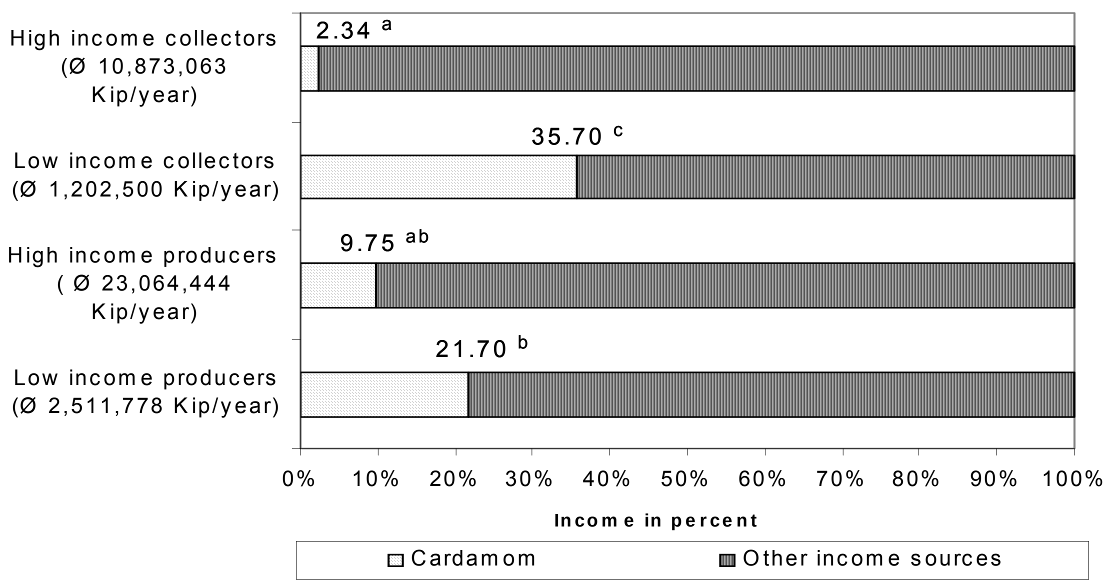
Table 10: Highest and lowest cash income quartiles, cash income range and average cash incomes in the research sites (collectors: n = 32, producers: n = 36)

Type of supplier		**Cash income range** (in 1,000 Kip/year)	**Cash average** (in 1,000Kip/year)	**Group average** (in US-$/year)
Collectors	High income	6,000 – 22,000	10,873	1,304
	Low income	< 2,000	1,203	144
Producers	High income	15,000– 30,000	23,064	2,765
	Low income	< 4,000	2,512	301

Exchange rate: 1 US-$ = 8,719.60 Lao kip

Figure 32: Share of total cash income (in %) from cardamom sales in 2008 for producers and collectors, distributed over income quartiles (producers: n = 36, collectors: n = 31).



Note: Numbers above the bars indicate the outcome of the statistical analysis. Letters indicate statistical differences, and values followed by the same letter are not significantly different at p = 0.05; Ø = average for this group

Table 11: Cash income sources in villages where cultivation of cardamom and collection from the wild occurs

	Village	Upland rice	Sugar cane	Maize	Pigs	Cattle	Poul-try	Other	Galan-gal	Tree bark	Rattan	Bam-boo	Broom grass	Carda-mom
Produ-cers	Pung Kok (*n*=10)	x	x				x	x						x
	Chaputhon Gau (*n*=1)	x			x	x				x				x
	Xiangkhaen (*n*=4)	x			x	x							x	x
	Meuto Kao (*n*=2)				x	x	x			x			x	x
	Kua Song (*n*=2)				x		x	x	x	x			x	x
	Nam Ha (*n*=7)			x		x			x	x	x		x	x
	Houay Dam (*n*=2)			x	x	x	x	x		x		x	x	x
	Houay Hom (*n*=5)			x	x	x		x		x		x	x	x
Collec-tors	Thung Thon (*n*=5)	x		x	x	x		x		x				x
	Hat Lom (*n*=8)			x	x	x	x	x		x			x	x
	Hat Teh (*n*=6)	x		x	x		x	x		x			x	x
	Mo Kah (*n*=8)	X		X	x		X	x		x			x	x

Note: No data are available for the income generated from rubber, since plantations were just being established at the time of research.
x:Provides cash income for most households in the village

6.6.3 Benefits in Areas Where Cardamom is Mainly Collected from the Wild

Income sources and distribution in villages where cardamom is collected from the wild, mainly located in Nalae district (Table 13), differ substantially from the cardamom-cultivating villages. Hat Lom is one of the richest villages where collection from the wild occurs. Sales of cardamom collected in this village contribute less than 1 % to overall income, compared to other income sources including raising buffaloes

Mo Kah, by contrast, ranks among the poorest villages where collection of cardamom occurs. In this village, household incomes stem predominantly from sales of pigs and rice, while cardamom accounts for about 9 %, more than 10 times as high as the share in Hat Lom.

In summary, Tables 12 and 13 suggest that poorer households and communities tend to rely more on the cardamom business for sustaining their livelihoods than the more affluent ones.

Table 12: Share of cardamom in the annual household cash income for 2008 in two villages that cultivate the crop

Type of commodity	Pung Kok (Akha; n=10) average household income		Kua Song (Khmu; n=6) average household income	
	in1,000 Kip	in %	in 1,000 Kip	in %
Upland rice	4,120	13.6	0	0.0
Sugarcane	13,637	44.9	0	0.0
Pig	1,966	6.5	643	12.9
Buffalo/cattle	7,800	25.7	625	12.5
Poultry	120	0.4	367	7.3
Galangal	0	0.0	313	6.3
Tree bark	0	0.0	100	2.0
Broom grass	0	0.0	683	13.7
Cardamom	2,462	8.1	697	14.0
Others	258	0.8	1,560	31.3
Total	30,364	100.0	4,988	100.0

Table 13: Share of cardamom in annual household cash income for 2008 in two villages that collect cardamom from the wild

Type of commodity	Hat Lom (Thai Lue; n=8) average household income		Mo Kah (Khmu; n=8) average household income	
	in 1,000Kip	in %	in 1,000Kip	in %
Upland rice	0	0.0	638	11.3
Maize	3,957	29.2	294	5.2
Pig	2,000	14.8	700	12.5
Buffalo/cattle	5,220	38.5	0	0.0
Poultry	600	4.4	200	3.6
Tree bark	169	1.2	213	3.8
Broom grass	50	0.4	85	1.5
Cardamom	86	0.6	491	8.7
Others	1,475	10.9	3,000	53.4
Total	13,557	100.0	5,621	100.0

6.7 Conclusions and Policy Implications

6.7.1 Potentials of the Cardamom Enterprise

Cardamom presents an interesting case with potential to enhance rural livelihoods and promote sustainable land use in upland areas of Northern Laos. It delivers high annual yields and is an important income supplement for rural households. Moreover, cardamom production enhances the temporal diversification of income generation, since harvesting occurs before that of rice and maize, thus balancing the labour requirements for rural families. Existing market channels are well-developed and -coupled with continuing improvements in transportation infrastructure - can open up new opportunities through trade for exports.

Cultivation of cardamom can be an option for rural people with land rights and an overall financial ability to bear the necessary investment costs, namely for seedlings and labour. Traditionally, collection from the wild has been a more viable option for the poorer parts of the rural populations that do not have access to land and capital. Yet with the on-going depletion of wild cardamom populations as a consequence of the expansion of rubber and teak plantations, this opportunity is rapidly diminishing. Shifting from collection to cultivation of cardamom could be a solution that delivers incomes when collection from the wild becomes impossible. In doing so, farmers need to consider their land endowment and the labour capacity of their families, as well as the fact that different varieties of cardamom have different agro-ecological requirements.

6.7.2 Policy Implications

Present tenure policy interferes with the life-cycle and the ecology of wild cardamom (AUBERTIN 2004). The central government allocates three land parcels per family for rainfed or dry rice, resulting in shorter fallow periods. This policy conflicts with the traditional rotation spanning over 15 years and leaving land in every stage of succession. This practice favoured spontaneous growth of wild cardamom, which normally requires at least 5 or 6 years for reaching moderate populations in fallows (YOKOYAMA 2004; NEEF et al. 2010). Moreover, many forests with wild cardamom populations are conservation zones which limit collection of NTFPs. Therefore, current allocation policies and forest zoning, coupled with interferences with the lifecycle of cardamom induce a decline of its agroecosystems. This puts at stake the potential for generating additional incomes for collectors, who are usually the poorest groups in the study area.

Vigorous promotion of rubber monocultures leads to large scale deforestation and habitat loss. Inevitably, this results in degradation of wild plant resources that are important for own use and commercial purposes. As this resource depletes further, the possibility to collect and sell cardamom - contributing up to a fifth of the total cash income in some communities in Nalae district - will also decrease. Continuation of this trend puts at stake an important base for the livelihoods of communities, especially in isolated mountain areas.

Conservation policies that protect forestland and biodiversity in the long term are imperative for maintaining the few remaining secondary mountain forests which provide moist and shaded habitats for the growth of cardamom. This is particularly relevant for watershed forests at higher elevations which conserve water resources amongst other ecological services. Laos is one of the countries that could benefit most from emerging REDD-plus projects and other payment schemes towards conserving its remaining forest cover and needs to develop an appropriate legal and policy framework that is more inclusive of small-scale, community-based forestry models (cf. NEEF, THOMAS 2009; see also DARGUSCH et al. 2010). Integration of such policies with rural development strategies will also help the central government to fulfil its commitments towards multi-lateral environmental agreements for mainstreaming biodiversity considerations into sectoral policy plans (MAF 2010).

6.7.3 Suggestions for Further Research

The present study provides an elementary assessment of the domestic part of the supply chain of cardamom in Northern Laos. Further research is required in order to identify which steps of the supply chain offer the largest potential for increasing economic efficiency. There is a need for accurate data on the amounts of cardamom traded in the market and in-depth comparative economic studies that will estimate the exact margin gained by cardamom and other crops. This assessment must include all steps of the value chain from supply of quality planting material and establishment of nurseries to harvesting, transport and processing.

Research on appropriate drying facilities that can be communally organized is needed for improving post-harvest handling and product quality. Monitoring the drying facilities and estimating the necessary monetary and labour inputs are also essential. The acute focus on cultivation of imported improved varieties has an apparent impact on the population genetics of wild cardamom. These effects should be considered and studied with a view to improving the resilience of the crop system, as local varieties are gradually neglected. Participation of rural communities in research forms the basis for the development of value chains of more plant products that may follow the supply-demand patterns of cardamom in the future.

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7 General Discussion and Conclusions

This chapter is divided into three sections. The first section summarises the perspective on Local Ecological Knowledge (LEK). In the second section policy implementation and management of LEK for sustainable agriculture practices are discussed. The final section presents the final conclusions, recommendations and implications.

7.1 Perspectives on Local Ecological Knowledge (LEK)

Local knowledge is a basic constituent of any country's knowledge system. To improve farmers' livelihood, a combination of experiences and skills of people is required (WORLD BANK, 1997), which involves passing down the knowledge from the older generations to the next generations. LEK is mainly knowledge that encourages to maintain a balance between humans and their surrounding environment and sustains life by promoting people to live harmoniously with nature. However, the challenge of development is to encourage sustainable natural resource management based on LEK for local people.

In this thesis the nature and scope of Local Ecological Knowledge was illustrated using case studies from agricultural systems in Northern Thailand and Laos (Chapters 1, 2 and 3). In Thailand, two cases were investigated. Farmers' knowledge on traditionnal silvolpastoral systems and local soil classification, erosion and associated natural processes were examined both at plot and landscape levels. In Laos, Local Ecological Knowledge on cardamom plantations was appraised based on how farmers improved their livelihood and increased income by cultivating and collecting cardamom. The study also included other aspects of traditional silvopastoral farming among the ethnic minority communities. With these examples and other references, the utility, usefulness, and limitaions and of local knowledge in natural resource management is discussed. Research and development based on local knowledge and innovations that are complemented with appropriate scientific investigation is advocated.

7.1.1 The Relationship between Local and Scientific Knowledge in this study

In the last decades, discussions of integrating LEK and scientific knowledge have been presented. Both types of knowledge are complementary (cf. GAGNON and BERTEAUX 2009, HOFFMANN et al. 2007). Collecting LEK by focusing on information complementary to scientific knowledge has helped us to identify several areas of convergence between LEK and current research. In the 3 cases of this study LEK provided more robustness and practical usefulness that scientific knowledge. LEK was collected and compared with scientific observations at similar scales of the same type of practices. WINKLERPRINS (1999) demonstrates that local soil knowledge is a significantly important source of information when planning for planting and can produce a guideline for managing agricultural areas. An example from my own research and from HAGEL et al. (2013) illustrates that the combination of the scientific knowledge and integration of Local Soil Maps can help to integrate the views of local people into land use planning, and perhaps prevent problems, which confront local communities if their interests are overlooked. In the first paper it was (corresponding to Chapter 4) found that farmers focus on top soil properties, which are easily perceivable as they do not have tools for complex analysis – although they do have detailed understanding of soil properties when indicating the soil quality by using the top soil colour. Farmers stated that the black soil is presenting the high nutrient contents and farmers believed that black soil is suitable for planting upland rice. Finally, the local soil map showed striking similarities with the petrographic map established by soil scientists while farmers did not have all the details of a soil map in mind. Thus, the differences between local knowledge and scientific knowledge concern soil parameters. Within LEK, visible characteristics are important. On the other hand, scientific knowledge refers not only to physical (visible), but also to chemical (invisible) characteristics. Therefore, many local soil classifications worldwide are based on soil colour (TAYLOR-POWELL et al., 1991; OLLIER et al., 1971). Moreover, the practice of traditional knowledge or LEK differs from that of scientific ecological knowledge in that it is largely dependent on local social mechanisms. Overall, LEK can carry on the mechanisms for internal social life and can be used for construction of local environments to improve local livelyhoods (BERKES 1989). However, there are properties of the soil profile and sophisticated analytical techniques, which local people do not understand. A basic understanding by the people has been presented in terms of soil colour from which they derive the soil suitability for growing crops. To support the results, similarities were highlighted from the study of SAITO et al., (2006), who presented that the farmers in Laos also mentioned that the black soil has the highest soil quality and is most suitable for upland rice. In Conclusion it is obvious that farmers and soil scientists will have different classifications for soil. Accordingly, the upland tribe farmers do not understand what the chemical properties of soil are, e.g. concerning the detailed composition of nutrients. Blending of local and scientific soil knowledge gives a more complete picture. And scientists can save time by building their analyses on local knowledge.

In fact, when scientists work together with local people, it turns out that this helps scientists to understand the situation more easily. The case studies presented in this thesis suggested that the traditional silvopastoral systems and cardamom cultivation are part of complex local agroforestry systems. Direct comparison of the case studies is difficult. The study on raising animals in the forest focused more on conservative aspects in contrast to the idea of growing cardamom, which concerns more economic perspectives (Chapters 5 and 6). This does not mean that farmers in both Thailand and Laos are not only concerned about economic aspects but also have a similar perception that cattle are able to serve as a source of cash income and at the same time do not damage the forest, in contrary they create positive impacts for its conservation (corresponding to Chapter 5). For example, farmers stated that the terraces decelerate surface runoff and soil erosion, while the accumulated sediment leads to an increase in soil fertility and increases the plant growth rate. Some farmers also argue in favour of soil conservation and improved water storage. In detail, trampling creates shallow holes on the ground that serve to store water and consequently decrease surface runoff, which contrasts with the idea from scientists which state that it will lead to increased soil erosion rates. Cattle – raised in the forest – is a basic element of their family economy, due to its high value and the possibility to sell it at any moment, when cash is needed. By contrast, the case of cardamom (corresponding to Chapter 6) has shown that this high-value product needs to be sold when the price of spices increases and, i.e. when there is high demand from the Chinese market. Farmers have to learn how to plant the new varieties and replace the local variety relative to the quantity needed. In general, local knowledge about cardamom is fully sufficient for the collecting variant. When grown in home gardens, scientific knowledge in plant breeding is helpful to create and provide improved varieties. And in both cases more appropriate drying procedures brought in based on scientifical principles could help to increase product quality.

7.1.2 LEK as a Tool for Change

LEK systems are at risk of becoming extinct because of rapidly changing natural environments and fast pacing economic, political, and cultural changes on a global scale. Practices vanish as they become inappropriate for new challenges or because they are adapted too slowly. However, many practices disappear only because of the intrusion of foreign technologies or development concepts that promise short-term gains or solutions to problems without being capable of sustaining them. The tragedy of the impending disappearance of indigenous knowledge is most obvious to those who have developed it and make a living through it. But the implication for others can be detrimental as well, when skills, technologies, artefacts, problem solving strategies and skills are lost. Moreover, cultural globalization is also influencing how people perceive their own resources and knowledge. Local coping strategies are eroding also because the people themselves, especially the younger generation, tend to disregard their own resources and knowledge because of growing exposure to global and national influences and the pressure of modernization and cultural homogenization (DEKENS, 2007).

The three papers from the study presented in this thesis desire to learn how small household farmers learn from their own knowledge and long term experience on agricultural practices to improve their livelihood. Moreover, to record and validate the local ecological knowledge transfer and development of agriculture practices along with the utility process of natural resource for sustainability are needed. While continuous importance is given to linkages between research-extension-farmer when developing, disseminating, and utilizing sustainable agricultural technologies, several socio-political and institutional factors act as constraints for such an effective linkage. Keeping these potential constraints in conventional transfer of technology, a framework for incorporating local knowledge systems into agricultural research and extension has been developed with the following salient features:

- Strengthening the capacities of regional research and extension organizations.
- Building upon local people's knowledge that is acquired through various processes such as farmer-to-farmer communication, and farmer experimentation.

- Identifying the need for extension scientists or social scientists in an interdisciplinary regional research team.
- Formation of a sustainable technology development association to bring farmers, researchers, and extension workers together well ahead of the process of technology development.
- Outlining areas that research and extension workers need to concentrate on during the process of working with farmers.
- Understanding that it is impractical to depend entirely on research for innovations considering the inadequate human resource capacity of the regional research system.

Taking local knowledge into consideration in terms of practices and contexts can help implementing organizations to improve their planning for and implementation of disaster preparedness activities and it can more specifically help to improve project performance and project acceptance, ownership, and sustainability.

7.1.3 Local Knowledge is a Part of Life for the Rural Poor

The livelihood of the rural poor depends almost entirely on specific skills and knowledge essential for their survival. Accordingly, local knowledge is how local people understand local systems which are particularly relevant to the development process of the following sectors and strategies: Agriculture, animal husbandry, ethnic veterinary practices, use of wild plants as preventive medicine, natural resources management, as well as lending, community development and poverty alleviation. In Paper II (corresponding to Chapter 5), it is demonstrated that within local societies, knowledge is not homogeneous. For instance, different knowledge among women and men in areas of fodder and animal resource management is common. Moreover, local ecological knowledge is not yet fully utilized in the development process. Conventional approaches imply that development processes always require technology transfers from locations that are perceived as being further developed. This has led often to overlooking the potential in local experiences and practices. Local peoples are diverse and cannot be treated as a single entity. Sharing ecological knowledge is based on the understanding that each local group has its own unique economic, practical, spiritual, political, and historical relationship to its homeland (TURNER et al., 2000).

7.1.4 Limitations of LEK and the Way of Learning

Particularly for research, it is impossible to assess and understand LEK from local people without their collaboration. Likewise, it is not possible to estimate in advance, whether and what kind of knowledge can be learned and gained from them. Therefore, this section focuses on aspects of LEK which has been utilized and gained from peoples experience passed down through the generations.

LEK plays a very important role in natural resource management although a simple user-approach based on the living generation may be inadequate. Adaptive skills of local people are usually derived from many years of experience. One important finding was that LEK is often communicated and learned through family members over generations of time - representing tested agricultural practices. While the successful practice goes on, people cannot explain why it works. This part of knowledge might never have been gained, or got lost over time. Strategies and techniques developed by local people to cope with the changes in the socio-cultural and environmental surrounding have mostly very strong reasons in experience. Agricultural practices are accumulated by farmers due to constant experimentation and innovation.

There are many ethnic variations involved in local knowledge alteration, as there are several perceptions that are dominated by ethnic lifestyles. Local knowledge is local due to local practice, not olways due to local origins. Increase of contacts to the outer world and its technologies are also playing a big role and affect the modification up to full disappearance of LEK. To apply LEK for sustainability requires time, as local people have been learning by doing for their whole life while new generations start learning new things first by watching and have less time to try it out carefully. In addition, the distance from the upland areas to the city regarding the transfer of knowledge has been lost, traffic and communication media bring urban elements to the remotest villages. Thus, to assist in maintaining and managing natural resources network building is required. This will connect different local experiences, enhance learning and will help to blend the old and new knowledge to achieve sustainability.

7.2 Policy Implementation and LEK Management for Sustainable Agricultural Practices

In general governments try to support better livelihoods for the farmers who live in upland areas, who are working in agroforestry systems and try to use the resources in a more sustainable mode, and moreover, to increase their cash income (Paper I, II, III). A coordination of policies with rural development strategies will help the government to fulfil its commitments towards multi-lateral environmental agreements for main-streaming biodiversity considerations into sectoral policy. Not all the local natural resource management systems are still relevant, as the conditions under which they were developed have changed. Given the high population growth rate and the increased pressure on the limited natural resources of the research areas, management techniques related to redistribution of human and livestock populations to under-utilized areas are becoming now less viable options.

In paper II; (corresponding to Chapter 5), it is underlined that with the provision of community services to villages such as infrastructure, health and educational facilities, the settlement pattern and consequently the use of the surrounding arable and grazing areas has become increasingly more permanent and nomadic shifting cultivation comes to ends. The farmers have been raising cattle and they move it into the forest in the planting season and take it back to the upland fields or paddy lowlands during severe droughts or after harvesting. Now government policies combined with veteri-nary regulations greatly influence the livelihood choices of people. The freedom of moving to new or under-utilized grazing areas or utilizing fall back pastures in years of persistent drought is now restricted. The establishment of legal animal rearing areas also inside the forest was started and is more permanent in Northern Laos, while this is not the case in Northern Thailand.

The loss and non-utilization of LEK affects the sustainability of agriculture which results in inefficient allocation of resources and manpower to inappropriate planning strategies. Meanwhile little has been done to alleviate rural poverty. With little contact to rural people, planning experts and state functionaries have attempted to implement programs which do not meet the goals of rural people, or affect the structures and processes that perpetuate rural poverty. Human and natural resources in rural areas have remained inefficiently used or not used at all. Clearly, trust amongst people has to be maintained for knowledge exchange to occur - and this puts responsibilities on researchers to manage the knowledge they acquire dutifully. There should be reciprocity between local communities and external researchers, which involves exchange of knowledge, since it is very difficult to see how researchers can be effective without an appreciation of local knowledge. Moreover, if they are effective then resource users will want to know about their results. During the interviews with local people in target communities, it was noted that if research information were available, local residents and nature enthusiasts could use these studies to find out more about the plant species in the areas and thus confirm their occurrences. Some of the places important to local users may not necessarily be a habitat of endangered species or include specific conservational values, but may nevertheless be of great personal importance to them.

Policy makers should give attention to actively preserving this diversity of knowledge. The main consideration of the government is to ensure that the right information is delivered to the right person just in time. This can be done by incorporating and disseminating local knowledge, and by creating awareness and supporting projects among local populations. Therefore, integration of local knowledge into development policy and the development process is a key to successful participation of local people in agricultural and rural development programs.

7.3 Final Conclusion, Recommendations and Implications

In this study, the upland farmer households located in both the Northern part of Thailand and Laos were explored. The approach and findings presented here when investigating factual ecological knowledge, the degree of complementariness between LEK and ecological science largely depends on the spatial and temporal scales from which each type of knowledge was derived. A knowledge base (KB) was created and presented in this research and has shown that the LEK is able to be basic information. The gathering of agro-ecological knowledge may provide the politicians or the planners with baseline knowledge in a relatively quick and cost-effective way for the development of appropriate research approaches for land use development. On the basis of this study, which was combined in three case studies, it can be concluded that research and development may benefit from an explicit account of the knowledge which exists in local farming communities. For example, from the soil science perspective, a better understanding was derived from local people's knowledge of plantation in terms of the soil physiology, where farmers understanding based on their visualization of soil colour and on local classification can easily be assessed. Learning from the three papers indicated that an inter-disciplinary approach is required. Regional research is responsible for developing agricultural systems in order to achieve sustainability. The disciplines such as animal husbandry, agro-forestry, agronomy, entomology, soil science and plant science are needed as well as rural sociology or anthropology. This is especially true if one looks at economic growth which results in rapid resource depletion through the conversion of tropical forest to agricultural land without proper maintenance of national resource properties or bio-diversity. Economic development and the modernization process have changed people's mode of production, consumption and livelihood, and set up relations of production where the state and the investors transfer an economic surplus from farmers and rural areas to outside centres.

How do the cases of the study contribute to improve local people’s livelihoods and their ability to generate food security, income and sustainable resource management? To answer is, that obtaining new insights for sustainable development of mountainous regions is needed. For example, it was found in Chapter 6 that the most severe loss of the cardamom fruits happens during the drying process when the fruits are prone to contamination by moulds. This leads to significant declines in respect to quality. The alternative way is to prevent losses during the drying process by implementing simple drying facilities adapted to the local conditions as the main harvesting is during the rainy season, which should be considered in research.

Is the way to integrate LEK with scientific knowledge able to be a precise alternative direction? From this study in particular, supporting soil and land use mapping, regional land classification and land use modelling at the watershed and landscape scale has provided solid examples. It was found that one of important research areas for future study is to gather more information about local knowledge on tree forage classification and evaluation used by farmers and to determine if similar fodder classification and evaluation are used widely by other tribal peoples. Indicators of fodder quality that they use may not be capable of differentiating new types of fodder or to show how to use existing fodder types in different ways or under different conditions.

Considering essential ecological knowledge which focuses on land uses of ethnic minority communities in the mountains of Northern Thailand and Northern Laos, what should be looked at? One important finding that may be able to answer that question is that local knowledge can offer alternative and/or complementary explanations on ecological systems while the supposed cause-and-effect relationships need further scientific investigation and validation. It was demonstrated that integration of local knowledge into scientific analysis and policy-making could provide valuable resources for achieving sustainable upland agro-ecosystems. Taking into consideration LEK within the interdisciplinary work in this study, how does it support and improve the academic work? It was not unproblematic to work with scientists, economists, social scientist and local people and particularly at the beginning there were complications as there are have been different knowledge backgrounds, skill and languages. Moreover, working in the interdisciplinary team about local knowledge, was also sometimes limitated as there was crossed perception which was based on different own understandings (RUDDLE and DAVIS, 2013**).**

The elicitation of local knowledge should be supported, as local knowledge is built at every phase of social activities and is the most important presentation of identity, saliency, awareness and resistance (SHAMS, 2005). Knowledge creation and dissemination in environmental management is an exercise in knowledge construction between different partners, and it challenges all those involved to reconsider received wisdoms. As suggested by STEVENSON (1998), there is a need to begin thinking of LEK not so much as a commodity but as a process to be developed and nurtured. Moreover, as supported by GAGNON and BERTEAUX (2009), the basis for starting LEK research is searching for appropriate approaches to blend several types of knowledge. It is important to create the coniction that it is essential to understand the level at which LEK and scientific observations operate. The combination and integration of LEK and scientific knowledge will take full advantage of the benefits from the mutual presentation and interaction of both knowledge types and can benefit significantly as the basis for future research.

8 Summaries

8.1 Summary

Conceptually, local knowledge is recognized and investigated by a wide array of disciplines, and the focus has shifted from definition of ‘indigenous’ or ‘traditional’ knowledge to a perception of local knowledge as a dynamic concept and a principal basis for decision-making processes. This enables the creation of a research environment that is conducive to participatory approaches seeking to bridge the division between local and scientific knowledge.

This thesis explains how local knowledge systems are composed by different knowledge types, such as practices and beliefs, values, and worldviews. The knowledge systems change constantly under the influence of power relations and cross-scale linkages both within and outside the community. Likewise, local knowledge and practices need to be understood as adaptive responses to internal and external changes which result e.g. in disaster preparedness or sustainable growth of livelihoods at the local level.

This thesis is based on interviews and using PRA tools about local knowledge and practices and attempts to give an overview and framework of local knowledge in sustainable land use and an understanding of the benefits and problems involved.

Local knowledge systems (LKS) are an important part of the lives of the poor. They are the basis for decision-making of communities in food security, human and animal health, education, and natural resource management. LKS point to how indigenous people manipulate their knowledge, which has accumulated, evolved and practiced for generations. They epitomize the relationship and interaction between local peoples and their natural surroundings.

In the study shown in paper I (Chapter 4), results based on group discussions suggested that farmers use observable morphological characteristics, such as color and, to a lesser extent texture, as major soil classification criteria. In the beginning, farmers distinguished only two classes of soil according to the colors red and black. After being specifically asked about other parameters, farmers were able to give more detailed information on such parameters as fertility, water content and drainage. They also used topographic parameters such as inclination, exposure and position along the slope. In a second step, individual farmers were asked to show plots with a specific soil according to their classification. While the soil scientists took soil samples and made a qualitative analysis of the soil to determine the soil type according to WRB classification, it was found that farmers were able to classify soil into as many as six different types as compared to eight major soil types that were identified by the scientific classification. Farmers were able to rank soil types according to yield potential, water retention capacity and workability. It was also revealed that farmers use an open range of mainly wooden plant species as soil fertility indicators. Through participatory soil mapping exercises, it was sought to develop a single, comprehensive soil classification reflecting the main soil types in the village territory. This process helped to explore the potential for using local soil classification towards regional soil mapping. It was concluded that the comparison of scientific soil classification and soil survey maps with local knowledge of soils can generate valuable synergies through integrating the perceptions of soil properties of scientists and farmers. Moreover, villagers in this research area will be able to have alternative or complementary options to grow plants and to generate improved revenues in the future.

In paper II (Chapter 5), it was found that traditional silvopastoral systems are a key component of sustainable forest management. Forestry and forst use is a part of the established activities of upland farmers, who show interest in sustainable management and utilization of their natural resources. This study emphasizes on the expansive and complex articulation of local farmers knowledge which has been so far excluded from governmental development policies. Key components of local knowledge were identified through a comparative analysis between the perceptions on traditional sylvo-pastoral farmers in Northern Thailand and Laos, two countries with surprisingly different forestry policy frameworks. From this study, it was shown that upland Thai and Lao farmers clearly recognize cattle to be a highly positive section of local forest agro-ecosystems due to their involvement in nutrient cycling, water retention and leaf-litter dispersal. Farmers placed highest values on local fodder species as important for feeding especially during the dry season. In Thailand, there is a restriction on cattle production in upland areas that is not effectively implemented, while the Lao government has strongly promoted cattle rearing as a major source of income for local farmers. It was concluded that local ecological knowledge about sylvo-pastoral systems can provide useful resources for striving towards more sustainable highland agro-ecosystems, if it is integrated into scientific analysis and policy making.

Paper III (Chapter 6) found that cardamom plantations/collections are considered as an effective approach to increasing household income of poor farmers. Cardamom is produced mainly for export to China. Marketing channels are well established and the product is in high demand with traders, middlemen and exporters. The prices of cardamom have risen in recent years and each group of stakeholders obtains a satisfying benefit from taking part in the cardamom business chain. However, it was also found that farmers lack knowledge of the postharvest processing process. Collecting cardamom in the wild is a good source of income for the poorest people.

When cardamom is grown it provides an alternative avoiding mono-cropping such as rubber, maize or sugar cane. Cardamom plantations can be considered as an important element of sustainable agroforestry systems, as long as the market prices remain high. Moreover it is an alternative to intensive forms of agriculture and can reduce local poverty in the future. As a result, this study emphasizes the potential of cardamom for poverty alleviation and sustainable rural development under conditions of increased resource scarcity in the uplands of Northern Laos. The supply chain of cardamom is identified and the socio-economic opportunities for collectors and cultivators are examined. We found that landless collectors of wild cardamom are facing increasing difficulties due to overharvesting, and middlemen offered lower prices to them. The main policy implication is that protecting the remaining of natural and secondary forests, for instance through making use of evolving international support mechanisms for community based forest protection including REDD-plus, will not only be of advantage for biodiversity conservation and climate change mitigation, but would also improve the livelihoods of the poorest in the uplands of Northern Laos.

The challenge for national resource managers is to combine the management of agricultural functions with ecological benefits through sustainable agriculture practices to enhance the livelihoods of local people. Local ecological knowledge can offer proven alternatives and complementary explanations of ecological cause-and-effect relationships. It may prove useful in further scientific investigation and can be utilized as a cross-reference with other findings and therefore contribute to sustainable resource management and improve the quality of local resources and livelihoods.

8.2 Zusammenfassung

Vom Konzept her wird lokales Wissen von vielen Disziplinen anerkannt und untersucht. Der Focus der Betrachtung hat sich dabei von einer Definition als “eingeborenes” oder “traditionelles” Wissen verlagert auf das Verständnis als dynamische und grundsätzliche Basis von Entscheidungsprozessen. Das ermöglicht die Schaffung eines Forschungsumfelds, das für partizipative Prozesse förderlich ist, die sich darum bemühen, die Spaltung zwischen lokalem und wissenschaftlichem Wissen zu überbrücken.

Im einleitenden Teil dieser Studie wird erläutert, wie lokales Wissen sich aus Praktiken, Glauben, Werten und Weltsichten zusammensetzt. Wissenssysteme verändern sich standing unter dem Einfluss von Machtbeziehungen und in Wechselwirkung zwischen Innen und Aussen von Gemeinschaften. Entsprechend sind lokales Wissen und locale Praxis als angepasste Antworten auf interne und externe Veränderungen zu vertehen, die beispielsweise zu verbesserten Lebensbedingungen oder zu besserem Vorbereitedsein auf mögliche Katastrophen führen.

Die Studie basiert methodisch auf PRA-Verfahren und einem “Werkzeugkasten zur Erfassung von lokelem ökologischem Wissen” und versucht, einen Überblick und einen konzeptionellen Rahmen zu lokalem Wissen im Bereich nachhaltiger Landnutzung zu geben, sowie ein Verständnis der damit einhergehenden Vorteile und Probleme.

Lokale Wissenssysteme sind besonders für ländliche Arme eine entscheidende Ressource. Sie sind die Basis für Entscheidungen der Gemeinden zur Nachrungs-Sicherung, zur menschlichen und tierischen Gesundheit, zur Erziehung und zum Management der natürlichen Ressourcen. Lokale Wissensysteme bedingen, wie die Menschen mit ihrem Wissen umgehen, das über Generationen enstanden ist und angewandt wird. Sie bestimmen die Interaktion zwischen den ansässigen Menschen und ihrer natürlichen Umgebung.

Die im ersten Artikel (Kapitel 4) dargestellte Untersuchung, zeigt mittels Gruppendiskussionen und Geländebegehungen, dass Bauern morphologische Eigenschaften wie Farbe und danach Textur zur Bodenklassifizierung heranziehen. Anfangs unterschieden die bauern nur zwischen schwarzen und roten Böden. Bei Nachfrage nach genaueren Merkmalen, konnten die Bauern auch Fruchtbarkeit, Feuchte und Drainage benennen. Sie benutzten auch topographische Merkmale wie Hangneigung, Exposition und Plazierung im Hang. Dann wurden einzelne Bauern aufgefordert, Böden entsprechend ihrer Klassifikation im Gelände zu zeigen. Dort nahmen die Bodenkundler Proben um den Bodentyp nach WRB-Klassifikation zu bestimmen. Forscher kamen auf 8 Boden-Klassen, Bauern ihrerseits auf 6, die sie in in Rangreihen bringen konnten nach Ertragspotenzial, Wasser-Rückhalte-Kapazität und Bearbeitbarkeit. Als Indikator für die Bodenfruchtbarkeit benutzen Bauern vorwiegend Gehölzpflanzen. Die partizipativen Boden-Kartierungs-Aufgaben erlaubten es schließlich, eine Dorf-umfassende Bodenklassifikation zu erstellen, die es den Bauern erlaubte, die Eignung von Flächen für eine alternative Bebauung abzuschätzen, die künftige Einnahmen steigern kann. Die Forscher konnten aus den Übereinstimmungen zwischen bäuerlichen und wissenschaftlichen Kriterien schnellere Verfahren für die Erstellung regionaler Bodenkarten ableiten. Insofern schuf die Kombination der beiden Wissenssysteme klare Synergien für beide Partner.

Im zweiten Artikel (Kapitel 5) konnte gezeigt werden, dass traditionelle agro-sylvopastorale Systeme ein zentrales Element nachhaltiger Waldwirtschaft sein können, und dass Bergbauern in den südostasiatischen Regenwaldgebieten ein Interesse an nachhaltiger Bewirtschaftung haben. Die Regierungen, die das locale Wissen seither oft ignoriert haben, sollten es in ihre Entwicklungspolitik und Planungen mit einbeziehen. Aus dem Vergleich der Situation in Dörfern in Nord-Thailand und dem benachbarten Laos, die sehr unterschiedliche Forst-Politiken verfolgen, konnten interessante Einsichten erzielt warden. Die betroffenen Bauern in beiden Ländern betrachten Rinderhaltung im Wald nicht nur als wichtige Einkommensquelle, sondern auch als positiv für das Nährstoff-Recycling, die Wasser-Rückhaltung und die Laubstreu-Umsetzung. Futter aus Waldweide wurde an beiden Standorten als entscheidend zur Überbrückung der Trockenzeit gesehen, und durch die Verlagerung der Rinder während der Anbau- und Ernteperiode in den Wald werden Flurschäden und entsprechende Konflikte vermieden. Thailand verbietet Rinderhaltung im Wald, auch wenn das nicht sehr effektiv kontrolliert wird, während Laos diese Form der Rinderhaltung sogar fördert. Erneut kann der Schluss gezogen warden, dass die Integration des lokalen Wissens über die nachhaltige Nutzung von Agrarpotenzialen im Hochland in Wissenschaft und Politik großen Fortschritt bringen kann.

Der dritte Artikel (Kapitel 6) kann klar zeigen, dass das Sammeln oder Anbauen von Cardamom ein wirksames Mittel ist, um die Einkommenssituation von Armen und Kleinbauern im Hochland zu verbessern. Cardamom wird aus Laos vor allem nach China exportiert. Die Vermarktung ist etabliert, und es besteht große Nachfrage auf allen Handelsstufen. In den letzten Jahren sind die Preise gestiegen, und die Wertschöpfungskette erlaubt den Partnern auf allen Stufen zufriedenstellende Gewinne. Selbst Landlose können über das Sammeln mitmachen. Kleinbauern können ihn auch anbauen, und damit den Anbau von Monokulturen wie Gummi, Mais oder Zuckerrohr auflockern. Es gibt erste verbesserte Sorten, die zu besserer Qualität führen. Die Wertschöfungskette wurde erfasst und die sozio-ökonomischen Potenziale für sammler und Anbauer konnten bestimmt warden. Das Geschäft ist lohnend. Allerdings sind Sammler in manchen Jahren von Übernutzung bedroht, und Händler bezahlen sie gerne schlechter als bessergestellte Bauern. Die Trocknung weist noch wesentliche Potentiale auf, durch einfache und schonendere Verfahren bessere Qualität zu erzielen. Und die Politik kann durch Programme zur Erhaltung von Waldgebieten in Dorfnähe – eventuell in Zusammenarbeit mit internationalen Organisationen wie REDD-plus – dazu beitragen, den Ärmsten der Armen in Nord-Laos, diese Einkommensquelle zu erhalten.

Die besondere Herausforderung für das Ressoucen-Management besteht in der Verbindung von nachhaltiger und lohnender Agrarproduktion mit Ökosystem-Diensten und dem Erhalt der natürlichen Ressourcen. Lokales Wissen kann wesentlich dabei helfen, die geeigneten Lösungen zu finden, und ist die erste Voraussetzung für deren Umsetzung. Lokales Wissen kann dabei helfen, von der Wissenschaft und Politik seither übersehene ökologische Zusammenhänge zu erkennen und zu berücksichtigen. Es kann künftige Forschung befruchten, als Vergleichsquelle für wissenschaftliche Ergebnisse dienen und so ganz wesentlich zu einem nachhaltigen Management natürlicher Ressourcen beitragen und die Ressourcen und Lebensverhältnisse auf dem Land verbessern helfen.

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Courses Taken and Workshops Attended

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Local Ecological Knowledge survey on landscape function, with focus on Teak, using Participatory Landscape Analysis Approach (PaLA) and Field report of the ToT in combination with Fieldwork (T&F) of LUSLOF project in Luang Prabang, LAO.

March 13-15, 2003

Lacal Institutions for Natural Resource Governance: A workshop on Research Methods, Chiang Mai, Thailand.

December 12-18, 2002

Developing Teaching Materials on Agroforestry and Environmental Services adaption and Translation of ASB Lecture Notes, Chiang Mai, Thailand.

September 25-December 7, 2002

Knowledge based systems in the analysis of local ecological knowledge, using the AKT5 toolkit and methodology at School of Agricultural and forest Sciences, University of Wales, Bangor, Wales

June 8-12, 2001

Local Ecological Knowledge and Knowledge-based Systems Approach, Chiang Mai, Thailand.

Work Experience

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Responsibilities: Study of the ecological restoration of tropical mountain forest based on natural succession by people in mountainous areas.

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Research assistant and translator at the Uplands Program, University of Hohenheim

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Field researcher the cooperative project of Royal Forest Department on the ecological restoration of tropical montane forest based on the natural succession of plan communities and local ecological knowledge of hill tribe people with Kyoto University.

Language skills

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Complete list of publications (in chronological order)

Articles in ISI-listed peer-reviewed journals

Choocharoen, C., Neef, A., Preechapanya, P., Hoffmann, V. 2014. Agrosilvopastoral systems in northern Thailand and northern Laos: Minority peoples' knowledge versus government policy. *Land* 3(2): 414-436; DOI10.3390/land3020414.

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Conference contributions / non peer reviewed articles

English

Pavlos Georgiadis, Chalathon Choocharoen, Annabell Redegeld .2011. People, Forest& Rural Development; rediscovering the neglected and underutilized ethnobotanical Heritage of N. Thailand. Trobentag conference in Born, 2011(poster) "Development on the margin" Tropentag 2011, October 5 - 7, Bonn, Germany

Pavlos Georgiadis, **Chalathon Choocharoen**, Annabell Redegeld .2010.Impact-oriented Ethnobotany for Sustainable Land-use and Rural Livelihood Diversification in Southeast Asian Mountains. International Symposium on "Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia" Hanoi, Vietnam; 21-23 July 2010.

Choocharoen, C. & Neef, A. 2007. Local ecological knowledge of Hmong and Kh'mu people and implications for resource management in Pha Oudom, Bokeo province, Northern Laos. Poster presented at the International Conference on "Integrating Conservation in the Upland Agriculture in Southeast Asia", Chiang Mai, Thailand, 24-26 October 2007.

Barbara M. E. Dannenmann, **Chalathon Choocharoen**, Wolfram Spreer, Marcus Nagle, Andreas Neef, Joachim Mueller. 2007. The Potential of Bamboo from Northern Laos as a Source of Renewable Energy. The tropentag conference in Witzenhausen, Germany"Utilisation of diversity in land use systems: Sustainable and organic approaches to meet human needs". Tropentag 2007, October 9 – 11.

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U. Schuler, **C. Choocharoen**, A. Weiss, L. Herrmann, A. Neef and K. Stahr. 2006. Elicitation of Local Soil Knowledge in Northern Thailand and Consequences for Land Use Decision-Making. Poster presented at the International Conference “Sustainable Sloping lands and Watershed Management: Linking research to Strengthen Upland Policies and Practice” in Luang Prabang, Lao PDR, 12-15 December 2006

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Thai with English abstract

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Declaration

Herewith I certify that I have completed this dissertation independently, have used only the indicated sources and resources, marked citations as literal or regarding to content, and have not been supported by a commercial agent or supervisor. The thesis has been generated under the umbrella of the Thai-Vietnamese German collaborative research program “Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia” (The Uplands Program - Sonderforschungsbereich 564).

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