Burning Changes

Action Research with Farmers and Swidden Agriculture
in the Upper Amazon

Kristina Marquardt Arévalo
Faculty of Natural Resources and Agricultural Sciences
Department of Urban and Rural Development
Uppsala

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Jacket photo: Majambo fruit (*Theobroma bicolour*), Cover photo: A view over the Upper Amazonian landscape, Chazuta, 2003.
(photo: K. Marquardt Arévalo)

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Burning Changes: Action Research with Farmers and Swidden Agriculture in the Upper Amazon

Abstract

This thesis addresses what responses might be found among farmers facing rapid changing land management conditions. By working with an Action Research (AR) approach in two villages in the Upper Amazon, with contrasting conditions of land pressure and strategic land degradation management, the research explores how non-Indian native farmers actively manage their agro-diversity. Land management experimentation with different tree and crop combinations, longer cropping periods, a more varied cash crop production and improved fallows as well as slope-, fallow-, fire-, weed- and agro-biodiversity management have been mapped out. Such an adaptive capacity reflects an ability to learn, experiment and innovate which involves learning agricultural diversity as a strategy to adapt to the unexpected, where the system's components of diversity, experiential learning and institutional arrangements support requirements for building resilience. This thesis suggests a local conception of soils as a property of the forest and forest management as the driver of the forest-soil complex, which is central in land management processes in the area.

The AR approach made it possible to explore the land management in a wider sense than originally planned, where farmers' learning and what type of learning environment would best enable farmers to learn and experiment with land management options could be explored in the research process. By arranging action learning activities as collective, experimental field activities, framed by a local institution the research could interact with an already existing social space for farmer learning and facilitate a joint learning process with the farmers, a local NGO and researchers. The iterative and reflective way to handle the research problems in AR has a great deal in common with farmers' own experiential learning. This overlap in approach therefore enabled shared learning and innovation between the actors and the research process, and further encouraged joint action learning within a regional context as well as with the closely collaborating NGO. Such a joint learning process is a way of combining local and scientific knowledge in a fruitful way, which would be useful in processes aiming at fostering resilience.

The research also discusses how farmers' own experimentation and experiential learning can be supported from outside in order to be scaled up, and where AR can be one of the tools to establish necessary reflective arrangements within the organisations providing farmer support, in order to develop actions relevant to farmers' land management.

Keywords: Land management, swidden agriculture, farmer experimentation, resilience, action research, action learning, organisational learning, Amazon, Peru

Author's address: Kristina Marquardt Arévalo, Department of Urban and Rural Development, SLU, Box 7012, SE-750 07 Uppsala, Sweden.
E-mail: Kristina.Marquardt@sol.slu.se

Cambios que queman. Investigación acción con campesinos y la agricultura de tumba y quema en la Selva Alta Amazónica

Resumen

La presente tesis trata sobre las respuestas de algunos campesinos frente a cambios vertiginosos en las condiciones de manejo de suelos. A través del trabajo con un enfoque de Investigación-Acción (I.A.), realizado en dos comunidades de la Selva Alta Amazónica, las cuales muestran condiciones contrastantes tanto en la explotación de suelos como en el manejo estratégico de la degradación de suelos, esta investigación explora como los campesinos locales no-indígenas manejan de manera activa su agrodiversidad. Se han registrado experimentos en el manejo de suelos con diferentes combinaciones de árboles y de cultivares; periodos de cultivo más largos; una producción más diversa de cultivos comerciales y mejoras en los periodos de barbecho (purma), así como en el manejo de las laderas, de las zonas de barbecho, del fuego, de la maleza y de la agrobiodiversidad. Tal capacidad de adaptación refleja una habilidad para aprender, experimentar e innovar, que incluye el aprendizaje de la diversidad agrícola como una estrategia de adaptación a lo inesperado, en el que los componentes de diversidad del sistema, el aprendizaje experiencial, así como las formas de organización institucional apoyan las bases para la construcción de resiliencia. La presente tesis sugiere que existe una concepción local en la que se percibe al suelo como una propiedad del bosque, y del manejo del bosque como el conductor del complejo bosque-suelo, el cual es un aspecto importante en los procesos de manejo de suelos en el área.

El enfoque de Investigación Acción hizo posible la exploración del manejo de suelos en un sentido más amplio de él que se planeó originalmente. En este proceso de investigación se pudieron explorar tanto el aprendizaje de los campesinos, como el tipo de contexto del aprendizaje más apropiado para que los campesinos aprendan y experimenten con diferentes opciones de manejo de suelos. La investigación pudo interactuar dentro un espacio social ya existente para el aprendizaje campesino y facilitar un proceso conjunto de aprendizaje con los campesinos, una ONG local y con investigadores, a través de la organización de actividades de aprendizaje en acción colectiva tales como actividades experimentales de campo enmarcadas dentro de una institución local. La manera interactiva y de reflexión en que se manejan los problemas de investigación en la I.A. tiene una gran similitud con el aprendizaje experiencial propio de los campesinos. De ahí que esta similitud de enfoques permitió el aprendizaje y la innovación de manera compartida entre los actores y el proceso de investigación, y promovió además el aprendizaje conjunto en acción dentro de un contexto regional, así como con la ONG con la que se colaboró de manera más cercana. Este aprendizaje en conjunto constituye una forma de combinar el conocimiento científico y el conocimiento local de una manera más fructífera, el mismo que podría ser de utilidad en otros procesos que busquen promover la resiliencia.

Por otro lado, la investigación discute como se pueden apoyar, desde afuera, la experimentación y el aprendizaje experiencial de los mismos campesinos a fin de que estos se incrementen, y en el que la I.A. pueda ser una de las herramientas que permitan establecer las estructuras de reflexión necesarias al interior de las instituciones que brindan apoyo a los campesinos, a fin de desarrollar acciones que sean relevantes para la forma de manejar los suelos que tienen los campesinos.

Palabras clave: Manejo de suelos, agricultura de tumba y quema, experimentación campesina, resiliencia, Investigación Acción, Aprendizaje basado en acciones, Aprendizaje organizacional, Amazonía, Perú

Dirección de la autora: Kristina Marquardt Arévalo, Department of Urban and Rural Development, SLU, Box 7012, SE-750 07 Uppsala, Suecia.
E-mail: Kristina.Marquardt@sol.slu.se




A mis amigos campesinos de San Miguel del Río Mayo y Chazuta -
esta travesía de aprendizaje se hizo junto con ustedes, teniéndoles como grandes maestros y compañeros







To the fellow farmers in
San Miguel del Río Mayo and Chazuta –
this journey of
learning was made
together with you as great
maestros and co-learners

Contents

List of publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Marquardt Arévalo, K., Salomonsson, L. and Brondizio E. Small-scale Farmers' Land Management Strategies in the Upper Amazon: An Action Research Case Study. *Submitted for publication.*

II Marquardt Arévalo, K. and Ljung, M. 2006. Action Research on Land Management in the Western Amazon, Peru – a Research Process, its Outcomes and the Researcher's Role, *Systemic Practice and Action Research,* 19, pp. 309-324.

III Marquardt Arévalo, K., Geber, U. and Salomonsson, L. Farmers Facing Rapid Agricultural Land Condition Changes in Two Villages in the Upper Amazon, Peru. Can Action Learning Contribute to Resilience? *Submitted for publication.*

IV Marquardt Arévalo, K., Ljung, M. and Sriskandarajah, N. Learning through feedback in the field: An Example of a Reflective Learning NGO in the Peruvian Amazon. *Submitted for publication.*

Paper II is reproduced with the permission of the publishers.

I am the first author on all four papers and responsible for the empirical material used in the papers.

In paper I, I have processed and structured the data, done the literature review within tropical land management and done the major part of the writing. Lennart Salomonsson and Eduardo Brondizio have contributed with discussions about how the results can be interpreted in a larger context.

In paper II, I have analysed the action research process of the Ph.D. project in detail. Magnus Ljung has contributed by critically examining the analysis and assisted the development of the work by being an active discussion partner. I am responsible for the major part of the literature review and the writing.

Paper III has developed during an very extended ongoing analytical discussion of my research data together with Ulrika Geber and Lennart Salomonsson. These discussions enabled us to see the data in a larger theoretical perspective, which has been highly important to the work. I have actively participated in these discussions and been responsible for the major part of literature review and writing. The second and third authors have supported the academic writing process to the final version.

In Paper IV, the working approach of the NGO I have closely collaborated with in the field is analyzed. Magnus Ljung and Nadarajah Sriskandarajah have been an active joint sounding board and have contributed with theoretical discussions concerning the interpretation of the data. I have actively taken part in the discussion and been responsible for the major part of the literature and writing. The third author has assisted with the final adjustments to the paper.

Glossary

Bajo Mayo	The area along the lower part of the river Mayo
caboclos	A native rural population of the Brazilian Amazon of mixed Indian, European and African ancestry, who for the most part reside in small rural communities within riverine environments and use the floodplain for agriculture and extraction. The *caboclos* have often been more linked to the larger society than the Amazonian indigenous populations
chicha	The local maize beverage, prepared by cooking ground maize with sugar and spices
choba choba	Traditional exchange of labour in the study area (called *minga* further down the Amazon basin)
CIAT	International Center for Tropical Agriculture
CIFOR	Center for International Forestry Research
Imperata	The problematic root weed *Imperata brasiliensis* called *kashu uksha* in the region
kashu uksha	The local name of the problematic root weed *Imperata brasiliensis*
Kechwa-Lamista	The largest group of indigenous people in the area which constitute about 3% of the population in San Martín (INEI, 1993b)
masato	The local cassava beverage, prepared by the women farmers,

	who chew the cooked cassava, leave the cassava mass to ferment and later dilute it with water
mujeo	The practice of seed swapping
native non-Indians	People of a mixed indigenous and European origin, who have lived in the study area for several generations, distinguished from indigenous people and recently immigrated colonists
NGO	Non-governmental organisation
PRADERA	The local NGO *Proyecto de Apoyo Rural de la Amazonía,* with whom the author has collaborated
PRATEC	*Proyecto Andino de Tecnologías Campesinas* is a national Peruvian NGO which works with local agriculture and farmers' own view of their agricultural work. PRATEC also gathers experiences from several local sister organizations, where PRADERA is one such organisation
ribereños	Native people of mixed indigenous and European origin, living in small, dispersed settlements on the river banks in the lowland forest area of the Peruvian Amazon (*selva baja*), practising agriculture, fishing, hunting and gathering forest products
selva alta	The hilly highland forest area of the Peruvian Amazon, where the Amazon and the Andean mountains meet
selva baja	The flat lowland forest area of the Peruvian Amazon, reaching from eastern Peru across the continent
swidden	An agricultural technique of cutting and burning the forests or woodlands in order to create fields for agricultural purposes. It is sometimes also called slash and burn agriculture and shifting cultivation

Preamble

My motivation for writing this thesis arises from a personal passion for the Upper Amazonian region, its people and its local agricultural system. The first time I saw the Peruvian highland forest and met with farmers from San Martín was in 1996, when I did a study about organic and colour-growing cotton (Marquardt and Rönnberg, 1997). Asking all kinds of questions concerning cotton cultivation, I particularly remember my frustration over the unexpected answer to the question:
- "Why did you begin to grow cotton?"
- "Because I like cotton (as a plant)."
The answer was illogical from an agronomic point of view, and I began to understand that I might know something about biological processes, but not a lot about the farmers. The cotton study, focusing on one particular crop, never achieved an understanding of the diverse and complex farming system to which the local cotton production belongs. Nevertheless, the time spent in the field awoke my curiosity regarding agricultural diversity and the people who practise it. So, in 1998 I went back to do my masters thesis on traditional swidden agriculture as an agricultural system, which compared farmers' and agronomy students' (from the local university) views on swidden farming and sustainability (Marquardt, 1998). At the same time I met with the Peruvian NGOs PRATEC (*Proyecto Andino de Tecnologías Campesinas*) and its sister organization PRADERA (*Proyecto de Apoyo Rural de la Amazonía*) who work with local agriculture, focusing on farmers' own views of their agricultural work as well as on the cultural part of agriculture. PRADERA and PRATEC have continued to be important inspirational and critical sources for my work ever since. PRADERA has also been a close collaborator during the Ph.D. research presented in this thesis.

During the Masters thesis work I observed farmers with impressive agricultural skills who were cropping large numbers of crop species and varieties. They also took various measures regarding erosion and land degradation, though neither these actions, nor the farmers' logic were emphasized by the local university or the majority of the agricultural NGOs in the region. I wanted to continue to explore that topic and in 2001 I started my Ph.D. research on farmers' own approaches to land management problems in San Martín.

My journey of learning during the past ten years has not only allowed me to develop a more profound knowledge about Amazonian agriculture, but has also been a process of personal development in relation to a methodological search for "action". The process started with questionnaire interviews in 1996, moving on to participatory observation and semi-structured interviews during the Masters thesis, to the approach to action research that is presented and analysed in this thesis. This evolution is a response to my dissatisfaction and frustration of being a researcher who was merely an observer, not understanding the people with whom I was working, and not being able to participate in the development of their agriculture, lest by elaborating my own ideas and perceptions "interfere" with my results. I wanted to work with a methodology where my own learning process became a factor in the research, subject to critical evaluation and expressed as connected to the farmers' learning process. I wanted to position myself as one among several participants, contributing and sharing knowledge with the others. I have a strong conviction that in order to create change in real social settings through science it is absolutely necessary to include the farmers in the whole process, from planning the project to evaluating the results. By taking an action research approach I attempted to overcome the researcher's dilemma of remaining aloof, by convention not creating close and reciprocal relations among professionals and farmers and withholding the researcher's scientific knowledge from the local land management learning process.

Yet this pre-analytic choice in turn raised new challenges. Inter-disciplinarity, and participatory research are considered by many actors in the international development community to be crucial. However, the organizational structures in the Swedish academic environment, are increasingly raising the demands on Ph.D. education in terms of tightening financing and time, which do not favour Ph.D. projects to develop as interdisciplinary and/or action research projects. An action research process is a learning process accomplished together with local people, hard to control and fully anticipate and can be difficult to include in today's slimline Ph.D. education of short field work assignments and fast delivery of publishable outcomes. In my case it has only been possible to carry out my project within the given time, as I already knew PRADERA well before starting the project, due to a JPO-position at CIAT[1] (Cali) which allowed me to be in the field for almost three years and finally as I have had two children during the research process and have been on long periods of maternity leave. These periods of leave have meant that the research process has extended over a longer period than normal in Ph.D. projects, which I believe has been very favourable to the outcome. If we want to truly develop high quality in research, where quality means not only scientific quality, but also the involvement of people and their views of their agriculture and natural resources, we have to question why the academic structures do not favour research that has a long term commitment.

This Ph.D. thesis consists of four scientific papers (listed at Page 8), found at the end of the thesis, and in a covering essay. The essay starting here, aims to connect the four scientific papers, in which my research is presented, as sections as well as a whole. I hope that in the future there will be an opportunity to continue where this thesis ends. It would be extremely interesting and worthwhile to continue the work with land management research in San Martín with ways of scaling up farmers' land management learning on a regional level within the learning setting of *choba choba* groups and *muejo* traditions in a similar collaboration constellation to that used in this Ph.D. research.

[1] International Center for Tropical Agriculture

1 An introduction to small scale agriculture in the Upper Amazon

1.1 History

Archaeological findings demonstrate that agriculture in the Amazon is not a new phenomenon. The first inhabitants of the Amazon 10 000 years ago (Smith, 1999, Roosevelt, 1989) were hunter- gatherers, but since about 100 BC there have evidently been development of complex societies, organised in chiefdoms, in several areas of the Amazon (Roosevelt, 1999). Little is known about these pre-European populations, but examples in the region of massive earthworks suggest that the populations were sedentary and practised intensive agriculture. Huge labour investments were made in soil management, as for instance in the mounds systems found at the Majaro Island in Brazil (Roosevelt, 1999) and in the relics of thousands of raised fields at Llanos de Mojos in Bolivia (Denevan, 1998). The earthworks made permanent cropping possible by transport of alluvial silt to fields from rivers and incorporation of organic matter. The labour investments in turn indicate large-scale and long-term occupation of the land. Other striking evidence of large sedentary populations are the areas of "anthropogenic Indian black earth", *terra preta do índio* (and the lighter brown soil *terra mulata*). The Indian black earth was formed by human activity; an accumulation of kitchen residues, ash and charcoal, and the impacts of intensive cultivation (Denevan, 1998, Smith, 1980, Erickson, 2003).

The agriculture practised by these pre-colonial peoples probably looked quite different from how it is practised today in the Amazon. Denevan (1998) argues that extensive swidden agriculture (which is what most indigenous and native non-Indian Amazonian populations practise today) was probably quite rare. Too much time and energy would have been required for felling large, hardwood trees without metal axes. Denevan reasons that once a field was established, it was likely to have been used for many years and therefore that pre-Columbian agriculture had a more permanent character than today's rotation swidden farming systems.

Three kinds of prehistoric fields can be identified on the basis of archaeological findings in the Amazon area; (1) Floodplain cultivation where annual crops were obtained; (2) Raised field ridges, platforms and mounds located in seasonally flooded savannas, probably cultivated continuously; (3) Semi-permanent *terra firme* (upland) cultivation with short-fallow systems integrated with permanent gardens and managed agro-forestry (Denevan, 1998). Little of this agricultural engineering is present in the Amazon today; the Spanish and Portuguese colonisation had severe implications for the indigenous populations as well as for the local agriculture. It is estimated that as many as 90% of the indigenous population died after the arrival of the colonial invaders into Latin America and the Caribbean, and a similar percentage is also conceivable for the Amazonian societies (Clement, 1999a, Heckenberger et al., 2007, Smith, 1999). The societies that survived diseases, warfare and slave raids could not continue their sedentary horticultural lifestyle. In order to survive they had to leave their fertile lands and moved into poorer *terra firme* land (upland). The surviving Indians moved to areas where it was harder to find them, but where it was also more difficult to perform agriculture. They survived mainly as trekkers and foragers (Balée, 1995). During this process, the cultural forests created by human activity, and native crops and varieties, disappeared and Amazonian agricultural landscapes and knowledge were lost (Clement, 1999a, Clement, 1999b, Smith et al., 1999). With time, secondary succession turned into mature forest and most of the pre-Columbian agriculture was forgotten. Nevertheless, traces of pre-Columbian farming, such as the areas of *terra preta* earth and the anthropogenic forests noted by the presence of high numbers of indicator species (Balée, 1989), are recognized and valued by farmers in different parts of the Amazon even today (Smith, 1999, Smith, 1980). There are also present times examples of locally specific and highly diverse Amazonian agriculture, created both by indigenous groups (e.g. Balée and Gély, 1989, Hecht and Posey, 1989) as well as by groups of native non-Indians (e.g. Padoch and de Jong, 1992, Chibnik, 1995, Hiraoka, 1992).

1.2 Background

During the 20th century the exploitation of the Amazon has intensified. Since then the Peruvian Amazon has passed through successive eras of commodity-based economic booms based on wood, rubber, coffee, maize, cotton, coca and rice etc. that in consequence have stimulated people to immigrate into the area. Large-scale immigration started in the 1960s and 70s when the Amazon region became more accessible as new major highways were opened. The immigration process triggered the expansion and intensification of the swidden agriculture system, in many areas beyond the recovery capacity of the native forest system. A large part of the deforestation is attributable to the increase of swidden agriculture in new areas of primary forest, but there is also an increased use of imported forms of large-scale settled agriculture that are not necessarily adapted to the biophysical and socio-economic environment of the region (such as pastures, irrigated rice production, mono-culture of oil palm). The effects of deforestation and intensive monocultures are visible in terms of erosion and land degradation. The highly weathered acid soils, relatively low in available plant nutrients, are vulnerable to rapid land degradation if the natural vegetation is removed (see Section 2.3.2).

Today, many Amazonian families who support themselves by means of small-scale agriculture are experiencing declining access to land, a high rate of deforestation, erosion and land degradation, decreasing harvests, declining biodiversity and crop diversity, fast population growth and other livelihood pressures. They increasingly perceive land degradation in their own fields, with measurable effects in terms of decreasing harvests, a higher weed pressure and fewer crop varieties. Many Amazonian farmers are caught in a vicious circle of having to shorten fallow periods or moving to areas of primary forest (Fujisaka and White, 1998), which results in a greater exposure to harvest variation and higher pressure on the virgin forest.

1.3 The changing context

The study area is situated in the province of San Martín, on the easternmost slopes of the Andes where the mountain range meets the Amazon basin (the area is further described in Chapter 2). Over the last decades, life in San Martín has changed drastically. The drivers, pressures, states and impacts of these changes are analysed in Table 1.

Table 1. *Drivers, pressures, states an impacts of change experienced by the farmers in the study area.*

Drivers	Improved terrestrial infrastructure, commodity based economic booms, large scale (mainly) Andean immigration
Pressures	Change from agriculture as a subsistence activity to a cash generating activity, population growth, increasing deforestation, decreasing possibilities to hunt, agricultural enterprises diminishing in area and/or complexity
States	High rate of deforestation, increasing numbers of small-scale farmers, loss of agricultural and wild biodiversity, agricultural production increasingly focussed on maize as the cash crop, nutritionally unbalanced and biologically improvised soils
Impacts	Farmers working on marginal lands, decreasing fallow periods, soil erosion, loss of agricultural productivity, increasing weed problems, higher exposure to harvest variations
Responses	Inter-linked crises perceived by farmers, who evolve new measures to moderate the cause or deal with the consequences

Source: Marquardt Arévalo, this thesis

Before the highway Carretera Fernando Belaunde Terry was constructed in the 1960s, all transport was by foot or by river boat. The inhabitants in San Martín used to trade their produce with people in the lowland, going downstream on rafts and boats to the cities of Iquitos and Yurimaguas. The boats would have up to three decks filled with produce such as fruits (citrus, coconuts, avocados etc.), palms, cows, and even stones for use in construction. People would come back upstream with local delicacies such as dried fish (*paiche*) and turtle eggs, but also kerosene, fabricated products such as textiles, soap etc. This commerce and the river transport still exist today, but with the construction of the highway and the airport in Tarapoto, these riparian activities have become very much reduced.

Several parts of San Martín have passed through a recent period of "coca fever". In the 1980s and 1990s higher price on the international coca market coincided with a depression in agriculture in San Martín (APECO, 1995) and a lot of farmers left food cropping, cut down their forests and focused on producing coca. When coca production reached its peak in San Martín, more than 200 000 hectares were estimated to be in coca production (Lay, 1994). Coca offered extremely high profits to producers, but it also led to social instability and a level of violence that seriously affected many rural families in San Martín (Lay, 1994). The expansion of coca production, in combination with the activities of the guerrilla group MRTA (*Movimiento Revolucionario Túpac Amaru* and in the southern part of the region also the guerrilla group *Sendero Luminoso*) led to a strong military presence in the area. The MRTA and the Peruvian military were both present in many villages, including the two villages where this research took place, for almost a whole decade (between the years 1985-1995) (Comisión de la Verdad y Reconcilación, 2003).

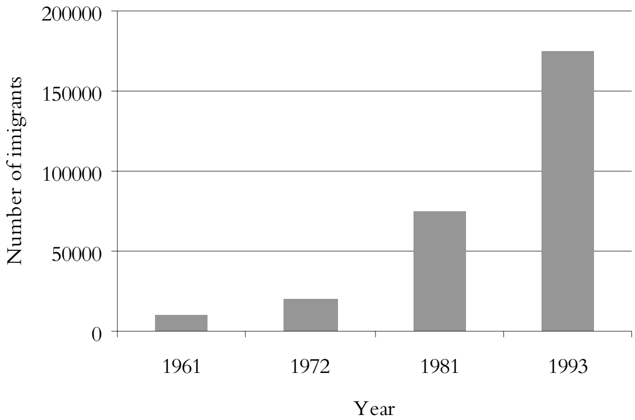


Figure 1. Number of immigrants to San Martín from 1961 to 1993. Source: elaborated for this thesis with statistics from the National Institute of Statistics and Information of Peru (INEI, 2006).

Large-scale immigration to San Martín began with the construction of the highway, the high coca profits and later also the booms in coffee and rice production. During the years 1961 to 1993 the migrant population increased from around 10 000 to around 175 000 persons (see Figure 1, INEI, 2006). The migrants are mainly people from the Andean part of Peru (INEI, 1997) searching for agricultural land. They are known as "people from the mountains" (*"serranos"*), attracted by the low land prices and the abundance of "land without an owner" in San Martín (though the forests are formally owned by the Peruvian state). Necessarily, most of the migrants arrive with agriculture knowledge based in a very different ecological context. This could create problems, as when the Andean people open very large fields, giving little value to the forest or to fallow in their production system, as stated by many farmers participating in this study. However, it also provides opportunities to bring new agricultural knowledge to the area, enriching the knowledge base through processes of natural and deliberate blending.

There are now several villages and even complete areas in San Martín exclusively inhabited by Andean people. The area of San Martin is 51 153 km^2 (an area larger than for example Costa Rica). With a population of 695 106 in 2005 and a population density of 13 persons per square kilometre, San Martín is still relatively sparsely populated (INEI, 2005). However, it is also calculated that more than half of the province consists of areas not suitable for agriculture (INEI, 1997). The agricultural area in the province has increased by 36% (INEI, 2007b) and 18% of the natural vegetation has been removed (INEI, 2007a). In year 2000, 1 644 577 hectares of the San Martín province were deforested, which corresponds to about 30% of the provincial territory. It is estimated that San Martín has had the highest deforestation rate per year in Peru (between 1985-1990, INEI, 2007a).

The majority of farmers in San Martín are small-scale farmers; more than 50% have access to less than ten hectares (INEI, 1996). The majority are working with swidden agricultural techniques without using any pesticides or mineral fertilizers (INEI, 1994). Production has become oriented particularly toward maize (*Zea mays*); it has become the dominant crop in San Martín, covering a third of the cultivated area. Plantain *(Musa spp.)* production covers a quarter of the cultivated area. Rice (*Oryza sativa*) and cassava (*Manihot esculenta*) are also important crops (INEI, 1996). Whereas 50% of the maize and rice is produced for sale, 70% of the plantain and cassava are grown for own consumption (INEI, 1996).

The fast changing land conditions (see Table 1) means that farmers are experiencing real problems of land management. As the title of the thesis indicates, these are *burning changes* for the farmers: literally, because the use of burning (fire) in swidden agriculture changes the biophysical resources the farmers work with. The title also refers to the severity of the problem of land degradation: it is perceived as "too hot" for many farmers (as well as becoming a "hot topic" in the global community). The farmers feel an urgent need for new farming knowledge in order to be able to maintain their families under such conditions. This thesis is about the responses which might be found among the farmers facing such *burning changes* in terms of active management of agro-diversity. The thesis is also about how such processes of endogenous evolution of farming systems could be supported by us, the outsiders.

2 An introduction to the study area, villages and farmers, and the collaborating NGO

2.1 The area

Along the eastern side of the Andean mountain region in Peru, big rivers like the Marañón, Huallaga and Ucayali flow north to enter into the biggest river of them all; the Amazon. This is the eastern region of Peru, known as *la selva* (the jungle) and the upper part of the Amazon basin. It covers 60% of the Peruvian territory (78,5 million hectares) and is divided into the highland forest (*selva alta*) and the lowland forest (*selva baja*) (Gazzo, 1982). The highland forest covers the final hillsides of the Andes, where it meets the Amazon forest (between 500 and 2000 m.a.s.). The highland forest temperature is cooler and not quite as humid as further down the basin. Typically, the area consists of steep-sided canyons covered by forest, where the river occupies the floor of the canyons and where there are sometimes small, flat areas along the river beds (Lathrap, 1970). The agricultural environment where most of the small-scale farms are operating in the *selva alta* area is therefore a hilly area of narrow valleys where numerous small rivers and streams flow down the slopes and into the bigger rivers. Due to its location in-between two ecological zones, it hosts a rich biodiversity and it is considered as a biodiversity "hotspot" which should be prioritized for conservation (Myers et al., 2000). In contrast, the lowland forest (*selva baja*) is a very flat area, reaching from eastern Peru across the continent to the mouth of the Amazon River in eastern Brazil. In the lowland forest area, the wide rivers often meander, flowing in multiple channels that encompass huge lenticular islands. Large areas are easily and periodically inundated (Lathrap, 1970). Figure 2 shows the regional landscape in profile.

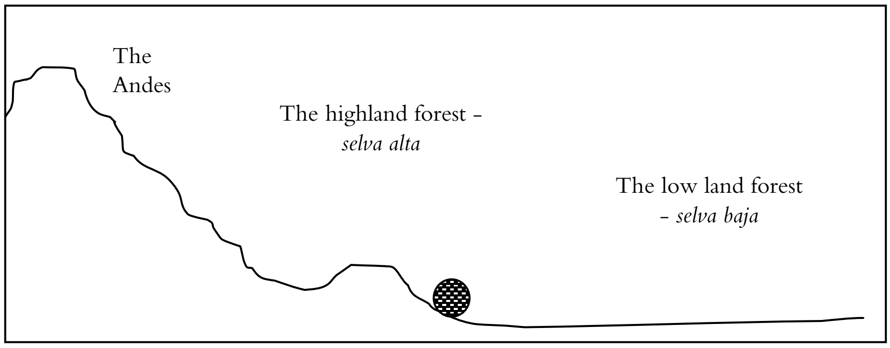
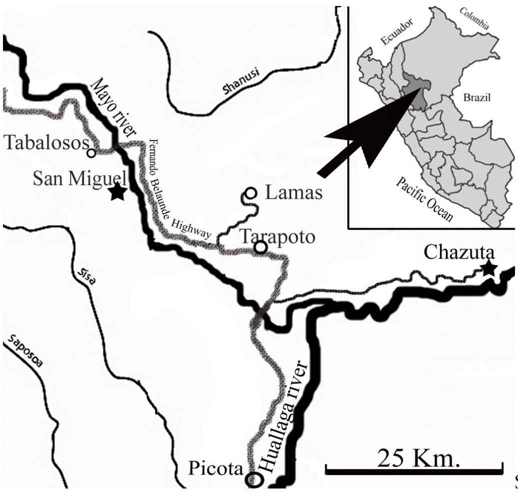


Figure 2. The Western part of the Amazon basin in profile. The patterned circle in the picture shows the location of the study area which is shown on the map in Figure 3.

The study has been carried out in the villages of San Miguel del río Mayo and Chazuta, situated in the province of San Martín in the highland jungle (*selva alta*) of Peru (see map, Figure 3). The provincial capital of San Martín is Moyobamba. However, since the highway *Carretera Fernando Belaunde Terry* was constructed (in 1968) and connected the region with the coast, it has been the city of Tarapoto which has developed into the commercial centre of San Martín. In the next two sections, life in San Miguel and Chazuta is introduced; for more details about the villages see Papers I, II and III.



Source: Alex Arévalo Vásquez, this thesis

Figure 3. Map of the study area in the province of San Martín, Peru, where the two villages San Miguel and Chazuta are situated.

2.2 The two villages

2.2.1 San Miguel

San Miguel is situated on the border of the river Mayo (see Figure 3 and Figure 4) and the highway Carretera Fernando Belaunde Terry. When going to San Miguel from Tarapoto, one passes first through flat areas on the edge of the city, dominated by irrigated rice cultivation. Where the highway approaches the river Mayo (see Figure 3), the landscape becomes more hilly with fields and bushy fallows covering the slopes. There is no primary forest along the river Mayo anymore, but intact forest may still be found four to five hours' walk into the valley system. However, the forest frontier is rapidly moving further away from San Miguel and other villages along the river Mayo. Going from Tarapoto to San Miguel by public transport (collective cars and minibuses), one reaches the villages on a paved road in 40 minutes which gives the farmers in San Miguel good access to one of the major markets in the region (the city of Tarapoto).

Figure 4. San Miguel del Río Mayo, 2003. Photo taken by Marquardt Arévalo.

With its 282 households (latest available statistics, INEI, 1993a), San Miguel is one of the larger villages along the lower part of the river Mayo, whose inhabitants make their living primarily from agriculture. The farmers interviewed during this study were mainly small land holders operating less than 10 hectares within one and half hours walk from the village. Maize (*Zea mays*), cotton (*Gossypium*) and several kinds of beans (*Vigna unguiculata, Vicia faba, Phaseolus vulgaris, Cajanus bicolor)* are the crops traditionally associated with San Miguel and are often intercropped in the same field. Maize is appreciated for various purposes; as a cash crop, as chicken and pig feed, and when ground it is also used for pastries and to make *chicha* (the local maize beverage, prepared by cooking ground maize with sugar and spices). The cotton grown is a *G. barbadense* subspecies with white but also coloured cotton in nuanced shades of brown. The area of the lower part of the river Mayo (Bajo Mayo) is known for its richness in bean varieties. During a seed market organized in 1993 in Bajo Mayo, 42 bean varieties were recorded (Rengifo et al., 1993). The farmers also grow plantain (*Musa spp.)*, cassava (*Manihot esculenta*), rice *(Oryza sativa)*, coffee *(Coffea Arabica)* and some vegetables like tomato *(Solanum lycopersicon*), sweet peppers *(Capsicum spp.)*, spring onions *(Allium fistulosum)*, herbs like coriander *(Coriandum* and *Eryngium foetidum*), local tubers like *dale dale (Calathea allouia)*, yam *(Dioscorea trifida)*, fruits like mango *(Mangifera)*, guaba *(Inga edulis)*, avocado *(Persea americana)*, rose apple *(Syzygium jambos)* etc.

The river Mayo never contains as much fish as the larger river Huallaga, and fishing is not practised as much in San Miguel as in Chazuta. With less access to intact forest, hunting has become quite a rare activity in San Miguel, but the farmers catch and shoot smaller animals that have their habitat in the agricultural fields. Until a few years ago, the only way to reach San Miguel from the highway was to cross the river Mayo in canoe (as during my first visit to San Miguel in 1996). Today there is a bridge that facilitates the traffic of people and products to and fro.

2.2.2 Chazuta

Figure 5. Chazuta, 2003. Photo taken by Marquardt Arévalo.

Going from Tarapoto, first on the highway Fernando Belaunde Terry in the direction of Juanjui, and then continuing on the dirt road, one reaches Chazuta on the borders of the river Huallaga (see Figure 3 and Figure 5). It is a two hour car journey on a winding road of extremely bad quality along the river Huallaga on one side, and steep mountains covered with primary forest on the other. Closer to the village, the hilly landscape flattens out and the huge flat Amazon basin begins. Chazuta was established in 1857 and was placed in the border between highland and lowland forest, strategically located for commerce at the time when the rivers were the most important means of transport.

With its 710 households, Chazuta (Banda Chazuta included) is larger than San Miguel (latest available statistics, INEI, 1993a). There are areas of primary forest around Chazuta that are still accessible to the village households (though these areas are becoming more limited), and hunting and fishing remain important food resources for most villagers. Behind Chazuta rises the Blue Cordillera (*La Cordillera Azul*) mountain massif. It has recently been declared a national park and several institutions are now working on how the national park should be managed. This will mean changes in the villagers' access to the forest and forest products.

The majority of the farmers interviewed in Chazuta had access to more land (where 50% of the interviewed farms had more than 25 ha) than in San Miguel. The greater part of the agricultural land is within four hours' walking distance from the village. Walking from the village on the paths leading to the fields, you reach primary forest after about one hour. This primary forest has owners who have legal papers to their land, but walking further into the valley system (4-5 hours), you find forest "without owner" that is used by the villagers for hunting. This part of the forest is also of interest to several logging companies.

The fields in Chazuta are rich in agro-biodiversity, especially in cassava *(Manihot esculenta)*, which is an appreciated staple food. PRADERA has recorded 14 varieties of cassava in their work in the region (PRADERA, 2001). The cassava is cooked and eaten as a food dish and highly appreciated as *masato*, the local cassava beverage, prepared by the women farmers, who chew the cooked cassava, leave the cassava mass to ferment and later dilute it with water. Other crops cultivated are plantain (*Musa spp.)*, maize *(Zea mays)*, rice *(Oryza sativa*), cocoa (*Theobroma cacao*), coffee *(Coffea Arabica)*, vegetables like wild cucumber *(Cyclanthera pedata)*, herbs like coriander *(Coriandum* and *Eryngium foetidum)*, local tubers like *dale dale (Calathea allouia)*, yam *(Dioscorea trifida)*, fruits like *zapote (Quararibea cordata)*, *caimito*, *(Chrysophyllum cainito)*, *cocona (Solanum sessiliflorum)*, *majambo (Theobroma bicolor)* etc.

The river Huallaga is the largest river in the area, and life in Chazuta relates very much to the cycles of the river. Fishing has its special season during July and August when the river is low. At this time the farmers leave their fields to fish in the Huallaga, using special spots of narrow passages as catch sites. The fish is then salted and dried in the sun and can be kept for up to a year. Most agricultural production is for the household and many families are more or less self-sufficient in food. It is not even necessary to buy salt, as there is a natural salt mine eight hours' walk from Chazuta (though this salt is not recommended for eating by the Peruvian health ministry as it does not contain any iodine). Though not being so integrated in the monetary economy as for example San Miguel, the farmers in Chazuta need to generate cash to cover costs for school education and medical care.

2.3 Farmers and farming systems in the two villages

2.3.1 The farmers

Most of the inhabitants of both villages, are people of mixed indigenous and mestizo origin, have lived in the area for several generations (see photo in Figure 6). This category of farmers is called native non-Indians in the Paper I, II and III, distinguishing them from the indigenous farmers (the *Kechwa-Lamista* people) in the area, and from the recently immigrated colonist farmers (mostly Andean people). The native non-Indian group of farmers can be compared to *ribereños* in the Peruvian *selva baja* context and *caboclos* in the Brazilian Amazon. Even though native non-Indians in many parts of the Amazon, as in San Martín, is the dominant land managers, little attention has been given to their ecological knowledge and land management activities (Campos, 2006, Brondízio, 2004, Padoch and Pinedo-Vásquez, 2006, Padoch and de Jong, 1992, de Jong, 1996).

Figure 6. Farmers from the San Pedro *choba choba* group, Chazuta, December 2003. Photo taken by Marquardt Arévalo.

2.3.2 Soils and swidden farming

The soils in this part of the humid tropics are old geological formations which have been created during conditions of high, even temperatures and abundant water. The combination of moisture and warmth implies that most soil processes are active all year round, and therefore the soils are highly processed, acidic (pH 3-5.5, Cuevas, 2001) and with little organic content. Weathering of primary rock minerals and clay minerals, including biological processes, have been going on continuously with little interruption over thousands of years. Because of high temperatures and heavy precipitation, which continuously permit weathering and nutrient leaching, the soils in the Amazon typically have low potential for supplying nutrients to plants (Jordan, 1985a). In the soil surface there are dense networks of fine roots. This enables the rapid re-absorption of any plant material falling to the ground, back into the tree biomass. It can be said to contribute to the buffering of nutrient losses.

The classic description of an Amazonian soil is an acid Oxisol or Ultisol with aluminium toxicity, low levels of phosphorus and potassium and low effective cat-ion exchange capacity[2] (Jordan, 1985a, Sanchez et al., 1982). However, several authors indicate that there is a greater diversity of soils within the Amazon basin and in the local setting than what is often mentioned in the literature, as a result of the enormous diversity of ecosystems found in the area (Beckerman, 1987, Morán, 1993).

Most soils of the Amazon are naturally acidic, and when agricultural crops are growing the soil pH decreases further (Nye and Greenland, 1960). Phosphorus is often mentioned as the most limiting factor in Amazonian farming systems, as it is only added through atmospheric deposition (which is extremely low, except at volcanic eruptions) and by weathering of primary minerals (Schroth and Sinclair, 2003). The low plant availability of phosphorus is linked to the soil acidity, because of the changes from soluble to insoluble phases of phosphorus at low pH levels. When soil pH goes down, it is the solubility of aluminium in the soil that increases instead, and in turn this increases aluminium uptake by the crop plants. Aluminium is toxic for plants and most crops cannot tolerate high levels, as it reduces root

[2] Many essential plant nutrients exist in the soil as cat-ions. Soil particles and organic matter are negatively charged on their surfaces and the cat-ion exchange capacity (CEC) refers to the degree to which a type of soil can absorb and hold positively charged (mineral) cat-ions, and is a measurement indicating one important component of soil fertility.

development (Schroth and Sinclair, 2003)[3]. When forest or fallow is burned, the woody material turns into basic potash (K_2CO_3), which raises the soil pH. This increase in soil pH will convert inaccessible phosphorus to plant-accessible forms of phosphorus (Ewel et al., 1981, Jordan, 1985b) and it will also lower the levels of toxic elements, mainly aluminium, by converting toxic elements to less plant-accessible forms (Jordan, 1989). Table 2 sums up what happens with pH, phosphorous availability and aluminium during the burning, cultivation and fallow episodes of the swidden farming cycle.

Table 2. *The soil pH and the plant availability of phosphorus and aluminium during the burning, cultivation and fallow periods in the swidden farming cycle.*

Burning	Cultivation	Forest fallow
pH rapidly increases ↑	pH gradually decreases ↓	pH slowly increases ↑
P immediately more accessible ↑	P gradually less accessible ↓	P slowly more accessible ↑
Al immediately less accessible ↓	Al gradually more accessible ↑	Al slowly less accessible ↓

Source: Marquardt Arévalo, this thesis

As humus compounds are decomposed in the soil, soluble phosphorus are continuously leached from these (Brady, 1996, Jordan, 1989). A decrease of organic matter in the soil consequently contributes to the decrease of phosphorus available to the growing vegetation. Formation of new organic matter is a slow process which is put on hold during the cropping period, until forest or fallow species residues are sufficient to begin to replenish the soil organic matter (Wadsworth et al., 1988). One of the problems associated with burning in farming practice is that the soil's organic matter, highly important for the agricultural quality of the soil, also burns when the above ground debris burns (however the degree of carbon losses depend on the temperature of the fire, Seubert et al., 1977, Ketterings and Bigham, 2000). The burning, particularly in combination with uninterrupted cropping, may lead to continuous decline in organic matter (and other nutrient losses, especially nitrogen). This decline in organic matter is related to decrease in organic material returned to the soil, and increased mineralization rates of organic matter during the cropping period, which may further lead to acidification of the soil (Schroeder, 1995, Schroth et al., 2003).

[3] There are exceptions to this sensitivity for aluminium, such as pineapple and cassava for example.

After an agricultural field has been abandoned, the forest succession begins to generate in four main processes: regeneration of surviving crops, germination of seed in the seed bank, sprouts from roots and stems, and seed migration from other areas (Tucker et al., 1998). Fallow management thus is an important part of soil management in swidden agriculture and secondary forests are an integral part of Amazonian agricultural strategies (Alcorn, 1990, Gómez-Pompa and Kaus, 1990, Staver, 1989). The fallow is valuable as it stores nutrient ash for the next farming cycle, and its restorative capacity in terms of structure and nutrients (Szott et al., 1999), but also as a weed-break where the shade suppresses and interrupts re-seeding establishment (de Rouw, 1995). Additionally, trees can access nutrient pools from the subsoil that are not normally accessible to the quite shallow rooted crops, the nutrients can in this way be deposited in the surface layer, and (provided that there are any nutrients in the subsoil) the trees can be said to act as a nutrient pumps (Schroth and Sinclair, 2003). Trees can further contribute positively to the soil fertility by decreasing nutrient losses (in erosion and leaching) and increasing in nutrient inputs (nitrogen fixating tree species converting atmospheric nitrogen, which is chemically very stable and not accessible for most biological processes, to organic forms). Trees also contribute to improved soil structure, water holding capacity and may provide suitable microclimates for increased biological activity (Schroth and Sinclair, 2003).

As the thesis will show, even if the farmers' conceptualisation of these processes is another than the chemical one described here, these are soil processes that the farmers know about and put to use in their farming system.

2.3.3 The swidden farming cycle

Most of the agriculture in the Amazon is classified as swidden agriculture, (sometimes also called slash and burn agriculture and shifting cultivation). The swidden farming cycle starts with the farmer opening up a piece of land (See photo 1-2 in Figure 7). The clearing is usually not indiscriminate: valuable timber, fruit trees and palms near the edges of the clearings are often saved. The plant debris is left to dry in the field (photo 3) in areas where the dry season is long enough for permitting burning; in wetter areas the planting might take place without the burning, between the mulching debris material (Jordan, 1987).

The burning is a direct and indirect fertilizer, as it adds the basic potash to the soil and subsequently releases a pulse of important nutrients, (See Section 2.3.2). The fire also kills seedlings, seeds, stumps and sprouting, and thereby enables easier access to the plot and contributes with pest disinfection. Examples of the variety of burning practices used by farmers are presented in Paper I. Some plants are favoured by the fire (depending on the fire's intensity). Domesticated plants such as the *shapaja* palm *(Attalea butyraceae)* and sometimes plantain (*Musa spp*.) sprouts survive in the fallow from the last cropping period and flourish again after the burning. Some weeds are also favoured by repeated burning and in San Martín there are two weeds in particular which indicate degraded acidic lands, namely; *kasha uksha* (*Imperata brasiliensis*) and a fern *shapumba (Pteridium aquilinum)*. Such lands, low in soil fertility and heavily infested by weeds are termed "tired fields" (*tierras cansadas*) by the farmers in the area. The burning is mostly not complete; larger trunks, thicker branches and stumps are left in the field after the burning (photo 4-6).

The planting is done between remaining half-burned trunks and branches and, as the fields are often diverse in their production, the planting is frequently a successive, drawn-out process (photo 7-12). At first glance the plants in a field may appear to have been placed randomly. However, the crops are mostly carefully placed, attention being paid to the fields' local topography; soil types, poly-cropping dynamics between different crops, and the particular preferences of habitat for some crops. As the crop develops, the farmers may have to weed (photo 13-15). The need to weed varies dramatically on the conditions of the farmed land. Roughly, one can say that the more degraded the land, the more weed infestation there is likely to be. In a maize field, for example, that is made in a primary forest or mature secondary forest, the farmer may have to weed once or sometimes not at all, whereas in areas with harder land pressures the farmer may have to weed two to three times, in order to harvest anything at all.

Figure 7. Photos showing what the work in an Upper Amazonian agricultural field might look like. Photo 1-3: Secondary vegetation is slashed and left to dry. Photo 4-6: Fields where the debris has been burned. Photo 7-9: Sowing of the field, often made with a great diversity of seeds and seedlings over an extended period of time.









Photo 10-12: The crop starts to develop, note the great differences between the agricultural systems in the photos. Photo 13-15: Weeding, done with machine, often as collective *choba choba* arrangements. Photo 16-18: Three examples of what the soil might look like in a producing field.
All photos taken by Marquardt Arévalo.

When the farmer stops actively managing the field, the land will slowly return to forest again. Seed of different tree species in the soil seed bank (as well as seeds migrating from other areas) will start to germinate, sprouts from roots and stems and surviving crops will develop into a fallow (forest fallow). Depending on the farmer's access to land, the farmer will return to convert the secondary forest into a field once again, in different stages of the development in the fallow succession. When there is a secondary forest cover, the soil temperature changes and there is a shift in light insolation to the soil surface which is used for weed management (Gallagher et al., 1999). The idea of shading out the problematic weeds such as for example *Imperata* is well known by farmers in this study, as well as in other parts of the tropics (Macdicken et al., 1997, Lojka et al., 2008). Avoidance of tillage also contributes to weed management as fewer weed seeds then get exposed to sunlight and germination (Gallagher et al., 1999).

Small-scale swidden agriculture in the Peruvian Amazon has been described as both highly diverse and as rapidly changing (Hiraoka, 1986, Hiraoka, 1992, Brookfield et al., 2002, Denevan and Padoch, 1987, Padoch, 2002, Padoch and de Jong, 1992, Padoch and Pinedo-Vasquez, 2001, Padoch and Pinedo-Vásquez, 2006). Recent research highlights how small scale farmers are working with diversified agricultural systems and fallow management. In San Martín particularly NGOs have published reports that describe and analyse local small scale agriculture (Rengifo et al., 1993, Arévalo Rivera et al., 1999). This thesis seeks to contribute to such a nuanced picture of Amazonian swidden agriculture.

2.3.4 A forest-focused agrocentric perspective

Latin-American ethnopedological studies show that many Amazonian people have complex and profound relationships with plants and forest and also that the soil is seen as a part of the forest and receives treatment as an extension of the forest (WinklerPrins and Barrera-Bassols, 2004). Several researchers have described how tropical land management in the Amazon (and parts of Central America) is based on a forest and tree perspective, where forests and fallows have crucial roles in the agricultural production (Gómez-Pompa and Kaus, 1990, Staver, 1989, Alcorn, 1990). This thesis supports this perspective and seeks to explore the issue a little bit further. In previous research experience in Bajo Mayo (close to San Miguel, Marquardt, 1998), the interviewed farmers compared the Andean tradition of worshipping Mother Earth (*Pachamama*) (Ishizawa, 2003) with their own relationship with the virgin forest. Since then, the issue of a soil-focused and a forest-focused perspective of the fundaments of agricultural production seems to be a crucial issue for understanding local land management[4]. I have termed this a "forest-focused agrocentric perspective", which in this thesis is shown to include epistemological, ontological and religious elements[5]. The term agrocentric refers to a view of agriculture as the central core of life which everything in village is related to and rotate around. The collaborating NGO PRADERA names this as the farmers' *cosmovisión* and *agrocentrismo* (Arévalo Rivera et al., 1999, Rengifo et al., 1993). The local agricultural approaches based on forest perspectives have been documented by PRADERA (Arévalo Rivera et al., 1999) and PEAM (Proyecto Especial de Alto Mayo) (Spittler et al., 2003).

2.3.5 Important local institutional arrangements

Institutions are established customs, usages, practices, organisations or other principles or conventions which regulate the needs of an organised community (SLIM, 2004). Ostrom and Hess (2007:42) define institutions as "*formal and informal rules that are understood and used by a community. They are the rules that establish the working "do's and don'ts" for the individuals in the situation…*". In both San Miguel and Chazuta, there are two local institutional arrangements of particular importance for sustaining traditional land management: namely, the traditional exchange of labour*, choba choba* (called *minga* further down the Amazon basin) and the practice of seed swapping, *mujeo*. These will be extensively discussed as the "rules of the game" in the thesis. They formed important spaces for shared learning among farmers in the area. The institutions of *choba choba* and *mujeo* also established the organisational arrangements for the structure and function of the interaction between researcher and farmer, an interaction that has proved crucial for how the research process evolved and for the kind of knowledge generated.

The *choba choba* groups are formed by members of the concerned families, neighbours or other villagers. The participants make mutually convenient arrangements to work on a rotational basis in each other's fields (Hiraoka, 1992, Arévalo Rivera et al., 1999). The group members do not receive

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[4] The farmers stated that the forest in the Amazon has its "mother" (*madre*, a guarding spirit), namely the *Sachamama* (Mother Forest) (Marquardt, 1998). The *Sachamama* (Mother Forest) is expressed in the forest as a giant boa, sometimes disguised as an old tree covered with vegetation (Regan, 1993).

[5] In Paper II the forest-focused agrocentric perspective is called a forest-focused agrocentric worldview (often used inter-changeably with the term cosmovision). In this introductory chapter, Paper I and III, I prefer to use the more neutral, if less rich, term, "perspective".

payment when working on each others' fields, although the host farmer provides meals and drinks to all participants. Typically, most of the food comes from the hosting farm: hens, cassava, plantain, rice, chili, *chicha*, and *masato*. During the action research process, learning situations were arranged, as in the land recuperation experiments, framed by the traditional institution of *choba choba*.

The agro-biodiversity is an important characteristic of the agricultural system in San Martín. The genetic diversity of crop species and varieties in the fields are the result of a conscious and continuous (though to outsiders at a casual glance sometimes quite invisible) process carried out by the farmers in order to maintain the genetic diversity in their fields (Salick et al., 1997, Peroni and Martins, 2000). The institution called *mujeo* allows farmers to swap seeds and vegetative plant materials with each other, as well as sharing the knowledge of how a particular crop or crop variety should be sown and nurtured (Arévalo Rivera et al., 1999, PRATEC, 1998, PRATEC, 1997, Rengifo et al., 1993). The word *mujeo* also relates to the word *muju,* that is, the seeds selected and saved (mainly by the women) for sowing next season. The exchange of seeds and vegetative plant materials occurs in a local context, between fields, but also between different villages or provinces (Badstue et al., 2006, Arévalo Rivera, 1997). Throughout the action research process *mujeo* activities have been promoted between the farmers (within the villages and between the villages) as well as between PRADERA and the farmers.

2.4 PRADERA

PRADERA (*Proyecto de Apoyo Rural de la Amazonía*) is a small local NGO that will figure a great deal in the thesis. PRADERA was born out of frustration with the agricultural development work in the area of San Martín in the 1990s.

2.4.1 Organizational background, mission and strategy

In a context where NGOs often have assumed roles in developmental work previously handled by the state (e.g. rural credit system, extension, research, management of national parks) or commercial organizations (e.g. promoting certain crops or products) (Bebbington, 1997), PRADERA began questioning why agricultural services did not conform with farmers' everyday reality. Alcorn (1989) argues that traditional agricultural thinking in the Humid Tropics is ideologically different from that of trained agronomists. For instance, traditional farmers focus on processes rather than on discrete items and spatial structures. In traditional farming in San Martín this can be exemplified by its loose boundaries of time and space in the farmed field; crops are mixed with each other in irregular patterns; processes of sowing, weeding, harvesting are occurring almost continuously throughout the year with different crops in the same field. Such complex integration of farming activities and diverse production is often not spoken out loud and therefore may be difficult for an outsider to explore or ask about, as the outsider has pre-conceived expectations of the farming system. In traditional agricultural thinking (ideology) meaning is expressed through work (what people mean is constituted in what they do, meanings are expressed in actions). Meaning is also constituted in local expressions, which is a rather neglected field of research. This neglect is important from a developmental as well as scientific point of view, as this bias may limit what an outsider can observe, hear and document in a local agricultural system. During the last fifteen years PRADERA has focussed its activities around local agricultural activities and expressions and the potential of traditional swidden agricultural practices. In a close collaboration with farmers in Bajo Mayo (where San Miguel is situated) and Bajo Huallaga (where Chazuta is situated), its emphasis has been to grasp farmers' holistic perspectives of agriculture and natural resources (their worldview, *cosmovisión*).

PRADERA's institutional role has been described by the staff (see Paper IV) as that of "holding a sensible dialogue" with rural people, where they highlight local and traditional knowledge (in contrast and as complement to scientific knowledge). The institutional mission is to join (co-operate) with farmers' efforts to re-establish their agricultural areas using a holistic perspective, which includes re-establishing productive fields and also the forest, and the collective life of the family and the village, with the conviction that farmers do have an important and organised fund of knowledge and do act rationally within their own world. PRADERA's everyday work is oriented towards the farmers' agricultural practices in the field, and the staff use their own participation in the agricultural work as a working technique to reach the farmers. PRADERA focuses a lot of its work around local institutions as the staff view these as carriers of knowledge and natural arenas for farmers' learning (see Paper IV).

2.4.2 The collaborative partnership formed by this research

My previous experience of collaboration with PRADERA's staff (Marquardt, 1998), inspired me to continue to work within the field of land management in small scale swidden agriculture. This collaboration has influenced the direction of this research (for the design of the research process see Chapter 5). PRADERA facilitated the contact with the farmer groups in both villages. The emerging design of the action research process was continuously discussed with PRADERA. The facilitation of the workshops arranged together with the farmer groups, the farmer group visits between the villages and the collective land degradation experiment fields in the two villages were designed as collaborative activities between PRADERA and the author. The PRADERA staff also has been an extremely valuable discussion partner throughout the research process. The joint action research that culminated in collective experimental fields, is described in Paper II.

3 The research problem and research questions

3.1 Problem statement

Land management is a crosscutting issue of direct relevance to both development and research activities in the Amazon. Today many Amazonian swidden agriculture farmers are caught in a vicious land management circle, of shortening fallow periods and movement further into new areas of primary forest. Most interventions in the land management problematic have focussed on implementation of external expert advice based on knowledge originating from universities and experimental stations (Biot et al., 1995). However, though the adoption of this advice by local farmers has often been limited, (Fujisaka et al., 1994) the latter have made their own responses to land management challenges (see Table 1). These responses have not been much researched. During earlier work in the area (Marquardt, 1998) I had observed farmers taking various actions related to erosion and land degradation, for instance, though neither these actions, nor the farmers' logic underlying these measures, were emphasized as a potential in local land management by the local university or by the majority of the agricultural NGOs in the region. This research therefore focuses on farmers' experimentation and learning processes related to farmers' own approaches to land management problems.

3.2 The initial research objective and research questions

When this research began, the objective was to document and analyse farmers' responses to land degradation and declining soil fertility in small scale swidden agriculture in the Upper Amazon, from the farmers' perspective. The initial research questions were: (1) What are farmers' perceptions of soil fertility and land degradation? (2) How do innovative farmers deal with land and soil fertility challenges, especially in terms of strategies, techniques and knowledge management?

3.3 Redefining the research questions through action researching

The initial research questions, on a quite detailed soil fertility knowledge level, became the entry point to the land management topic. The land management techniques in turn opened the door to the farmers' interest in wider collaboration. However, the action research process led to a redefined focus. The research questions were re-developed and re-defined as the research objective moved towards exploring land management in a wider sense than initially planned. Exploration of how farmers learn about land management, and what type of learning environment enables farmers to learn and experiment with land management options, allowed me to develop a new understanding of what was at stake. The deeper additional set of research questions that emerged were: (3) What are the resilient components in Upper Amazonian agriculture? (4) How can farmers' learning processes be supported from outside? (5) Can action research methodology contribute to practical implementation of resilience theory, and if so, how? This research contributes to the foundations of an answer to these three emergent research questions, but further work is needed to fully and adequately respond to them.

The confrontation between these five questions and the empirical and experimental data has generated four papers:

- Paper I describes the diversity of land management activities in agricultural systems and the agricultural relevance of the farmers' land management.
- Paper II examines the action research process from a critical perspective. It finds that land management learning processes are slow processes, that there are no shortcuts if we want to achieve change, but that close interaction between researchers, development workers and farmers can support the learning process that accompanies and sometimes drives change.
- Paper III analyses farmers' land management knowledge and action from the perspective of resilience theory. It discusses how the

agricultural diversity presented in Paper I, and farmers' preference of experiential learning could reinforce systemic resilience.

- The last Paper, IV, examines the working approach of the NGO research collaborator, PRADERA. Its commitment to starting from the farmers' perspective and practices, and its respect for local social institutions' effectiveness as spaces for knowledge generation, are of particular concern here. Analysis allows discussion of the kind of continuous, intrinsic learning an organization must achieve in order to develop relevant farmer support in the field.

4 Theoretical and conceptual framework

4.1 Action research

The action research methodology originates from Lewin's (1946, 1952) thinking on how to develop relationships between social science research and the concerns of people in society (Flood and Romm, 1996). Lewin argued that scientific research should be used for improving societal problems, and by means of the researching process, thereby allow the outcome of the same to result not only in research findings, but also in action. Since then, several branches of action research have developed, including: emancipatory action research (Fals Borda, 2001), participatory action research (Whyte, 1991, Castellanet and Jordan, 2002, Kemmis and McTaggart, 2000), community-based action research (Stringer, 1999), action research from a pedagogical perspective (Freire, 1972), action research from a collaborative inquiry perspective (Reason, 1994, Svensson, 2002a), action research in education (Whitehead and McNiff, 2006), action research in an organizational learning perspective (Argyris and Schön, 1996), and action research in change management (Dick, 1997, Zuber-Skerritt, 2001).

As indicated above, action research varies in focus, and presents a range of different perspectives, methodological choices and target groups. However, Reason (2006) argues that there are core characteristics of action research in terms of choice and quality: viz it addresses practical purposes; is made with, for and by people in a democratic and participative process; researchers are deeply involved; many ways of knowing are acknowledged; and it accepts that it is impossible to design a fixed blueprint for the action researching process in any particular context because the process is an emergent development form. Dick (2000) simply describes the essence of action researching as cyclic, participative, (mainly) qualitative and reflective. An action research approach by implication is systemic, striving for action and change through learning about and improvement of situations described as problematic by the participants themselves (Dick, 2000). Reason and Bradsbury (2001:1) further add, with reference to the practical purpose of action research, that is: *"seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons in their communities"*.

The rigour of the research is built into the approach by an iteration, specifically an iterative process of critical questioning and interpretation that combines collection of "working data", interpretation, further cycles of enquiry and shared reporting (Dick, 2000). (For the iterative process followed in this research see Chapter 5). As the research unfolds as an iterative engagement with a concrete situation both change and understanding can be pursued through the cycles of action and critical reflection. Review of previous actions leads to the planning of new cycles of action. Action research is innovative in so far as it focuses on facilitation of interaction and quality of dialogue (Ljung, 2001). The researcher both contributes to and facilitates the learning process in the specific problem situation. The action research learning spiral, constituted in the iterative cycles of planning, action, observation and reflection, has potential to create self-organizing learning processes. The action research approach may thus be considered especially useful in complex social settings where it is hard to define the exact nature of the problem, the boundaries of the system of interest, or the vital research questions at the outset (Dick, 2000).

There are consequences of the choices that action researching entails, that do not sit comfortably with conventional research norms. For instance, it is impossible to control and fully anticipate what actions might unfold. The action researcher must therefore develop skill in handling the unpredictable and in catching the opportunities that present themselves along the way (Flood, 1999) as illustrated in Box 1.

Box 1. *Instructive "failures" along the action researching process.*

Rabbits ate up all the cover crop (*Mucuna*) in one of the experiment fields. However, this "surprise" – conventionally labelled a "failed experiment" and not reported - also lead to new opportunities. The "failure" generated farmer discussion on alternative crops as useful soil cover for weed management. In another experiment field the group (due to intensive rains) had decided not to burn the opened field. They intended to mulch the slashed debris and had planted the whole field with tree seedlings. A neighbour, innocently wondering why the field had not been burned, decided to go ahead and burn the field – and the seedlings. This generated discussions on the need for the group to develop a certain level of formalisation in order to be recognised as contributing to the learning experience of the whole village.

Source: Field notes from Chazuta, January and February, 2004.

Action research has been criticised on two main grounds: validity and the researcher's role (Waterman et al., 2001). Critics claim that action research usually does not generate objective knowledge and repeatable scientific experiments, which are key guarantees of validity in science. Action research does not exclude the possibility that participants may choose to investigate a problem also by means of scientific measurements. However, more typically action research seeks rigour and validity from a different perspective. Checkland and Holwell argue that action research is recoverable instead of repeatable, recoverability helps to maintain the rigour of performance and to justify validity of generalisations and transferability within the research approach (Checkland and Holwell, 1998). The intellectual framework (the epistemology) used in a research process, enabling interpretation and conclusions, is explicitly stated and must be presented as part of the results and be possible for an outsider to follow (Checkland and Holwell, 1998). Action research generates defensible generalisations in terms of exploring research themes (Checkland and Holwell, 1998), by descriptions, and by comparing case studies (Svensson, 2002b). Svensson argues that this is a valid relational research approach instead of a relativistic shortcoming (2002b). In other words, generalisation and validity within action research can be understood as capturing the uniqueness of a situated problem, and as trying to explain this uniqueness by maximizing the variation and recognising similarities in different situations (i.e. by using results from different case studies or to move the results to a similar context) (Svensson, 2002b).

Action researchers are also criticised as being too involved in the research process, so that the researcher becomes incapable of separating herself from the research process and of losing her objectivity. However, this closeness between the researcher and the researched is seen as a requirement (rather than a weakness) in action research in creating conditions favourable for understanding practice and promoting appropriate change (Waterman et al., 2001). Svensson (2002a) notes that the quality of any interactive research, is very much dependent upon the relation between the researcher and other participating actors. My own action researching experience heads towards what Svensson (2002a:11) calls *research with – a joint knowledge production*. Nevertheless, the degree of community in the research process can be questioned throughout the phases of the research process. Although the outputs of this research were recorded on farmers' terms, as well as in formal research records, the formal writing phase has not included the farmers or PRADERA at all (see Section 5.1.2).

Another of the foundation stones of action research methodology is the importance of being self-critical. In action research the action researcher's own learning process comes under scrutiny in an explicit process of striving to develop self-reflective practice. The iterative structure of reflection and action in action research is a tool that enables a constant critical reflective review of the researcher's own role (and results) to become established in the research process, as well as creating a certain distance from the research activities to enable such a critical view. In my case, the process of developing self-reflectivity was enabled by the continuous dialogue with the farmers, PRADERA, my supervisors at SLU, my supervisors at CIAT and by keeping a carefully detailed research diary as prompt for internal dialogue.

4.2 Action learning

The concepts of action learning and action research can be viewed as closely related concepts which overlap in terms of active learning, problem solving and systemic inquiry (Zuber-Skerritt, 2001). However, action learning and action research originate from two quite different fields of interest that have influenced the development of their methodology. Action learning was introduced by Reg Revans in primary business management and development, and action research was developed from Kurt Lewin's work for improving social conditions. Action research as a *research* process aims to be systemic, rigorous, open to scrutiny, verifiable and always made public, which is not necessarily the case in an action learning process (Zuber-Skerritt, 2001). In the presentation of the action researching process used in this study, the term action learning is used for the learning that took place within the framework of an action researching process.

Problem-solving is an important aspect of learning in the context and environment where I have worked. I will use Kolb's learning cycle (Kolb, 1984) as an analytical framework for understanding farmers' processes of learning. Experiential learning is concerned with every-day learning (rather than with a formal educational setting, though experiential learning theory is sometimes also used as a tool in formal education). It reveals how practice and experience can be a central part of knowledge generation and learning (Kolb, 1984, Daniels and Walker, 2001). Keeton and Tate summarise experiential learning thus: *"It involves direct encounter with the phenomenon being studied rather than merely thinking about the encounter or only considering the possibility of doing something with it"* (Keeton and Tate, 1978:2, cited in Kolb, 1984:5).

Kolb's concept of experiential learning rests on the assumptions that learning is (i) a process (not an outcome), (ii) derives from experience, (iii) requires an individual to resolve dialectically opposed demands, (iv) is holistic and integrative, (v) requires interplay between a person and environment and (vi) results in knowledge creation (Kolb, 1984). A person learns by recognizing and responding to the environment and/or personal demands, in an interdependent interplay in acquisition and transformation of knowledge. Kolb's learning cycle is a conceptual model that describes this learning process as a process of concrete experience, reflective observation, abstract conceptualization and active experimentation, implicating a process of action, reflection and new, slightly modified action based on earlier experiences. The reflective activity is seen a central part of the observation. A perceived experience is constituted in acts of distinction (differentiated from other courses of events not perceived and not reflected on) (Reed, 1992). If there is no reflection upon the experience and if the experience does not stand out as something distinct or challenging in comparison to the previous action or courses of events, learning will not occur and the doing (action) will be routine rather than a developing process. Learning is constructed in the reflection about and in interaction with the surrounding world, within its particular institutional frame and context dependence (Röling and Wagemakers, 1996). Thus it is acknowledged explicitly that the kind of interaction (action) and the kind of institutional arrangements that occur will affect the kind of reflection and knowledge that will be generated in the learning process. For example, the construction of scientific knowledge and local farming knowledge can be seen as two fundamentally similar forms of learning in action which however take place in particular institutional contexts and organisational arrangements and with particular demands which lead to different types of knowledge i.e. contextual versus generalized knowledge (Waldenström, 2001). The strong implication is that it is the organisational arrangements within which learning occurs, and the design of the learning process, which set science and farming apart. The action research reported here has then stimulated learning through actions taking place within the farmers' institutional framework of learning. The design role of the action research project has been to create possibilities for reflective practice around structured experimental events situated in the practical environment that shapes farmers' learning. Kolb's model of learning might also be criticised as a simplification of learning processes where the cyclicity of the process may be questioned and where prior understanding, cultural, linguistic institutional aspects contribute to the possibility of experiencing and observing something in the first place (Kayes, 2002). Nevertheless, the experiential learning model proposed by Kolb has contributed to this thesis by emphasizing learning as a continuous process grounded in farmers' experience (Daniels and Walker, 2001). Further, action research which aims to provide a relation between science and practice, connects with experiential learning in its emphasis on learning from experience and its intention to improve practices (Dick, 1997). The iterative process of swinging between action, reflection and refined action in action research and action learning takes off from a view of learning which is founded on the experiential learning cycle (the concrete experience, reflective observation, abstract conceptualization and active experimentation).

The idea of practice as necessary for knowledge generation, where learning is seen as a process of action and reflection, connects to farmers' learning through experimentation (Haverkort et al., 1991, Rhoades and Bebbington, 1991). Farmers' learning through experimental practices, is particularly relevant in the complex reality of rural livelihoods, where this research project took place. By focusing my own research on farmers' own experiences, innovations and experimentation, I was able to explore systematically how local management of land in fragile environments can be sustained by incremental change in knowledge rather than by crises of depletion (Berkes and Turner, 2006).

4.3 Systems thinking

Systems thinking is a way of thinking about how the world is organized and of understanding the world's complexity (Checkland, 1981). In systems thinking, a "system" is a construction of something, as a dynamic whole, where the boundaries of a system is determined by the perspective of those that participate in it (Blackmore et al., 2007). The farming system in San Miguel and Chazuta, is not a visible system with physical boundaries, but it does exist as a construction which the villagers are aware of, and that is defined and delimited by the farmers' view (meaning for example that "farming" is understood to include different stages of forest vegetation). Systems thinking takes the view that a system is a construct where the components have emergent properties when the parts are understood in relation to the whole (Capra, 1996, Odum, 2007). A systemic perspective encourages a contextualized understanding, Ison (2008) suggests that research on problems in messy social situations often means that a choice of using a systemic approach is appropriate because it helps to reveal the interconnections within the system. Specific system components or phenomena identified from a systems perspective can subsequently be explored in a conventional systematic, reductionist way once problems are better defined. My systemic practice is evidenced by the way that the local farming system was explored and analysed in terms of the context, as understood from farmers' perspectives, by seeking to establish the purpose and the nature of relationships within the farming system. However, the research has not used tools such as systems diagramming as a way to analyse the farming system.

4.4 Resilience and resilience theory

Resilience theory approaches the world from a systems perspective, emphasising how the biological and human worlds are connected and interdependent (Berkes and Folke, 1998). Resilience theory was developed as a response to the problem of managing dynamic uncertainty in socio-ecological systems. In this research resilience theory has provided an understanding of social and ecological systems as integrated parts of the same system (Berkes and Folke, 1998, Berkes et al., 2003b, Gunderson and Holling, 2002, Holling, 2001, Berkes et al., 1998, Milestad and Darnhofer, 2003, Tengö, 2004, van der Leeuw, 2000, Gadgil et al., 2003). Resilience theorists have explored how to deal with change and uncertainty by developing dynamic responses to disturbances (Berkes et al., 2003b, van der Leeuw, 2000). Resilience refers to the buffer capacity, or ability of a system to absorb or adapt to disturbance (such as changes in weather conditions, population pressure, access to forest etc.) without change in structure and function. Resilience also refers to the system's capacity for learning and adaptation and to organize after a disturbance (Gunderson, 2000, Berkes and Folke, 1998, Holling et al., 1995). Folke et al. (1998) point out that several management practices (including agricultural practices) and associated social assets (including ecological knowledge, institutional structures and their dynamics, worldview and cultural values) can build up resilience by allowing disturbance and experimentation at low levels (local problems at field, farm or village level), thereby increasing resilience at the next higher level (such as farm, village, regions or nations respectively). In an overview of characteristics of farm resilience, Milestad and Darnhofer (2003) describe resilient farming management principles giving as important instances diversity and flexibility in crop planning, working compatibly with natural cycles in crop rotation and pest management, development of local market networks and, tight feedback loops at all levels and sectors. Farmers' strategies to maintain and increase resilience in an Amazonian perspective seem to be based on complex and dynamic farming systems characterized by a continuing process of experimentation within these farming systems (cf. Padoch and Pinedo-Vasquez, 2001, Smith et al., 1995). The capacity for continuous generation of knowledge about ecosystem responses to action are thought to be crucial for sustaining livelihoods based on local ecosystems. Over time the knowledge gained is integrated in local resource users' management practices, co-evolving within local institutional frameworks (Olsson, 2003, Berkes and Turner, 2006). Though the resilience component of the swidden agriculture system in San Martín need to be further researched, resilience theory has contributed as a frame of analysing which farming system's qualities have been seen as desirable in a long term perspective.

Given its focus on learning and adaptation processes, there is an overlap between resilience theory and action research. Resilient structures are today quite well described in the research literature but how do you move from description to action? Yorque, for example, asks *"How can we implement forms of management based on learning? How can we overcome difficulties at the personal level (multiple and shifting problem domains), and difficulties faced by large, bureaucratic institutions? How do we blend traditional and other forms of knowledge with scientifically based ones?"* (Yorque et al., 2002:437). Yorque et al. (2002) argue that conventional approaches will not suffice in the face of a spectrum of potentially catastrophic and irreversible environmental problems.

Therefore, research is needed to develop the necessary level of understanding that can embrace the dynamics and resilience of social and institutional structures, together with practitioners. Yorque argues for flexible institutions and human organizations that can build adaptive capacity in synergy with ecosystems dynamics and respond to feedback (Yorque et al., 2002). These are the issues that action research methodology tries to explore. My findings suggest that action research can provide reasonable answers to Yorque's questions above concerning learning for resilience, and that resilience theory adds theoretical and analytic depth to action research practice.

Resilience theory recognizes that there are many ways of knowing and that local people's (indigenous and non-indigenous) knowledge is a crucial ingredient in resilient natural resource management. When researching this knowledge, there seems to be a general agreement within the resilience literature of the advantage of participatory approaches and stakeholder involvement (Walker et al., 2002): the level of participation within adaptive management has however been questioned as not addressing questions of involvement, but emphasising a pragmatic justification for participation, and information capture (Stringer et al., 2006). All in all there is surprisingly little discussion in the resilience literature about methodological approaches to "fostering" resilience and how to reach participation within this process. Olsson and Folke (2001) for example argue that one of the advantages of complementing scientific knowledge with resource user's knowledge is to recognize the latter's practical and experimental learning, though without connecting this to any discussion about *how* the practical and experiential learning could become a point of departure for fostering resilience management in practice. In adaptive management processes, the emphasis on shared learning and dialogue between stakeholders, suggests that action research could be a useful bridge between practical knowledge and scientific ways of knowing. Berkes (1999) further mentions another bridge where practical and scientific knowledge could meet and merge, namely in the act of adaptive management, in other words, in dealing with real-life problems in action. Here is another possibility for using action research as a tool to reach such a merging in action, where action research's iterative and reflective way of approaching (adaptive management) issues by learning from practical experiences, has a lot in common with people's own experiential learning.

5 The design of the study and methods used

The direct relation to practice, the close collaboration and relationship with PRADERA and the farmers were fundamental to how the challenge of research design was met. As a researcher (and as a curious human being) I wanted to open up to the agricultural logic of the farmers, which I assumed to be different from my university trained logic, and for the research process to be receptive to anything surprising or unexpected which might appear along the way. These design principles point early on to action researching as an appropriate frame (see Section 4.1) and to grounded theory for the initial definition of the research problem. These design choices have allowed emergent development of understanding throughout the action research process, in accordance with a hermeneutical epistemology (Alvesson and Sköldberg, 2000, Ödman, 1994) that offers a methodology of sense-making. Key terms are now further elaborated.

The hermeneutical spiral is an epistemological statement of how interpretation is made in order to reach understanding. Hermeneutics is the logic of an interpretation of data. Data are understood to have meaning only as connected to the context, conversely, the context can be understood only by understanding the data about the constituents of the context (Alvesson and Sköldberg, 1994). The hermeneutic process – or in everyday language, the process of sense-making - is dynamic and aims to develop understanding by constantly shifting focus between the parts and the whole (the context) in the researching process (Kvale, 1997). These shifts become iterative circles of understanding; the understanding in one hermeneutical cycle becomes pre-understanding in new learning cycles that create new understanding that again develops new interpretations and understanding: a hermeneutic spiral will evolve (Kvale, 1997, Ödman, 1994). Alvesson and Sköldberg (2000:53) describe the evolving understanding as: *"you start at one point and then delve further and further into the matter by altering between part and whole, which brings progressively deeper understanding of both"*. The analysis becomes an interplay between explaining and understanding in a process of interpretation; this process becomes more than just the sum of the separate interpretations included in the overall interpretation and implies using different kinds of knowledge in order to achieve understanding (Ödman, 1994). This means that the research results as such are not the end product of the research, the data generated by the research enter into the flow of understanding and the conclusions remain intertwined in the research process (Gillebo, 2007). In designing my research process I thus provided structured opportunities that marked the shifts in focus between empiric data and theory-forming and between analysis and interpretation at different scales (such as field, farm, farming system, village and regional scale) of connectivity.

Grounded theory is closely connected to the design sketched above. It is associated with a methodology that emphasises practice as a way to drive theory development and implies an "empiricist" scientific focus. Its point of departure is an iterative engagement with an empirical situation (the collected empirical data become coded into interpretative categories, until theoretical saturation is reached). At this point the abstraction of underlying principles and reforming of the research questions become possible allowing a tentative theoretical framework to emerge gradually which can be tested in relation to the data (Glaser and Strauss, 1967, Alvesson, 2003). The researcher's ability to accurately represent reality then becomes manifested in collecting data, processing and analysing the data. The value of emergent theory is established in relation to the data (Alvesson and Sköldberg, 1994). These methodological preparations gave rise to the following activities:

- entry into and immersion in 'the field';
- data collection through (i) individual and group interviews (made by the researcher in the local language), (ii) workshops, (iii) field walks, (iv) crop budgets, (v) field experiments, (vi) farmer visits, (vii) participatory observations and (viii) revision of local literature and maps. All of this has been collected during more than one hundred visits made to the villages (for details on data generated see Table 3);
- formation of tentative theories about (i) forest-focussed agro-centric farming, (ii) the applicability of resilience theory to this context; and (iii) the complementarity between resilience theory and action researching.

All research activities were carefully documented by means of notes, sketches, photos, templates for planning and performing all group activities, and taping of interviews. A detailed research diary was kept throughout the whole project (McNiff, 2002) in order to retrospectively track the unfolding action research process, and as a reference for checking data captured by the qualitative and semi qualitative methods used. On each return to Tarapoto from the field, the interviews were transcribed and processed (manually) into interpretative categories based on farmers' and scientists' land management domains. The data were then analysed together with the transcribed interviews and the information about and results of the collective activities. These preliminary findings, together with the self-reflective queries recorded in the research diary, allowed the development of a tentative theoretical perspective. I then returned to the field to verify the preliminary findings, analysis, and emergent theoretical perspectives. Further crosschecking with farmers in village, with the farmer groups separately and when the groups from the two villages coming together in the field, and with local NGOs and professionals, allowed the emergent understanding to be further tested. These encounters also served to mark any changes in individual and collective learning. By means of a process of naturalistic enquiry, in the form of informal conversations, participant observation and in sharing practical work, it became possible to further validate emergent research data and interpretations. Over time, following iterated cycles of these steps, the local framework for practising land management emerged.

Table 3. *The research activities and data generated, blue colour signifies interviews, dark yellow - workshops, green – field experiments, orange - farmer groups visits. Figures refer to number of farmer participants in the activity.*

	Research stages	San Miguel	Date	Chazuta	Date
	Exploring farmers' land management				
	"Reading the context" semi-structured in-depth interviews	*10*	*June-July 2002*	*9*	*Aug-Sept 2002*
	Crop budgets	*7*	*June-July 2002*	*9*	*Aug-Sept 2002*
	Semi-structured in depth interviews on local land management techniques	*13*	*May 2003*	*11*	*April-May 2003*
	Preparative workshops	*4*	*15th of Feb 2003 (17 farmers), 3rd of May 2003 (15 farmers), 4th of Oct 2003 (15 farmers) and 24th of April 2004 (14 farmers)*	*3*	*18th of Feb 2003 (15 farmers), 25th of March 2003 (19 farmers), and 15th of Nov 2003 (12 farmers)*
	Farmer experimentation				
	Practical work in the experiment fields	*12*	*About once a month since 13th of Oct 2003 to March 2005*	*17*	*About once a month since 30th of Dec 2003 to 7th of July 2004 in field I and since 6th of December 2003 to March 2005 in field II*
	Farmer groups visits	*4*	*- Visiting a local farmer successful at recuperating degraded land 11th of Oct 2003* *- Visit to Chazuta: 24-25th of March 2003, 28-29th of June 2004, 17-18th of Mars 2005*	*3*	*Visit to San Miguel: 5th of April 2003, 2-3rd of May 2003 and 23-24th of April 2004*
	Semi-structured in depth interviews on the experimentation and institutions	*6*	*July 2004*	*9*	*July 2004*
	Institutionalisation of learning processes				
	Methodological workshop with the collaborating NGO PRADERA	*2*	*13-14th Jan 2003 in Tarapoto (10 participants from three different NGOs)* *23rd of Feb 2004 in Lamas (14 participants from four different NGOs)*		
	Semi-structured interviews with PRADERA staff	*10*	*March 2005*		

Source: Marquardt Arévalo, this thesis

5.1 How the action research process was designed

Conceptually, the research design was executed as three explorative working phases. During each of the three working phases, a specific theme was emphasized: during working phase I - agro-ecosystem characteristics; during working phase II – farming system resilience; and during working phase III - institutionalisation of learning process. Throughout the different phases of the work, there were three recurrent and all-pervading core subjects: namely agro-diversity, farmers' learning and institutions. The ensuing process of knowledge development is depicted in Figure 8. It visualises how the emphasis has shifted during the phases of the work, but also how the three core subjects have informed the research process. The thematic focus in the working phases created a close understanding of the local agricultural system in a cyclic way, necessary in order to enable detailed interactive discussion of local land management alternatives. Research purposes and research activities of the three working phases are presented in Table 4.

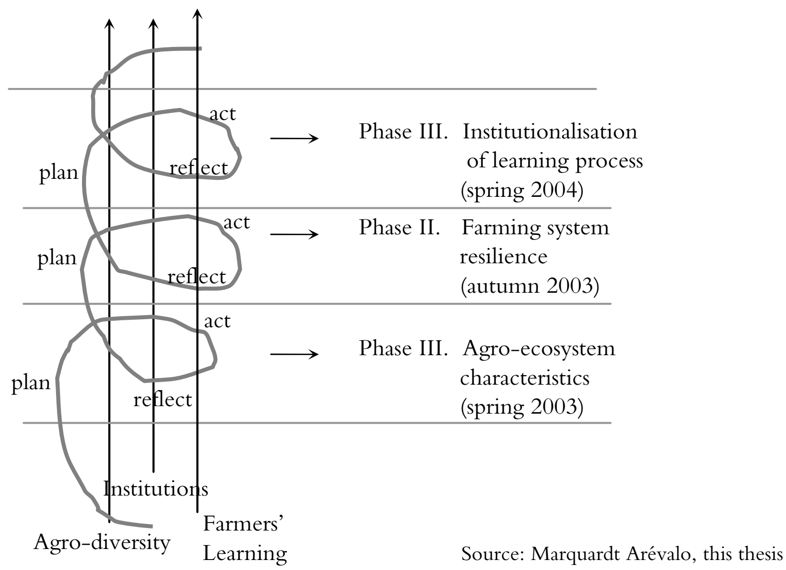


Figure 8. The PhD project's process of knowledge development.

The two villages, Chazuta and San Miguel were chosen with a common agricultural history of extensive swidden agriculture, but which today provide contrast in current conditions of land pressures and strategic land degradation management. This provided an opportunity to compare responses from two contrasting conditions and contexts of incrementing changes in soil fertility, erosion vulnerability and decreasing land access. The selection of the visited farms within the villages was done in cooperation with PRADERA, which has worked in both villages, by using mutually agreed criteria to identify farmers with an interest in farm development. A large part of the work has taken place with groups of these farmers (*choba choba* groups), and meetings between the two villages have been arranged.

Table 4. *Research purposes and research activities developed within the structure of the three working phases. Blue colour signifies – interviews, dark yellow - workshops, green – field experiments, orange - farmer groups visits, light yellow participatory observations.*

Working phase & theme to explore	Research purpose	Research activities
I. Agro-ecosystem characteristics	To learn about the local swidden farming system and farmers' perceptions of land degradation and soil fertility	In depth *interviews* *Crop-budgets* *Workshops* on land degradation and its problem in the areas
II. Farming system resilience	To detect where the strengths and the weaknesses of the local farming system are from a resilience perspective	*Collective experimentation* together with the farmers from the farmers' points of view of worthwhile land recuperation activities; focusing on fallow and trees *Farmers visits* to the two study villages with local innovative farmers In depth *interviews*
III. Institutionalisation for learning processes	To develop the action research approach and collective experimentation experience as a working tool with the collaborating local NGO.	Follow the group dynamics (*participatory observations*) within the group of farmers and within the local NGO. Reflective *methodological workshops* with the local NGO

Source: Marquardt Arévalo, this thesis

The action research process was braided together with four threads that I have called: (i) "reading the context"; (ii) "exploring farmers' land management perspectives"; (iii) "farmer experimentation"; (iv) "conceptualisation of the farmers' perspective". These are presented in detail in Paper II.

5.1.1 The contribution of PRADERA

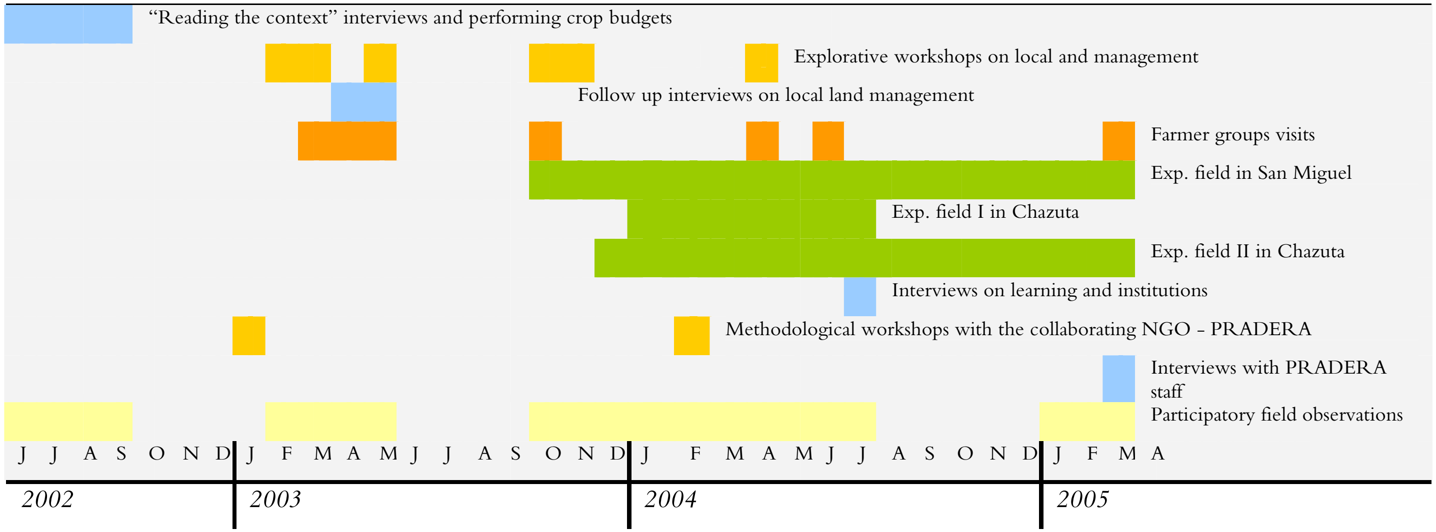
PRADERA stands out from other organisations in the region, by its commitment to achieving very close personal long-term relations and commitments with collaborating farmers. PRADERA's working approach generated the initial questions about land management developments. PRADERA's commitment to and capacity for learning as an organization, which is described in Paper IV, also pointed attention toward the centrality of learning as a key to transformative change. This led to the inclusion of PRADERA as a "research object" in the overall design of the study. Semi-structured in-depth interviews were made with the staff of PRADERA. The interviews covered the following topics: PRADERA's approach to the concept of knowledge, the perceptions of the people and the geographical context they interact with, the relations between farmers and professional, the kind of activities undertaken, how the work was linked into a context of meaning, why PRADERA worked differently from other regional NGOs, and the social structures in the context they work in. In addition, two method workshops were held, where the staff members were invited to reflect on their working approach and their roles as professionals.

The fieldwork has been carried out over 29 months, from April 2002 to August 2004, in the two villages San Miguel del Rio Mayo and Chazuta described in 2.2.1 and 2.2.2. It has been complemented with field visits during January to March 2005 and sporadically during 2006. In Table 5 the reader can see how the research activities took place over time.

5.1.2 Limitations to farmer involvement in the research

The ambition as an action researcher to involve farmers and PRADERA in the research process has had its limitations as far as the writing process is concerned. This problem is difficult to avoid because we have different roles in the research process and different motives for participating. These differences can give rise to ethical dilemmas. The way these have been dealt with is as follows: to strive for a process design which fits with the farmers' terms, to carefully confirm the outcomes of this process with the farmers (and PRADERA) in order to check if there was agreement on any interpretations made (and if not, what the grounds of difference were, giving rise to new exploration). However, any interpretations and analysis made after returning to do the academic writing in Sweden has not been approved by the others involved (except Paper IV which has been discussed with PRATEC), and has been carried out according to the academic "terms of engagement" and standards for scientific presentation of research. This is unsatisfactory in so far as the reason for starting the research was to be part of a joint learning process. Nevertheless, this research mission will not end with writing this thesis. A summary of the process design and methods used is being compiled for use by the NGO worker community around the city of Tarapoto, and a second publication is being prepared for a farmer audience, oriented towards the practical land management outcomes.

Table 5. *Calendar of research activities, blue signifies interviews, dark yellow - workshops, orange - farmer groups visits, green – field experiments, light yellow participatory observations.*



Source: Marquardt Arevalo, this thesis

- The experiment field in San Miguel and experiment field II in Chazuta were run by the collaborating NGO PRADERA together with the farmer during August to December 2004

6 The main findings

6.1 Small scale agriculture in the Upper Amazon[6]

6.1.1 Active management of agro-biodiversity

This research identifies, describes and evaluates farmers' active land management strategies in the two villages. The local land management is described in terms of slope-, fallow-, fire- weed- and agro-biodiversity management which are activities integrated in the agricultural production (see Paper I). Slope management (see Paper I) is practised in terms of fallow, forest reserves and natural re-generation of forest used to protect steep areas were noted. Within the agricultural fields, living barriers and tree plantings are used by the farmers to hold and maintain the soil in the field and

[6] Throughout the thesis the words strategy, management, technique and skills will be used. Strategy refers to a comprehensive idea of how to handle an issue, a tactical grip in a wider sense, such as: a strategy used to handle declining productivity, and to handle decreasing access to forest and mature fallows. Along with strategic thinking, there are management approaches and operational categories of how to execute the strategy, for example, the loss of productivity due to declining soil fertility could be confronted with a fallow management. Technique refers to a particular working practice such as a weeding technique, a propagation technique etc. Skill is the ability to perform (agricultural) techniques (or management as well as strategy plans) with an individual ability that varies between farmers; some farmers are more skilled in combining several crops in poly-cropping systems than others for example.

different ways of leaving the weed residue and arrangements of debris perpendicular against the slope gradient further catch silting mineral material and prevent surface wash. As the fallow period is generally decreasing on the farms, some farmers have responded by trying to improve the quality of the fallow (see Paper I). By deliberately sowing nitrogen-fixating tree species (such as guaba, *Inga indulis*) intercropped with the food crops during the cropping period, as well as leaving tree sprouts to stand in producing fields while weeding other plants, the farmers actively assist the establishment of the subsequent fallow. Several palm species, such as *shapaja* (*Attalea butyraceae)* and *poloponta* (*Elaeis oleifera*) often exist in the fallow preceding the field burning as they survive the burning and grow parallel with the annual crops in the field. They are important and cared for components in the re-generating fallow as they provide roof construction material. In terms of weed management (see Paper I) the farmers know about the weeds and their propagation strategies. Different weeding techniques are distinguished by how the work is carried out, the type of weed vegetation weeded (weed growing as a tuft, with tap root, a root weed or tree sprouts etc.) and the kind of tool used. The farmers also know about and practice shading as a way to handle particularly problematic weeds such as *Imperata*. Fire management (see Paper I) is a crucial component of swidden agriculture which has not received very much attention by research. This research shows a variety of burning strategies and that most burnings are patchy and not necessarily severe. There is a range of burning techniques such as milder burning, complete burning, burning of piled plant material, in field burning or deliberately no burning at all. The farmers' choice of technique when burning is complex, where factors such as farmers' weed management strategy, weather conditions, the kind of proceeding vegetation (secondary succession or primary forest) being cleared and the families' access to labour influence the choice (see Paper I). Several of these management activities in field may be carried out as *choba choba* activities, where the farmers gain access to a larger group's labour (see Papers I, II, III, IV). All of the management techniques mentioned are found in San Miguel, the more degraded of the two villages, whereas less are found in Chazuta. The farmers in San Miguel said that the land management challenges they encounter (land degradation, weed infestations, diseases and pests) are particularly due to working intensively on small land areas (see Paper III). The research suggests that groups of farmers in San Miguel are responding and adapting to the new conditions of erosion and land degradation and are dealing with the situation by experimenting with different land management techniques (see Paper I).

The slope-, fallow-, fire and weed management are examples of dynamism within a cropping system constantly under change. Further adding to the dynamism in the farming system is the agro-biodiversity (see Paper I). The research identified over 70 different food and cash crops in the two villages (see Appendix 1). The diversity handled by many farmers, is significant, where some work with a wide range of fruits, vegetables, grains, medical plants, spices, tubers, fibres, wood, etc. Among the numerous species cultivated, there is also a wealth of varieties within the species. Several tree and palm species are also actively manipulated (see Appendix 2). This abundance of species and varieties found in the farming system is the result of continuous selection carried out by the farmers in order to build and maintain agricultural diversity. The informal institution *mujeo* facilitates farmers' access to diverse genetic material in a local context between fields, but also in a wider, larger context between villages and regions (see Papers I, II, III). Though Chazuta is the more agro-biodiverse of the two villages, San Miguel showed a more varied cash-crop production than Chazuta (see Paper III), and also less economic dependence on maize production (which is the dominant cash crop in San Martín).

The farmers in San Miguel and Chazuta are today facing rapid agricultural land condition changes (see Paper III). The research compares the land management situation in the two villages by analyzing the farmers' responses when they visited each other. These visits enabled a reflection on the land management situation in their own village and generated descriptions of what disturbances the farmers were experiencing. This is compared to their problems of responding to these disturbances and connected to the findings on land management strategies (see Paper I). Chazuta is currently at the crossroads of extensive and highly complex poly-cropping for self-sufficiency and increasingly intensive agriculture producing monoculture bulk crops for cash, where most farmers have had no experience of land recuperation experiments (see Paper I, III). In San Miguel this trend has been evident for many years, and the farmers stated that their initial response to land shortage was to continue to force the production on smaller holdings and increasingly poor lands. However, without any nutrient input and as more and more labour was required for weeding, some farmers have started to experiment with different farming techniques (see Paper III). Whereas the farmers in San Miguel have started trials on 1) mixtures of perennial tree cops and annual crops; 2) different trees (often N-fixating)

Table 6. *Farmers' experimental land management techniques in San Miguel, 2002-2005*

Purposes	Techniques on sloping land	Use of fire	Weed management	Agro-biodiversity management	Fallow management
Improve nutrient status	*- Weeded plant material left as soil cover and slope impediment arrangements serve as green manure*	*- Intensity of burning vary from complete burning to milder burning*	*- Weed material is left to mulch in piles*	*- Continuous and pulsed harvest patterns supply soil throughout the year with organic waste as green manure* *- Inclusion of nitrogen fixing plants and trees in the system*	*- Nitrogen fixing trees (Inga spp.) are inter-cropped for an improved fallow* *- Prolonged use of fields while the fallows are re-growing*
Reduce erosion	*- A minimum of soil movement in the field preparations* *- Impediment arranged to slow down surface water* *- Ditches are filled with plant material* *- Appropriate selected farm land*	*- Leave burned stubs with their roots systems standing in the cropped field*	*- Weed material is spread as a land cover*	*- Plantation of a wide range of crops with different phonologies are able to capture released nutrients*	*- Particularly steep lands are left to become forest reserve*
Speed up fallow establish-ment	*- Reforestation by transplanting tree sprouts* *- Voluntary germinating tree sprouts in the field are not weeded out, but cared for*	*- At milder burning some trees and plants survive the fire*	*- The shadow of fallow (or crops) are used for combating the problematic weeds*	*- Sowing, transplanting and caring for voluntarily germinating sprouts from wide range of species*	*- Improved fallow* *- Selective weeding, thinning and selection of healthy plants in the growing fallow*
Reduce pest impacts	-	*- The field burning has a sterilizing effect in terms of pests* *- Limited in-field burning during the production phase also in order to control pests*	*- Pests are often identified while weeding*	*- Large number of species are included in the farming system, and co-planted*	*- During the fallow period the pests feeding on food crops will become reduced*

Source: Marquardt Arévalo, Paper III

in order to improve the nutrient management and assist the establishment of subsequent fallow; 3) integrating new cash crops in the farming system; 4) using the fields for longer periods of time (for example converting annual cropping field into plantain fields) and 5) semi permanent agro-forestry, the farmers in Chazuta have very limited experience of experimenting with new land management activities (see Paper III). The documented farmer trials in San Miguel trials, summarized in Table 6 (from Paper III), are highly relevant as they involve experimentation with local practical land management techniques. Paper III questions if Chazuta could learn from San Miguel about how to handle soil nutrient depredation? It is argued that the farmers in Chazuta can learn from the farmers in San Miguel in terms of how they have responded to the resource crisis with local agricultural knowledge and experiential learning, and that this learning process can be supported by created space and opportunity for learning.

The joint experimental activity aiming at joint learning on recuperation of degraded land, between farmer groups, the local NGO and the researcher included several of the presented land management techniques. The experimentation started with the three groups developing a problem description of their area and discussions on what kind of available measures could manage these problems. The problem description led to an idea of doing collective experimentation that one farmer named; *"hacer revivir nuestras chacras"* – to revive our fields. All groups chose to work with reforestation as a way to restore the land and worked with a wide range of tree species (see Appendix 2). It was particularly interesting that all three groups also made plans for using the in-between space for short term production and in-between the tree seedlings cotton *(Gossypium barbadense)*, maize *(Zea mays)*, beans *(Phaseolus vulgaris)*, chili peppers *(Capsicum spp.),* wild cucumber *(Cyclanthera pedata)*, *witino (local tuber),* pumpkin *(Curcubita spp.),* plantain *(Musa spp.),* cassava *(Manihot esculenta),* papaya *(Carica papaya)* etc. were sown. In Figure 9 the field development of one of the experimental fields in Chazuta can be seen. The farmers chose to restore a fallow totally infested by *Imperata* (photo A). In order to keep the *Imperata* down while the tree seedlings were developing a canopy, velvet bean *(Mucuna)* and *kudzu (Fabaceae)* were tested as covering crops on the initiative of PRADERA and the researcher (photo B). However, as the rabbits ate these leguminous plants with great appetite, the farmers decided to plant cassava while waiting for the velvet bean and *kudzu* to develop, and they stated that cassava is the plant that would cover a field fastest in order to combat the *Imperata* (photo C). After six months of collective work, organised as *choba choba* sessions (frequency about once a month), the group decided that the field was manageable for the owner and his family in terms of caring for the planted seedlings and handling the *Imperata* infestation, and decided to start new work in another field. The experimental field served as a practical experiment on how to recover lost farming land (photo D), which generated land management discussion within the group.

A) 31st of December 2003

B) 10th of February 2004

C) 13th of May 2004

D) 17 of June 2004

Figure 9. The experiment field with the San Pedro group in Chazuta worked form January to June 2004. Photos taken by Marquardt Arévalo.

6.1.2 A forest–focused agrocentric perspective

The landscape of the Upper Amazonian forest is a diverse and heterogeneous landscape and the conditions for agriculture may vary quite drastically from one valley to another, between neighbouring farmers and even within the field (as seen in the photos in Figure 7). During the course of this research an understanding emerged of how the farmers take their starting point from the forest-soil complex as the driver of agricultural biomass when practising agriculture (rather than soil related biomass management, see Paper I, II). During conversations, the farmers very clearly stated that soil fertility comes from the forest in terms of leaves and trunks falling down to the ground, decomposing and turning into soil:

> – *"A good soil is a recuperated soil, a recuperated forest. [--]. In primary forest everything that used to live, the leaves, the trunks have rotted. Because of this it (the soil in primary forest) has manure, because of this it produces everything."*
> Interview with T.T., Chazuta 010503

During an early stage of the work with the experimental fields and the farmers' individual experimenting I was interested in the idea of using the manure found around the poultry-houses and the pigsties (were the households' hens and pigs sleep during the night) on the farms. Discussing the experimental work on recuperating degraded land and what measures were necessary to manage the problems, I made great efforts to include the idea of using animal manure in the recuperation work. None of the farmers supported the idea however, and there was no interest in testing if the land might respond to such a treatment. In all land recuperation discussions the farmers put forward the use of trees and reforestation as the preferred recuperation method (Paper II). This is how one of the farmers explained soil fertility:

> - *"What is falling from the trees, the leaves, rotten, and sometimes (even) the trunks (rotten). Why think of other things that could give some substance to the soil? What more can give it (fertility)? There is no other (thing). You see that the leaves, the trunks fall and rot. It stays there as manure for the soil."*
> Interview with J.I., Chazuta, 140503

Consequently the physical, biological and chemical "capital" of the soil in a field depends on the quality, composition and age of the fallow or forest which occupied the land before (and not the other way around as I would have reasoned!). I have interpreted this redirecting of what might be seen as soil-related questions as a perspective of soil as a property of the forest in a forest-soil complex rather than soil as the fundamental element for the agricultural production, and I have termed it a "forest-focused agrocentric perspective"[7]. In practice this means that there is a clear forest focus on agricultural matters which may often be soil related questions for agronomists (like me). A short quote from an interview may show the differences in emphasis:

> Farmer: – *"The trunks rot and give manure, the leaves (as well). The soil comes from the trunks."*
> The researcher, thinking that we agree on the soil-manure-vegetation relationship says:
> – *"And the trunk comes from the soil!"*
> Farmer: – *"No!"*
> The researcher: – *"No? How is it then?"*
> Farmer: – *"From this* (showing a seed) *they grow."*
> Interview with H.O., Chazuta, 010503

When the farmers described the land types and the variations within their fields, the conversations showed a detailed knowledge of the different field conditions in terms of soil colour, humidity, texture, gradient etc (Paper I). However, when talking specifically about describing these soil conditions as different soil categories, the farmers mainly categorized soils in approximate terms according to colour and texture. During earlier work in the area (Marquardt, 1998) and through the work for the thesis I have been bewildered as well as intrigued by this relatively dichotomous soil classification in very complex farming. By recognizing that there are different perspectives of natural resources we may search for new learning, where different kinds of action and solutions might be explored (see Papers I, II). This issue will need to be explored further, as it is a very central point in resource management, but at the same time a difficult matter to address in research.

[7] In paper II the forest-focused agrocentric perspective was called a forest-focused agrocentric worldview.

6.2 Action researching

6.2.1 Interacting with local, social spaces for learning

The greatest methodological advantage of action research in this research has been that the iterative and reflective way of handling research problems has a lot in common with farmers' own experimental learning (see Section 4.2. and Paper II). An important part of the farmers' learning and experimentation is to belong to a context where knowledge can be exchanged, stimulated and gained. Collective working groups such as the *choba choba* groups (described in all four papers) are natural arenas for learning and sharing knowledge between farmers (see Paper II). While working, the farmers observe and reflect upon problems the particular host farmers might have and actions taken. In this way *choba choba* provides an environment and space for farmers' daily learning. The action research process (documented and validated particularly in Paper II, but also in Papers I, III, and IV) was structured in order to create useful opportunities of joint action learning. As action research emphasises collaboration and learning, which blends well with the institution of *choba choba* it seemed that *choba choba* was a suitable institutional framework for participatory work on practical land degradation management learning. By arranging collective experimental field activities, framed by *choba choba* (and *mujeo*), the research could interact with already existing social space for farmer learning and facilitate a joint learning process with the farmers in a suitable way (see Paper II). The farmers themselves pointed out the joy of working in and belonging to a *choba choba* group.

The research process further encouraged the joint action learning within a regional context, where farmer-NGO workshops and meetings between farmers from the two villages were arranged and experiences could be shared (see Paper II). The research began to approach the issue of scaling up local land degradation management as part of the action research process. Two methodological researcher-NGO and researcher-NGO-NGO-extensionist workshops were organised and facilitated (see Paper IV). These meetings between different actors generated learning experiences on systemisation of the agricultural complexity and dynamics in San Martín. PRADERA (and two other NGOs, see Table 3) systematized and analysed the local swidden small-scale agriculture in San Martín by using Flood's (1999) four windows of (1) processes and changes; (2) structure of the agricultural system; (3) meaning (ideology, worldview) and (4) knowledge and power (drivers) as ways of analyzing its organizational life. Throughout the process c*hoba choba* was the theme that overlapped all four windows: c*hoba choba* was described as a vital farmer to farmer learning situation and way of diffusing diverse genetic material; to enable extensive work; its' influence in the local economic balance of monetary versus subsistence economy; and being part of the collective reciprocal community thinking in many farmer communities. This resulted in understanding the importance and potential of *choba choba*, not only due to its role in interchanging agricultural knowledge, but how its institutional role forms part of the core of local agriculture in several ways, and as such it became central all along this research process (see Figure 8). Currently, the tradition of *choba choba* is eroding in San Martín and is becoming replaced by a paid day labourer system (*peón*). However, during the research two out of three groups spontaneously started to organise themselves into *choba choba* "circles" (*ruedas*); the third group was already working *choba choba*. It might not be so difficult to revive the *choba choba* groups in areas where paid labour is gaining ground, and *choba choba* would be a suitable potential for local land management learning in villages such as San Miguel and Chazuta (see Papers II, IV).

As in other research approaches, it is difficult to establish if learning really takes place within the action research process, and if so, will the learning be implemented in the field? The results suggest that there is internally driven learning concerning land degradation management going on among farmers, particularly in San Miguel (see Papers I, III). Results from the externally driven learning process (the experimental field process facilitated by the researcher and PRADERA) suggests that the farmers' direct responses in field work (such as the repeated feed back loops between farmers' practical theories and practices within the collective experimentations) took place, and probably would not have occurred in the same way with a more conventional research approach (see Paper II). By using techniques and strategies for learning which many farmers stated as new for them (i.e. working with experimental fields with the *choba choba* groups) there has also been learning about learning taking place among the farmers (as well as with PRADERA during the methodological workshops). It was documented how some of the farmers applied the tested land management techniques on their own lands. By using the iterative and reflective approach of action research, the abstract understanding of forest, fallow and soil have been made more explicit in discussions and open to further investigation (see Paper II). By constant questioning of the data and continuous exploration of how natural resources are perceived an idea of local management emerged in a more holistic perspective, where institutions and farmers' learning became central concepts.

6.2.2 Action researching for organisational learning

Paper IV aims to explore how farmers' own experimentation and experiential learning could be expanded by support from outside. During the research process the collaborating NGO PRADERA emerged as different from other organizations working with land management issues in the research area, with an approach of close collaboration with farmers, their emphasis on grasping farmers' perspective on agriculture, targeting local institutions in the villages as natural arenas for learning and their way of including topics such as culture and worldview in their analysis. NGOs which are acting as bridges between farmers at field level, and the international development community, need to develop as organisations in order to maintain farmers' attention and to respond to increasing demands in a climate of growing competition for donor funds. In order to act as a meaningful link between local farmers and the outside world, it is necessary to reach a degree of reflexive consciousness for continuous learning and transformation, within the organisation (see Paper IV). Here, there is a paradox in the donor-NGO relation, as donors want mainly action outcomes presented in the results, not internal reflection. PRADERA's ability of reflective learning within its organization is therefore analyzed in terms of single–loop learning (instrument learning), double-loop learning (reflection on the single-loop learning) (Argyris and Schön, 1996) and triple loop learning in Paper IV. There is considerable literature on what enables an organisation to reach deeper levels of learning (double- and triple-loop learning). PRADERA like many other NGOs, is undertaking pointed reflections on the environment it acts in (double-loop leaning), but does not move to the next level of learning. Triple-loop learning implies a transformation process where the learner steps back and reflects on the underlying assumptions (principles and values) and goals, and on the reflection itself. The research findings showed no established internal arrangements for such continuous intrinsic learning that would foster ongoing triple-loop learning within PRADERA. However, Paper IV argues that there is space and potential within the organisation which could favour triple-loop learning, not necessarily as a continuous process, but as significant moments of change, contributing to the organisation's transformation. PRADERA has great potential to become a regional important and valuable bridge between farmers and the internal development community. They focus their learning on farmers' own farming logic and action research methodology would be one way for PRADERA to achieve continuous reflectivity necessary for deeper learning levels and transformation within its organisation (see Paper IV). Action research viewed as a learning process of how people interact with the world and others, intending to understand different discourses; what is meant, what is valued, can well describe what NGOs like PRADERA is doing. The step to formalise an internal process of organisational learning of reflexive consciousness i.e. to develop an "internally action researching system" might therefore be possible.

6.2.3 Action research to strengthen local farm resilience

When intensive semi-permanent mono-cropping is no longer possible, some farmers try to solve their land management problems through a process of experimentation on new crop combinations and land management techniques (see Papers I, III). This adaptive capacity reflects an ability to learn, experiment and innovate and appears to involve learning agricultural diversity as a core element for adaptation to the unexpected (the disturbances). Here the local institution of *choba choba* have an important function as it operates as the natural local arena for sharing knowledge, experiences and learning between farmers (see Papers II, III, IV). By examining these land management strategy findings from a resilience theory perspective, the research asks how adaptive responses, learning, buffer capacity and capacity to organise after a disturbance (the components of resilience) can be identified in practice. The research highlights that in practice the above mentioned components of resilience are overlapping in terms of diversity, experiential learning and institutional arrangements within the system (see Paper III) which hence are contributing to building resilience. It is argued that the experiential learning process is not only a way of living with conditions of change and uncertainty, but that change and uncertainty generate a certain preference of learning among farmers; the experiential learning (see Paper III). Farmers' experimental learning as such creates possibilities for adaptive response to happen as it opens up for experimenting and testing activities. These activities further support local farming resilience and contribute to the local agricultural diversity and farmers' learning (see Paper III). In this setting, action research creates an opportunity of creating a joint learning process which starts out from and include diversity, experiential learning and institutional arrangements, crucial to the local farm resilience. In this research the institutional frame of *choba choba* and *mujeo* gave an opportunity to create possible structures and organisational arrangement for such fruitful interaction between researchers, NGO-workers and farmers in order to scale up learning activities in a collective context. Such an experiential land management learning approach, did not only tune in with farmers preferred way of learning, but (see Papers II, IV) naturally connected areas such as agro-biodiversity, diversity management and local institutions (see Papers I, III). To approach and emphasize these vital farming system's components, within their complex and dynamic context, and practically include them in a joint learning process is one way to support processes of learning agricultural resilience in practice and thereby strengthen farm resilience.

7 Discussion

7.1 Viewing agricultural conditions with a local focus

The short historical sketch of pre-Columbian agriculture offered at the beginning of the thesis introduced to the reader's imagination the kind of agricultural techniques and designs that might have sustained Amazonian agriculture, food systems and civilisations, and which also might reveal something valuable for resilient Amazonian agriculture in the present and the future. The available pre-historical evidence suggests that what can be considered appropriate ways of performing agriculture in the Amazon has matched the diverse array of habitats, suggesting that there is no one package solution to sustainable Amazonian land management. A second speculative lesson is that appropriate systems include different ways of combining elements of agro-forestry systems and highly agro-biodiverse cropping systems rich in crops and crop varieties. Chazuta provides examples of the kinds of traditional, locally specific and highly diverse agricultural systems still found in the Amazon. Padoch and de Jong (1992:173), impressed by the diversity of crop mixes in different agricultural succession stages in a *ribereño* community, at the Ucayali river (further downstream from Chazuta and the Huallaga river), write: "*agriculture on the lower Ucayali is indeed far more complex than has ever been appreciated. [-] we can never hope to adequately understand how people make a living in Amazonia*". If we aim to understand the complex and diverse Amazonian farming systems, at least partly, this can *only* be done if we include the people living within and creating systems through their practice, informed by their own views of the world. A highly structural rationalised concept of agriculture, which favours simpler systems such as flat quadratic fields with maize sown in straight lines, clearly is too narrow to comprehend the resource management practised by these people (Rerkasem and Pinedo-Vásquez, 2007). The agricultural heterogeneity makes sense in a region of considerable economic, social and biological complexity where the farmer needs to think and act in terms of improving a situation characterised by many interacting problems (Brouwers, 1993). In such contexts, agricultural research needs to be open to agricultural ideas and solutions from all sources of potential innovation, including those originating from farmers trying to survive within their agricultural reality, and to incorporate the heterogeneity and the "messiness" of agricultural practices in such systems into scientific agricultural thinking.

The research shows how and why the farmers prefer to re-locate (what might seem) soil related questions within a forest (vegetation) perspective, that is on that considers the spatial and temporal dynamics of agriculture as related to fallowing cycles and spatial rotation of gardens i.e. forest-focused agrocentrism perspective identified and described in this study. The conceptualisation of soils as a property of the forest and forest management as the driver of the forest-soil complex has important implications on how to develop land management processes. However, in order to reach understanding and knowledge that is mutually intelligible by the partners in collaborative research projects of this kind there are not only linguistic, but extremely important conceptual barriers. In this study, the very word management did not even exist in the local language (where the farmers speak of *crier* or *cuidar*, nurture, instead of *manejo,* management). Also researchers may be tempted to oversimplify the human-nature relationships that they begin to observe. Resource management research tends to fragment the meaning and values inherent in the local and indigenous knowledge in search for technical explanations that fit into current ecological models and theories (Kendrick, 2003). They disassociate the 'objects' of study from the sense-making and meaning that has created them, and to isolate them from the web of relationships which sustain them in use (Scheffer et al., 2002). The understanding and language developed through this study here identified as "forest-focused agro-centrism" may serve to contribute shared meaning that connects farmers and professionals in land degradation management in the Upper Amazon.

When soil fertility is interpreted through the filter of forest and vegetation, many farmers find themselves in a truly critical situation when there is no forest around anymore. In a situation of decreasing land availability many begin to carry out swidden agriculture more intensively until the inevitable consequence follows - the fallows no longer re-generate sufficiently for the land to recover its fertility. More frequent cultivation means that the weed pressure increases, and consequently the workload of the family also escalates, while at the same time the yields drop, which means that the economic return for the family decreases (Papers I, III). Under such livelihood pressures, researchers readily identify soil fertility as a decisive problem, farmers identify the core problem as lack of forest. While the researchers' definition seems to offer many opportunities for escaping the downward spiral, through soil nutrient management technologies, the farmers' definition apparently provides very few choices: stop farming, move further into the forest or explore alternative ways of farming. Yet this study documents that the farmers' way of looking at the problem is also giving rise to a search for appropriate technical and social solutions by means of "practical experiments" informed by the local worldviews i.e. that some farmers are taking action in order to respond to the critical situation through forming locally designed land management responses (see Papers I, II, for farmer responses to soil fertility problems in a different context, see also Brouwers, 1993). Innovative farmers are including more trees in the cropping system, in different combinations, practising longer cropping periods, adopting a more varied cash crop production and improving fallows (see Papers I, III). From the research findings presented, the thesis also shows that these non-Indian native farmers manage their biodiversity by actively managing successions through space and time and on the basis of explicit principles that exploit diversity of soils, habitat, the poly-cropping preferences of plants, shade, topography, texture and humidity. This is an interesting outcome of the study from a biological and agronomic point of view, but also from a development perspective, as the farmers experimentation is done in real agricultural and livelihood settings, adapted and made to fit within the local farming context.

7.2 The relation between farmers' learning and external support

In all four papers it is argued that effective outside initiative is based on the farmers' own view of their agriculture. An NGO (or development project) needs to be deeply based in farmers' reality and knowledgeable about the farmers' context. This implies that an NGO must have a working approach that encourages the professional to develop such an understanding, but also continuity and stability to work over a longer period of time in an area. Farmers' learning, that is constituted within local institutional structures, needs to be approached in such a way that the farmers feel comfortable with any opportunity for learning stimulated by outsiders and have the possibility (right and power) to raise new questions as well as to contribute to the research agenda. This necessarily implies that formal research capacity needs to accommodate, and support, practical field-oriented approaches and "rules of engagement" which fit with farmers' experiential learning (Papers II, III, IV). When the Center for International Forestry Research (CIFOR) analysed the slow spread and low impact of land recuperation in the Western Amazon in Peru, at a workshop with local professionals (in Tarapoto year 2004, see Meza et al., 2006), the professionals called attention to the fact that they could not reach the farmers with the proposed land use packages, and that these packages often were out of reach of many small farms in terms of the embedded knowledge they assumed and the economic demands they made (Meza et al., 2006). Gómez-Pompa and Kaus suggest that one of the reasons for such implementation problems in "transfer of technology" efforts is the insufficient local focus in problem descriptions (where the "forest-focused agrocentric perspective" might be one key) and the lack of acknowledgment of others' knowledge systems (Gómez-Pompa and Kaus, 1992). This thesis argues that there is therefore a need to rethink researchers' working methodology, and the allocation of scarce professional resources.

The resilience literature uses the term 'bridging organization' for an institution which provides an arena for effective collaboration (Hahn et al., 2006, Folke et al., 2005). In practice this is often an organisation that brings together members of different social and economic positions and influence and that provides access to information, initiatives and technologies which the members may otherwise not learn about (Marsh, 2003). PRADERA is one NGO with potential as a bridging organization (Paper IV). Acting as a bridging organization in a global world, is however in many cases a paradox. The outside world often just wants a bridge that scientists can cross to access local knowledge, but they bring with them their own standards and assumptions that may mean they never do comprehend local knowledge, returning across the bridge only with artefacts and materials that may be of use in their own world. Many NGOs have responded to such external demands by becoming one-sided action/activity oriented, leaving aside the development of professionalism as continuous internal reflections. In the inter-play between action and reflection, action research methodology could serve as a tool for bridging organisation's internal "inherently action researching system" (see Paper IV).

7.3 Action research: what does it contribute to resilience theory?

Resilience theory captures the dynamism in farmers' land management in so far as it focuses on the ability *"to maintain stability in the face of change"* (Berkes et al., 2003b:15) and includes emerging and adaptive learning that constitutes an experimental reality of most farmers. When it comes to land recuperation in the Upper Amazon this study indicates that such efforts should give emphasis on management of forest, fallows and secondary forest successions. One of the demonstrated advantages of the resilience concept is that it is able to encompass the worldviews within the socio-ecological system of interest, as well emphasising the importance of relationships and of processes such as knowledge and learning. Action research, on the other hand offers a methodology that enables the researcher to get close enough to achieve an understanding of such abstract and difficult issues as worldview, knowledge and learning. This thesis, on the basis of the findings presented, indicates that resilience theory combined with action research would be a practical and farmer-orientated way to approach the challenge to developing agriculture that moves toward sustainability and development goals.

Berkes et al. (2003a) suggest that qualitative analysis within resilience theory is understood as *"the understanding of the system's behavior to help guide management directions"* (Berkes et al., 2003a:7). Most resilience research is quite theoretical or descriptive in relation to system behaviour; it does not usually include methodological discussion on how *to foster resilience* or how to implement practical learning that *moves system behaviour* in a desired direction. This study shows that action research may usefully complement resilience research by the way in which it addresses the 'how to' challenges posed by resilience theory. If the aim of research is "to help guide management directions" then close collaboration with farmers (and other resource users) is inescapable. The challenge then redefines itself as how to design and facilitate effective joint learning. This further implies that qualitative methodology has much to contribute, not only by being complementary to quantitative approaches, but as associated with research methods that build development capacity and self-organisation skills (see Paper IV).

Berkes and Folke (2002:146) write about different knowledge perspectives in complex systems thinking as following: *"combining complex systems science with useful insight and attributes of local and traditional systems dealing with complex ecosystem dynamics may enhance adaptive capacity for coping with disturbances and* *building social-ecological resilience"*. Different kinds of knowledge and processes for generating knowledge, that is reliable in the context of use, need not only to be recognized but also to be respected and valued. Here, PRADERA for example has made a very specific commitment to value farmers' knowledge and has created organisational capacity to follow through on the implications. From an action researcher's point of view this could be expressed as a capacity for: *"combining local and traditional systems with the useful insights and attributes of complex systems science, that deal with ecosystem dynamics, in order to enhance adaptive capacity for coping with disturbance and building socio-ecological resilience" (this thesis).* This is not to say that resource users' knowledge, data and theories should be accepted uncritically, but it does mean that their land management knowledge and skills are the necessary frames for developing resilient land management action.

7.4 The action researcher: a negotiated balancing act

This study has been a lengthy journey of learning. The most important learning outcome has been the development of an understanding of the diversity and complex dynamic these farmers are managing. During this process of learning I, as probably many other action researchers, have struggled to acquire the discipline of self-reflection. The two issues that have recurred throughout the twists and turns of the hermeneutical spiral have been the following: Firstly, how can an academic Ph.D. thesis contribute to practical, local, resilient land management? There have been several transient land management projects in the study area, passing through Chazuta and San Miguel, spending millions of dollars, and still the land management crises persist. Could the present study make a difference? How could this research influence the situation for the good? The second issue is: how does the researcher deal with the different quality and intensity of participation by the farmers and PRADERA in the research process during the different stages of the research?

Looking at the first question, the practical contribution has been on two levels: first in relation to the local agricultural NGO-worker community in the study area, and second, to the local farmers. From the perspective of the local agricultural NGO worker community, this research can be seen as an exploratory study, that tests a working approach and working tools in close collaboration between farmers, a local NGO and researchers. This thesis contributes by demonstrating an alternative way of approaching land management problems, and raises awareness of the value of farmers' knowledge among different local stakeholders. In terms of the farmers, the drivers of rapid change may make it difficult for many farmers to devise suitable adaptive responses fast enough. In such a context the contribution of this research has been to ask questions, put key problems and questions forward, find good examples, be present and accessible, and to design a shared learning process that may strengthen farmers' capacity to find effective responses. My and PRADERA's work have stimulated ideas and actions on land management among the participating farmer groups, which have been tested in the field, both by the groups and sometimes also by individual farmers. A three-year period is however, a very limited period of time when it comes to land management processes, and a continued collaboration with locally based NGOs such as PRADERA is one way to follow the development over the longer term.

8 Conclusion

8.1 For agricultural development policy and practice

This research explores how small-scale native non-Indian swidden farming farmers, a highly overlooked group when it comes to studies of ecological knowledge and land management activities in the Amazon, are practising relevant land management experimentation with local, practical land management techniques. In the villages San Miguel and Chazuta, these farmers actively manage their agro-diversity in terms of different tree and crop combinations, longer cropping periods, a more varied cash crop production and improved fallows as slope-, fallow-, fire-, weed- and agro-biodiversity management. The analysis of their local agro-diversity highlights the complexity of Upper Amazonian farming systems and the local farming logic.

This thesis suggests that the farmers in the Upper Amazon do not relate agriculture to the soil, but to the forest-soil complex. The conception of soils as a property of the forest and forest management as the driver of the agricultural biomass has important implications on how to develop land management processes. Recognising the importance of reflecting on farmers' point of departure when dealing with agriculture and soil is crucial in land management development work and could lead to new learning, where different kinds of action and solutions might be explored.

The situation of land degradation in large parts of San Martín is worrying, and although many small scale swidden farmers in the region have relevant land management knowledge, they need support in order to learn and adapt fast enough to keep up with the current, rapidly changing agricultural conditions. Support is particularly needed which aims towards the agricultural components contributing to the qualities of a farming system which constitutes its resilience capacity. This research shows such contributing components in the local agriculture in terms of agro-diversity, experiential learning and institutional arrangements which assist the adaptive responses of learning, buffer capacity and capacity to organise after a disturbance, i.e. the requirements for building resilience.

The support (and extension) to farmers in San Martín comes almost exclusively from NGOs. It is therefore particularly important that farmers' supporting organisations develop relevant land management activities. This thesis argues the need to work from a practically oriented approach in the field as this fits in with farmers' experiential learning. The institution of *choba choba*, which is a natural arena for joint land management learning and action processes in the study area, is an example of a potential for increasing such practical learning activities in a collective context; where agro-biodiversity, management diversity and local institutions are naturally connected. A practical field approach to learning events will not only facilitate the process of how to reach the farmers, but will also contribute to the development worker's agricultural learning and ability to develop land management activities relevant in a local perspective. However, this needs to be combined with an organisational development of professionalism as a capacity of intrinsic learning in the necessary interplay between action and reflection.

8.2 For science practice

Many farmers working with swidden agriculture work with heterogeneous, complex, dynamic farming systems and also possess highly relevant knowledge and management skills in how to approach problems of land degradation. Agricultural research needs to be aware of their knowledge and skills and to incorporate the heterogeneity and "messiness" of agricultural practices in such systems into scientific agricultural thinking. This would not only be highly interesting in strictly scientific terms of understanding the systems, but also necessary in order to be able to generate research contributions relevant to these farmers, who support their families in rapidly changing agricultural conditions.

Here there is applicability of resilience theory, which would enrich the view of small-scale farmers' complex farming systems, as it provides an understanding of the integration of social and ecological systems as parts of the same system. It also emphasises the importance of relationships and of processes such as knowledge and learning when dealing with change and uncertainty in human interactions with nature. However, the point of departure for such research necessarily has to be in deep involvement and interaction with the local reality: the local problem description, the local users' view of their land, the local knowledge of land management, and the preferred approach and arrangements of learning. There is a complementarity between resilience theory and action research as action research offers a methodology that enables the researcher to get close enough to achieve an understanding of such abstract and difficult issues as worldview, knowledge and learning. Action research's emphasis on joint contextual learning processes, which are necessary if we aim at fostering resilience. This thesis indicates that resilience theory combined with action research would be a practical and farmer-orientated way to approach the challenge to developing agriculture that moves toward sustainability and development goals.

Action research is not a rapid-appraisal-approach and cannot be practised with less than a long term commitment to an area, as the researcher-farmer relation is crucial in this methodology and to develop trust and confidence takes time. This has implications for planning, financing and the goal of a research project which is mostly not in line with today's academic structures.

8.3 For action researchers

This research has been performed in close action research collaboration with farmers and a local NGO, active in the two villages where the research has taken place. The methodological advantage of action research when working with the farmers is that the iterative and reflective way of handling research problems has a lot in common with farmers' own experiential learning. This overlap in approach enables shared learning and innovation between actors and the possibility to combine science and practice, where local and scientific knowledge may blend into something new. This action research process interacted with social spaces where such shared learning could happen (three farmer groups did collective experiments on land degradation management arranged as *choba choba* activities). Learning also took place in a regional setting; between the two study villages, between the NGO and the farmers, and between several NGOs and extensionists. Within such organisational learning, action research can be one tool to establish necessary reflective arrangements for professionalisation and transformation within the own organisation.

The action research approach made it possible to explore the local land management in a wider sense than originally planned, where new, re-developed and re-defined research questions could become part of the research process. Exploring of how farmers learn about land management, and what type of learning environment enables farmers to learn and experiment with land management options, allowed a new understanding to develop.

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Appendix I Food and cash crops cultivated in San Miguel and Chazuta

Spanish name	**English name**	***Latin name***	**Use**
Achiote	Annatto	*Bixa orellana*	Food colouring
Aguaje	Moriche palm	*Mauritia flexuosa*	Fruit
Ají	Chili peppers	*Capsicum spp.*	Spice
Ají dulce	Sweet pepper	*Capsicum spp.*	Vegetable
Algodón	Cotton	*Gossypium*	Cash crop/ weaving carry belts
Arroz	Rice	*Oryza sativa*	Staple food
Bijao		*Heliconia cannoidae*	Food wrapping
Bombonaje		*Carludovica palmata*	Fibres
Cacao	Cacao	*Theobroma cacao*	Cash crop/ home consumption
Café	Coffee	*Coffea arabica*	Cash crop/ home consumption
Caihua	Wild cucumber	*Cyclanthera pedata*	Vegetable
Caimito	Star apple	*Chrysophyllum cainito*	Fruit
Camote	Sweet potatoes	*Ipomoea batatas*	Tuber
Caña	Sugarcane	*Saccharum officinarum*	Sugar extraction
Carambola	Star fruit	*Averrhoa carambola*	Fruit
Casho/marañón	Cashew	*Anacardium occidentale*	Fruit
Cebolla china	Spring onion	*Allium fistulosum*	Vegetable
Cereza	Cherry	*Malpighia glabra*	Fruit
Chiclayo	Cowpea	*Vigna unguiculata*	Bean
Chirimoya	Custard apple	*Annona cherimolia*	Fruit
Ciruelo	Hog plum	*Spondias purpurea*	Fruit
Coca	Coca	*Erythroxylon coca*	Medical plant/cash crop
Coco	Coconut	*Coco nucifera*	Fruit
Cocona	Peach tomato	*Solanum sessiliflorum*	Fruit
Culantro menudo	Coriander	*Coriandum*	Herbs for cooking
Dale dale	Leren	*Calathea allouia*	Tuber
Gengibre	Ginger	*Zingiber officinale*	Spice, medical plant
Granadilla		*Passiflora spp.*	Fruit
Guaba	Guaba/Guava	*Inga edulis*	Fruit
Guanábana	Soursop	*Annona muricata*	Fruit
Guayaba	Guava	*Psidium guayava*	Fruit
Guineo	Banana	*Musa spp.*	Fruit
Guisador	Turmeric	*Canna spp.*	Food colouring
Habitas	Broad bean	*Vicia faba*	Bean
Higo	Fig	*Ficus carica*	Fruit
Huasca poroto	Common bean	*Phaseolus vulgaris*	Bean
Huitino	Cocoyam	*Xantohosoma spp.*	Potato
Jagua		*Genipa american*	Fruit
Lima		*Citrus medica*	Fruit

Limón	Lime	*Citrus aurantifolia*	Fruit
Lúcuma		*Pouteria lucuma*	Fruit
Maíz	Maize	*Zea mays*	Cash crop/ for pastries, *chicha*
Majambo		*Theobroma bicolor*	Other food stuff
Mamey		*Syzygium spp.*	Fruit
Mandarina	Tangerine	*Citrus mandarina*	Fruit
Mango	Mango	*Mangifera indicata*	Fruit
Maní	Peanuts	*Arachis hipogaea*	Other food stuff
Maracuyá	Passion fruit	*Passiflora spp.*	Fruit
Melón	Melon	*Cucumis melo*	Fruit
Mishucsi		*Xanthosoma viridis*	Tuber
Naranja	Orange	*Cirtus sinensis*	Fruit
Palta	Avocado	*Persea americana*	Fruit
Pandisho	Bread fruit	*Artocarpus altilis*	Other food stuff
Papaya	Papaya	*Carica papaya*	Fruit
Pepino	Cucumber	*Cucumis anguria*	Vegetable
Pijuayo	Peach palm	*Bactris gasipaes*	Other food stuff
Piña	Pineapple	*Ananas comosus*	Fruit
Plátano	Plantain	*Musa spp.*	Staple food
Pomarrosa	Rose apple	*Syzygium jambos*	Fruit
Puspo poroto	Pigeon pea	*Cajanus bicolor*	Bean
Sacha culantro	Long coriander	*Eryngium foetidum*	Herb
Sacha inchi	Inca peanut	*Plukenetia volubilis*	Other food stuff
Sacha papa	Yam	*Dioscorea trifida*	Tuber
Sandía	Watermelon	*Citrullus lanatus*	Fruit
Shica shica		*Aiphanes deltoidea*	Nut
Sidra		*Citrus spp.*	Fruit
Soya	Soybean	*Glycine max*	Other food stuff
Taperibá	Golden apple	*Spondias mombin*	Fruit
Tomate	Tomato	*Solanum lycopersicum*	Vegetable
Toronja	Grape fruit	*Citrus paradisi*	Fruit
Tumbo	Banana passion fruit	*Passiflora mollissima*	Fruit
Umarí		*Pouraqueiba sericea*	Fruit
Yerba luisa	Lemon grass	*Cymbopogon citratus*	Herb for the
Yuca	Cassava	*Manihot esculenta*	Staple food
Zapallo	Pumpkin	*Curcubita spp.*	Vegetable
Zapote	Sapote	*Quararibea cordata*	Fruit

Appendix II Wood and palm species* actively manipulated

Local name	***Latin name***
Bellaco caspi	*Himatanthus sucuuba*
Bolaina	*Guazuam crinita*
Bolaquiro	*Schinopsis peruviana*
Caoba	*Swietenia macrophylla*
Capirona	*Calycophyllum spruceanum*
Cedro	*Cedrela odorata*
Cetico	*Cecropia spp.*
Copal	*Dacrydodes spp.*
Eritrina	*Erythrina spp.*
Estoraque	*Miroxylum balsamum*
Fapina	*Cupania latifolia*
Huicungo	*Astrocaryum spp.*
Huimba	*Ceiba pentandra*
Ingaina	*Roupala complicata*
Ishpingo	*Aiouea tambillensis*
Jergón sacha	*Dracontium loretense*
Metohuayo	*Caryodendron orinocense*
Moena	*Nectandra reticulata*
Ocuera	*Vernonia baccharoides*
Ojé	*Ficus insipida*
Paliperro	*Vitex seudolia*
Palo blanco	*Simarouba amara*
Piazaba	*Leopoldinia piasaba*
Poloponta	*Elaeis oleifera*
Pucaquiro	*Simiria williamsii*
Renaco	*Ficus paraensis*
Rufindi	*Inga ruiziana*
Shaina	*Colubrina glandulosa*
Shapaja	*Attalea butyraceae*
Shimbillo	*Inga spp.*
Topa	*Ochroma pyramidale*
Yanavara	*Pollalestra discolor*
Yarina	*Phytelephas microcarpa*

* For fruit trees species grown see Appendix I