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IMPACTS OF INTENSIFIED AGRICULTURE ON LIVELIHOOD AND NATURAL RESOURCES IN NORTHERN THAILAND: A CASE STUDY IN BAN MAE KHI (UPPER ZONE OF THE MAE RAM SUB-WATERSHED)

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Abstract

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The intensive cultivation of crops (vegetable and cut flower) is the main economic activity of the people in Ban Mae Khi. This is characterized by applications of high levels of inputs such as agrochemicals, labour and capital. The aim of this study is to identify the driving forces behind agricultural intensification as well as the impacts of this development on the livelihood of the people and natural resources in the study area. The study thus indicated that the availability of ready markets, need for more income to cope with household expenses, restriction imposed to the expansion of land area for cultivation, the Royal Project and availability of water for dry season cultivation among others are the main driving forces for farmers intensifying their agricultural practices. The study also showed an improvement in the living standards of farmers as a result of intensified agricultural production. This is reflected in their increased income levels, better educational prospects for children, access to quality health care among others. According to respondents in the study area there has been no deforestation as a consequence of intensified agriculture due to policies that forbids encroachment into forest areas. However, based on a land-use change analysis conducted in a highly cultivated area, a 38% decrease in the forest cover has occurred. Analysis of soil samples showed that the soil is polluted with N and P with moderately high levels of NO_3^- and plant available P respectively but with inconsiderable concentrations of pesticides residues. Soil pH values were found to be suitable for vegetable production and SOC was optimal. The water was found to be clean with low levels of NO_3^- and PO_4^{3-} and no pesticide residues.

Key words: intensified agriculture, natural resources, driving forces, socio-economic consequences, Ban Mae Khi, Northern Thailand

Abbreviations

BMP	Best management practices
CO_2	Carbon dioxide
DO	Dissolved oxygen
DoA	Department of Agriculture
EC	Electro conductivity
FAO	Food and Agricultural Organization
FFTC	Food and Fertilizer Technology Centre
FGD	Focus group discussion
GAP	Good Agricultural Practices
GIS	Geographic Information System
GPS	Global Positioning System
HRDI	Highland Research and Development Institute
K	Potassium
L	Litre
mg/kg	Milligram/kilogram
mg/l	Milligram/litre
ms/cm	Millisiemens/ centimetre
N	Nitrogen
NGO	Non-governmental organization
NO_3^-	Nitrate
O_2	Oxygen
OECD	Organisation for Economic Co-operation and Development
P	Phosphorus
pH	Percent of Hydrogen ion
ppm	Part per million

PO_4^{3-}	Phosphate
PVC	Polyvinyl chloride
RH	Relative humidity
RP	Royal project
SOC	Soil organic carbon
SOM	Soil organic matter
SSI	Semi structured interview
TAO	Tambon Administration Organization
USDA	United States Department of Agriculture
µS/cm	microsiemen/centimeter

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1. Introduction

Main authors: Tedese, Tobias
Contributing author: Daniel, Wanploy

The agricultural sector of Thailand has experienced great changes within the past 50 years. As one of the world's major exporter of agricultural commodities based on conventional production methods in an open market economy, the agricultural sector has been the main driver for the rapid industrial development that Thailand has undergone since the 1950's (Buch-Hansen, 2001). However, great population growth and increasing international competition has led to a demand for enhancement and effectiveness of the agricultural production, which has had severe impacts on the agriculture. As a consequence, especially during the 1960's and 1970's, Thailand suffered from deforestation transforming the landscape from a rather dense cover of tropical forest to an expanding cultivated arable land (Buch-Hansen et al., 2006). This change in land-use, as a result of agriculture, may be related to the changes in the Thai government's agricultural policies as prescribed in the first to eight National Economic and Social Development Plans (Jiang et al., 2007). In addition, the production of market-oriented cash crops was introduced as an alternative to the subsistence system and an increasingly intensification of the agricultural production took place. Intensification of agriculture by use of high-yielding crop varieties, fertilization, irrigation, and pesticides has contributed substantially to the tremendous increases in food production, leading to an unsustainable land-use and environmental degradation especially in the Northern and Northeastern parts of the country (Matson et al. 1997). Today though, encouraging a strategy of agricultural sustainability, the Thai government is now facing the great challenge of sustainability: combining protection of the environment and the natural resources with socio-economic development (Buch-Hansen, 2001; Jiang et al., 2007). This has been the focus of the ninth (2002-2006) and tenth (2007-2010) National Economic and Social Development Plan (Koomsin, 2007; Office of the National Economic and Social Development Board).

A progress of intensified agricultural production has not only environmental consequences but also plays a major role in the livelihood strategies of the many million Thai farmers. These farmers, often small scale and relatively poor, can possibly gain economically from this development but at the same time also lack the necessary agricultural input and market access that are needed, resulting in decreasing income and higher inequality. Furthermore, the farmers are highly dependent on the access and quality of the natural resources and a degradation of the environment will consequently affect the long-term agricultural production and sustainability (Buch-Hansen et al., 2006).

In the hills of northern Thailand, gradual process of agricultural commercialization has taken place over the last three decades due mainly to population increase. The period of traditional shifting cultivation has declined and replaced by short fallow period or permanent agriculture (Turkelboom et al. 2008). The land-use has shifted from mainly rice production to a high percentage of permanent crops constituting 44% of the cultivated area in 2003 compared to just 9% in 1963 (Jiang et al., 2007).

Agriculture has developed rapidly over the last four decades being the third largest source of income and one of the most important economic sectors in Chiang Mai. About 15% of the

gross product of the province is from agriculture and 35% of the labor force is in this sector. Due to the open economy of Thailand, agricultural modernization oriented towards increased production has been promoted by government agricultural policies and agricultural research. The aim of this modernization and agricultural intensification is the increase of yield per hectare.

Agricultural intensification can be defined as a production system where there is land intensification, high use of labor or high capital inputs to increase output per unit area. Land can be intensified by increased cropping intensity or intercropping, multiple cropping or by shortening or absence of the fallow period. Labor intensification refers to the increased use of labor per unit area. Capital intensification is the higher use of input such as fertilizer, pesticide, herbicide, machineries, irrigation and high-yielding crop varieties per unit area (Løvenbalk et al, 2003, Reardon et al., 1999).

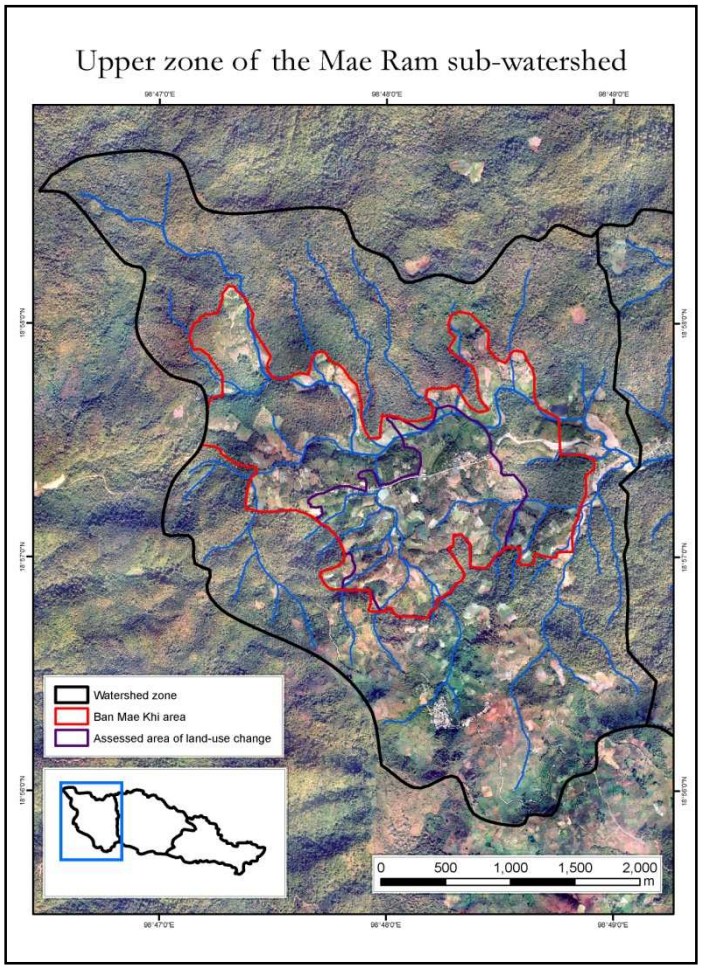

Figure 1: Map of upper zone of the Mae Ram sub-watershed

In the focus area of this study, Ban Mae Khi in the upper zone of the Mae Ram sub-watershed in northern Thailand (bounded by coordinates 18º58' - 18º56' N and 98º46' - 98º49' E), such a process of intensified agriculture is taken place. The farmers in this village are involved in intensive rain fed and irrigated agricultural production of cash crops (cut flowers, lettuce, cabbage etc.) which constitute their main economic activity. Ban Mae Khi is the oldest community about 200-300 years old of two communities in the upper zone of the

Mae Ram sub-watershed located in Mae Rim district, approximately 25 km northwest from Muang Chiang Mai district in Chiang Mai province. In 2009, the village comprised 91 households with a population of 733 with approximately equal proportion of male and female. The main ethnic group in Ban Mae Khi is Hmong while the others are Kon Muang and Shan (Aumtong et al. 2009; HRDI, 2005).

The area comprising the upper zone is mountainous with an elevation range of 900-1500m above sea level. It has a size of 14 km^2, which is approximately 25.83% of the entire Mae Ram sub watershed. The upper zone is the headwater area of the Mae Ram watershed, which is made up of a dendrite drainage system (Aumtong et al., 2009). A report from 1994-2000 at Nong Hoi Mai Royal Project near Ban Mae Khi showed that the average highest and lowest temperatures were 32.6 °C and 17.0 °C respectively. The hottest month was April and the coldest month was January. The annual amount of precipitation was 1,416.8 mm with the highest rainfall in August and the lowest rainfall in January. Average relative humidity (RH) was 86% that had a peak in October and lowest in March, 96% and 69% respectively (HRDI, 2005).

Soil resources in the upper zone of the watershed are mainly soil groups 62, 29C and 60. Soil group 62 which covers the largest area (10.8 km^2) of the region is unsuitable for crop cultivation thus it is fated for forest conservation to protect the environment and the headwater. Soil group 29C, which covers an area of 3.1 km^2 on the other hand and by virtue of its high clay content, are suitable for cultivating fruit trees and cash crops. The remaining 0.1 km^2 comprise soil group 60, which is suitable for cultivating cash crops and growing vegetatables (Aumtong et al., 2009).

Before the 1980s the area was dominated by opium cultivation. Small areas of forest was cleared with slash & burn methods and there were no use of fertilizers or irrigation. The practice was using short cropping period (1-3 years) followed by long fallow period hence requiring large amount of land per capita. From 1980 to 1997 the farming system was changed to mainly fruit trees. Since the 1997 intensive vegetable production was started and more intensive production of vegetable and flowers in greenhouse was introduced from 1999. This study focuses on the most recent period of agricultural intensification beginning in 1997.

Table 1: Timeline for change in farming practices in Ban Mae Khi

Periods	1980		1987	1997	1999
	Opium cultivation	Introduction of alternative crops	Lychee production	Intensive vegetable production	Introduction of greenhouse
Crops	Opium Maize Upland rice	Maize Upland rice Lychee Plum Arabica coffee Vegetables	Lychee Small proportion of vegetables, maize and upland rice production	Vegetables Flowers Small proportion of fruits, maize and upland rice production	
Cultivation practice	Slash and burn	Permanent cultivation			

The development of intensified agriculture in this area can provide socio-economic changes to the farmers but at the same time also cause environmental degradation. This relation between human utilization of natural resources and natural resources degradation is very complex. Thus, assessing the impacts and sustainability of intensified agriculture requires a broad holistic interdisciplinary approach that embraces both natural and social science. The aim of this study is therefore to identify the driving forces behind agricultural intensification in Ban Mae Khi in the upper zone of the Mae Ram sub-watershed and its contribution to the economy and livelihoods of the people as well as the impact on natural resources.

1.1. The main research question and sub-questions

Main research question

What are the driving forces and the impacts of intensified agricultural production in Ban Mae Khi?

Sub research questions

What are the driving forces behind the intensification of agricultural production?

What are the socio-economic consequences of intensified agriculture?

What are the impacts of intensified agriculture on the natural resources?

2. Methodology

Main authors: Daniel, Mirjan, Nuhu, Wanploy
Contributing authors: Tedese, Tobias

The study employed both natural and social sciences methods to obtain a reliable data to answer the research questions. Data was also collected through literature review to supplement the findings from primary data. A combination of multiple methods was used to source data from different respondents with the aim of ensuring the reliability of the data collected.

2.1. Transect walk and observation

To understand the problem and to familiarize with the study area, an informal conversation (discussing and asking questions about the problem) with a local community guide was carried out during a transect walk. This helped to get a first-hand understanding of the extent of agricultural intensification and management practices used by some farmers observed during the exercise.

2.2. Community mapping

To get an overview of the relative distribution of the natural resources in the study area a community mapping exercise was carried out with the assistant village headman with the assistance of two other community members. This also helped us to know the community boundary and areas of intensified agricultural cultivation.

2.3. In-depth semi-structured interviews

Four in-depth semi-structured interviews were conducted with key informants: Assistant village headman, officials from the Royal Project, village school teacher and the president of the village agricultural cooperation. This was conducted to find out the changes in the farming systems that have occurred in the area, the driving forces for these changes but with focus on intensified agriculture and the impact of this development on the livelihood of the farmers and natural resources. These key informants were purposively selected based on their experience and knowledge of the agricultural activities going on in the study area.

2.4. Questionnaire

In finding answers to some research questions which require quantitative data for statistical analysis, a questionnaire survey was conducted. A stratified random sampling technique based on the ethnicity, and membership in Royal Project was used to sample 32 farmers (comprising 23 Hmongs and 9 Kon Muangs; 21 and 11 farmers outside and within the RP respectively) involved in intensive agriculture in the study area for this survey. To facilitate the process, questions from our Thai colleagues were merged with those of Danish students.

2.5. Focus group discussion

Though two focus group discussions were intended to be carried out to get a detail explanation to some research questions, a meeting with three key informants (Assistant Village Headman with the two Tambon Administration Organization (TAO) representatives of the village each representing the two ethnic groups) was conducted which we call "focus group discussion". Notwithstanding, it provided us with a lot of data and confirmed most data we had already collected from different key informants and methods.

2.6. Aerial photographs and GIS analysis

To map and assess the land-use changes, its effects on natural resources as well as measure the extent of agricultural intensification, a comparison between the land-cover in 2002 from aerial photographs and field observations was carried out in the study area. The collected data was later analyzed and mapped using GIS.

2.7. Soil and Water Sampling and Analysis

Figure 2 illustrates the upper part of the watershed. Only a subpart of the upper part was considered as representative to collect the water and soil samples. The representative area was divided in three strata: upper, middle and lower strata. The main criterion for this division was the altitude. The reason behind this is to see how application of agricultural inputs applied in the upper strata can affect the lower strata as the water flow follows the direction of gravity.

A. Compositing soil sample method

The methodology followed to collect soil samples was compositing soil samples (Carter, 1993). A number of 5 to 8 sub-soil samples were taken in 20 cm depth in different cultivated plots of each stratum and mixed equally volume together to form one composite soil sample. An overall of three composite soil samples were collected per each stratum, where one composite soil sample represents 1/3 of the overall stratum surface. In addition two more soil samples were collected under Lychee tree plantation and analysed separately without mixing with the soil samples collected in cultivated plots. The overall number of soil samples collected in the study area was eleven (11).

B. The methodology of water sampling

The black dots in the map (Figure 2) relate the sites where the water samples were collected. The sites were marked using GPS. Five water samples were collected in total in all the subpart. In addition sediment samples from the base of the stream were collected in each site where the water samples were collected in order to measure the concentration of pesticide and herbicide. Test kits were used to measure some of the parameters and water samples were analysed in laboratory.

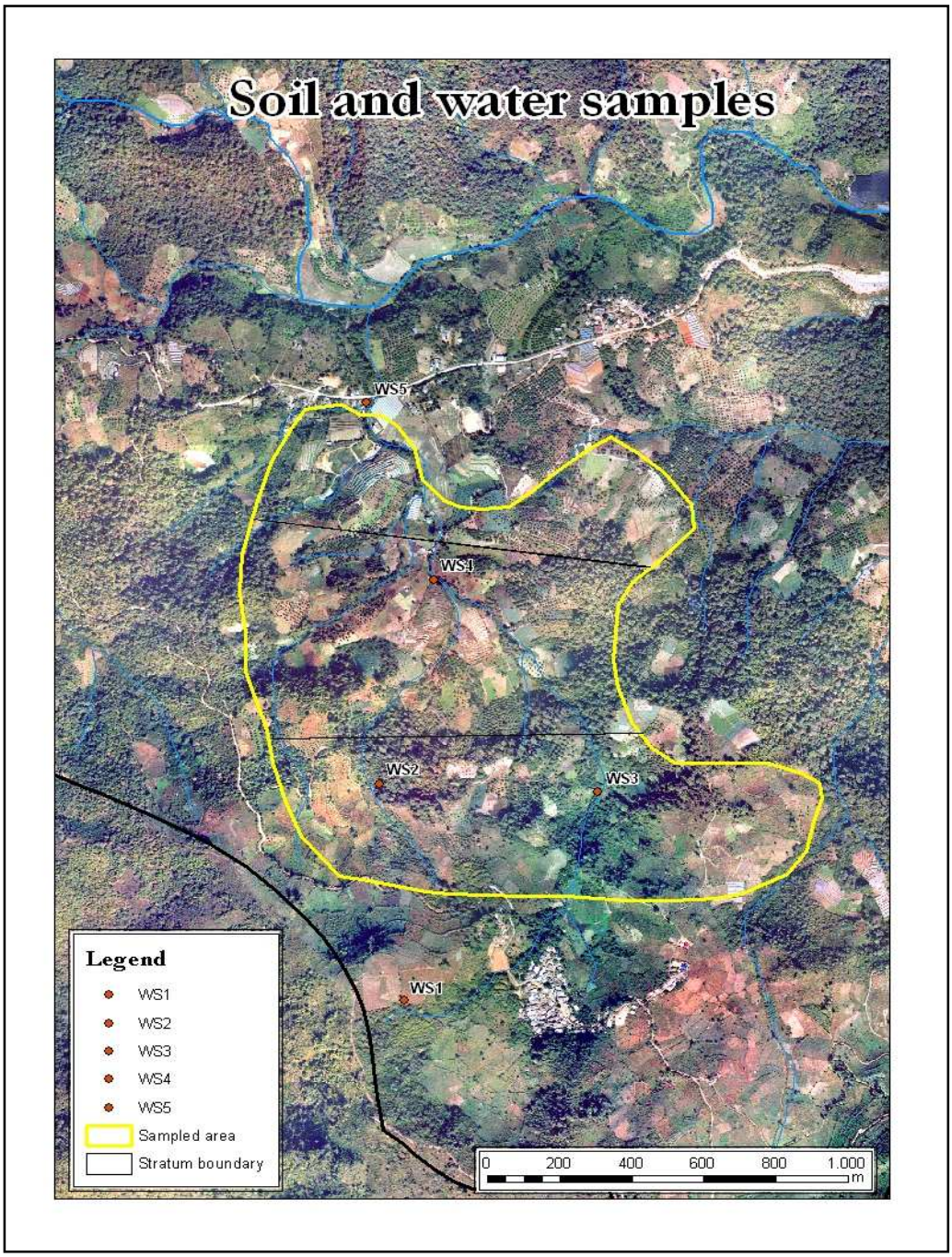

Figure 2: Soil and water sample map

2.8. Reflections on methodology

The questionnaire survey provided a quick collection of data and also made it possible to observe farmers fields as the interviewing of farmers in their fields was the only possible option at our disposal. Hence it provided opportunity to compare farmers' answers to what they are really practicing and thus seek clarifications where necessary. Some assumptions leading to the formulation of close-ended questions in the survey were found not be applicable to farmers' conditions. As a result those questions were reframed as open-ended questions. The in-depth interviews with key respondents provided us with enough data however most of them were time consuming and extended beyond the estimated time.

3. Results and discussion

3.1. Driving forces for intensified agriculture

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Contributing author: Tobias

In order to understand the driving factors behind the intensification of agricultural production, it is important to know the changes in land use and farming system in the study area from the past to present. This provides the basis to identifying the reasons or factors motivating farmers to change their agricultural practices. However, in the light of the research question, more attention would be focused on why farmers within the study area intensify their agricultural practices.

A. Changes in land use and farming system in Ban Mae Khi

The study area has under gone significant changes in land use and farming system over the past three decades. These changes can be categorized into three main phases as follows:

Phase I: Cultivation of opium for sale and upland rice and maize for home consumption prior to 1980 by Hmong people. Land preparation was characterized by slash and burn and expansion of cultivation areas into forest areas.

Phase II: Between 1980 and 1997, large scale cultivation of tree crops such as lychee and some vegetables but on small scale. Lychee cultivation was characterized by application of low levels of chemical fertilizers and pesticides, low labour requirement and rain-fed.

Phase III: From late 1990s to early part of 2000, lychee cultivated area have been changed to the cultivation of temperate vegetable crops (cabbages, Chinese cabbages, head lettuce, lettuce, carrot, etc.) and cut flowers. These are intensively cultivated throughout the year and characterized by the application of increased levels of nitrogenous fertilizers, pesticides, plant hormones, irrigation water during the dry season and increased labour requirement. This is illustrated in the responses from 32 respondents from a survey as seen in the charts below (Figure 3). This progress has led to still more intensified agricultural practices with the introduction of greenhouses for the cultivation of cut flowers and vegetables around 1999 and; the major vegetable expansion from 2002 leaving almost no lychee cultivation today in 2009.

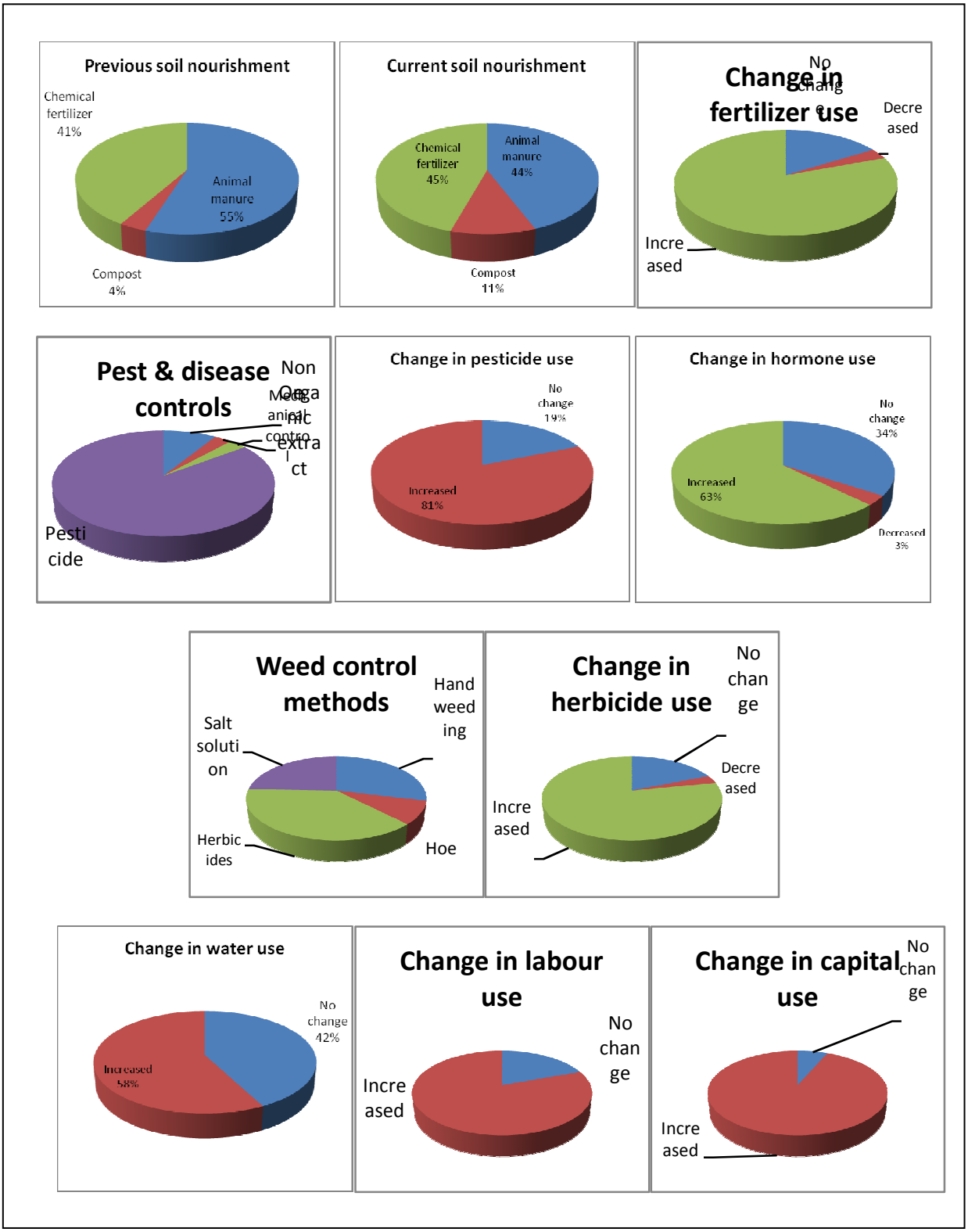

Figure 3: Changes in levels of input used by farmers

To assess this most recent land-use changes a comparison between the land-cover in 2002 and today (2009) has been conducted based on an aerial photo and observation in the area respectively (see map below, Figure 4). The assessed area covers a total of 147 hectares in the most intensively cultivated area in the upper zone and corresponds to 37% of the Ban Mae Khi community area. Lychee trees dominated this land in 2002 and only small areas of greenhouses and vegetable production existed. In the past seven years, just over half of the assessed area (51%) has experienced change in land-use mainly into vegetable production (69% of the 147 hectares) as the following table shows:

Table 2: Land-use change from 2002 to 2009 in Ban Mae Khi

Land-use changes from 2002 to 2009 in Ban Mae Khi				
	Km^2	**Hectares**	**Rai**	**%**
Upperzone area of watershed	13,992	1399	8.743,75	100
Ban Mae Khi community area	3,980	398	2.487,50	28
Ban Mae Khi community area	3,980	398	2.487,50	100
Assessed area in land-use change	1,468	147	918,75	37
Assessed area in land-use change	1,468	147	918,75	100
Changed land-use	0,747	74,71	466,94	51
Changes in land-use from 2002-2009:				
Vegetable	0,517	51,74	323,38	69,25
Sacred Forest	0,099	9,99	62,44	13,37
Greenhouse	0,067	6,66	41,63	8,91
Fallow	0,031	3,11	19,44	4,16
Banana	0,024	2,36	14,75	3,16
Orchard	0,009	0,85	5,31	1,14
Total	**0,747**	**74,71**	**466,94**	**100,00**
Area of greenhouses				
2002	0,033	3,32	20,75	2,26
2009	0,096	9,64	60,24	6,56
Difference	0,063	6,32	39,49	
290 % increase				

Note: The percentage of change in land-use shows the relation to the total area changed since 2002 (74.71 hectares). The percentage in the area of greenhouses shows the relation to the overall cover of greenhouse in the assessed area (147 hectares)

Land-use changes into vegetable production clearly prove that the area of intensified agriculture has expanded significantly. In addition, the area of greenhouses has almost tripled within the past seven years, which shows a tendency towards an even higher level of agricultural intensification.

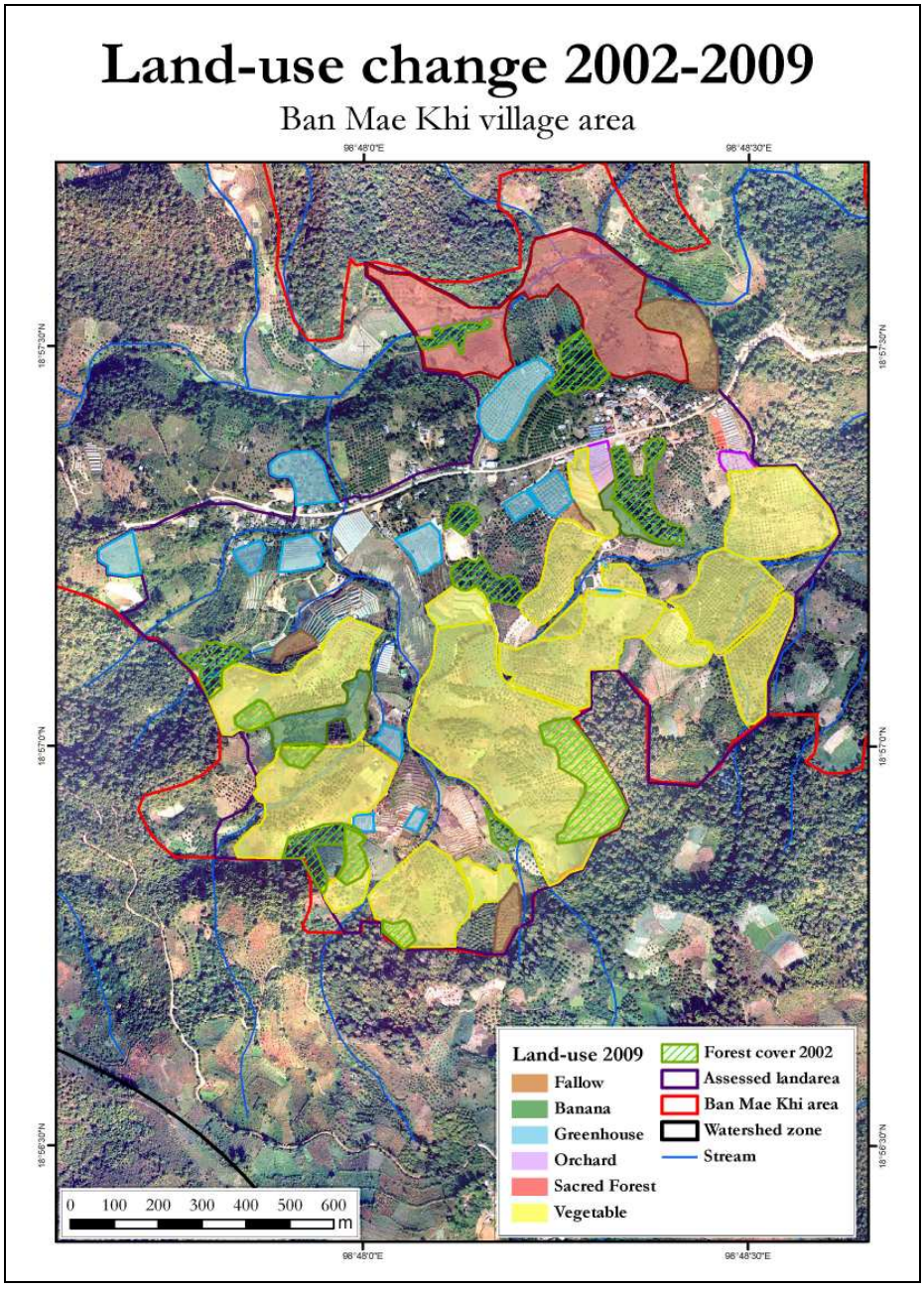

Figure 4: Compare changes in land use between 2002 and 2009

B. Driving forces

The main driving forces motivating farmers to change their land use and farming systems as described above are:

From phase I to phase II: Opium cultivation is illegal. The King, His Majesty King Bhumibol Adulyadej's visit to eliminate its cultivation and to improve the living standard of the hill tribe people (HRDI, 2007). From phase II to phase III: Productivity of lychee declined due to heavy rains, fall in lychee price in 1997 and the fact that it can only be harvested once in a year.

With respect to the reasons why farmers intensify their agricultural practices, the following driving forces have been identified from the study according to farmers' perspective. Figure 5 below shows the result from 32 respondents in the survey conducted.

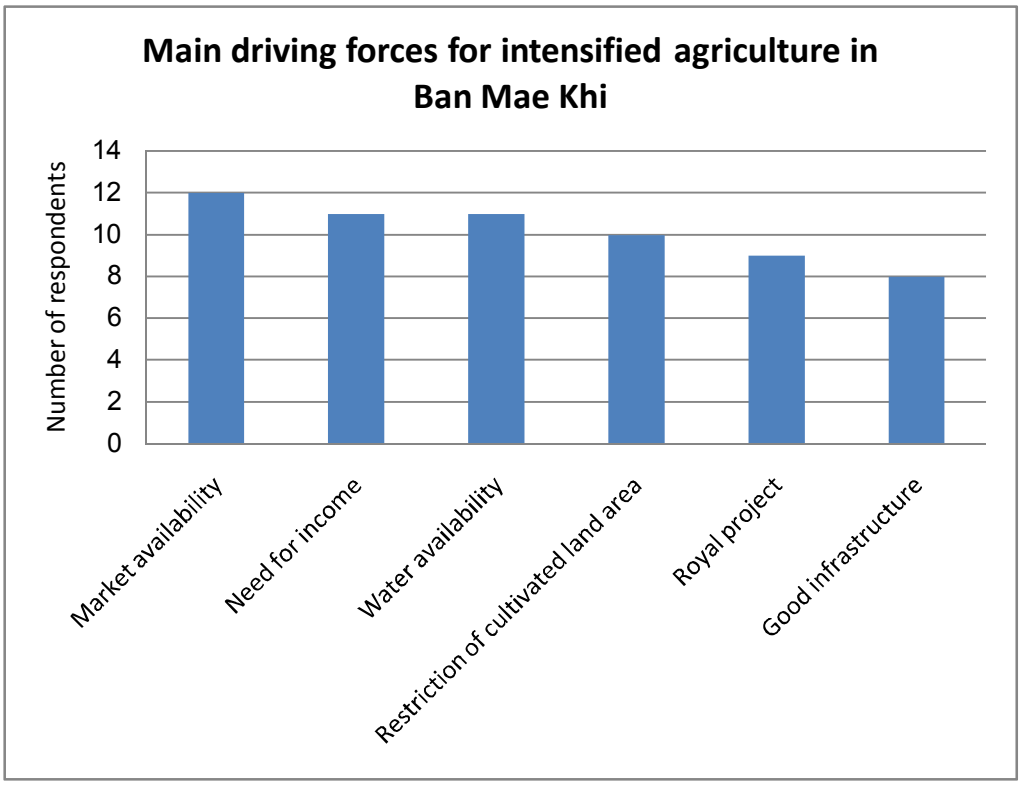

Figure 5: The main driving forces for intensified agriculture in Ban Mae Khi

The availability of ready market all year round is the main motivating factor for farmers intensifying their agricultural practices. This ready market is as a result of the fact that vegetables constitute an essential component of the Thai diet culminating into the increase in the per capita consumption of vegetables in recent years (FAO, 1999). Also, the upsurge of urbanization and economic growth has increased the demand of vegetable for urban consumption in Asian cities (Midmore and Jansen, 2003). To meet the growing urban demand for vegetables its cultivation has become an important component of the farming systems in the rural highland area and peri-urban areas (Bastakoti, 2009) of which Ban Mae Khi is no exception. This could be compared to the situation in the central plains of Thailand where there has been a substantial increase in vegetable and fruit production over the past

two decades as noted by Chunnasit et al., (2000). The demand and availability of ready markets for vegetables in Chiang Mai, as well as its proximity to the study area has been a motivating factor for farmers to intensify their vegetable production. This is further enhanced by the good road network linking the study area to the city. Farmers have direct access to middle men and thus sell their products to these people having the ability to negotiate the price. In addition to this, the Royal project also provides ready market, to some extent, to its contract farmers by buying products (only 10%) from these farmers and further selling in Chiang Mai, Bangkok, Thai Airways and other developed markets using its brand.

Crop production is the main income source for farmers within the study area. With increasing household expenses on education, quality health care, among others, the need for more income to cope with this trend cannot be over emphasized. The increasing household expenditure calls for farmers to intensify their production by cultivating throughout the year and ensuring higher yields through the application of agrochemicals. In the past, there were no prospects for education and even if schools were available, families did not send all their children to school and require some to work on the farm. Nowadays, all children of school going-age in all farm households surveyed are in school and only help in farm operations during school vacations. In addition to this, farm households are aware of, and practice good quality health care by attending clinics in the cities. Generally, they live in well ventilated houses and posses different assets. They must also meet other social demands financially. In order to meet the demands of these household expenses especially for education and health which keep on increasing, the farmer requires more income but which is based only on crop cultivation. As a result, the farmer needs to increase the yield of crop per unit area by increasing his land use intensity.

Agriculture in Ban Mae Khi is mainly rain-fed. However, by virtue of its location within the watershed (near the head water area – the most important water supplier of all the other zones in the watershed), and the extensive dendrite drainage system (Aumtong et al., 2009), water is readily available for both lowland and upland areas close to water for cultivation during the dry season. Almost all the farmers within the study area take advantage of this important natural resource by investing in irrigation facilities and structures (PVC pipes, sprinkler, irrigation pump, water storage ponds, etc.) to provide water for dry season cultivation. This process has greatly reduced the fallow periods and the land is put under cultivation throughout the year. In the contrary, lack of water during the dry season in the middle and lower zones of the watershed, has shifted the focus of activities of the people from farming to the collection of non-timber forest products and city employment respectively.

With reference to the Land Code of 1954, all mountain land and land within 40 metres of the foot of the mountain must not be damaged, destroyed or taken possession of. The hill tribes have no legal right to land in these mountainous areas (Rerkasem and Rerkasem, 1994 in Schmidt-vogt, 2001). Likewise, farmers within the study area possess no legal land right documents. They are also restricted from expanding their land area for cultivation into the forest as the result of the Land Code Act. To prevent encroachment into the forest area, the Royal project demarcated the land area for individual farmers thus restricting them from expanding their farm lands.

This could be seen as a driving force to the agricultural intensification process in the study area. As seen in the equation below:

Area under cultivation × Yield = Total production.

To increase total production implies that either the area under cultivation or yield or both must be increased (HRDI, 2007). But with the restriction imposed on farmers to expand their area under cultivation, farmers have no other option to increase their total production except by increasing the yield per unit area. To achieve this and still maintain the fertility of the soil, farmers apply more chemical fertilizers such as urea and N-P-K and now poultry manure (to reduce cost) and also control pest and diseases. In addition, farmers have to invest a lot of financial capital in order to purchase and install irrigation facilities in upland areas where water is relatively scarce during the dry season.

In terms of agricultural development, the Royal Project could be seen as one of the main driving force for agricultural intensification in the study area. Following its inception, it has helped farmers to transfer from opium cultivation to fruit trees and now vegetables. Today all farm households in the study area grow one or more types of vegetable crops for sale, with upland rice and maize for home consumption only.

By following the donor's concept of sustainability (though it is not donor funded), the Royal Project supports farmers in giving them seeds, seedlings, extension services, marketing and distribution of their crops based on a quota system. It also sets quality standards and ensures that farmers meet the requirements of good agricultural practices (GAP) among others.

But the question is whether this is really sustainable considering farmers cultivation practices. In 2003-2004, 300 farmers from six villages (Ban Mae Khi, Ban Pang Hai, Ban Nong Hoi Mai, Ban Sam Lang, Ban Nong Hoi Kew and Ban Pang Eka) were registered with the Nong Hoi Mai Branch. Today the membership has drastically reduced to 194 with only 5 members (2.6%) in Ban Mae Khi. This decline in membership is a result of having opportunity to sell the product directly to city market with negotiable price. Moreover, farmers' inability to meet the quality standards of the Royal project is a reflection of farmers not using the prescribed levels of resources (fertiltizers, pesticides, etc) in a way that will yield long-term benefit. Also the decline in membership might be due to the delays in payment (within six months) by the Royal project as claimed by some farmers on contract with the Royal project.

It is important to note also that the climatic conditions especially the topography of the study area is important to temperature and temperature fluctuation. The diurnal temperature variation occurring at elevation over 800-1,000 metres is beneficial to many crop such as Brassica (lettuce) and onion (Tindall et al., 1990). Education (both formal and informal) and the financial assistance from village agricultural cooperation to interested farmers also play a significant role as driving factors for agricultural intensification within the study area.

3.2. Socio-economic consequences of intensified agriculture

Main authors: Nuhu, Tedese

The development of intensified agriculture has provided socioeconomic changes to farmers in Ban Mae Khi. Farmers in this area are engaged in intensive production of crop (vegetables) which is the main source of income for about 97% of the respondents. Likewise, 87.5% of the respondents get all their incomes from intensified agriculture. According to International Seminar of Food and Fertilizer Technology Centre for the Asian and Pacific Region (FFTC, 1997) vegetables are profitable cash crops in slope-land areas, especially in tropical countries where temperate vegetables grow well in higher altitudes. Similarly in Ban Mae Khi cash crop production constitute for almost all the farmers income, of which vegetable production dominates and therefore it contributed immensely to the peoples' livelihoods.

A. Farmers' standard of living before agricultural intensification and now

The living standard of farmers in Ban Mae Khi has improved due to intensified agriculture. As indicated in Table 3, the living standard of 93.8% of the total respondents has improved. None of the respondents indicated that their living standard is worse off with intensified agriculture.

Table 3: Farmers' standard of living before agricultural intensification and now

Standard of living	Hmong		Kon Muang		Total No of respondents	Total percent
	Number of Responses	Percent	Number of Responses	Percent		
Much Better	5	21.7	2	22.2	7	21.9
Better	18	78.3	5	55.6	23	71.9
Same	0	0	2	22.2	2	6.2
Worse	0	0	0	0	0	0
Total	23	100	9	100	32	100

In comparing the two main ethnic groups, the living standard of all the Hmong respondents has improved; whereas 77.8% Kon Muang responded to have better standard of living due to intensified agriculture. On the other hand 22.2% of the Kon Muang respondents said their standard of living is the same, because their main income sources come from non-agriculture (handicraft production, remittance and city employment) and they produce crop only for household consumption. This improvement in living standard of the people is measured based on their cash income, assets such as cars, motorbikes, housing, TV, mobile phone, home furniture and education of their children. The study shows that on the average, farmers in the village earn 10,000 to 20,000 baht per month. Therefore, the people of Ban Mae Khi have better standard of living due to intensified agriculture compared to the last ten (10) years.

B. Category of the community benefiting most from intensified agriculture.

All farmers engaged in intensive agriculture are benefiting from it. The main category we intended to look at was in terms of wealth and landholding to see who is benefiting most from intensified agriculture. However, it was difficult to categorize farmers in terms of wealth and landholding category within the community. According to information obtained from semi-structured interviews benefits from intensified agriculture is based on ones investment. The more farmers invest, the more profits they are likely to gain. Regarding farmers within and outside Royal project, benefits depend on the market prices and not being a member or not.

Table 4: Contribution of intensified agriculture to income of the people

Proportion of income from intensified agriculture	Hmong		Kon Muang		Total No of respondents	Total percent
	Number of Responses	Percent	Number of Responses	Percent		
All	22	95.7	6	66.7	28	87.5
More than half	1	4.3	0	0	1	3.1
Half	0	0	1	11.1	1	3.1
Less than Half	0	0	1	11.1	1	3.1
None	0	0	1	11.1	1	3.1
Total	23	100	9	100	32	100

For the two main ethnic groups, the Hmong people are more engaged and invest in intensified agriculture and almost all the respondent get their income from it. Initially they expand their farmlands by encroaching in to the forest before demarcation between farmland and forest was done by the Royal Project. As indicated in Table 4, about 96% of the Hmong respondents get all their incomes from intensified agriculture; whereas for Kon Muang respondents it is only 67%. It is important to note that the Kon Muang people are less interested in agricultural activities and have less farmland. Even some of them sell parts of their farm land to the Hmong people; they rather prefer getting their income from city employment and daily labor work and from remittances. About 11.1 % of the Kon Muang stated that none of their income is from intensified agriculture for they produce only for household consumption. So, based on farm land holding and level of investment, the Hmong people are benefiting more from intensified agriculture compared to Kon Muang.

C. Influence of intensive agriculture on education

Table 5: Influence of intensive agriculture on education

Change in the Level of schooling	Hmong		Kon Muang		Total No of respondent	Total percent
	Number of Responses	Percent	Number of Responses	Percent		
Improved	20	87	5	55.6	25	78.1
Same	3	13	4	44.4	7	21.9
Lessened	0	0	0	0	0	0
Total	23	100	9	100	32	100

Agriculture intensification has a positive influence on education in Ban Mai Khi in terms of sending children to school compared to ten (10) years back. As indicated in Table 5, 78% of the respondents showed that the level of schooling of their children has improved because of increase in income due to intensified agriculture. And 22% stated that no change in the level of schooling of their children because they don't have school age children. The average number of children in household of the respondents is 3, out of which 2 children are attending school. The rest are below schooling age.

Similarly from semi structured interview with a school teacher, it is noted that in the past 10 years, farmers hardly sent their children to school. For instance in a household with 4 children, only one would be given formal education. Today, on the contrary, since farmers' income from intensive agriculture has increased they are able to provide basic needs for their families. Even if labor requirement for intensified agriculture increased, they hire labors on farm. They send all children of school going age to school and most of them are now able to pursue further education in the cities.

D. Influence of intensive agriculture on health of the farmers

Information obtained from focus group discussion and semi structured interview indicated that few farmers who have not followed prescribed precautionary measures in the application of pesticides have had skin irritation (allergic conditions), respiratory problems and exhaustions. In most cases, as these health problems are not severe, the farmers will normally recover within a week.

Attempt was made to contact health official in the area for information regarding influence of intensified agriculture on health of the farmers. This was not carried out because almost all the farmers prefer to go to hospital and clinics in the city for better health services than the village clinic which is also not nearby the Ban Mae Khi area. On the other hand, in order to get information from each respondent on influence of application agrochemicals on their health, it would have been better to add this question in the questionnaire. Generally due to increased income from intensified agriculture most farmers can afford the health expense in the city hospitals.

Farmers in general compared the last ten years due to increased income from intensified agriculture are able to access better health services.

E. Influence of intensified agriculture on community collaboration

According to information obtained from the assistant village head man, most farmers in Ban Mae Khi area are vastly engaged in intensified agriculture and everybody is busy on his farm which make them become more individualistic. Therefore, cooperation between the farmers such as helping each others during planting and harvesting has decreased compared to ten (10) years ago. Instead, the farmers tend to hire more Shan labourers for their agricultural activities.

It is observed that cooperation within the community is influenced by intensified agriculture. 56.3% of the respondents stated that some cooperation exists within the community as production groups, water user groups and helping each other in planting and harvesting times which is not as strong as before. However, 37.5% of the respondents said there is no cooperation as a result of intensified agriculture. As compared to the last ten (10) years, cooperation within the community is reduced to intensified agriculture as farmers are now more individualistic.

F. Risks of intensified agriculture

Before the intensification of agriculture, farmers mostly produced only one type of crop and they harvest only one time per year. In this case once the crop fails due to natural disaster or pests, farmers have to wait for one year to get the next harvest. Similarly, if the market price of their product falls, they did not have other income source to compensate. However, with intensified agriculture farmers are able to diversify their crop type on plot of land per each harvest. They also harvest 2-5 times per year due to availability of irrigation water and short maturation period of vegetables. Now they are able to reduce risk of crop failure because if one crop fails they can get harvest from other crops at the same time; or even they can replace the crop and harvest within a short period of time. The same way if the market price of one crop falls, they have a chance to get income from other crops and from shortly coming successive harvest. Farmers also depend on current market price and cultivate crop type with high market price. Therefore, for such risks farmers are more secured now than before.

According to Jitsanguan T. et al (2000), diversification of crops on each farm is necessary in order to reduce risk and uncertainty from a supply surplus and falling prices, as well as outbreaks of pests and diseases. This is mostly applicable to the case in Ban Mae Khi.

On the other hand, agricultural intensification require more investment in order to obtain high yield. Most farmers still feel unsecured by associated risks such as loss of the invested capital in case of fall in market price and crop failure

G. Contribution of agricultural intensification to employment

Jitsanguan, T. et al (2000) report on Development of Sustainable Agriculture in Thailand wrote that agriculture has been found to be a social safety net in Thailand, in terms of food security and as a source of employment. In the same vein, intensified agriculture contributes a lot to employment in the Ban Mae Khi. The average household size in the study area is six (6), half of which are engaged in agriculture. The remaining half is children in school and the aged in the household. In contrary to this, the FFTC International Seminar (1997) reported that in many slope land areas, most able-bodied men have left to find work in towns, leaving behind the women, children and old people as the only agricultural work force.

Labouring on agricultural production farm is the main source of income for Shan people who migrated from Burma and settled in the area; and for some Kon Muang and Hmong people with average daily labour wage of 120 Baht.

According to our interview with one Burmese labourer who was working in city before and now working in the village, she prefers working on farms in the village rather than the city. Because she makes the same daily wage as in the city and also cost of living the city is higher. For this reason, she is able to send her children to school and also living a better life than previously.

3.3. Impacts of intensified agriculture on natural resources

Main authors: Mirjan, Tobias

Intensification of agriculture characterized by high level of agricultural chemical inputs and intensive land use can influence the soil and water quality and increase soil erosion. Farmer's interests to increase the production may result in expanding their cultivated area in the forest direction. All these issues were investigated in order to measure the impacts of intensified agriculture in the mentioned natural resources: soil, water and forest.

A. Forest

The upper zone area of the Mae Ram watershed had an evergreen forest cover of 79% in 2008 (Aumtong et al., 2008) despite high rates of deforestation because of slash and burn practices and logging among other factors. In 1989 a national logging ban on Thailand's natural forest was implemented (Hares, 2004) and 5-6 years ago the Royal Project and the Land Department measured the boundaries of the plot of the farmers in the study area to control and halt deforestation. As a consequence, no land-expansion into forest areas is allowed and the farmers are therefore forced to intensify their already existing land. All the interviews conducted confirmed this and claimed that the forest cover has not changed due to intensified agriculture as cutting of forest is illegal. However, some sources argue that the density of the forest has decreased due to annual forest fires destroying the smaller trees; a tendency that meanwhile cannot be directly linked to agricultural intensification.

Table 6: Forest cover change from 2002 to 2009 in Ban Mae Khi

Forest cover change from 2002 to 2009 in Ban Mae Khi				
	Km^2	**Hectares**	**Rai**	**%**
Upper zone area of watershed	13,992	1399	8.743,75	100
Ban Mae Khi community area	3,980	398	2.487,50	28
Ban Mae Khi community area	3,980	398	2.487,50	100
Assessed area in land-use change	1,468	147	918,75	37
Forest cover				
2002	0,111	11,131	69,57	7,57
2009	0,069	6,874	42,96	4,68
Difference	0,042	4,257	26,61	
38 % decrease				

Note: The percentage in the forest cover shows the relation to the overall forest cover in the assessed area (147 hectares)

Nevertheless, according to the observation carried out in the area a 38% decrease in forest cover has occurred over the last seven years (Table 6). In this regard it is important to bear the following in mind: (1) the assessed area constitute as mentioned earlier a highly cultivated area in the upper zone of the watershed with a bare 7.57% forest cover in 2002 and is therefore in no way representative for the land-cover in the total upper zone area and

(2) the definition of forest chosen plays an important role in the extent of the forest cover. A significant area has for instance been transformed into a form of sacred forest just north to Ban Mae Khi village. This land was former dominated by grassland and various forms of vegetable production and now may be characterized as some kind of emerging forest (The exact land-use and function of this area are yet not clear). If this land-use change is regarded as a transformation into a young emerging forest the change in forest cover will of course be completely different. Still, the fact that a decrease in the forest cover has been found contradicts the information from the interview conducted in the area.

The vast majority of the land outside the assessed area is dominated by forest. Even though there has been observed forest degradation in this area especially on mountain tops the condition of the forest may be increasing due to the documented improvement in the livelihoods and income of the farmers. As people become deeply engaged in full time cash crop production leading to increase in income, they may tend to decrease the level of logging and stop other damaging practices to the condition of forest. This argument might be questionable, but compared to people in middle zone of the watershed who are involved in the collection of non timber forest products resulting in conflict with the Royal forestry department (Aumtong et al., 2009), the livelihoods of the farmers of Ban Mae Khi are considerably more protective to the condition of the forest. Moreover, according to the Royal Project the protection of the forest is highly important and annual tree plantation within the community is organized through the Royal Project to generate more forest.

B. Soil

Table 7: Result of soil sample analyses

Sample position	pH 1:1	EC 1:5	NO_3^-	Available P	SOC	SOM	K	Pesticide
		(µS/cm)	(mg/kg)	(mg/kg)	(%)	%	(mg/kg)	
Lychee	5.61	757	4.9	58	2.87	4.95	216	
U 1	6.67	177	18.8	252.1	1.91	3.3	283	0
U2	6.02	284	17.7	435.2	2.57	4.44	238	1
U 3	4.82	297	16	132.4	3.23	5.58	205	0
M1	5.85	273	52.2	580.3	2.39	4.13	175	1
M2	6.04	215	15.1	152.3	2.57	4.44	195	2
M3	5.97	304	50.6	413.4	1.73	2.99	163	1
L1	5.1	202	28	136	2.09	3.61	150	0
L2	5.89	106	4.6	215.8	2.87	4.95	166	0
L3	5.68	225	53.7	268.4	2.27	3.92	114	0

Remarks for pesticide: 0 –not detected, 1 to 4 detected but safe for consumer, over 5 – not safe for consumer.

Nitrates and Available Phosphorus

The results showed a variation of 38.9 mg nitrates/kg soil between the 9 soil samples taken in cultivated plots regarding to nitrates. The average concentration of nitrates in the upper, middle and lower stratum are 17.5 mg/kg, 39.9 mg/kg and 28.76 mg/kg respectively which compared to the standard table values of nitrates in soil corresponds to a medium, very high and high level respectively. Whereas in the lychee tree plantation the value of nitrates detected was 5mg/kg which is considered as low (FAO 1987).

In addition very high level of available plant phosphorus (P) were detected in all the sampled area except the soil sample collected in lychee tree plantation where the value was relatively lower (58mg/kg) but compared to the standard table it is considered high level. The average available P concentration in soil in the upper stratum was 273 mg/kg, and in the middle and lower stratum are 382 mg/kg and 206.7 mg/kg respectively.

The difference between the available P and NO_3^- concentration between lychee and intensive plots gives a clear indication that the reason behind this situation is the lack of Best Management Practice (BMP) which brings a great misbalance in soil nutrients (Rechcigl, 1995). Farmers were putting amounts of fertilizer, without measuring the soil fertility. More exactly they were generally applying fertilizers at least two times per crop: Chicken manure when planting and chemical fertilizers like Urea (most of the cases), complete fertilizer (15:15:15) and 13:13:21 in later stages of the crop development. The continual long-term application of P fertilizer and manure at levels exceeding crop P requirements can increase available plant soil P levels above those required for optimum crop yield. When soil available P levels become excessive, the possibility for P loss in runoff and drainage water is higher. This situation becomes more serious considering that available P in runoff can be 3 times higher than in the source soil. Drainage water and runoff from agricultural fields may contribute to nitrate pollution of surface water (Rechcigl, 1995). “However surface runoff generally contains only small quantities of soluble N unless high rates of surface applied N fertilizers are followed by heavy rains” (Rechcigl, 1995).

Soil Organic Carbon (SOC)

Regarding to SOC as an indicator of soil use intensity and degradation (Aumtong et al., 2008) there is no big difference observed between intensified fields and lychee trees. The average SOC in the upper, middle and lower stratum was 2.54%, 2.23%, and 2.42% respectively which is defined as high level (FAO, 1987). The result indicates a sustainable level of SOC. This seems to be as result of organic manure applied by farmers per each crop.

pH

The pH value in all soil samples varied from moderately acidic (4.8) to slightly acidic (6.7) (Borggaaard, 2008). Generally these pH values are considered suitable for soils carrying intensively cropped vegetables (Tindall, 1990).

Electro conductivity (EC)

The average electro conductivity (EC) of the upper, middle and lower stratum was 246.6, 268 and 178 µS/cm respectively. The highest level of EC 760 µS/cm was determined in the lychee tree plantation, however in the other soil samples EC does not exceed the value of 300 µS/cm. These detected values of EC do not indicate high soil salinity concentration (Jensen, 2006) even though farmers were applying salt solution (40 kg of salt per 200 L of water) as herbicides on young weeds. The reason can be the application of heavy irrigation before planting by farmers; heavy irrigation enables the salt washing from the soil (Jensen, 2006). However this practice of using brine as herbicide might have a long-term salinity effect and subsequent deterioration of the soils structure (Borggaard, 2008) though it appears seemingly good in the short term and no immediate salinity effect detected.

Pesticide

Residues of pesticide organophosphate group and carbamate group were detected in some soil samples. Unfortunately it cannot be defined exactly in which soil sample, because of changes in the marks of soil samples that have happened in laboratory. The variation of pesticide residues in soil samples are from zero to two which means that pesticides are detected but the concentration is under the values which can present risk for the consumer.

Erosion

Apart from the environmental impacts from intensified agriculture mentioned above, problems about erosion may also be influenced by the change in farming practices. As a result of the slash and burn practices during the opium cultivation big parts of the forest was cut down, included forest on the many slopes in this part of the watershed. Forest in the upper zone and on slopes plays a significant role in managing the water-balance, water quality and runoff especially during the rainy season and as bigger areas are left for crop production the risk of erosion and floods increases. However, water imbalance and erosion problems can also be a result of, for example road construction, which has been carried out in the area since the 1970's (Delang, 2002).

The problem of erosion and seasonal floods does not seem like a major problem for farmers in the study area. According to the interview with the official from the Royal project 10% of the farmers engaged in the Royal Project are experiencing problems of erosion in the rainy season and according to the focus group discussion the impact of intensified agriculture on soil is erosion. Another source claims that the problem of erosion is mainly experienced during the rainy season. Additionally, based on the questionnaires conducted in the study area, 13 of the respondents have erosion problem and this must therefore be considered a general problem for the farmers especially during the rainy season. However, as the majority of the farmers know how to prevent erosion and also do conservation practices such as terracing, furrow and soil ridge, erosion problems in the area are not as severe as first expected.

In addition to that, landslides and floods also occur in the study area. As mentioned earlier, most farmers have at least two separated plots of land; one in the upper part and one in the lower part of the upper zone. The plot in the lowland areas close to water is normally left to fallow during the rainy season due to these floods and landslides and the land in the upper part is then cultivated during that time, leaving the farmer with a continuous possibility of all year round cultivation. Because of this fact, farmers are not suffering significantly from landslides. The reason for landslides could be ascribed to low forest cover in the area especially on slopes and hilltops due mainly to past opium cultivation and therefore no direct link can be established between intensified agriculture and an increase in floods and landslides.

C. Water

Table 8: The results from water test kits and water samples analyses.

Water Samples (dry season)	pH	O_2 (ppm)	EC (µs/cm)	NO_3^- (mg/l)	PO_4^{3-} (mg/l)	Pesticide	T(°C)
1.Forest	7.2	8	300	0.5		0	21.4
2.Upper stratum (under Nong Hoi village)	7.7	8	270	1.75	0.38	0	20.5
3.Upper stratum	6.9	8	300	1	0.08	0	22
4.Middle stratum	7.8	6	170	0.2	0.13	0	21
5.Lower stratum	7.6	8	160	0.1	0.05	0	22.5
Water samples (Rainy season)	**pH**	**O_2 (ppm)**	**EC (µs/cm)**	**NO_3^- (mg/l)**	**PO_4^{3-} (mg/l)**	**Pesticide**	**T(°C)**
1. Under Nong Hoi village	5.3	1	600	0.5	VL		19.5
2. Lower stratum (outlet)	7.3	1	700	0.1	VL		21.7

Nitrates and Phosphates

The highest levels of nitrates and phosphates (in dry season) were detected in the water sample number 2 (under the village), 1.75 mg/kg and 0.38 mg/kg respectively, whereas in the remaining water samples the level of nitrates was below 1mg/kg and the level of phosphate concentration was below 0.13mg/kg. The values resulted to be lower than standard tables (FAO, 1985); therefore it does not affect aquatic organisms. The increase in nutrient concentration up to optimal levels may lead the proliferation of algae and aquatic plants. Since the level of available phosphorus detected is very low the situation gets favorable considering that algae require ten times as much N as P by weight, in this case the lack of phosphorus appears as an inhibitor in algae development (Rechcigl, 1995).

Results from analyses of water samples taken in the wet season showed that the highest level of nitrates detected in all the upper zone of the watershed was 0.5 mg/kg, and the concentration of phosphates resulted to be very low (difficult to detect).

In the dry season farmers were using sprinklers to irrigate the fields which were spraying a soft rain in the cultivated plot that did not allow any chance for erosion or water leaching into the streams. This seems to be the main reason that explains the results of water samples analyses in the dry season.

The results from the wet season analysis again do not indicate water contamination comparing with standard tables (FAO, 1987) but even lower than the ones in dry season. This seems to be contradictory when considering the high levels of phosphates and nitrates detected in the fields and relatively high rainy intensity (Nong Hoi Weather Station Chiang Mai, 2008) and slope of the overall area which enables access to erosion. The NO_3^- and PO_4^{3-} enriched soil particles eroded into the streams are predicted to increase the concentration

of NO_3^- and PO_4^{3-} in the water in the rainy season. But this seems not to be the case. The reason behind this may be related to the time that water samples were taken.

The water samples probably have been taken some hours after rainfall. During a long rainy time the surface water (coming from rain) flows through the fields into the streams washing the surface of the soil. In this time the volume of water coming from the washed fields into the stream can be higher than the water that comes from the source of the stream. If the water samples are taken during this time the water coming from fields will be more representative in the stream. However, still the concentration of NO_3^- and P may remain low because of the dilution that happens due to high amount of water in the stream.

Some hours after the rain stops, the volume of water coming from agricultural fields into the stream decreases until achieving values near zero, but the volume of water coming from the source of the stream does not significantly change. In this time the majority of the total water of the stream (in outlet) is contributed from the source of the stream not from the washed fields. In the study area the slope from the source of the stream to the outlet of the area is high, which brings a high flowing water velocity. A high flowing velocity enables the water to come from the source to the outlet in a short time, if the water samples in outlet are taken a few hours after the rain stops the majority of the water will come from the source of the stream which is water in natural conditions. This can be the reason that the results of water sample analysis indicate clean water (illustrated in Figure 6 in appendixes).

Another reason may be as losses via runoff of inorganic N are small, even from fertilized fields, unless surface application is followed by a heavy rainstorm. (Rechcigl, 1995)

pH and Dissolved Oxygen (DO)

The results from dry season indicated very good levels of Dissolved Oxygen (DO) around 8 ppm (FAO, 1985) and pH ranges from neutral to slightly alkaline without achieving pH value of 8. The values of pH from 6.5 to 8.2 are considered as optimal conditions for most aquatic organisms. (https://www.geology.ucdavis.edu/~pcp/Reading/pH.pdf). On the other hand, results from rainy season indicate pH ranges from moderately acidic to neutral and DO value of 1 ppm. High levels of DO indicate a non biological activity, no CO_2 production as a result of respiration from microorganisms, whereas an increase in carbon dioxide in the water, increases the amount of carbonic acid and consequently decreases the pH. (https://www.geology.ucdavis.edu/~pcp/Reading/pH.pdf)

Electro Conductivity (EC)

The values of electro conductivity found in the water samples in the dry season indicated a low concentration of salts (Jensen, 2006). In the rainy season the concentration of salts in water increases, achieving values of 700 µs/cm which is considered irrigation water with medium salt concentration (Jensen, 2006), which can increase the salt concentration in soils. The reason for the higher salt concentration in the rainy season can be the washing up of the salts from cultivated fields by rainstorms.

Pesticide

No residue of pesticide was detected in any sediment sample. Even though the concentration of contaminates in the upper zone of the watershed are lower than the values that can present problems for the aquatic environment, because of the high water velocity characterizing the upper zone, the effect of water pollution here may mostly appear in the middle and lower zone of the watershed where the mean residence time of the water in the area is higher as the slope decrease and the water velocity decreases.

4. Conclusion

Main authors: All group members

The study area has undergone series of changes in land use and farming systems which can be conveniently categorized into three phases as follows: phase I: opium cultivation; phase II: tree crop i.e. lychee cultivation, and phase III: vegetables and cut flower production. Over the past decade, the study area has undergone a major change in land use and farming system from phase II to phase III where most lychee tree plantations has been converted into vegetable fields and greenhouses. Phase III which has been the focus of this study is characterized by all year cultivation, the application of increased levels of agrochemicals, plant hormones, irrigation water during the dry season and increased labour requirement. A more intensive production system is the recent shift into greenhouse production of some vegetables and cut flowers. The study shows that the availability of ready markets in nearby cities, need for more income to cope with household expenses, restriction imposed to the expansion of land area for cultivation, the Royal Project and availability of water for dry season cultivation among others are the main driving forces for farmers intensifying their agricultural practices.

Intensified agriculture has clearly influenced the socio-economic livelihood development of the people of Ban Mae Khi compared to the past ten years. They have a better standard of living due to intensified agriculture having increased cash income and assets. All farmers engaged in intensive agriculture are benefiting from it. On the basis of farm land holding and level of investment, the Hmong people tend to be benefiting more from intensified agriculture compared to Kon Muang. Based on the findings of the study, intensified agriculture has positively influenced education in the area. All children of school going age are in school with most of them pursueing further education in the cities. Farmers in general, due to increased income from intensified agriculture are now able to access better health services. However, minor health problems may be attributed to some farmers who do not follow the prescribed precautionary measures during agrochemical applications. Regarding risk of crop failure and fall in market price for their products, farmers feel more secured now than before due to crop diversification but vulnerable because intensified agriculture require more investment and in case of total crop failure or fall in market prices beyond producer prices farmers might become indebted to their creditors. As compared to the past, cooperation within the community is reduced due to intensified agriculture as farmers are now more individualistic in carrying out their agricultural practices. They rather hire labourers for their farm activities since these activities are labour intensive. Therefore, intensified agriculture contributes a lot to employment in the study area.

According to respondents in the study area there has been no deforestation as a consequence of intensified agriculture due to policies that forbids encroachment into forest areas and demarcation of cultivated land area by the Royal project. The density of the forest has decreased because of annual forest fires but the general condition of the forest may have improved as a result of higher income for farmers in the Ban Mae Khi community area. However, based on a land-use change analysis conducted in a highly cultivated area where the forest cover was 7.57% in 2002, a 38% decrease in the forest cover has occurred. Other areas have at the same time been transformed into young emerging forests. Overall,

assessing the forest cover and condition of the entire upper zone, intensified agriculture must be concluded to have no clear negative impact and may even have improved the condition of the forest outside the most intensive cultivated areas.

The continuous application of chemical and organic fertilizers to soils have led to the accumulation of high levels of available P and Nitrates which can contribute to water pollution during runoff. However, analysis of stream water resulted to be fresh and clean, the parameters analysed in the dry season were found to be in optimal levels.

Residues of pesticide were found in low levels that are considered safe.

No correlation was found in terms of contaminates concentration from upper stratum to middle and lower stratum.

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6. Appendixes

Appendix 1: Questionnaire

SLUSE JOINT COURSE
INTERDISCIPLINARY LAND USE AND NATURAL RESOURCE MANAGEMENT
(ILUNRM), 2009

IMPACTS OF INTENSIFIED AGRICULTURE ON LIVELIHOOD AND NATURAL RESOURCES IN NORTHERN THAILAND: A CASE STUDY IN BAN MAE KHI
(UPPER ZONE OF THE MAE RAM SUB-WATERSHED)

Students from University of Copenhagen and Roskilde University (Denmark) in cooperation with students from Chiang Mai University and Maejo University (Thailand), are conducting a survey, as part of our academic study, in Bae Mae Khi to find out the factors driving the intensification of agriculture and the impacts of this development on the livelihood and natural resources.

We would greatly appreciate your time to answer these questions. Your answers will be kept anonymous and the analysis of these answers will be used only for academic proposes.

Questionnaire No.____

Part 1: Background Information

1. Name of respondent_____Address_____
2. Gender
   - ☐ Male
   - ☐ Female
3. Household size
   a) Number of adults (>18 years) _____
   b) Number of children (<18 years) _____ and number attending school_____
4. How many of your household members are engaged in agriculture? _____
5. What is your level of formal education?
   - ☐ None
   - ☐ Primary
   - ☐ High school
   - ☐ Tertiary
   - ☐ Other, please state_____
6. Ethnic group
   - ☐ Hmong
   - ☐ Kon Muang
   - ☐ Other, please state_____

Part 2: Change in agricultural system

1. Land-use information

Plot No.	Land size (Rai)	A. Location of the plot	B. Type of Ownership	C. Land obtainment	Crop types	No. of harvests/yr	Number of years		
							<5	5-10	>10

Notes: **A.** Land location: 1 – Upland & close to water, 2 – Upland & far from water
3 – Lowland & close to water, 4 – Lowland & far from water
B. Land ownership: 1 – NS 4)Chanote(, 2 – NS 3 Kor, 3 – NS 3,
4 – SK 1, 5 – Sor Por Kor 4-01, 6 – Sor Tor Kor
C. Land obtainment: 1 – Tresspass, 2 – Inheritance, 3 – Purchase, 4 – Lease

2. What type of crops were you cultivating before the new crops were introduced?
   Plot 1 _____
   Plot 2 _____
   Plot 3 _____
   Plot 4 _____
   Plot 5 _____
3. In the past ten years, how did you manage to use the land for cultivating that specific kind of crop?
   - Soil preparation_____
   - Fallow period_____
   - Soil nourishment_____
   - Others, please specify_____
4. How has the labor requirement on your farm changed during this period?
   - ☐ Same
   - ☐ Increased
   - ☐ Decreased
5. What type of cropping pattern were you using for your crops?
   - ☐ Mono cropping
   - ☐ Mixed cropping
   - ☐ Inter cropping
   - ☐ Other, please state_____
6. What method do you use to clear land for the cultivation?
   - ☐ Slash and burn
   - ☐ Animal drawn implements
   - ☐ Hoe
   - ☐ Tractor

- ☐ Spray with chemicals
- ☐ Other, please state_____

7. How do you control weeds on your farm land?
   - ☐ Hand weeding
   - ☐ Weeding with hoe
   - ☐ Spray with chemicals
   - ☐ Other, please state_____
8. What type of fertilizer do you use?
   - ☐ None
   - ☐ Green manure
   - ☐ Animal manure
   - ☐ Compost
   - ☐ Chemical fertilizer
9. What do you use to control pest and diseases on your crops?
   - ☐ None
   - ☐ Organic extract
   - ☐ Biological control
   - ☐ Pesticide
10. What has been the change in the duration of your fallow period?
    - ☐ No change
    - ☐ Shorter, by_____months
    - ☐ Longer, by_____months

11. What is the change in the level of use in the following inputs?

(Remarks: 1 = Decreased, 2= no change 3 = increased)

Inputs	**Remarks**		
	1	**2**	**3**
Fertilizers			
Pesticides			
Herbicides			
Capital (Farm implements)			
Water			
Labor			
Hormones			
Others, please specify			

Part 3: Driving factors

1. What are your motivating factors for intensifying your agricultural practices?
   (Please rank them in order of importance from 1 to 3; 1= most important, 3=least important)

Factors	**Scale**		
	1	**2**	**3**
Royal project			
Sell directly to market			
Increased number of people			
Support from government			
Availability of irrigation			
Education			
Labor availability			
Good infrastructures			
Availability of agro-chemicals on time			
Village agricultural cooperation			
Other, please state… 1._____ 2._____ 3._____ 4._____	 _____ _____ _____ _____	 _____ _____ _____ _____	 _____ _____ _____ _____

2. Are you a member of any of the fallowing organization?
   - ☐ Royal project
   - ☐ Village agricultural cooperation
   - ☐ Others, please state_____
3. What role does the royal project play in your farming operation?
   - ☐ Provide seeds
   - ☐ Provide fertilizers
   - ☐ Provide pesticides
   - ☐ Subsidies
   - ☐ Buy products
   - ☐ Provide extension services
   - ☐ Others please state_____
4. Where do you sell your farm products?
   - ☐ Royal project
   - ☐ Village markets
   - ☐ Chiang Mai markets
   - ☐ Middle men
   - ☐ Other market, please state_____
5. How did you sell your farm products 10 years ago?
   - ☐ Royal project
   - ☐ Village markets
   - ☐ Chiang Mai markets

- ☐ Middle men
- ☐ Other market, please state_____

6. What are the available sources of water for crop production?
   - ☐ Rainfall
   - ☐ Stream
   - ☐ Borehole (ground water)
   - ☐ Pipe water
   - ☐ Others,_____please state
7. ?What method do you use for the efficient management of irrigation water
   - ☐ First come first serve
   - ☐ Schedule, please describe_____
     _____
   - ☐ Others, please state_____
8. Are there any restrictions on the way you use water for crop production?
   - ☐ Yes ☐ No

   If yes, what is/are the restrictions? _____
   _____
9. How do you update your information about your farming practices in general?
   - ☐ TV, radio, newspapers
   - ☐ Agricultural magazines
   - ☐ Governmental offices / officers
   - ☐ Agro-chemical shops
   - ☐ Neighbours
10. How important do you think the update is for your own cultivation?
    - ☐ Very much ☐ Medium ☐ Little

Part 4: Socio-economic

1. What are the sources of labor you use in your agricultural activities?
   - ☐ Family members only
   - ☐ Hired labors only
   - ☐ Both family members and hired labors
   - ☐ Other, please state_____
2. How many laborers do you use per rai? _____
3. What is the daily wage for a labourer?_____THB
4. What are the Income sources of the household?
   - ☐ Crop production ☐ Daily laborer ☐ Forest products
   - ☐ Merchant ☐ Livestock production ☐ Remittance
   - ☐ Employee ☐ Handicraft production
   - ☐ Others, please state_____
5. What proportion of your income is derived from intensified agriculture?
   - ☐ All ☐ Half ☐ None
   - ☐ Majority ☐ Less than half
6. How do you compare your living standard before agricultural intensification and now?
   - ☐ Better ☐ The same
   - ☐ Much better ☐ Worse

   Give reason for your choice _____
   _____
7. Do you feel that there is a risk in intensified agriculture in case of:
   a) Crop failure ☐ Yes ☐ No
   b) Fall in market prices of the product ☐ Yes ☐ No
   c) Agro-chemical availability ☐ Yes ☐ No
   d) High price of agro-chemicals ☐ Yes ☐ No
8. If your answer is yes to any of question 7, what do you do to protect yourself?

_____
_____

9. In what way has the changes in agriculture changed the level of schooling?
   - ☐ Improved
   - ☐ Lessened
   - ☐ Same

   Why_____
10. Has there been cooperation within the community as a result of agricultural intensification?
    - ☐ Yes ☐ No ☐ Don't know

    If yes, what is the type of cooperation?
    - ☐ Production groups
    - ☐ Helping each other in plantation and harvesting times
    - ☐ Other, please state_____

Part 5: Impact on natural resources

1. Has your area under cultivation changed in the last years?
   ☐ Yes ☐ No
   If yes, what is the trend?
   ☐ Increased ☐ Decreased
2. How has the proportion of cultivated land for cash crop changed?
   ☐ Increased ☐ Decreased ☐ Same
3. Do you have erosion problem on your cultivated land?
   ☐ Yes ☐ No
4. Do you practice any conservation methods on your cultivated land?
   ☐ None
   ☐ Terracing
   ☐ Ploughing across the slope
   ☐ Furrow
   ☐ Soil ridge
   ☐ Other, please state_____
5. What was the conservation practice on your cultivated land 10 years ago?
   ☐ None
   ☐ Terracing
   ☐ Ploughing across the slope
   ☐ Furrow
   ☐ Soil ridge
   ☐ Other, please state_____
6. What kind of chemical fertilizer do you use?
   ☐ Urea
   ☐ Nitrate ammonium
   ☐ DAP
   ☐ Superphosphate
   ☐ Other, please state_____
7. How many bags of fertilizer do you apply per rai?
   ☐ Less than 1 bag
   ☐ 1-2 bags
   ☐ 3-5 bags
   ☐ More than 5 bags

Appendix 2: Semi-Structured Interview Guide

<u>Village Headman</u>

Agricultural intensification

1. How does the type of land ownership and water right affect agricultural intensification?
    a. Type of land ownership
    _____
    _____
    b. Size of land
    _____
    _____
    c. Availability of the sources of water
    _____
    _____
    d. Who has right to use the water resources?
    _____
    _____

Socio-economic impact of intensified agriculture

1. What are the Income sources of peoples in the area?
    _____
    _____
2. What proportions of the people in the area are engaged in agriculture?
    _____
    _____
3. What proportions of the farmers in the area are engaged in intensified agriculture?
    _____
    _____
4. What is the influence of intensive agriculture on education?
    _____
    _____
5. What is the influence of agricultural intensification on social relation? (Within and between the community)
    _____
    _____
6. Are there farmers' associations to help getting farm inputs and selling their farm produces?
    _____
    _____
7. What are the kinds of conflict resulting from intensive agriculture?
    _____
    _____
8. What alternative means is there in case of crop failure; fall in price of produces, un-availability of farm input?
    _____
    _____

9. Which category of the community is benefiting most from intensified agriculture?
    a. Community Members
        - Farmer: within /outside RP
        - Farmer: poor /middle/rich
        - Farmer: land owners/ tenants

_____
_____
_____

    b. Community vs. Outsiders
        - Farmers
        - RP
        - Middlemen
        - Others

_____
_____
_____

Impact on natural resources

1. How has the forest cover changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution

_____
_____
_____

2. How has the area under cultivation changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution

_____
_____
_____

3. How has the area of intensive agriculture changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
    c. In terms of crops

_____
_____
_____

4. What has been the effect of intensified agriculture on the soil and water resources?

_____
_____
_____

Royal Project Officers

Agricultural intensification

1. Which types of crops have been introduced to the community?
   _____
   _____
2. When were they introduced and why?
   _____
   _____
3. Which type of crops were farmers cultivating before the introduction of new crops?
   _____
   _____
4. What has been the trend in duration of fallow periods?
   _____
   _____
5. For how long do farmers put the land under cultivation during the year (Land use intensity)?
   _____
   _____
6. What has been the change in cropping pattern (e.g. mono cropping, mixed cropping)?
   _____
   _____
7. What has been the trend in the change of the levels of the following inputs used by farmers:
   a. Fertilizers_____
      _____
   b. Pesticides_____
      _____
   c. Herbicides_____
      _____
   d. Farm implements_____
      _____
   e. Irrigation water_____
      _____
   f. Labour_____
      _____

Driving forces for Agricultural intensification

1. What factors motivate farmers to intensify their agricultural practices?
   _____
   _____
   _____
   _____
2. What in your opinion are the most important factors?
   _____
   _____

_____
_____

3. How do these factors drive the intensification of agriculture?

_____
_____
_____
_____

4. What role does the Royal project play in agriculture intensification in the study area?

a. Setting quality standards for farmers

_____
_____

b. Marketing (quotas) and production and storage facilities?

_____
_____

c. Subsidies?

_____
_____

d. Educating farmers via agricultural extension?

_____
_____

e. Infrastructure development (roads, small irrigation system, electricity)

_____
_____

f. Socio-economic activities

- School establishment?
- Medical service?
- Cooperation within the community?
- Small-scale agricultural facilities (pre-cooling, storage, canning plant, packaging)?
- Agricultural product marketing (packaging, transportation, markets)?

_____
_____
_____
_____

Socioeconomic impact of intensified agriculture

1. What kinds of cash crops are cultivated in the area and when is introduced?

_____
_____

2. What is the farmers' standard of living before agricultural intensification and now?

_____
_____

3. What is the contribution of cash crops as income generation for farmers?

_____
_____

4. Which category of the community is benefiting most from intensified agriculture?

_____
_____

5. What is the role of intensive agriculture as a source of income for farmers?
   _____
   _____
6. What is the influence of agricultural intensification on social relation? (Within and between the community)
   _____
   _____
7. Are there farmers' associations to help getting farm inputs and selling their farm produces?
   _____
   _____
8. What are the kinds of conflict resulting from intensive agriculture?
   _____
   _____
9. What alternative means is there in case of crop failure; fall in price of produces, un-availability of farm input?
   _____
   _____
10. Which category of the community is benefiting most from intensified agriculture?
    a. Community Members
       - Farmer: within /outside RP
       - Farmer: poor /middle/rich
       - Farmer: land owners/ tenants
    b. Community vs. Outsiders
       - Farmers
       - RP
       - Middlemen
       - Others

    _____
    _____
    _____
    _____

Impact on natural resources

1. How has the forest cover changed during the period of agricultural intensification?
   a. In terms of area
   b. In terms of distribution

   _____
   _____
   _____
   _____

2. How has the area under cultivation changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution

_____
_____
_____
_____

3. How has the area of intensive agriculture changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
    c. In terms of crops

_____
_____
_____
_____

Appendix 3: Focus Group Discussion

A. Introduction (2 minutes)

a. How long have you been living in this community?
b. How long have you been in agricultural production?

B. Changes in farming system

a. What has been the change in farming system before agricultural intensification?
   - Purpose of cultivation.
   - Type of farming system (e.g. shifting cultivation).
   - Duration of fallow period.
   - Type of crops cultivated/ area cultivated/farm size.
   - Inputs used (e.g. Fertilizers, pesticides, irrigation, etc.).
   - Any technological changes in crop production (greenhouse production/ hydroponics)
   - Land use intensity.

b. Land use
   - The community's record of land use
   - Present condition of land use
   - Factors that influence the change in land use
   - Restrictions of land use in respect of community as a whole

c. Land management
   - Does the community have any policy that deals with land management for agricultural practices?
   - Establishment, Period of establishment and Involved/cooperated people/organizations

d. Land use classification and community's boundary
   - Does the community have land use classification and community's boundary? (i.e. conservation forest and village's boundary)
   - Does the community have policy dealing with conservation and utilization?
   - Establishment, Period of establishment and involved people/organizations

e. Have you ever recognized the change in season due to intensive agriculture?

C. Driving factors

a. What are your motivating factors for intensifying your agricultural practices?
b. Please rank them in order of importance?
c. How do you update your information about your farming practice?

D. Role of Royal project in agricultural intensification

a. What role does the Royal project play in agricultural intensification in the study area?
   - Marketing (quotas) and production and storage facilities?
   - Subsidies?
   - Agricultural extension?
   - Infrastructure development (roads, small irrigation system, electricity)

E. Land ownership and water right

a. Type of land ownership.
b. Size of land.
c. Availability of the sources of the water.
d. Who has right to use the water resources?
e. What amount?
f. Who pays and how much?

F. What are the channels available to farmers to access inputs and sell their farm products?

a. Availability of agro-shops and markets.
b. Proximity of agro-shops and markets to farms.
c. Storage facilities and pre-cooling structures.

G. How does the change in population affect agricultural intensification?

a. What is the trend in population growth?
b. What is the cause of population growth?
c. Does the population change put any pressure on land use?
d. Does the population change affect labour availability on farm?

H. What is the impact of formal education on agricultural intensification?

a. What is the influence of formal education on migration?
b. What is the influence of formal education on labour availability on farm?
c. Does the level of formal education have any influence on agricultural intensification?

I. Socio-economic impacts

a. What is the farmers' standard of living before agricultural intensification and now?
b. What is the role of intensive agriculture as a source of income for farmers?
c. Which category of the community is benefiting most from intensified agriculture?
d. What is the influence of intensive agriculture on education?
e. How has cooperation within the community changed due to agricultural intensification?
f. What are the kinds of conflict resulting from intensive agriculture?
g. What alternative means is there in case of crop failure; fall in price of produces, un-availability of farm input?
h. Do farmers feel more secure now compared to before agricultural intensification?

Appendix 4: Finding from Focus Group Discussion

FOCUS GROUP DISCUSSION

March 15, Ban Mae Khi
With the Assistant Village Headman and 2 representatives of the Village (one Hmong and one Kong Hmong) to the Mae Ram TAO

Change in Agriculture System

Prior to 1980, the people of Ban Mae Khi cultivated opium for sale. They also cultivated upland rice and maize for home consumption. Their livelihood was dependent mainly on the opium cultivation. After 1980, as the opium cultivation became illegal and the King paid a visit to the village offering the people an opportunity to improve their standards of living, the farmers started to cultivate fruit trees (Lychee) and vegetables in addition to the upland rice and maize.

In 1987, lychee production reached its peak and drastically declined 10 years later in 1997. As a result, the people turned on to growing vegetables. The reasons for the switch is that the market price for lychee was very low comparing to the price for vegetables, the limited number of harvest (once a year) and the vast damage on the products due to the heavy rainfalls during the rainy season.

Around 10 years ago (1999) greenhouse cultivation was introduced to the village for the cultivation of new crops such as sweet pepper and tomato. The greenhouses were utilized to control the amount of sunlight and prevent diseases and pest from infecting the vegetables. Farmers who have no access to irrigation during the dry season form about one third of the entire farmers population and would harvest once per year. Generally however, the cropping intensity for both upland and lowland areas are the same with average harvest of 3 times per year.

Driving forces

Basically, the driving force for the farmers to do intensified agriculture is they need more money to cope with their increasing expenses and also the introduction of the Royal project into the area.

Moreover, the restriction on agricultural land expansion which prevents farmers to expand their area of cultivation into the forest areas is another important factor for farmers to intensify their land. The farm size varies from farmer to farmer but according to the meeting; there was no land size classification within the community.

Socioeconomic impact

There are approximately 733 villagers (91 households) in Ban Mae Khi and comprising two ethnic groups: the Hmong ethnic group forming the majority with 554 people (66 HH) and the other being the Kon Moung with 179 people (25 HH).

Household		**Population**	
91		733	
Hmong	Kon Moung	Hmong	Kon Moung
66	25	554	179

The main source of income for villagers is agriculture. The other sources of income are urban jobs such as labour work at construction sites and also handicraft.

Agriculture intensification is mostly done by the Hmong people and only few Kon Muang. Majority of the Kon Muang prefer to work in the city and only cultivate their land for subsistence. Also, some of the Kon Muang has sold their farm lands to the Hmong and now work as farm labourers.

The living standard of the people has improved. They measure it based on their income, assets (car, housing, TV, mobile phone etc.) and education of their children. On average farmers in the village make 10,000 to 20,000 baht per month.

Impact on Natural Resources

Impact of intensified agriculture on soil is erosion, especially during the rainy season. Water quality also has been affected by soil erosion during rainy season too. The colour and taste might change in this period because agrochemicals and debris washed down into the water bodies. They claimed that this village has not been experienced water pollution but downstream people said that there was water pollution. They also acknowledge that the forest cover has not changed due to intensified agriculture.

Other

The village received annual budget from the Mae Ram TAO to support in its development:

- Road construction
- Subsidies to aged and physically challenged and
- Support
- The population of the village has increased in recent years due to increase in births

Appendix 5: Finding from Semi structured interveiw with Ban Pang Hai school's teacher

SEMI-STRUCTURED INTEVIEW WITH SCHOOL TEACHER

March 11, Ban Pang Hai

Agriculture within the area involves the cultivation of vegetables such as cabbages, head lettuce, lettuce, Michili, Chinese cabbages and carrot. Farmers grow more than one of these crops on plots located generally at different locations such as upland and lowland areas all year round with the application of irrigation water from nearby streams or constructed ponds usually during the dry season. Average number of harvest per crop is 3 times per year.

Land preparation involves the use of the hand hoe and or small tractors. Due to the intensity of the land use, farmers ensure that the fertility of the soil is maintained through the application of urea and N-P-K fertilizers. The control of pest and diseases is also achieved via the use of pesticides. The rate of application depends on the farmer's personal experience. With the high cost of chemical fertilizers, environmental and health related problems associated with exceedingly high application rates of these agro-chemicals farmers now tend to adopt the use of farm-yard manure, for example chicken manure and cow dung. An indigenous innovation adopted by farmers for the control of weeds on their farms is the application of salt solution. This method, according to the farmers, is very efficient in controlling young weeds before seed setting. Application rate varies among farmers, but, generally, 40 kg of salt per 200 L of water is used. This might have a long-term salinity effect on the soils though it appears seemingly good in the short term.

Driving forces for agricultural intensification include:

Income: Farmers need more income in order to cope with the increasing expenditure of the family. Each family has about 3-4 children. To provide these children with quality education, the farmer needs to increase his income so as to be able to pay his or her ward's fees in school. In addition to this, the famer must meet other household as well as social demands financially which require higher income. This calls for all year cultivation and the application of agro-chemicals to get the required yields for higher incomes.

Royal Project: The RP is seen as a driving force for agricultural intensification process mostly for farmers who join it. The reasons being that, the RP as part of its strategies to help hill tribe people improve their living standard, provides them seeds and or seedlings, extension services as well as ready market for farmers by buying their farm products on quotas. However, these products must meet the quality standards set by the RP.

The entire livelihood of the people depends on agriculture. This is because they are uneducated and have no qualification for city employment. In the past 10 years, farmers hardly sent their children to school. In a household with 4 children, only one would be given formal education, while the rest would work as farm hands in the fields. Today, on the contrary, farmers are able to provide the fundamental basic needs for their families. All children of school going age are enrolled in school and most of them pursue further education in the cities. They, however, help the farm only during their vacations. Almost all farm households involving in intensified agriculture have at least, one car, house, TV sets, and motorbikes, to mention but a few.

In addition to the family labour (usually the couple), most farmers employ the hands of Burmese labourers who live in tents on the hills and close to the farmlands. The daily wage for a labourer ranges from 120–150 THB per day. On the other hand, some farmers employ labourers to cultivate the land and carry out all the farm operations until the crop is harvested and sold. The farmer then shares the income equally with the labourer after deducting the production cost.

Few farmers who have not followed prescribed precautionary measures in the application of pesticides have had allergic conditions, lung problems and exhaustions.

Farmers rarely experience erosion problems during the dry season since irrigation is simply the use of sprinklers to provide water in fine droplets to crops. However, in the rainy season, erosion is usually severe as the rainfalls wash off chemical residues down into streams. As a result, water fetched from streams for domestic purposes are used only for washing. To prevent these occurrences, farmers are engaged in conservation practices such as terracing and contour ploughing and soil ridge. These have been effective in minimizing erosion in the fields.

Agricultural intensification has no effect on the area covered by forest because the farmers are not allowed to expand their area of cultivation.

Appendix 6: Finding from Semi structured interveiw with the Royal project officer

SEMI-STRUCTURED INTERVIEW WITH ROYAL PROJECT OFFICER

March 11, Ban Nong Hoi Mai
With Mr. Pauuat Fongkam, Vice-director of the RP, Nong Hoi Mai Office

Introduction & facts

- 6 villagers in the area are under the RP
- 150.000 villagers have been involved in the RP
- Farmers receive 450.000.000 baht annually from the RP
- In 1969 the King visited the highlands and established the RP
- The Nong Hoi station is responsible for 3.000 Rai under the RP
- 300 members 5-6 years ago. Now 194 members (5 households in Bah Mae Khi)
- The decrease mainly due to farmers difficulties meeting the high standards
- The low member of Ban Mae Khi due to shorter distance to the market, the market price is often the same as the RP and rather sell to middlemen
- Four main agricultural practices:
    - GAP (Good Agricultural Practices)
    - EUGAP
    - GLOBALGAB
    - Organic production
- Farmer can apply once a year for membership and the RP decide which farmers can join
- It is the farmer that chose to join the RP and not vice versa
- 50% financed by the government and 50% financed by the King
- Each year the RP lose 200.000 baht
- The farmers receive their money about a week after they sell the products

Agricultural intensification

Which types of crops have been introduced to the community?

- Head lettuce, Chinese cabbage, Carrots, Michili, Lettuce, Japanese onion

When were they introduced and why?

- Within the last 5-8 years the crops were introduced mainly due to falling lichee prices and also the fact that the number of harvests could be increased with these new crops

Which type of crops were farmers cultivating before the introduction of new crops?

- Mainly Lichee and before that (25 years ago) rice and opium

What has been the trend in duration of fallow periods?

- Unchanged

For how long do farmers put the land under cultivation during the year (Land use intensity)?

- 20% is irrigated land cultivated throughout the year with 4 harvests (chemicals use)
- 80 % of the project area is cultivated from June-January with 2-3 harvests. From February-May fallow period (chicken manure/organic)
- The aims is to cultivate throughout the year for all land through irrigation development – use of the ground water

What has been the change in cropping pattern (e.g. mono cropping, mixed cropping)?

- Now mostly mono cropping

What has been the trend in the change of the levels of the following inputs used by farmers: More organic use – policy of the RP

- Fertilizers -> Decreased
- Pesticides ->Decreased
- Herbicides ->Decreased
- Irrigation water -> Unchanged but plan to use more in the future

Driving forces for Agricultural intensification

What factors motivate farmers to intensify their agricultural practices?

- The King is the most important factor.

How do these factors drive the intensification of agriculture?

- When the King visited the area and established the RP with the aim of stopping opium production people followed his words. He has a extremely big influence on the people

What role does the Royal project play in agriculture intensification in the study area?

- Selling fertilizer/pesticide to farmers below the market price
- Setting quality standards for farmers
- The RP set high quality standards. Standards for the use of pesticide (only two types can be used, which results in farmers chose not to join)
- Guidelines for the use of fertilizer

Marketing (quotas) and production and storage facilities?

- The RP can only accept 10% of the products because of big supply. Meeting each year between RP officers and farmers before production begins to plan the amount of crops being produced

Subsidies?

- No supply of subsidies. 20 years ago this was provided during crisis but now the farmers are more independent and should be able to take care of themselves.
- Educating farmers via agricultural extension?

Infrastructure development (roads, small irrigation system, electricity)?

- No

Socio-economic activities

- School establishment -> No
- Medical service -> No
- Cooperation within the community -> The RP take care of the entire community and make cooperative meetings and activities and also an annual forest day where farmers plant new trees
- Small-scale agricultural facilities (pre-cooling, storage, canning plant, packaging) -> Pre-cooling, packaging and storage facilities are available at the office. The RP receive the

products and is responsible for the packaging and storage before transporting the products to the markets in Thailand or for export

Socioeconomic impact of intensified agriculture

What kinds of cash crops are cultivated in the area and when is introduced?

- See part 1, question 1

What is the farmers' standard of living before agricultural intensification and now?

- Much better

What is the contribution of cash crops as income generation for farmers?

- Cash crops constitute for almost all the farmers income in this area

Which category of the community is benefiting most from intensified agriculture?

- Both rich and poor farmers are benefitting from intensified agriculture.
- The middlemen are the groups that are benefitting the most from intensified agriculture
- The RP price guarantee means that farmers inside the project fell more secure and benefit more than farmers outside the project

What is the influence of agricultural intensification on social relation? (Within and between the community)

- Activities and meeting are held for the community

What are the kinds of conflict resulting from intensive agriculture?

- The market price – misunderstanding between the RP and farmers about the price
- Soil quality decline and water unavailability
- Understanding the policies and standards of the RP is important for benefitting from intensified agriculture

What alternative means is there in case of crop failure; fall in price of produces, un-availability of farm input?

- No alternative

Which category of the community is benefiting most from intensified agriculture?

- Community Members
    - Farmer: within /outside RP

- Farmer: poor /middle/rich
- Farmer: land owners/ tenants

- Community vs. Outsiders
  - Farmers
  - RP
  - Middle men
  - Others

Impact on natural resources

How has the forest cover changed during the period of agricultural intensification?

- Before slash and burn but now this is illegal.
- 5-6 years ago the RP and the land department measured the boundaries of the plot of the farmers to control possible deforestation.
- Annual tree plantations through the RP in the conservation forest

How has the area under cultivation changed during the period of agricultural intensification?

- Area under cultivation has not changed

How has the area of intensive agriculture changed during the period of agricultural intensification?

- Increased area under intensified agriculture as a result of the introduction of cash crops
- More organic production is planned because the world market demands it and because the RP import chemicals and will therefore save cost on organic production
- Small amounts of fertilizer/pesticide use have a small effect on the environment
- Erosion problems for 10% of the farmers engaged in the RP
- The RP practices conservation for erosion
- The farmers know how to prevent erosion from the opium production

Appendix 7: Finding from Semi structured interveiw with the assistant of village headman

SEMI-STRUCTURED INTERVIEW

March 7, Ban Mae Khi
With the Village Assistant Respondent: Mr. Chawalit Saelee

In the past, Hmong people slashed and burned the conservation forest for opium, maize and upland rice cultivation. During that time, the use of fertilizer was rare since the soil they used was still fertile. In 1979, opium cultivation was banned by the Thai government and that had an immense effect on Hmong people as opium cultivation was their main resource of income. The Royal Project has been introduced to this village for more than 30 years ago. The cultivation of lychees, Chinese apricots and Arabica coffee was introduced to the villagers as a means to eliminate slash and burn practices as well as opium cultivation. The Royal Project also aimed to improve the livelihood of the villagers by providing them agricultural inputs, plant materials for propagation, market channels and loans.

In 1997, the farmers changed lychee orchards to vegetable production like cabbage, Chinese cabbage, lettuce, Japanese onion, garlic, chili, including some cut flowers such as Gerbera, Lily and Chrysanthemum. The change from lychee orchards to vegetable cultivation was a result of a low market price, a high risk of crop failure and a limited time for harvesting as lychee could only be harvested once a year. If the farmers were unable to cultivate and harvest at the right time, they would simply lose all products.

Agriculture has always been the main resource of income for Hmong people. At this moment, as most farmers within Ban Mae Khi are vastly engaed in intensified agriculture, they become more individual; therefore, the cooperation between the farmers such as helping each others for plantation and harvesting decreases. Instead, the farmers tend to hire more Burmese and Chan labors for land preparation, especially in case of farmers who possess more than 2 Rai of land. Intensifying agricultural practices also increase the use of agricultural inputs such as chemical fertilizers, pesticides and herbicides.

According to the village assistant, though the farmers do not have any land ownership document, they can manage to arrange a verbal agreement with the buyer to sell their lands. The area of the farmland varies from farmer to farmer. Both rain fed and irrigation agriculture are practiced in this area. That is, during the rainy season, the farmers will practice rain fed agriculture on the upland area, while in the dry season, farmers will do the cultivation on the lower area where water sources are available. ‘First come first serve’ is the strategy applied for the right to use water resources in this village. This does not yet mean that farmers who come later cannot use water from that resource at all. They are allowed to connect the pipe to the water resource, but only at the spot below where other farmers already connect their pipes. There is also a schedule for distributing water. For instance, if four farmers want to use the same water storage, they may manage the schedule like two of them use the water for two days and after that the other two can use the water.

The upstream farmers could use the water from November to June and after that they have to stop pumping the water to their farmlands in order to allow the downstream farmers to use the

water for their paddy fields. The village assistant also claimed that there is no conflict within the community arising from intensified agriculture.

Generally, since farmers cannot avoid the risk of crop failure and the fall of production price, they have to intensify their agricultural practices more in order to increase an opportunity of gaining profits. That is, if they are produce for more than one crop per year, once one crop fails, they still have a chance to earn more from other crops. Apart from agricultural practices, the farmers can acquire financial support from the village fund and the village agricultural cooperative that provides low-price fertilizer and pesticide.

It remains unclear, within the community, who benefits the most from intensified agriculture. The village assistant said that the more farmers cultivate, the more profits they are likely to gain. For the farmers, joining the Royal Project or not is not a significant issue since their income merely depends on the market prices. Put it bluntly, on the one hand, if the market price is high, the Royal Project will offer a higher price. On the other hand, if the market price is low, the Royal Project will offer an even lower price.

Nowadays the number of farmers joining the Royal Project is very little due to a very slow payment process. For instance, some farmers receive their money six months after they sell their products. On the contrary, if the farmers distribute their products at the market, they will immediately receive case and have an opportunity to negotiate for the price of the low quality products that are rejected by the Royal project.

Regarding an effect of intensified agriculture on education, children seem to have more opportunity to go to school. That is, due to intensified agriculture, farmers gain more income that enables them to afford their children's education. Also, since children have to pursue their education, their parents hire labors to help them on the farmlands. Yet, the proportion of the first issue is higher than the latter.

The area covered by the forest has not changed during this period because this area has been under the policy of the RP that forbids the farmers from expanding any cultivated land. However, in terms of the density of the forest, there is some change. Due to every year forest fire, the smaller trees are destroyed and new trees are not planted so there is only the bigger trees that could tolerate the forest fire survive.

Intensified agriculture affects soil and water resources in the following ways; soil under cultivated land becomes stickier and more acid and the villagers suspect that they have been water pollution which indicated by extinction of some fish species.

Appendix 8: Finding from Semi structured interveiw with director of village agricultural cooperation

SEMI-STRUCTURED INTERVIEW WITH THE AGRICULTURAL COOPERATION PRESIDENT

March 9, Ban Mae Khi

With Mr. Neng Thechalertpana, The president of The Royal Project Agricultural Cooperation

Introduction

- In 1989 hydropower station cooperation was established for their power (electricity) needs. When the community started to receive electricity from the regional grid power station there was no need for hydropower.
- By selling material from the hydropower station (20.000 bah) in addition to the amount collected as electricity bills enough money was generated to establish the agricultural cooperation in 1992 to support farmers in the agricultural activities.
- The agricultural cooperation was renamed The Royal Project Agricultural Cooperation in Ban Mae Khi in 2007.
- Ban Mae khi is within the coverage area (area of operation) of the Royal project.

Objectives

- 4 main objectives:
    - Provide loans/credit
        - Existed from the start. Loans to buy pesticide/fertilizer and make small investments. No loans to farmers if the harvest fails or in case of falling prices.

          Types of Loans
        - ❖ Short-term loans for 1 year with 9% interest rate (money). Existed from the start
        - ❖ Medium-term loan for 3 years - 3% interest rate (cows) Started 5 years ago
        - ❖ Long-term loan for 4 years – 1% interest rate (greenhouse). Started 1 year ago
    - Existed from the start. Sell fertilizer/pesticide (agro- chemicals).
        - The price is above the market price to generate profit.
        - Fertilizers(50kg): 50THB profits on each Pesticides (0.5-1litre) 20THB profit on each
        - Farmers do not need to be member to buy products. Members get 3% from the profit and 3 % from share holder.
        - 700-800 bags of fertilizer pr. Year
        - 300 bags of pesticide
        - 300 bags of herbicide
    - Began 5 years ago. Provide heifers to farmers who want to feed them the price not more than 13,000 THB. This is support from District Cooperatives. The repayment within 3 years and the cooperative gets 3% of it.
    - Started last year. Build 10 greenhouse for organic vegetable growing financed by the Ministry of Agriculture (440,000 baht).Payback in 4 years with 1% interest

Membership

- The cooperation is financed by the members/stakeholder.
- Payment of member contribution is source of fund for the cooperation

- Free membership - all farmers can join the cooperation
- 60 household-members 15 years ago – now 70 out of a total 150 household in Ban Mae Khi
- 100 baht in registration fee and 20 baht for custom fee.
- Members receive 3% of their membership each year (dividend)
- The farmers can be member of the cooperation at the same you are member of the PR

Appendix 9: Description of the sites where soil samples were taken .

Soil sample marked U1(Upper zone)

One part of the field was very sloppy, it was covered by spinach, the field was approximately 0.08 ha. 3 Soil samples were taken within the field. The next nearby field was planted with lettuce, the plot was approximately 0.07 ha. 2 soil samples were taken in that field. The next field was a just harvested one, cabbage harvest was removed from the field one week before taking the soil sample, two soil samples were taken in that plot. The area was planted 3 times per year. Terraces were present as erosion conservation method. Chicken manure was applied before each crop planting and urea was applied 2 times during the crop development.

The 6 subsoil samples were composed together to form one overall soil sample.

Soil Sample marked U 2(upper zone)

The overall field was composed from different mono-cropping plots planted with cabbage (just planted plots and ready to harvest plots) and lettuce. Cabbages plots occupy approximately 75 % of the all field. Terraces were present. Six subsoil samples were taken in different plots of the field, which were composed to form an overall soil sample.

Soil sample U3(upper zone)

The majority of the field was covered by maize residues. And the other part around 50% of the overall field was burned and fallow land. The field had not access to irrigation and was cultivated only during the rainy season. Four sub-soil samples were taken in the field to form a composite soil sample. From observation, this field could be considered as non-intensified agriculture land but there is no information on the management practices.

Soil sample M1(middle zone)

The overall field was planted with cabbage except a fallow plot which was under preparation for planting the new crops. The sloop was approximately 15%, terraces were present only in the upper part of the field. The cabbages were healthy and near harvesting time. (the interview with the owner for management practices of the plots lack)

Soil samples M2 (middle zone)

The field was composed with plots planted with cabbage. One part of the field was situated near the forest. The slope was approximately 30%. Terraces were present. Five soil samples were taken in different plots of the field and composed to form an overall soil sample.

Soil sample M3(middle zone)

The overall area was dominated by hydroponic greenhouses (mainly tomatoes and flowers). Were not taken soil samples in the greenhouses. The other plots were planted with melon (very healthy), and cabbage. The area was slightly sloppy, terraces were not present. No information about farmer management practices.

Soil sample L1(lower zone)

Cabbage under irrigation. Terraces were present.

Soil sample L2 (lower zone)

The upper part of the field was sloppier than the lower part in which were not present terraces. In the upper part of the field there were some fallow plots and cabbage plots. The lower part of the field was planted also with cabbage and carrot (appearing healthy with relatively high biomass).

Soil sample L3 (lower zone)

Completely planted field, no fallow period, sloppy, terraces were present. The field is located near the stream. Crops planted were cabbage and lettuce. Subsoil samples were taken from each plot and mixed to form one compositing soil sample.

Appendix 10: Description of water sample sites (Dry Season)

1. The first water sample was collected in a damp near the source of the stream in the forest, in natural conditions.
2. The second water sample was taken under Nong Hoi village. The water of the stream seemed to be polluted from household discharges.
3. The third water sample was taken in a small damp (under a banana plantation) near the source of the stream.
4. The fourth water sample was collected in the middle strata, in a point where the upper streams are joint.
5. The fifth water sample was taken in the outlet of the representative part which corresponds to the lower strata.

The Thai students have taken the water samples in the same stream under Nong Hoi village and in the outlet (only two water samples).

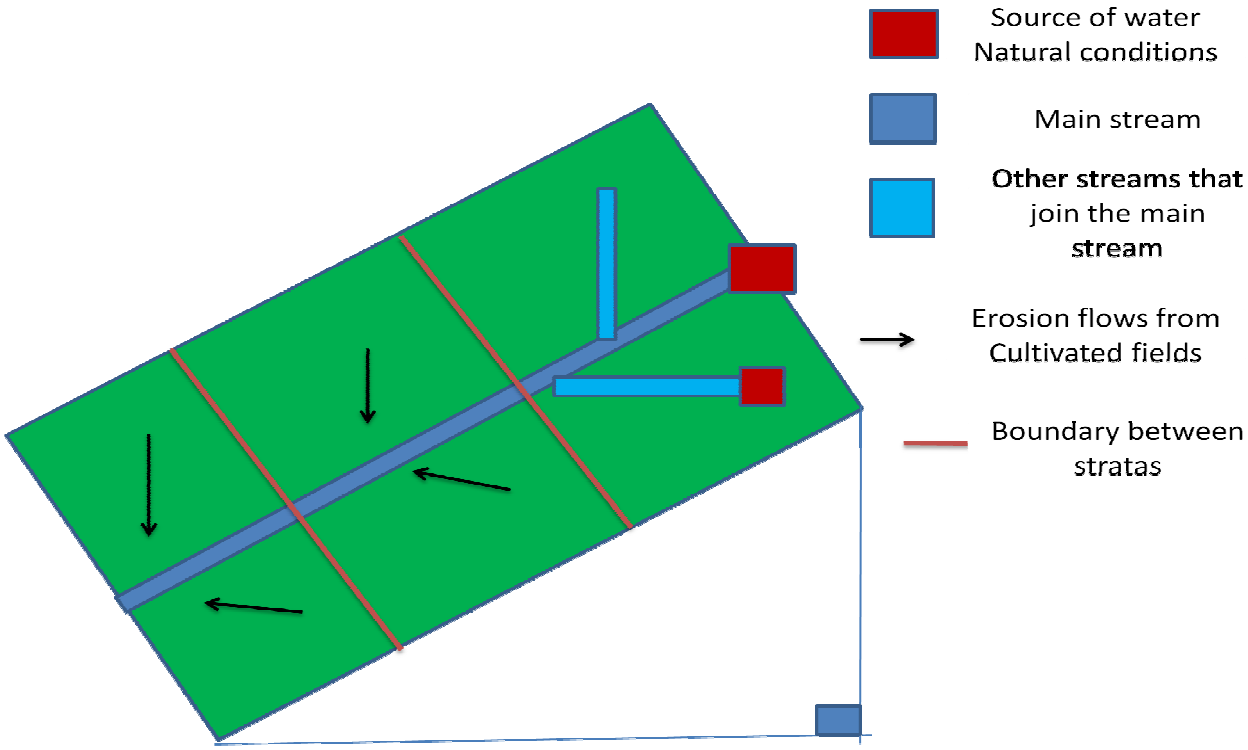

Figure 6: Runoff trend

Appendix 11: Synopsis

SLUSE JOINT COURSE
INTERDISCIPLINARY LAND USE AND NATURAL RESOURCE MANAGEMENT (ILUNRM), 2009

IMPACTS OF INTENSIFIED AGRICULTURE ON LIVELIHOOD AND NATURAL RESOURCES IN NORTHERN THAILAND: A CASE STUDY IN BAN MAE KHI (UPPER ZONE OF THE MAE RAM SUB-WATERSHED)

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Content

Acronyms

DoA	Department of Agriculture
FGD	Focus group discussion
GIS	Geographic Information System
NGO	Non-governmental organization
RH	Relative humidity
RP	Royal project
SSI	Semi structured interview

Introduction

The agricultural sector of Thailand has experienced great changes within the past 50 years. As one of the world's major exporter of agricultural commodities based on conventional production methods in an open market economy, the agricultural sector has been the main driver for the rapid industrial development that Thailand has undergone since the 1950's (Buch-Hansen, 2001). However, great population growth and increasing international competition has led to a demand for enhancement and effectiveness of the agricultural production, which has had severe impacts on the agriculture. As a consequence, especially during the 1960's and 1970's, Thailand suffered from deforestation transforming the landscape from a rather dense cover of tropical forest to an expanding cultivated arable land (Buch-Hansen et al., 2006). This change in land-use, as a result of agriculture, may be related to the changes in the Thai government's agricultural policies as prescribed in the first to eight National Economic and Social Development Plans (Jiang et al., 2007). In addition, the production of market-oriented cash crops was introduced as an alternative to the subsistence system and an increasingly intensification of the agricultural production took place leading to an unsustainable land-use and environmental degradation especially in the Northern and Northeastern parts of the country. Today though, encouraging a strategy of agricultural sustainability, the Thai government is now facing the great challenge of sustainability: combining protection of the environment and the natural resources with socio-economic development (Buch-Hansen, 2001; Jiang et al., 2007). This has been the focus of the ninth (2002-2006) and tenth (2007-2010) National Economic and Social Development Plan (Koomsin, 2007; Office of the National Economic and Social Development Board).

A progress of intensified agricultural production has not only environmental consequences but also plays a major role in the livelihood strategies of the many million Thai farmers. These farmers, often small scale and relatively poor, can possibly gain economically from this development but at the same time also lack the necessary agricultural input and market access that are needed, resulting in decreasing income and higher inequality. Furthermore, the farmers are highly dependent on the access and quality of the natural resources and a degradation of the environment will consequently effect the long-term agricultural production and sustainability (Buch-Hansen et al., 2006).

In the hills of northern Thailand, gradual process of agricultural commercialization has taken place over the last three decades due mainly to population increase. The period of traditional shifting cultivation has declined and replaced by short fallow period or permanent agriculture (Turkelboom et al. 2008). The land-use has shifted from mainly rice production to a high percentage of permanent crops constituting 44% of the cultivated area in 2003 compared to just 9% in 1963 (Jiang et al., 2007).

Agriculture has developed rapidly in over the last four decades being the third largest source of income and one of the most important economic sectors in Chiang Mai. About 15% of the gross product of the province is from agriculture and 35% of the labor force is in this sector. Due to open economy of Thailand, agricultural modernization oriented towards increased production has been promoted by government agricultural policies and agricultural research. The aim of this modernization and agricultural intensification is the increase of yield per hectare. It is supported by popular technologies such as adopting high yield varieties, applying chemical fertilizers and pesticides, irrigation and the introduction of new crops (Reardon et al., 1999). The use of these

new technologies for increasing production may result in environmental degradation (declines in soil fertility, pollution of surface/ground water, loss of biodiversity etc.) (Jiang et al., 2007).

In the focus area of this study, Ban Mae Khi in the upper zone of the Mae Ram sub-watershed in northern Thailand (bounded by coordinates 18º58' - 18º56' N and 98º46' - 98º49' E), such a process of intensified agriculture is taken place. The farmers in this village are involved in intensive rain fed agricultural production of cash crops (cut flowers, lettuce, cabbage, fruits, grapes, etc.) for export. The selected community is the oldest (about 200-300 years old) of two communities in upper zone of the Mae Ram sub-watershed located in Mae Rim district, approximately 25 km northwest from Moung Chiang Mai district in Chiang Mai province. In 2003, the village comprised 68 households with a population of 523 with approximately equal proportion of male and female. The main ethnic minority group in Ban Mae Khi is Hmong while the others are Kon Muang and Lahu (Aumtong et al. 2009; Nonghoy Develop Center, 2005).

The area comprising the upper zone is mountainous with an elevation range of 900-1500 m above sea level. It has a size of 14 km2, which is approximately 25.83% of the entire Mae Ram sub watershed. The upper zone is the headwater area of the Mae Ram watershed, which is made up of a dendrite drainage system (Aumtong et al., 2009). A report from 1994-2000 at Nonghoy Development Center near Ban Mae Khi showed that the average highest and lowest temperatures were 32.6 °C and 17.0 °C respectively. The hottest month was April and the coldest month was January. The annual amount of precipitation was 1,416.8 mm with the highest rainfall in August and the lowest rainfall in January. Average RH was 86% that had a peak in October and lowest in March, 96% and 69% respectively (Nonghoy Develop Center, 2005).

Soil resources in the upper zone of the watershed are mainly soil groups 62, 29C and 60. Soil group 62 which covers the largest area (10.8 km2) of the region is unsuitable for crop cultivation thus it is fated for forest conservation to protect the environment and the headwater. Soil group 29C which covers an area of 3.1 km2 on the other hand, and by virtue of its high clay content, are suitable for cultivating fruit trees and cash crops. The remaining 0.1 km2 comprise soil group 60, which is suitable for cultivating cash crops, trees and growing vegetation (Aumtong et al., 2009).

The total land area of the upper zone is partly covered with governmental areas such as National park and Royal Project (RP) areas. The RP which introduced temperate fruits, vegetables, herbs, cut flowers and ornamental plants as an alternative to opium poppy cultivation for the hill tribes in order to improve livelihood of the people covers 13.6 km2 while the National park covers 1.7 km2. The high elevation of the study area in the upper stream positions it for both rainy season cultivation and summer production (Aumtong et al., 2009; Jayamangkala, 2004).

The main economic activity of the people is agriculture. However, most of the agricultural activities are embedded in the Royal Project, which plays key functions in setting quality standards and buying products from farmers on quotas. A green house has been established by an investor for production of flowers for export to the Netherlands. The watershed and headwater types have been classified with the aim to conserve the natural resources of these areas. This notwithstanding, the intensive nature of agricultural intensification within the study area is bound to cause problems of erosion and pollution of water bodies and soil by agro chemicals (Aumtong et al., 2009).

The development of intensified agriculture in this area can provide socio-economic changes to the farmers but at the same time also cause environmental degradation. This relation between human utilization of natural resources and natural resources degradation is very complex and complicated. Thus, assessing the impacts and sustainability of intensified agriculture requires a broad holistic interdisciplinary approach that embraces both natural and social science The aim of this study is therefore to identify the driving forces behind agricultural intensification in Ban Mae Khi in the upper zone of the Mae Ram sub-watershed and its contribution to the economy and livelihoods of the people as well as the impact on natural resources.

The main research question and sub-questions

Main research question

What are the driving forces and the impacts of intensified agricultural production in Ban Mae Khi?

Sub research questions

What are the driving forces behind the intensification of agricultural production?

What are the socio-economic consequences of intensified agriculture?

What are the impacts of intensified agriculture on the natural resources?

Methodology

1. Data collection method

Secondary data

A review of literature on researches relevant to our study will be used in identifying the driving forces of agricultural intensification and also compare with data collected from the field. In addition, statistical data and standard tables will be used.

Questionnaire

In order to get information for data analysis and to understand the overview of the situation in the village, we are going to carry out 30 questionnaires with farmers. We will use stratified sampling method to select our respondents. The strata that we are going to consider will be: farmers within and outside the royal project, farmers from different ethnic groups and farmers in different well-being categories.

Semi-structured interview

Eight semi-structure interviews will be conducted to get in-depth information regarding driving forces of intensified agriculture and its impact on livelihood and natural resources. The respondents will be official from Department of Agriculture, Royal Project, Royal Forestry Department, Royal Irrigation Department. Also NGOs, GIS experts and local researchers will be consulted.

Focus group discussion

Two focus group discussions will be carried out with 6-10 farmers in order to get the driving forces of intensified agriculture and its impact on livelihood and natural resources from the farmer's perspective.

Soil and water sampling

The study area will be divided in strata. The criteria for dividing the strata will be: the topography of the cultivated land (the upset zone, the middle zone, the lowest zone) as the runoff follows the gravity vector. In each stratum 10 soil samples will be taken (until 30cm depth) which will be mixed all together to form only one compositing soil sample per strata (Kim H. Tan 2005)**.**The mixed soil sample(compositing sample) will be analyzed for the parameters(see table 3 in the synopsis).
The standard error of the sample size will be calculated after obtaining (It is necessary to identify the amplitude of each parameter from secondary data or from analyses) the results using t-test (Kim H. Tan 2005).
The number of water samples per strata will be dependent on the number of streams and other water sources that are present in each stratum.
The tables below show how each of the method will be use in eliciting data for the various sub research question.

2. Sub research Questions

2.1. What are the driving forces behind the intensification of agricultural production?

Operational questions	Methods	Respondents	Sampling
Which changes in the farming system have occurred in the study area?	GIS		
	Secondary data	Statistical offices	
	Focus group discussion	Farmers within/outside the Royal project	Purposive 2 FGD (6-10 Participants)
	Semi-structured interview	Royal project officials	Purposive 1-2 SSI
		Department of agriculture officials	Purposive 1-2 SSI
Why do farmers intensify their agricultural practices?	Focus group discussion • Preference ranking matrix	Farmers within/outside the Royal project	Purposive 2 FGD (6-10 Participants)
	Semi-structured interview	Farmers within/outside the Royal project	Purposive 2-3 SSI
		Researcher in study area	Purposive 2-3 SSI
How does the distribution of the natural resources affect agricultural intensification?	GIS		
	Community mapping	Farmers	Purposive 1 FGD

	Observation (transect walk)	Local community guides	
What role does the Royal project play in agricultural intensification in the study area?	Semi-structured interview	Royal project officials	Purposive 2-3 SSI
	Questionnaire survey	Farmers within the Royal project	Straified 30 Questionnaires
	Focus group discussion	Farmers within the Royal project	Purposive 1 FGD (6-10 Participants)
How does the type of land ownership and water right affect agricultural intensification?	Questionnaire survey	Farmers within/outside the Royal project	Stratified 30 Questionnaires
	Focus group discussion	Farmers within/outside the Royal project	Purposive 2 FGD (6-10 Participants)
	Semi-structured interview	Local government officials (or local researchers)	Purposive 2-3 SSI
What are the channels available to farmers to access inputs and sell their farm products?	Questionnaire survey	Farmers within/outside the Royal project	Stratified 30 Questionnaires
	Focus group discussion	Farmers within/outside the Royal project	Purposive 2 FGD (6-10 Participants)
	Semi-structured interview	Royal project officials	Purposive 1-2 SSI
		Investors	Purposive 1-2 SSI
How does the change in population affect agricultural intensification?	Secondary data	Statistical offices	
	Focus group discussion	Farmers	Purposive 1 FGD
What is the impact of formal education on agricultural intensification?	Questionnaire survey	Farmers within/outside the Royal project	Stratified 30 Questionnaires
	Focus group discussion	Farmers within/outside the Royal project	Purposive 2 FGD (6-10 Participants)

2.2. What are the socio-economic consequences of intensified agriculture?

Operational questions	Methods	Respondents	Sampling
What are the income sources of peoples in the area?	Questionnaire survey	Farmers	Stratified 30 questionnaires
	SSI	Non-farmer Agricultural Officer Local government officer	Purposive 3 SSI
What is the contribution of intensive agriculture as a source of income?	Questionnaire survey	Farmers	Stratified 30 questionnaires
	FGD	Farmers	Purposive 1 FGD (6-10 farmers)
	SSI	Agric Officer Royal project officer	Purposive 2 SSI
What is the contribution of agricultural intensification to employment?	FGD	Farmers	Purposive 1 FGD (6-10 farmers)
	SSI	Agric Officer Local government officer	Purposive 2 SSI
What is the farmers' standard of living before agricultural intensification and now?	Questionnaire survey	Farmers	Stratified 30 questionnaires
	SSI	Royal project officer	Purposive 1 SSI
	FGD	Farmers	Purposive 1 FGD (6-10 farmers)
Which category of the community is benefiting most from intensified agriculture?	SSI	Royal project officer Agricultural Office	Purposive 2 SSI
	FGD	Farmers	Purposive 1 FGD (6-10 farmers)
What is the influence of intensive agriculture on education?	Questionnaire survey	Farmers	Stratified 30 questionnaires

	FGD	Farmers	Purposive 1 FGD (6-10 farmers)
	SSI	Royal project Local government officer	Purposive 2 SSI
	Secondary data	Education office	
What is the influence of intensive agriculture on health of the farmers?	FGD	Farmers	Purposive 1 FGD (6-10 farmers)
	Secondary data	Health office	
How has cooperation within the community change due to agricultural intensification?	Questionnaire survey	Farmers	Stratified 30 questionnaires
	FGD	Farmers	Purposive 1 FGD (6-10 farmers)
	SSI	Royal project officer Local government officer	Purposive 2 SSI
Do farmers feel more secure now compared to before agricultural intensification?	Questionnaire survey	Farmers	Stratified 30 questionnaires
	SSI	Royal project officer Local government officer	Purposive 2 SSI
	FGD	Farmers	Purposive 1FGD (6-10 farmers)

2.3. What are the impacts of intensified agriculture on the natural resources?

Operational questions	Methods	Respondent	Sampling
How has the forest cover changed during the period of agricultural intensification?	- Aerial photo and GIS analysis	- GIS expert	1
	- Secondary data	- local researchers	
	- Semi-structured interview	- NGO official - Royal Project representative - Local administrator - RDF representative - GIS expert	Purposive 5
How has the area under cultivation changed during	- Aerial photo and GIS analysis	- GIS expert	1

the period of agricultural intensification?					
		- Secondary data	- local researchers		
		- Semi-structured interview	- Royal Project representative - Local administrator - RDF representative - GIS expert	Purposive 4	
		-Questionnaire	- Farmers	Stratified 30	
How has the area of intensive agriculture changed during the period of agricultural intensification?		- Secondary data	- local researchers		
		- Semi-structured interview	- Royal Project representative - Local administrator	Purposive 2	
		-Questionnaire	- farmers	Stratified 30	
		- Aerial photo and GIS analysis	- GIS expert	1	
What kind of fertilizers and pesticides do farmers use?		-Secondary data	- local researchers		
		-Semi-structured interview	-Farmers	Purposive 4	
			-Royal project official -DoA official -Agronomist	Purposive 3	
What is the amount of fertilizers that farmers use per unit of area per crop[1]?		-Secondary data	- local researchers		
		FGD	-Farmers	Stratified 1	
		-Semi-Structured interview	-Royal project official -DoA official -Agronomist	Purposive 3	
What is the amount of pesticide that farmers use per unit of area per crop?		-Secondary data	- local researchers		
		FGD	-Farmers	Stratified 1	
		-Semi-Structured interview	-RP official -Agronomist -DoA	Purposive 3	
What is the level of soil contamination from the agro-chemical	pH EC Pesticide & Herbicide	Laboratory analysis		10 within The strata	Composting[2] (within the strata) Stratified

applications?	Nitrate Phosphate			3 in all area	(within the all area)
What is the level of surface and ground water contamination from agro-chemical applications in cultivated fields?	pH EC O_2 BOD Pesticide & Herbicide NO_3^- PO_4^{3-} Turbidity	Laboratory analysis		X^2 within The strata 3 in all area	Composting (within the strata) Stratified (within the all area)
What is the eroded surface in area?		- Observation - Aerial photo and GIS analysis		All area	

X^2: Refer to Soil and water sampling under methodology

Time schedule

The research project will be done in five phases as follows.

Phase	Activity	Location	Duration
1	Literature review	Life Science	3rd to 24th Feb. 09
2	Writing, submission and presentation of the draft synopsis	Life Science	6th to 18th Feb. 09
3	Submission and presentation of the final synopsis	Life Science	25th to 27th Feb. 09
4	Preparing Questioners and question/ interview guides for FGD and SSI.	Life Science	25th to 29th Feb. 09
5	JFC 2009 Orientation	CMU SLUSE	4th Mar. 09
6	Collaboration with Thai students	CMU SLUSE	4th to 6th Mar 09
7	Pre-testing of questionnaires Introduction and Demonstration of field equipments	CMU SLUSE	5th Mar. 09- Morning 5th Mar. 09- Afternoon
8	Group work Work plan presentation	CMU SLUSE	6th Mar. 09- Morning 6 th Mar. 09- Afternoon
9	Leaving CMU to Base camp Introduction to key villagers	Base camp	7th Mar. 09
10	Community meeting	Ban Mae Khi	8th Mar. 09
11	Data collection	Ban Mae Khi	8th to 16th Mar. 09
12	Midterm presentation	Base camp	13th Mar. 09
13	Back to Chiang Mai and Preparation of the final presentation	CMU SLUSE	17th Mar. 09
14	Submit draft final report	CMU SLUSE	19th Mar. 09
15	Final presentation	CMU SLUSE	20th Mar. 09
16	Data analysis, report writing Final report and submission.	Life Science	24th Mar. to 6th Apr. 09

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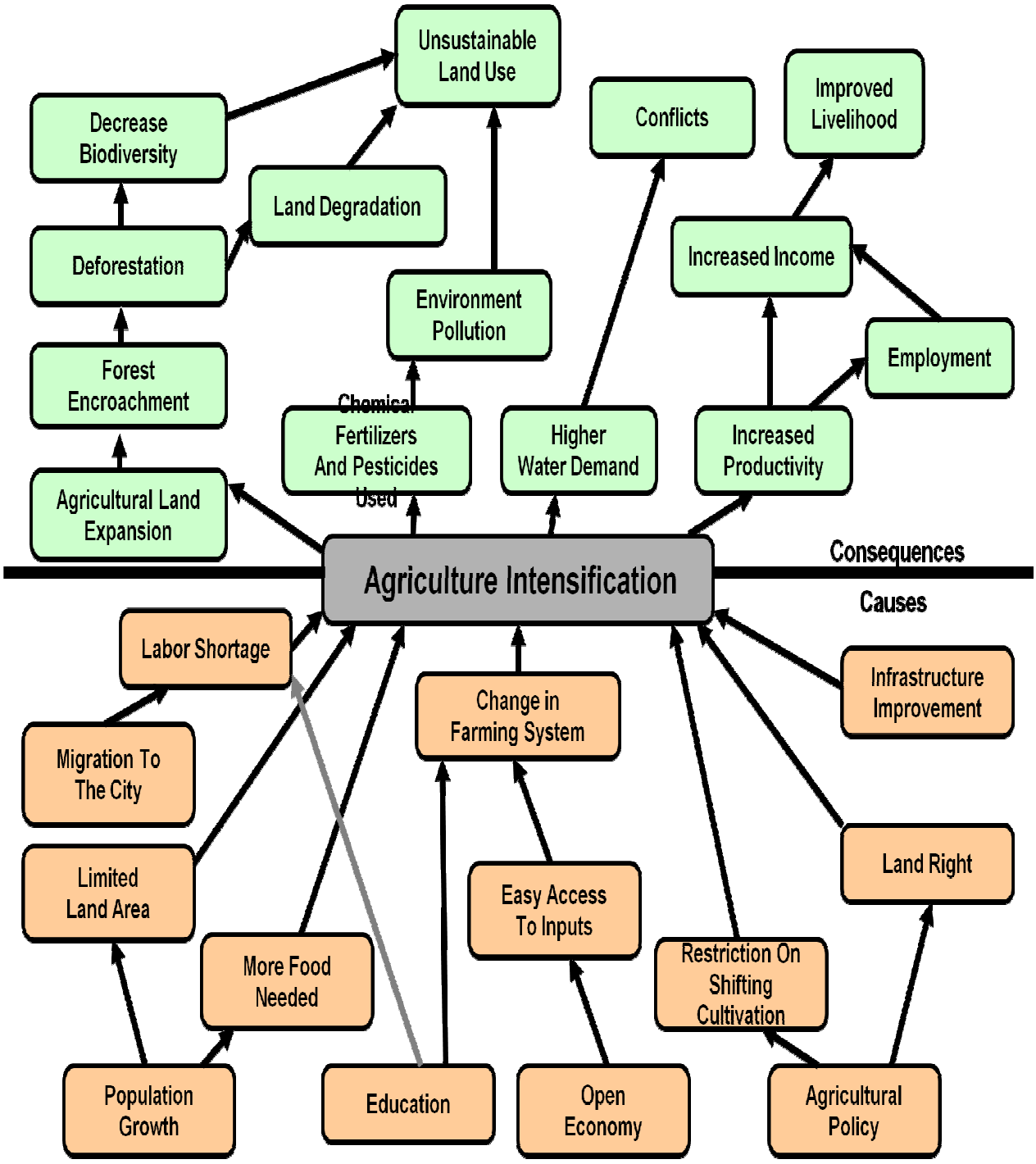
Appendices

Appendix 1: Problem Tree

To understand the complexity of the problem of the study, a brainstorming section revealed the expected causes (driving forces) and consequences.



Appendix 2: Questionnaire

SLUSE JOINT COURSE
INTERDISCIPLINARY LAND USE AND NATURAL RESOURCE MANAGEMENT
(ILUNRM), 2009

IMPACTS OF INTENSIFIED AGRICULTURE ON LIVELIHOOD AND NATURAL RESOURCES IN NORTHERN THAILAND: A CASE STUDY IN BAN MAE KHI (UPPER ZONE OF THE MAE RAM SUB-WATERSHED)

Students from University of Copenhagen and Roskilde University (Denmark) in cooperation with students from Chiang Mai University and Maejo University (Thailand), are conducting a survey, as part of our academic study, in Bae Mae Khi to find out the factors driving the intensification of agriculture and the impacts of this development on the livelihood and natural resources.

We would greatly appreciate your time to answer these questions. Your answers will be kept anonymous and the analysis of these answers will be used only for academic proposes.

Questionnaire No.____

Part I: Background Information

7. Gender
   - ☐ Male
   - ☐ Female
8. Household size
   c) Number of adults _____
   d) Number of children _____ and number attending school_____
9. What is your level of formal education?
   - ☐ None
   - ☐ Some primary
   - ☐ Primary
   - ☐ Some high school
   - ☐ High school
   - ☐ Some tertiary
   - ☐ Tertiary
   - ☐ Other, please state_____
10. Ethnic group
    - ☐ Hmong
    - ☐ Lahu
    - ☐ Kon Muang
    - ☐ Other, please state_____
11. What is the size of your farm?
    ☐ Less than 1 Rai ☐ 1-2 Rai ☐ More than 2 Rai
12. What types of land ownership do you posses?
    - ☐ Nor Sor 4 (NS-4)
    - ☐ Nor Sor 3 Kor (NS-3K)
    - ☐ Nor Sor 3 (NS-3)
    - ☐ Nor Sor 2 (NS-2)
    - ☐ Sor Kor 1 (SK-1)
    - ☐ Sor Por Kor 4-01
    - ☐ Other, please state_____

Part II: Agricultural Activities

11. What are the available sources of water for crop production?
    - ☐ Rainfall ☐ Stream ☐ Pipe water
    - ☐ River ☐ Borehole
12. Do you have equal right to use available water?
    - ☐ Yes ☐ No

    If no, what is the barrier? _____
13. What is the source of agro-chemicals for your farm?
    - ☐ Agro-shops ☐ Royal project ☐ Government
    - ☐ Other please state_____
14. Are agro-chemicals available at the time you need them?
    - ☐ Yes ☐ No
15. How long does it take you to obtain your agro-chemicals?
    - ☐ Less than 1 hr ☐ 1-3 days
    - ☐ 1-24 hr ☐ Other please state_____
16. What are your motivating factors for intensifying your agricultural practices? *Please rank them in order of importance from 1 to 7? (1= most important, 7=least important)*
    - ☐ Royal project
    - ☐ Market demand
    - ☐ Population pressure
    - ☐ Government policies
    - ☐ Water availability
    - ☐ Education
    - ☐ Others, please state_____
17. Are you involved in RP?
    - ☐ Yes ☐ No
18. What role does the royal project play in your farming operation?
    - ☐ Provide seeds ☐ Subsidies
    - ☐ Provide fertilizers ☐ Buy products
    - ☐ Provide pesticides ☐ Provide extension services
    - ☐ Others please state_____
19. Where do you sell your farm products?
    - ☐ Royal project ☐ Local markets ☐ Export
    - ☐ Other market, please state_____
20. What kind of post-harvest facilities are accessible to you?
    - ☐ None ☐ Packaging
    - ☐ Pre-cooling ☐ Storage house
    - ☐ Other, please state_____
21. Who provide these facilities?
    - ☐ Royal project ☐ Community
    - ☐ Government ☐ Self
    - ☐ Investors ☐ Other, please state_____

22. Do you have to pay for using these facilities?
    - ☐ No
    - ☐ Yes, please state the amount _____THB
23. How many of your household members are engaged in agriculture?
    - ☐ Less than 3
    - ☐ 3-6
    - ☐ 7-10
    - ☐ More than 10
24. What are the sources of labor you use in your agricultural activities?
    - ☐ Family members only
    - ☐ Hired labors only
    - ☐ Both family members and hired labors
    - ☐ Other, please state_____
25. What are the Income sources of the household?
    - ☐ Agriculture
    - ☐ Daily laborer
    - ☐ Forest products
    - ☐ Merchant
    - ☐ Livestock production
    - ☐ Remittance
    - ☐ Employee
    - ☐ Handicraft production
    - ☐ Others, please state_____
26. What is the main source of income for the household?
    - ☐ Intensified agriculture
    - ☐ Non-Intensified agriculture
    - ☐ Non-agriculture
27. What proportion of your income is derived from intensified agriculture?
    - ☐ All
    - ☐ Half
    - ☐ None
    - ☐ Majority
    - ☐ Less than half
28. How do you compare your living standard before agricultural intensification and now?
    - ☐ Better
    - ☐ The same
    - ☐ Much better
    - ☐ Worse

    Give reason for your choice _____
    _____
29. Do you feel that there is a risk in intensified agriculture in case of:
    e) Production ☐ Yes ☐ No
    f) Marketing ☐ Yes ☐ No
    g) Input availability ☐ Yes ☐ No
30. What is the influence of intensive agriculture on education?
    b) More children needed for labor and stop schooling. ☐ Yes ☐ No
    c) More children schooling due to income increase ☐ Yes ☐ No
    d) Other _____

31. Has there been cooperation within the community as a result of agricultural intensification?

☐ Yes ☐ No ☐ Don't know

If yes, what is the type of cooperation?

☐ Production groups

☐ Helping each other in plantation and harvesting times

☐ Other, please state_____

32. Has your area under cultivation changed in the last years?

☐ Yes ☐ No

If yes, what is the trend?

☐ Increased ☐ Decreased

33. How has the proportion of cultivated land for cash crop changed?

☐ Increased ☐ Decreased ☐ Same

Appendix 3: Semi-Structured Interview Guide

Agricultural Officers

1. What are the Income sources of peoples in the area?
2. What proportions of the people in the area are engaged in agriculture?
3. What proportions of the farmers in the area are engaged in intensified agriculture?
4. How do you compare the farmers' standard of living before agricultural intensification and now?
5. What is the role of intensive agriculture as a source of income for farmers?
6. Which category of the community is benefiting most from intensified agriculture?
7. Are there farmers' associations to help getting farm inputs and selling their farm produces?
8. How has the forest cover changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
9. How has the area under cultivation changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
10. How has the area of intensive agriculture changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
    c. In terms of crops
11. Which types of crop have been introduced to the community?
12. When were they introduced and why?
13. Which type of crops were farmers cultivating before the introduction of new crops?
14. What has been the trend in duration of fallow periods?
15. For how long do farmers put the land under cultivation during the year (Land use intensity)?
16. What has been the change in cropping pattern (e.g. mono cropping, mixed cropping)?
17. What has been the trend in the change of the levels of the following inputs used by farmers:
    a. Fertilizers
    b. Pesticides
    c. Herbicides
    d. Farm implements
    e. Irrigation water

Local Government Officers

1. What are the Income sources of peoples in the area?
2. What proportions of the people in the area are engaged in agriculture?
3. What proportions of the farmers in the area are engaged in intensified agriculture?
4. What is the influence of intensive agriculture on education?
5. What is the influence of agricultural intensification on social relation? (Within and between the community)
6. Are there farmers' associations to help getting farm inputs and selling their farm produces?
7. What are the kinds of conflict resulting from intensive agriculture?
8. What alternative means is there in case of crop failure; fall in price of produces, un-availability of farm input?
9. How has the forest cover changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
10. How has the area under cultivation changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
11. How has the area of intensive agriculture changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
    c. In terms of crops
12. How does the type of land ownership and water right affect agricultural intensification?
    a. Type of land ownership.
    b. Size of land.
    c. Availability of the sources of the water.
    d. Who has right to use the water resources?
    e. What amount?
    f. Who pays and how much?

Royal Project Officers

1. What kinds of cash crops are cultivated in the area and when is introduced?
2. What is the farmers' standard of living before agricultural intensification and now?
3. What is the contribution of cash crops as income generation for farmers?
4. Which category of the community is benefiting most from intensified agriculture?
5. What is the role of intensive agriculture as a source of income for farmers?
6. What is the influence of agricultural intensification on social relation? (Within and between the community)

7. Are there farmers' associations to help getting farm inputs and selling their farm produces?
8. What are the kinds of conflict resulting from intensive agriculture?
9. What alternative means is there in case of crop failure; fall in price of produces, un-availability of farm input?
10. How has the forest cover changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
11. How has the area under cultivation changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
13. How has the area of intensive agriculture changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
    c. In terms of crops

<u>GIS expert</u>

1. How has the forest cover changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution

2. How has the area under cultivation changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution

3. How has the area of intensive agriculture changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
    c. In terms of crops

<u>NGO officials</u>

1. How has the forest cover changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution

RDF representative

1. How has the forest cover changed during the period of agricultural intensification?
    a In terms of area
    b In terms of distribution
2. How has the area under cultivation changed during the period of agricultural intensification?
    a In terms of area
    b In terms of distribution
3. How has the forest cover changed during the period of agricultural intensification?
    a In terms of area
    b In terms of distribution
4. How has the area under cultivation changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
5. How has the area of intensive agriculture changed during the period of agricultural intensification?
    a. In terms of area
    b. In terms of distribution
    c. In terms of crops

Farmers

Which types of crop have been introduced to the community?

1. When were they introduced and why?
2. Which type of crops were farmers cultivating before the introduction of new crops?
3. What has been the trend in duration of fallow periods?
4. For how long do farmers put the land under cultivation during the year (Land use intensity)?
5. What has been the change in cropping pattern (e.g. mono cropping, mixed cropping)?
6. What has been the trend in the change of the levels of the following inputs used by farmers:
    a. Fertilizers
    b. Pesticides
    c. Herbicides
    d. Farm implements
    e. Irrigation water
7. What factors motivate farmers to intensify their agricultural practices?
8. What in your opinion are the most important factors?
9. What role does the Royal project play in agriculture intensification in the study area?
    a. Setting quality standards for farmers
    b. Marketing (quotas) and production and storage facilities?
    c. Subsidies?

d. Educating farmers via agricultural extension?
e. Infrastructure development (roads, small irrigation system, electricity)
f. Socio-economic activities
    - School establishment?
    - Medical service?
    - Cooperation within the community?
    - Small-scale agricultural facilities (pre-cooling, storage, canning plant, packaging)?
    - Agricultural product marketing (packaging, transportation, markets)?

10. How does the type of land ownership and water right affect agricultural intensification?
    a. Type of land ownership.
    b. Size of land.
    c. Availability of the sources of the water.
    d. Who has right to use the water resources?
    e. What amount?
    f. Who pays and how much?
11. What are the channels available to farmers to access inputs and sell their farm products?
    a. Availability of agro-shops and markets.
    b. Proximity of agro-shops and markets to farms.
    c. Storage facilities and pre-cooling structures.
12. What is the impact of formal education on agricultural intensification?
    a. What is the influence of formal education on migration?
    b. What is the influence of formal education on labour availability on farm?
    c. Does the level of formal education have any influence on agricultural intensification?

Appendix 4: Focus Group Discussion

Before we start, I would like to remind you that there is no right or wrong answers in this discussion. We are interested in knowing what each of you think, so please feel free to be frank and to share your point of view, regardless of whether you agree or disagree with what you hear. It is very important that we hear all your opinions. We appreciate your time and would like to assure you that this discussion will take 1 hour.

You probably prefer that your comments not be repeated to people outside of this group. Please treat others in the group as you want to be treated by not telling anyone about what you hear in this discussion today.

Let's start by going around the circle and having each person introduce himself/herself. (Members of the research team also introduce themselves and describe each of their roles).

A. Introduction (2 minutes)

- How long have you been living in this community?
- How long have you been in agricultural production?

B. Changes in farming system

- What has been the change in farming system before agricultural intensification?
    a. Purpose of cultivation.
    b. Type of farming system (e.g. shifting cultivation).
    c. Duration of fallow period.
    d. Type of crops cultivated/ area cultivated/farm size.
    e. Inputs used (e.g. Fertilizers, pesticides, irrigation, etc.).
    f. Any technological changes in crop production (greenhouse production/ hydroponics)
    g. Land use intensity.

C. Driving factors

d. What are your motivating factors for intensifying your agricultural practices?
e. Please rank them in order of importance?

D. Role of Royal project in agricultural intensification

- What role does the Royal project play in agricultural intensification in the study area?
    a. Marketing (quotas) and production and storage facilities?
    b. Subsidies?
    c. Agricultural extension?
    d. Infrastructure development (roads, small irrigation system, electricity)

E. Land ownership and water right

g. Type of land ownership.
h. Size of land.
i. Availability of the sources of the water.

j. Who has right to use the water resources?
k. What amount?
l. Who pays and how much?

F. What are the channels available to farmers to access inputs and sell their farm products?

d. Availability of agro-shops and markets.
e. Proximity of agro-shops and markets to farms.
f. Storage facilities and pre-cooling structures.

G. How does the change in population affect agricultural intensification?

e. What is the trend in population growth?
f. What is the cause of population growth?
g. Does the population change put any pressure on land use?
h. Does the population change affect labour availability on farm?

H. What is the impact of formal education on agricultural intensification?

d. What is the influence of formal education on migration?
e. What is the influence of formal education on labour availability on farm?
f. Does the level of formal education have any influence on agricultural intensification?

I. Socio-economic impacts

i. What is the farmers' standard of living before agricultural intensification and now?
j. What is the role of intensive agriculture as a source of income for farmers?
k. Which category of the community is benefiting most from intensified agriculture?
l. What is the influence of intensive agriculture on education?
m. How has cooperation within the community changed due to agricultural intensification?
n. What are the kinds of conflict resulting from intensive agriculture?
o. What alternative means is there in case of crop failure; fall in price of produces, un-availability of farm input?
p. Do farmers feel more secure now compared to before agricultural intensification?