Subsistence and intensive farming in Ban Kayan, Northern Thailand - it's ecological and socio-economic impacts

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In this report it will in the headline of each chapter or section appear who the author [initial] of the section is. If there is more than one, the first is the responsible author and the second is the contributing author.

Set up and formatting by EJP

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Abstract

Intensive farming in Northern Thailand is a reality, and this system has been seen as a problem to the environment mainly because of its amount of chemicals used. This report is a result of a work carried out by Students from Denmark and Thailand, were the understanding of the socio-economic and ecological impacts of intensive farming in Ban Kayan is stated as the main objective of the work. The study area is located in the Upper Mae Pae Watershed, Northern Thailand. The area of Ban Kayan is inhabited by 98 people, distributed in 20 households.
Based on the interdisciplinaryty of the study group, qualitative data regarding biodiversity including crops and weeds, value of nature, water quality, nutrient flow, soil properties, forest composition and socio-economic status of the village were gathered. Regarding socio-economic aspects, the results show that the benefits from the intensive farming depend on some interventions such as the Royal Project and the amount of loans gathered for each crop season.
Furthermore, the villagers still use forest products, mainly as medicinal source, food and construction as part of their livelihood needs. The ecological data reveals that there has been an increase in forest cover since the beginning of farming intensification. Soil analysis shows that it is mainly potassium that is mined from the soil. Changes in the biodiversity during especially the last 20 years are characterized by losses of species, crops, wild plants and animals. It is overall concluded that the system of today is not fully sustainable.

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1. Introduction [EJP & HAJ]

1.1 Thailand's farming history

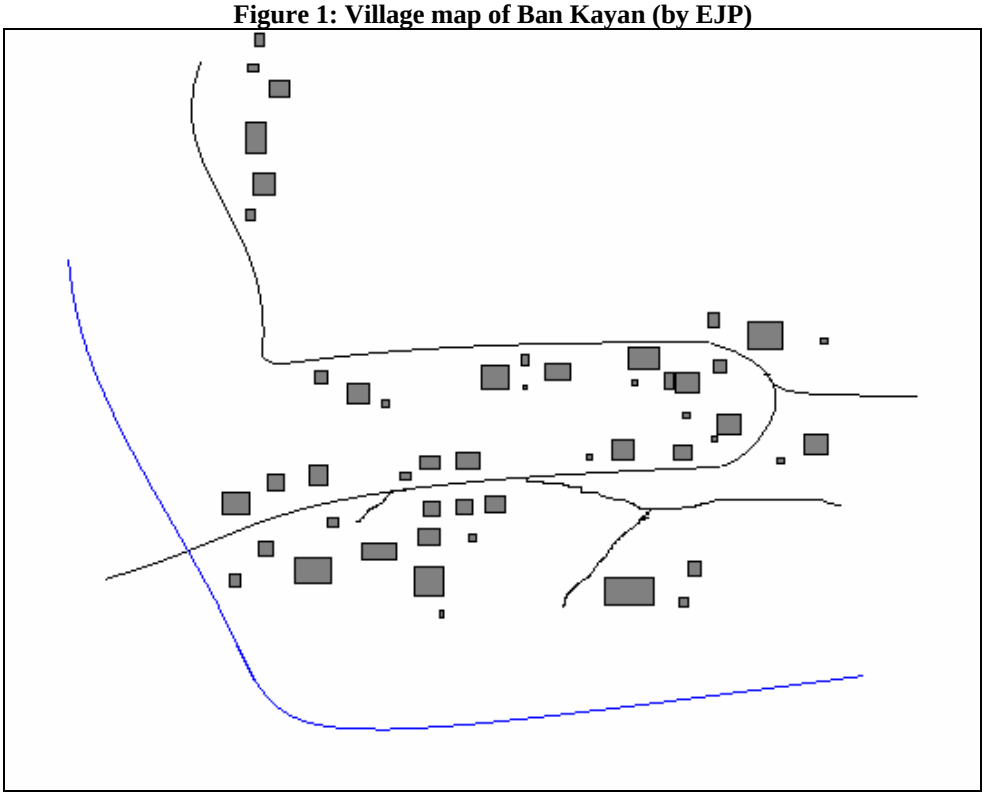
According to Thai Agriculture Department (Apai & Navanugraha 2004), evidence has shown that the farming patterns of today are still based largely on mono-cropping practices with a large amount of agrochemical use, natural resources degradation and too much pollution. These patterns have led to increased soil erosion; loss of soil organic matter and soil fertility depletion (Apai & Navanugraha 2004). To cope with the pressure the farming strategy is changing by using newly developed technologies and the demand of vegetables has been growing annually.
The land area available for agriculture has in the last years been declining caused by increase in population and at the same time the growing population pressures the production of domestic food (FAO 1999).

The Northern part of Thailand has been known for its opium production throughout generations (Falvey 2000) but today the main source of income in the peri-urban and irrigated areas, like the Chiang Mai region, is from vegetable production (FAO 1999).
Because of the increasing population pressure and food demand these parts of Northern Thailand have a well established partner of Governmental and Non-Governmental Organisations trying to improve the livelihood of the villages and to support a sustainable production.

1.2 The location of the study

This study was carried out in a small village, in the southern part of one of the sub-watersheds to the Upper Mae Pae watershed, called Ban Kayan. The village is located in the bottom of a narrow valley adjacent to intensively cultivated steep hill sides. And it is surrounded by forest and this natural resource has through generations been used as a supplement in their livelihood strategy, for example for feeding cattle, food, medicine, fuelwood and constructing materials.
The village consists of 20 households (figure 1) and most of them produce cabbage, red onions and other vegetables characterized by a substantial use of fertilizers and pesticides (Mingtipol et al. 2007).

Figure 1: Village map of Ban Kayan (by EJP)



In the past the village had a subsistence farming practice where they grew different crops/vegetables for self consumption together with upland rice and rice on paddy fields. Today the farming system is mainly a combination of subsistence rice production and intensive vegetable production with a few exceptions. Mutual for all the households is that the only income source is from agriculture.
The farming practice today differs from the past, in the way that the upland rice is grown as a mono-crop and the other crops and vegetables besides rice are grown with the purpose of selling.

1.3 Purpose of this study

The main purpose of this study is mainly academic, which is based on the integration of different disciplines to understand a practical agricultural situation in a developing country context.
Specifically to Ban Kayan it is interesting to discover the socio-economic and ecological status of the current livelihood situation in the village. To do this the following research questions and objectives have been drafted.

Research question:

Are the farming systems practiced in Ban Kayan sustainable livelihood strategies?

Sub-research question:

1. What are the socio-economical impacts of the farming systems?
2. What are the ecological impacts of the farming systems?

General objective:

Investigate the socio-economic and the ecological impacts of the farming systems in Ban Kayan.

Specific objectives:

- Understand the current socio-economic situation in Ban Kayan
- Understand how the local people value nature
- Investigate the effects of farming practices for biodiversity in forest, field and river
- Understand the farmers dependence on the forest products
- Understand the impacts of farming practices on forest species composition
- Estimate the nutrient flow in different farming system
- Estimate the irrigation water quality that may lead to soil salinization
- Identify the different livelihood strategies

1.4 Interdisciplinarity

To cover this very broad research question the different disciplines in the group have be taken advantages of.

- The two agronomists have covered the nutrient flow and the quality of the irrigation water used in the fields concerning the impacts on the soil.
- The biologist has investigated the different farming practices from before and until today and theirs effect on the biodiversity.
- The forester has investigated the farming practice's influence on the composition of species in the forest and the villager's dependence on the forest products.
- The geographer has covered the more socio-economic part of this study, by investigating the changes in factors influencing the way of practicing farming and the livelihood strategy.

In Thailand two Thai-students joined the above mentioned group. One of them investigated different subsistence farming practices influence on soil erosion. And the other investigated the relationship between subsistence farming and intensive farming in past and present.

2. Methodology

2.1 Qualitative data [EJP]

All the qualitative data for this report was collected within 3 different tools (questionnaires, interviews and PRA).
To get a current overall picture of the livelihood situation in Ban Kayan, a 100% questionnaire survey (table 1) has been carried out.
Semi-structured interviews (table 1) have been made to get more detailed information on the different farmers farming strategy. For triangulation and to get the official view of the current situation in the rural areas of Northern Thailand, different Governmental and Non-governmental Organisation have been interviewed.

Table 1: Qualitative data collected in Ban Kayan

Methods	Number	Respondents	Data
Questionnaires	20 (appendix 1)	Farmers	To give a current picture of the livelihood situation in Ban Kayan
Interviews with officials	4 (appendix 2)	TAO, CARE, Agriculture Extension, National Park	To show the official opinion on the farming situation in Northern Thailand
Interviews about village	1 (appendix 3)	Village leader	To introduce the group, to get information on the village and to get permission for the coming work.
Forest	8 (appendix 7)	Farmers	To know the main forest products and their uses
Nutrient flow	10	Farmers	To determine the flow of nutrients in their fields, regarding the amount of fertilizer used, harvested product, straws and soil conservation practices
Biodiversity	2	Men (40 years + 70 years old)	To find the changes in diversity within

	2 (appendix 4)	Women (40 years + 70 years old)	wild plants, animals and weeds. To get the local perspective on nature and how nature is used.
Crop production	2 (appendix 5)	Farmers	To find out the ways of cultivation, production and pest management

The PRA tools (table 2) were carried out with two different sessions and as two different walks in the village and the surroundings.

Table 2: PRA tools used under the field course and the purpose of the different tools

Activity	Men	Women	Data
Cropping calendar	X	X	To know about the crop production and its changes during the year.
Historical timeline – village	X (box 1)		To obtain knowledge about the village history
Livelihood ranking	X (box 3)	X (box 3)	To get the villagers opinion on their current livelihood situation
Ranking of farming practices	X		To confirm the existence of identified farming practices
Historical timeline – crops	X (box 2)	X (box 2)	To know about the changes in crops over the last 100 years in Ban Kayan
Village map	X (according to figure 1)		To know the local perspective of the village
Daily activity plan		X	To get information about the female role and importance in the village
Walk in fields and forest	X		To get an overview of the spatial pattern of the village and surroundings.

Walk in garden and fields	X		To learn about crops/wild plants grown in the garden and fields in past and present.

The PRA sessions were with the villagers, one with around 10 men, and the other with 5 women. The field-forest walk was guided by two farmers, and one of them also guided the garden-field walk.

Critique of qualitative methods and bias [HAJ & EJP]:

Sources of bias must be taken into consideration when data are collected and analysed.
The questionnaire was not tested enough (only once at Chiang Mai University). It was changed very fast without all the group, when we could see that the questions prepared were not suitable after we got some more information on the village. Different interviewers had different agendas and different answers were the result.
Covering all the qualitative methods translation was a source of bias. Both the translation from English to Thai and from Thai to Karen. When translation was done information was lost and answers were shortened. It was not always clear if the answer came from the respondent or from the translator when the local villagers translated between Thai and Karen.
The terms past and present were generally used and have led to unreliable data because of no exact timeframe. It can be difficult for people to remember what happened in the past. For example it seems like there is a tendency to make the past very idyllic as well as some memories might be from their childhood, where for example trees will look very much bigger than for an adult.
Some of the identification materials were not sufficient and some local names could be very difficult to look up in literature/internet. The dry season gave a twisted view on the village and surroundings compared to the rainy season.

2.2 Quantitative data

2.2.1 Biodiversity [HAJ]

To investigate **water quality** in Ban Kayan water and sediment samples were taken from inlet, outlet and a middle point of Kayan stream running through the village. The purpose was to evaluate the effect from intensive farming on the stream by looking for chemical residues from fertilizers and pesticides applied on the fields. As a further indicator stream invertebrates were collected at each point and used as indicators for water quality after the “water pollution index” by Kanjanavanit & Tilling (2002). The information on water quality can be used to evaluate the general effect on living organisms in Ban Kayan caused by intensive farming.

To investigate **weed diversity** number of species and individuals were counted on different fields cultivated with respectively paddy rice, cabbage, red onion and upland rice during the rainy season or irrigated during the dry season. On each field 3 plots of 0,25m^2 were made with a bamboo frame and number of total species and number of individuals within each species were counted. When it was possible the species was identified to family, genus or species level. The four fields belong to two different farmers and were chosen because by they covered the main cultivation methods within a transect from stream to forest. On each field the plots were non-randomly selected to be representatives for the whole field. Simpson’s diversity index (Begun et al. 1996) was used to measure the evenness of the individuals distributed within each species (see figure 2).

Figure 2: Simpson's diversity index

$$D = \frac{1}{\sum_{i=1}^{s} Pi^2}$$

Critique of quantitative methods and bias in changes in biodiversity [HAJ]

To get an overview on the water quality, invertebrates were used as indicators. The results may however be biased because of only one time sampling for each place, samplings on different times in the day and because of identification errors (done in the field). Critique on the method can be given to the fact that only some animals are considered indicators while others, also living in specifically clean/non-clean water, are not indicators.

For the studies of weed diversity a lot of things could have been done differently if more time had been available, but some complications were, however, caused by a not well-chosen season to register weeds.

Because of lack of time in the field the study was changed from being a transect running from stream to forest to instead being a study of weed diversity in four specific fields with different cultivation in the same test area. Also the plot size was changed from $1m^2$ to $0{,}25m^2$, which increased the probability of errors. The number of plots were raised from two to three in each field, but they were not randomly selected, because of very big differences within the field and were too few plots to make sure they would represent the area.

Three of the four fields were not actually cultivated at the time of the study and the different time of harvest had made different conditions for weed growth beside the conditions of intensification investigated. Furthermore the paddy field was grazed while the others were not. There where confusions whether some of the plants might have been new shoots from the same individual make some of the data unreliable.

Simpson’s diversity index is biased when only few species are considered since it will give a high level of evenness and thereby seems to be more diverse.

An average diversity index for each field was calculated as well as the average number of species. It was done to compare the fields more easily but if the species on each plot had been known it should have been calculated as a new diversity index with information from all plots as one plot in the calculation.

2.3 Forest [JM]

In order to understand the impact of different farming systems on the forest composition, plots were established on different areas. Three plots were established on the Natural Forest (NF), two in a 12 years fallow field (12 yrs fallow field), where upland rice and cabbage was cultivated (according to the guides during the field-forest walk) and two plots were established on a 20 years fallow fields (20 yrs fallow field), which was used to grow opium. Unfortunately, the data of the last two plots are not used in this report, because there was no clear agreement if that were a 20 yrs fallow field or 12 yrs fallow field.

Square plots were used, with the following dimensions: 20x20m, which the width against the contour lines were changed based on the slope table (appendix 7). Inside these plots, one plot with 10x10m were also established. In the 20x20m plots, the diameter breast height (Dbh) of all trees with Dbh more or equal to 10cm were gathered, including their local species name. In the 10x10m, the breast diameter of all trees with Dbh <10cm were gathered, including the local name of the species, which were after identified, using the guidelines of Northern Thailand trees (Gardner et al 2000).

2.4 Nutrient flow estimation in different farming systems [AN & AH]

Six farming systems (paddy rice, upland rice, upland rice-cabbage, herbs, onion-cabbage and lettuce) were identified in the site by asking the local farmers about the existing of such systems and actual farming practices carried out. Description of each identified field in the site was done. The level of intensification was defined according to use of fertilizer and time of land use throughout the year. From these fields soil samples were taken using bulked sampling method (Rowelle 1999) to determinate pH, soil electric conductivity (EC) (pH-meter), organic matter content (OM) and nutrient status NPK (Kasetsart University test kit and methods described in Rowelle 1999).

Using both data from nutrient flow interviews and the bulked sampling data nutrient balances were established at the field level by knowing the fluxes of nutrients in the system. Guidelines were used to estimate the amount of nutrients in each harvested product (Defoer et al 2000, La Malfa 1996)

2.5 Irrigation water quality estimation [AN & AH]

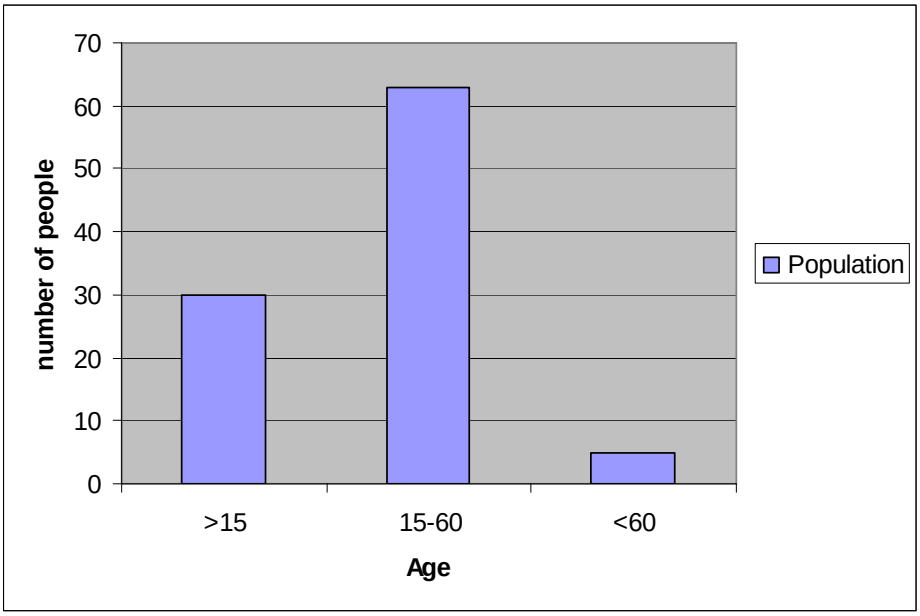
Water source for irrigation was identified in the village using a local guide. Water was tested for electric conductivity (EC), salinity, total dissolved solids (TDS), pH, dissolved oxygen (DO), nitrate and total phosphate and pesticides residues. Guidelines were used to classify the quality of water used for irrigation in the site (FAO 1985).

3. Results and discussion

3.1 Socio economic factors [EJP]

During the 10 days in Ban Kayan a 100% questionnaire survey was carried out. This survey showed that there are 20 households in the village. The total population (figure 3) is regarding to the questionnaires 98 people, where most of them (63) are between 15 and 60 years old and only five are more than 60 years old. The rest of population (30) is children under 15.

Figure 3: The population in Ban Kayan divided by age



Looking at the historical timeline (box 1) the main activities started 24 years ago. The families lived earlier in association with the nature and forest and practiced subsistence farming. They grew rice, different root vegetables and fruits (box 2). Most of the different crops they grew in the past they also grow today, but almost all crops except the rice is today for sale, and instead they buy the food they need.

Box 1: Historical timeline

Year	Event	Households
1907	Village founded (approximately)	⌂⌂ 8-10
1973	Started to use plough instead of buffaloes to prepare the fields	
1977	Fields in the forest – rotation system	
1978	Flood – caused big soil erosion in the fields	
1982	The Royal Forest Department (RFD) starts to work in the area. They introduce red beans. The rotation system and the fields in the forest stops because of new regulations from RFD.	
1984	The Royal Project (RP) build the road to the village	⌂⌂ 15
1984-87	Starts growing cabbage and onion. RP supports lettuce and salad.	
1985	No rain. Water pipeline into the houses. The pipeline in the fields came a few years later.	
1987	The last bear is seen in the area. The RP introduced the electricity in the village.	
1992	The village buy the first motorcycle	
1994	The village sale the motorcycle and buy a pick-up truck instead.	
1995	The last tiger is seen in the village – eat all the villages pigs	
1997	The lowest forest area. Starts to limit the farming area.	
2002	The H-monk Village founded. This resulted in a conflict about the forest. The H-monk cleared the forest for their fields and the wild animals diapered. Grow opium.	
2004	The last barking deer is seen. Big forest fire. Hail storm destroyed the yield. Very low rice yield.	
2005	Stops grow opium	
2007	Low prices on cabbage	⌂⌂ 20

Additional information

- Raised cattle in the forest until 2002. Visited them ones or twice a week.
- RP visit the village each year. The villagers cant remember the last visit from Agriculture Extension
- See them selves as a Royal Project village.
- Typhoid in the village each year (when the weather gets cold.
- In the latest years some people have got asthma.
- The farmers gets side effects from using chemicals
- The Monk people causes many changes in the forest.
- There are no conflict about the land with other villages, but there are conflicts about the water resource in the dry years.

Box 2: Cropping timeline

PRA session with men

Year	
1907-1969	Started with upland rice and then later came paddy rice.
Grown in all period	They have grown sticky rice before but the like non-sticky more
	Taro, sweet potatoes (easy to plant but cannot sell)
	Pineapple, papaya, chilli
	Species of lettuce (as now, but now smaller)
	Black bean (other species than now)
	Birds and many plants from the forest. Also as medicin
	Big and a lot of fish in the river
	Still grow all the same but the soil not fertile any more, so they need chemicals. Same seeds but not so good quality anymore (when asked about changes in variety of seeds)
1969	Start opium planting by H-mong hill tribe
	Still poor even though it is a cash crop
	Regular forest fires: - give land to grazing cattle
	- give fire belts
1984	Royal Project → got money from cash crops
	Need more land and for the first time they use each field every year.
	Potatoes, red onion, red beans, plum and chinese pear, cos, salad vegetables
	Carrots stated but not fertile – stopped again
	Start chemicals
	Fertilizer: 200 bath/bag
	Dept started. Invest. Borrow money from RP (for fertilizer, chemicals etc.)
1992	Ornamentals started (as now)
	Cabbage started (by themselves)
1995	Stopped opium
1996	Stopped red kidney bean
2007	Sell vegetable to middleman in Chom Thong. No storage possibility.
	Buy lots of food now. Before only salt.
	Much less plants (food and medicine) in the forest
	Less birds
	Less and smaller fish in the river
	Cabbage 1 bath/kg (sold in the beginning of march)
	Fertilizer: 500 bath/bag
	Lettuce and vegetable (subsistence) smaller than before.
	More rice because of chemicals in the soil
	Spend more money on doctor – less plants for medicine
	Access to hospital and school

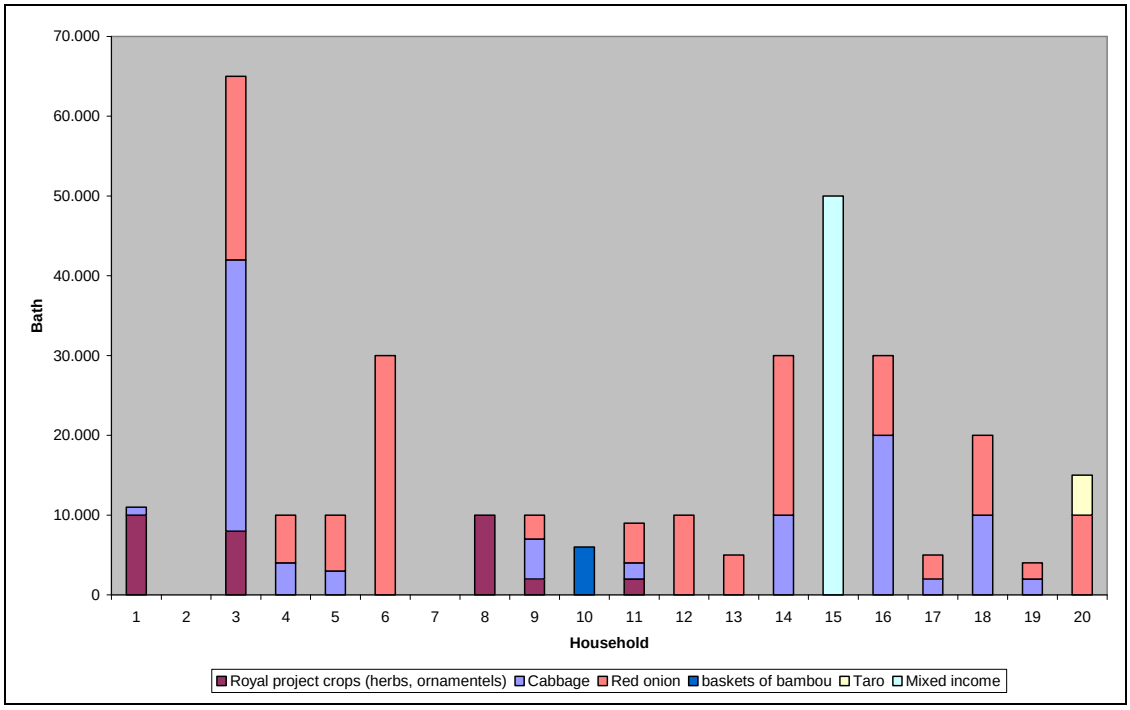
Box 2: Cropping timeline (continued)

PRA session with women

- Before The Royal Project there was a bigger production of subsistence vegetables
- In the past they grew black sesame together with the upland rice. They stopped growing sesame when RP came to the area.
- Local corn, beans (green, red, black, white)
- Taro, cassava, sweat potatoes, yam, pumpkin, cucumber, seasoning plants, eryngo, egg plant, chilli, bitter lettuce.
- Chinese mustard together with the rice → still, but less now.
- They have limited land so all land is used every year. It means decrease in rice yield.
- Because of the limited land resources the villagers have to priority how they use the land. Rice is more important than vegetables for the household.

The farming practice changed with the introduction of the Royal Project (RP) in 1983-84 (box 1, appendix 2;RP). The idea behind RP was to improve the quality of life of the hill tribes, to decrease the opium cultivation and replace it with other cash-crop and to conserve the natural resource (appendix 2;RP). One of the first initiatives the RP introduced was the road to the village; suddenly the villagers had easily and quicker access to the rest of the area (box 2).
The RP also stimulated the intensive farming, and started a new marked for selling vegetable. If the projects buys the crops the villagers get a higher price for the yield. According to some of the villagers (appendix 3, appendix 5) and the Tambon Administration Organisation (TAO) (appendix 2;TAO) the RP has changed the life in the village in a positive way.

Figure 4: The agricultural income (in Bath) of all 20 households in Ban Kayan divided in five different income sources

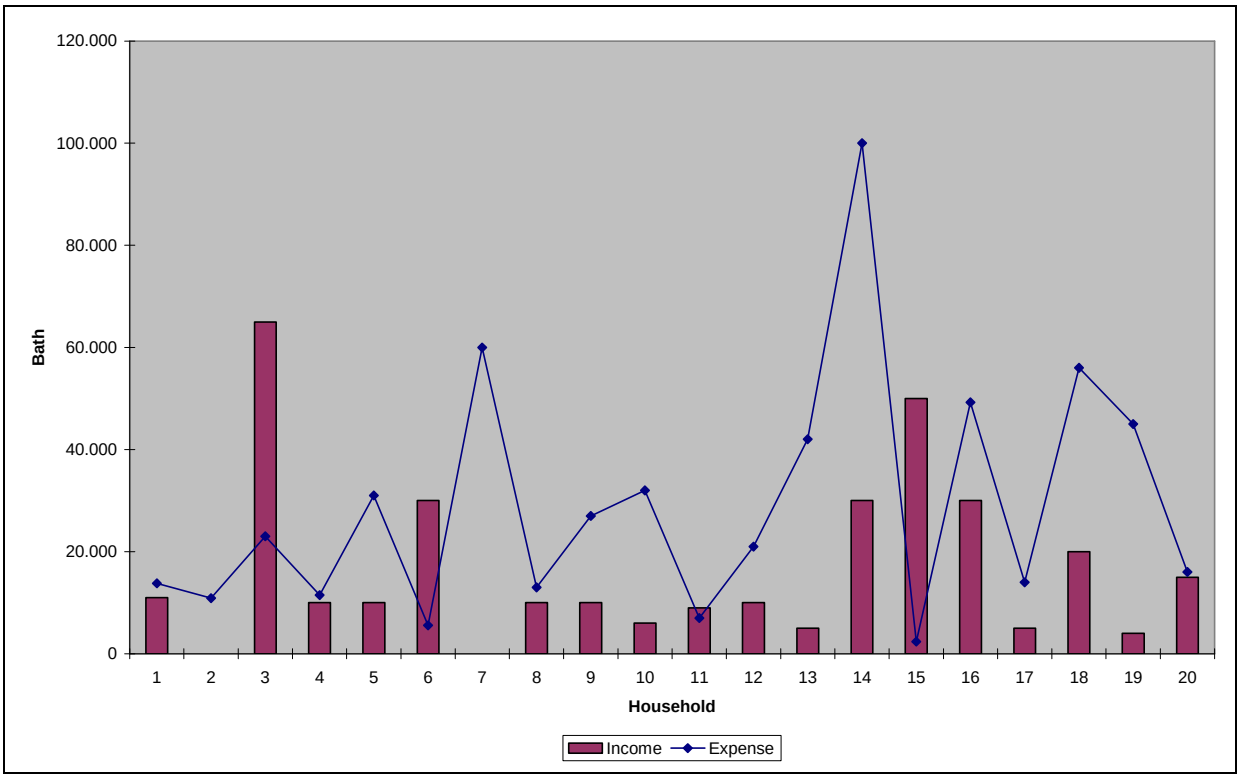


In the season 2006-07 20 households have grown either upland rice, paddy rice or upland rice and paddy rice. Besides this 18 of the 20 households (figure 4) have been growing vegetable and other crops for selling. The farmers have sold most of these crops to either a middleman in Chom Thong, directly on the marked or to RP.
Most of agricultural income comes from selling cabbage and red onions. Two farmers have earned money from other crops than red onion, cabbage and from RP; one farmer has made baskets of bamboo and sold them, and the other has made money from selling taro.
There was one farmer who was not able to separate his income in different products, but he has told that he only has grown rice and cabbage.

The villagers call themselves a RP-village, but only 25% (figure 4) of the households have sold herbs and no vegetables to RP this year.
There were in the ten days in the village pointed out different problems with RP. The quality of the vegetables has to be high and the farmers are not allowed to use so many chemicals. Instead of growing cabbage for selling to RP, they can sell it themselves and the yield will be higher if using more chemicals and in that way the farmers will earn more money (appendix 5). Another problem with the RP is that there is a limited quota of the product they want to buy. One farmer (answer in questionnaire) gives the example, that a farmer has a yield on 10kg of herbs but the RP only wants to buy 3kg the rest of the yield will become useless for the farmer. His expense will then exceed his income.

Figure 5 illustrate that the relationship between the total agricultural income for each farmer and the household's (housekeeping and agriculture) expenses only in 3 households are positive. That means that 3 of the 20 households have earned more money than they have used. The rest of the households have this year used more money on fertilizer, chemicals, education fees, household expenses etc., than they have earned.

Figure 5: The total income and expenses for all 20 households in Ban Kayan



This negative income has a big influence on the farmer's loan situation. This year one of the farmers has chosen not to cultivate other fields than two fields with paddy rice. To prevent getting more in debt the farmer choose not to grow any cash crops, but he will be in the same situation next year. He is not the only one who has loans. 15 households have loans from 1.000 to 100.000 baths, borrowed from Bank of Agriculture and Cooperative in Chom Thong, the village fond and other funds (answers in questionnaires). They have taken up loans to improve their livelihood or just to cope with the current situation and survive the year.
None of the households in Ban Kayan have any savings, but they are aware that it is important to have if suddenly something happens (additional information - PRA with women) for example sickness or natural disasters.

For the farmers not only in Ban Kayan but in the whole of Upper Mae Pae Watershed there are different complications with farming in the area. The Agriculture Extension (appendix 2) representative listed the following, as the problems related to farming practices and to get a sustainable farming system seen from their point of view.

1) Lack of knowledge in sustainable farming practices
2) Lack of water in the dry season
3) The prices of products is not stable
4) The imputs (fertilizer, pesticides) are more expensive because of the transportation costs. This results in a smaller profit.
5) Lack of communication between the local people and the official representatives.

Source: Appendix 2;Agriculture extension interview

In 3 of the 5 points the representative listed the village leader of Ban Kayan agrees. He (appendix 3) points out that 1) not enough water, 2) a very low and unstable price on the products, 3) the inconvenient transportation and 4) the high prices on fertilizer and pesticides are the main problems related to farming in Ban Kayan.

The villagers in Ban Kayan have also noticed the decreasing amount of water especially in the river (appendix 4). Looking on our studies it is not possible to obtain the reason for the decrease in water in Ban Kayan. But one thing is sure the lack of water causes conflicts with other nearby villages and with the lowlanders (box 2, appendix 2;CARE).

This year the prices on cabbage according to the TAO (appendix 2) are acceptable for the farmers. But this is not the opinion of the farmers. When the field course started the price on cabbage was a little over 1 bath/kilo (box 1), but when the field course ended the price was 0,8 bath/kilo. That is the lowest prices in a very long time.
According to the village leader (appendix 3) on the first day in the field the prices this year should be between 1-7 bath/kilo, while last year the price was between 1-10 bath/kilo, because of surplus cabbage on the market this season.

The villagers have further more problems with storage of production after harvest. The villagers have no other choice than sell the products all at once, because there are no storage room in the village, and that they don't have access to one for example in Chom Thong. In that way the villagers can not wait selling their product until the prices are better. In the nearest future the TAO has plan to support setting up storage rooms in the area (appendix 2), but it is not clear who will get access to these.

The very low prices on the products this year have resulted in farmers not being able to sell their vegetables and instead leaving them in the fields. With the high prices on chemicals the farmers are left with a very big deficit (see figure 5).
The high prices are not the only problems related to chemicals. The villagers have over the last couple of years noticed changed in their health when they are spraying with the chemicals in the fields. Some of the side effects the farmers have experienced are headaches, coughs, itching and dizziness (appendix 5, box 2). When this happens during the work in the field, they just take a break until it stops and then start working again.

3.2 Changes in biodiversity [HAJ]

3.2.1 Situation

The biodiversity in Ban Kayan has decreased during the past 40 years while the population has increased and new farming systems have been introduced to the area.
The local people explain how the big mammals as bear, tiger, wild pig and barking deer have disappeared from the forest together with several species of birds, fish and insects which before were an important food input for them (Table 3).

Table 3: Changes in biodiversity from past to present based on interviews and timelines

Surroundings in general	River	Wildlife	Wild plants	Weeds
Less trees and smaller trees More forest fires Subsistence to cash crops More people and houses now The road has come Soil quality and fertility poor now More erosion	Less water, not as good water quality, less and smaller fish	No tigers, wild pigs and barking deer. Less useful insects and bugs for eating More insects and worms in crops	Less coral trees, orchids, herbs and wild vegetables, pigweeds, gongai, ferns and liku (species) around the creek	More weeds also in upland rice where there were little before

Many wild plants, trees and herbs, have been lost and the villagers have to find new sources for food and medicine mainly from the city. As an observer it is possible to see several fields cultivated with the same mono-crops and a look back in history tells of several crops grown before in a much bigger scale.
All the respondents see the changes as a necessity in order to follow the development and in order to earn money and improve their lives. However, all as well think it is sad with the decrease in biodiversity, forest area and water level.

3.2.2 Habitat loss

The loss of species can be seen as a cause of several things. The main reason for loss of species is loss of habitats. Others can be used of pest management (discussed below), climatic changes and cultural habits. At least three main habitats are observed; forest, field and water.

Forest

Changes within the forest include the smaller area covered by forest but also the removal of grazing cattle and opium fields. The latter has caused that the forest area has been increasing again but not to an extend where the species have come back (appendix 3). The smaller forest habitat is probably the main explanation of the loss of the big mammals, which rely on big continuing undisturbed areas (reaching further than Ban Kayan) to find food and shelter. The loss of birds and insects can as well be caused by the decreased field habitats.

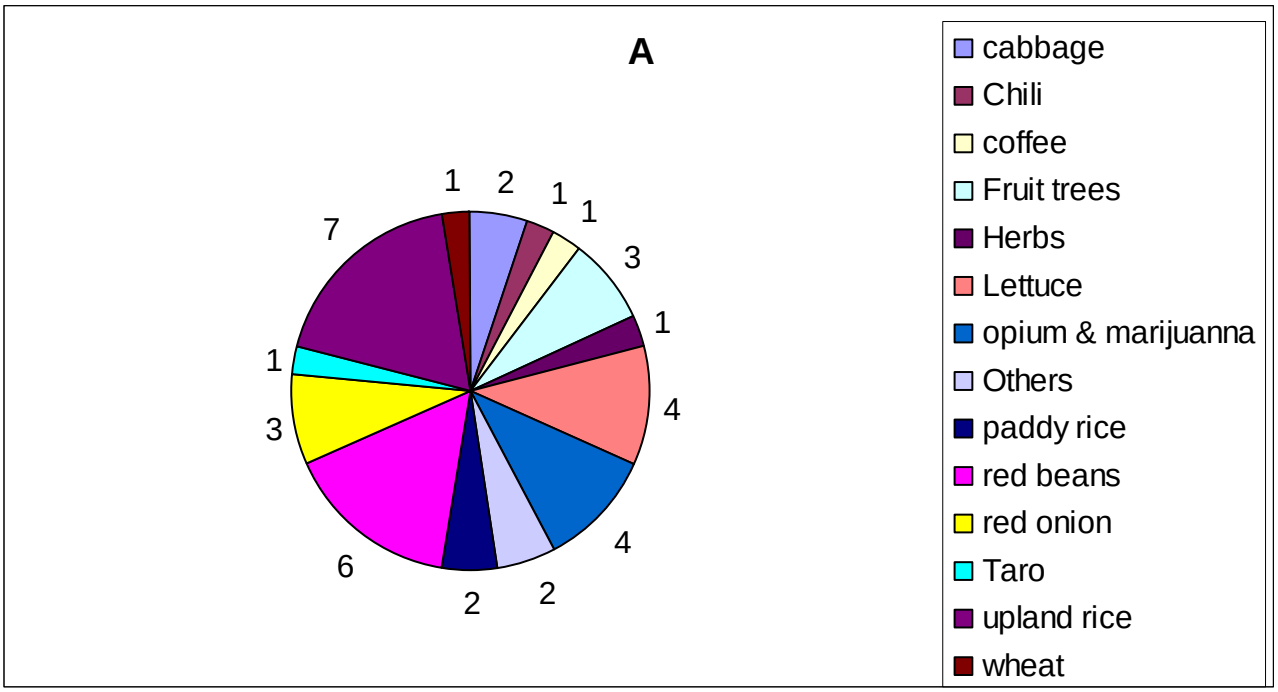
Field [HAJ & EJP]

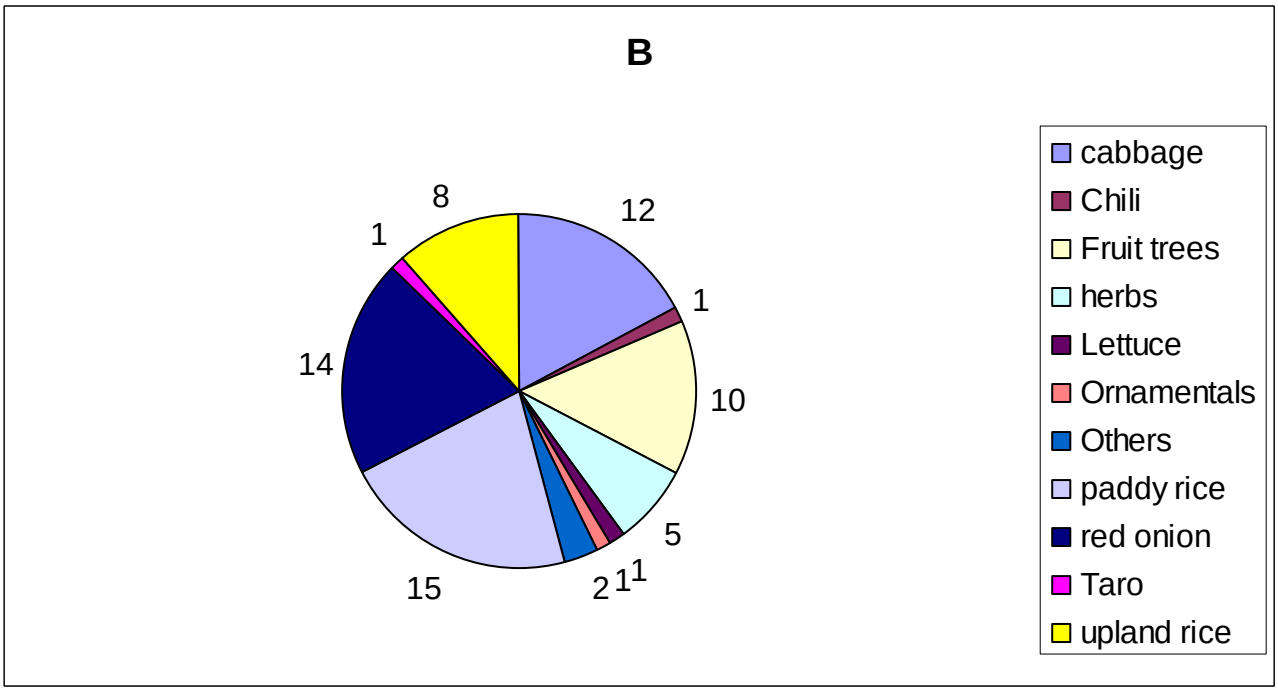
Habitats in the fields have changed considerably. From being a system with rotational farming and fallow fields for up to 7 years, where new wild plants could re-inhabit and create new habitats, to a system where the fields are cultivated every year with the same crop. Furthermore has the cultivation practice changed from being mainly paddy rice and upland rice where especially the latter was cultivated with several subsistence vegetables as eggplant, cucumbers, tomatoes, leaf vegetables, root crops, sacrificing plants and other valuable food crops or cultural plants (box 1 + appendix 4). The practice now seems to be mono-cropping of subsistence rice as well as different cash crops not originally local to the area. The fields have thus lost species both in the sense of the loss of crops and the loss of habitats where wild plants/weeds and animals (for example birds and

insects) would live. Many of those wild plants were considered very useful and used for food as well as the crops (appendix 6;specieslists).

According to the questionnaires there are 10 crops which has been grown in both past and present, they have only started to grow 1 new crop (ornamentals?) and 4 crops are not grown anymore. In the past there were 14 different crops on 38 different fields, where there in the present are 11 different crops on 53 fields. In the figure 6B of the present there are 70 fields and not 53 because of more than one cultivation period on the same field.

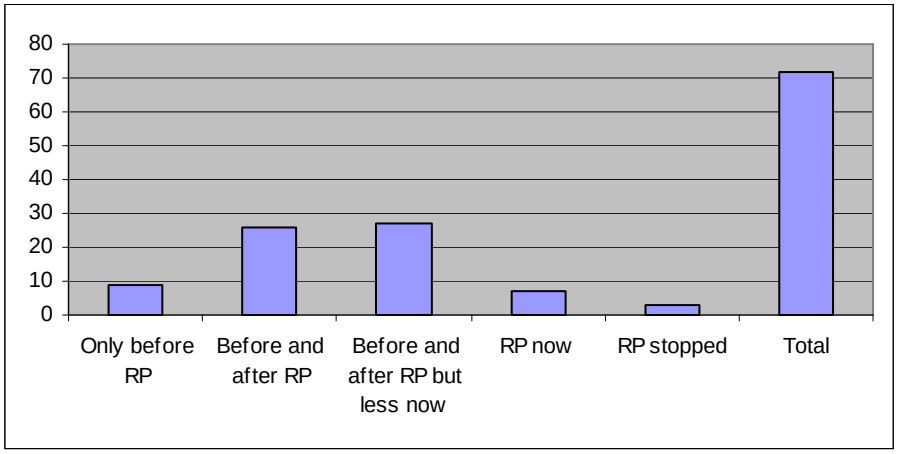
Figure 6: The crop production according to number of fields with a specific crop in A) past and B) present.





A total of 72 different species of crops (where more varieties of the same species the varieties are considered as species in this study) have been mentioned as being cultivated now, in the past or in both periods in Ban Kayan when data from interviews, PRA-sessions and observations are included investigated as well. However, the list of crops is probably not comprehensive since many of the crops were first mentioned when asked directly about that specific crop. Of the 72 species, 10 species came to the village with the Royal Project. 7 is still cultivated while three has stopped (figure 7).

Figure 7: Species of crops cultivated in Ban Kayan only before the Royal Project; before and after the Royal Project and before and after the Royal Project but less now.



9 local crops stopped to be cultivated after RP began (table 4) while 53 have continued being cultivated. For half of them the cultivated area has decreased very much. Mainly because they now are cultivated in the gardens instead of being intercropped with upland rice.

It was expected to find a decrease in varieties of the same crop sown in the same field (especially rice) but it was however not confirmed. Asking different farmers and villagers all said that they only grow one variety of each type of rice and it has not changed during the history.

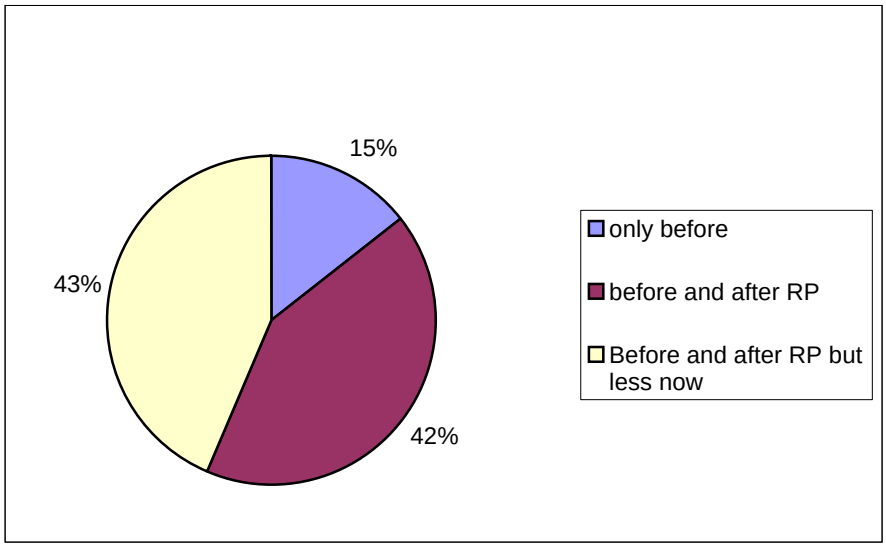
Table 4: Crops in Ban Kayan not cultivated/seen anymore (source: appendix 6;crops and weeds species list)

Scientific family	Common name	Scientific name	Comment
Amaranthaceae	Pigweed	*Amaranthus sp. L*	Weed/ornamental in upland rice. Sacrifice for good harvest. Not wild anymore but they keep seeds and plant it with upland rice.
Asteraceae	Spilanthes	*Spilanthes acmella Murr.*	Planted with upland rice before. Gone now. Leaves and flowers eaten.
Asteraceae	Lettuce, bitter	*Lactura virosa*	
Bromaliaceae	Pineapple	*Ananas comosus Merr.*	
Cannabaceae	Hemp	*Cannabis sativa*	

Fabaceae	Black bean	*Phaseolus vulgaris*	Smaller than the one they cultivate for RP
Fabaceae	Bean, wild	*Unknown*	Found as weed in upland rice. Might have been used for eating before. Pods with fur, bean alike lablab
Papaveraceae	Opium	*Papaver somniferum L.*	Started by H-Mong. 1969-1995
Pedaliaceae	Sesame, black	*Sesamum indicum L*	
Pedaliaceae	Wild sesame Gongai	*Sesamum indicum L*	Use to dry the rice. Do not eat seeds Not wild anymore but they keep seeds and plant it with upland rice.
Poaceae	Glutinous rice (sticky)	*Oryza sativa var.glutinousa*	Like the non-sticky more
Rubiaceae	Coffee	*Coffea arabica*	

Of all the reported crops cultivated before the Royal Project (62 species), 15% are not cultivated anymore (9 species) and 44% have gone down in number (27 species) (figure 8). With the addition of the RP crops the number of species are more or less the same as before (figure 7).

Figure 8: Species of crops (in procent) cultivated in Ban Kayan either before and after the Royal Project or only before.



The information concerning cultivated crops has a lack of specific time periods and due to that it is not know if all the crops before were cultivated at the same time. Another factor is that it is not known how widespread each crop was in the past compared to now. The most important factor is the decline of many species because of the change to monocultures instead of multiple intercropping. This creates a much less diverse field and system, which is much more vulnerable to pests and diseases (Collins & Qualset 1999, Angkasith & Apichatpongchai 2000).
Table 5 shows the changes of the main plant families represented in Ban Kayan. As seen some families have lost big number of species, whereas others have substituted the local species with

non-local. Traditionally they have cultivated many legumes (Fabaceae), (Table 5, appendix 6;crop list) which have provided them with a nutrient rich diet but also added nitrogen to soil with left residues on the ground. Also in intercrop cultures other crops have had more nitrogen available when they did not have to compete with the legume. Due to rotational cropping and fallow periods the soils regular had the time to restore and rebuild a nutrient resource.

Table 5: Changed based on major plant families (source: appendix 6;crops and species lists)

Plant family	Comment
Apiaceae	Many spices grown less now
Asteraceae	Local species stopped or gone down but new species introduced by/when RP came
Brassicaceae	Local species stopped or gone down but new species introduced by RP
Cucurbitaceae	Most species grown same number as before RP
Fabaceae	Most species stopped or grown less as before RP
Labiatae	Local species stopped or gone down but new species introduced by RP
Poaceae	Most species same as before RP, but some lost/introduced
Solanaceae	Most species grown less as after RP
Zingiberaceae	All species grown less as before

In the traditional way of farming in Ban Kayan the gap between crop and weed is not very far, which has caused an even higher biodiversity in the field. With the change of the many useful weeds seen in smaller quantities into more invasive and useless species in high numbers the diversity in the field has declined even further. For instant, now they plant the cultural important plants (gongai and pigweed (Appendix 6;weed species list)) in rice fields because the weeds do not grow by themselves anymore, probably because of herbicides left in the field from the cabbage. The local people also reported many vegetables (for example sorrel and Chinese mustard) as being useful weeds, but sometimes even planted in the fields (Appendix 6;crop species list). With the traditional knowledge these people possess, they have been able to make use of almost every plant in their surroundings (forest, fields, water) for either food, medicine or handicrafts.

Water

The water habitat is also affected by the change of farming system. In the same period with the decrease in forested area and more use of water for irrigation the water level in the stream have declined and have led to smaller and fewer fish compared with before the change. Also plants near the stream (table 3) seem to be effected and probably also invertebrates. The tests for water quality supports partial this pattern. Water quality evaluated by indicator animals shows fairly clean water in Kayan Stream (table 6). Inlet water is rather clean to clean and it is slightly better than the rather clean water from middle point and outlet. The differences are very small though and could however just be caused by coincidences or sources of errors.

Table 6: Water quality by indicator animals (source: appendix 6;water pollution index)

Point	Water pollution index	Evaluation
Inlet	6,38	Rather clean to clean water
Middle point	5,50	Rather clean water
Outlet	5,75	Rather clean water

The water analysed for nitrate and phosphate also indicates a good water quality, since the content of those nutrients in all positions are well below the critical values (table 7).

Table 7: Water and sediment samples of Kayan Stream (source: appendix 6)

Position for sample	NO_3 (mg/L)	T-PO^{3-}_4 (mg/L)	Chemical residues above critical values in sediment
Critical value*	**0,25**	**0,40**	
Inlet	0,087	0,013	Cabofuran
Middle	0,096	0,011	Cabofuran Mevinphos
Outlet	0,071	0,039	-

*Critical values given by Chiang Mai University.

The sediment of all samples, however, content residues of insecticides (table 7). In the inlet and middle of the stream, residues were found in a concentration higher than the threshold limit values (TVL). The carbamate; cabofuran, was found in both places whereas the organophosphate; mevinphos, was found to be above TVL only in the middle.
Organophosphates are nerve poisons. They are extremely toxic to insects and mammals but not so persistent in the environment. Carbamates are also nerve poisons but less toxic to mammals than organophosphates. However, most are extremely toxic to bees (pollination) and parasitic wasps (natural insect enemies) (Begon et al. 1996).

It is difficult to measure changes since the quantities data only measures the quality as it is now. In general the water quality is good, but the chemical residues of insecticides and the decrease in the amount of water are worrying factors when considering health of the ecosystem and humans in all Upper Mae Pae Watershed.

3.2.3 Pests and management

Another reason for the loss of species besides the loss of habitats is chemical pest management. Chemicals which were introduced by RP and includes both herbicides and insecticides. The noteworthy point is that both weeds and insects have increased since then. Also in the subsistence fields with paddy and upland rice where only little problems were seen before the introduction of new cash crops and pesticides.

Invertebrate pests

Cabbage fields attract several insects and worms (Winch 2006), which can damage both these fields but also neighbouring fields with other crops. So far the farmers in Ban Kayan have used only the chemical method for removal of pests and have experienced an increase in need of insecticides (appendix 5).
Pesticides kill their target organisms as well as influencing non-target organisms directly or via food chain reactions. Pest organisms that are important food for organisms in higher trophic levels can cause loss of other species when they are eliminated from the ecosystem. Furthermore, some insecticides can influence plants, both weeds and crops (Begon et al. 1996).
In smaller extends traditional knowledge on wild plants containing certain toxins against insects have been used by farmers during the history to kill pests. As an example a liana (found in the forest on the field-forest walk, unknown species), which stem boiled in water releases toxins. Natural pesticides will of course also release toxins in the field, and is by no means automatically better

than synthetic ones in an environmental perspective. The type of the toxin needs to be considered, but generally the natural toxins have a much shorter half-life in the environment than synthetics, which however may be a problem, because most pesticides must have some residual activity in order to effective (Duke 1990). An advantage for the farmers though could be that pesticides are without costs.
Pest management can be very complicated and has to follow the interactions of the ecosystem. An integrated pest management (IPM) is recommended in Ban Kayan to raise biodiversity and use less chemicals.

Weeds

Problems with weeds follow the same pattern. After the introduction of cash crops and more intensified use of the land, weeds have become an increasing problem in all types of fields (table 3, appendix 4, appendix 5). However, the agricultural extension officer told that there had been no change in weeds (appendix 2;agriculture extension), but it is not known which time period the representative refers to and how well he has looked into this subject. Observations and theoretical literature (Froud-Williams 1997, Booth et al. 2003, Jensen et al. 1998, Cousens & Mortimer 1995) supports the experiences of the local farmers.
New invasive weeds have spread in the area within the last 20 years and cover big areas of both cultivated fields and fields used for grazing until next cropping season (appendix 6;weed species list). Chromolaena for instant was seen in all the area in big populations, but was originally introduced from South America to India to prevent soil erosion and spread to all South-East Asia (Froud-Williams 1997, Wanderhouse 1994). New weeds could also have been introduced by seeds from the market. The change in the agricultural system will often cause change in weed populations. Change in soil nutrient content (both depletion and addition of fertilizer), and other crops and cultivation practice which create new habitats and will change the composition and diversity of species (Hyvönen & Salonen 2002).
Lack of crop rotation can cause more weeds probably because of the allelopathic interference of certain crops (Jensen et al. 1998, Liebman & Dyck 1993, Wandermeer 2003). For instant Chinese mustard and soybean seems to effect next crop in a allelopathic way and thereby reduce weeds (Frick & Johnson 2002). Both of these plants are cultivated less now than in the past, where they were intercropped with upland rice.
In relation to the general health of an ecosystem a more diverse system is preferred (Begon et al. 1996) and it includes also weeds (Jensen et al. 1998). Research supports that species richness and diversity is higher in production without use of fertilizers and herbicides, compared to where those chemicals are added, even though the diversity is also highly dependent on type of crop (Hyvönen & Salonen 2002, Jensen et al. 1998).
The four fields investigated for weeds represent the main cultivation practices in Ban Kayan (table 8).

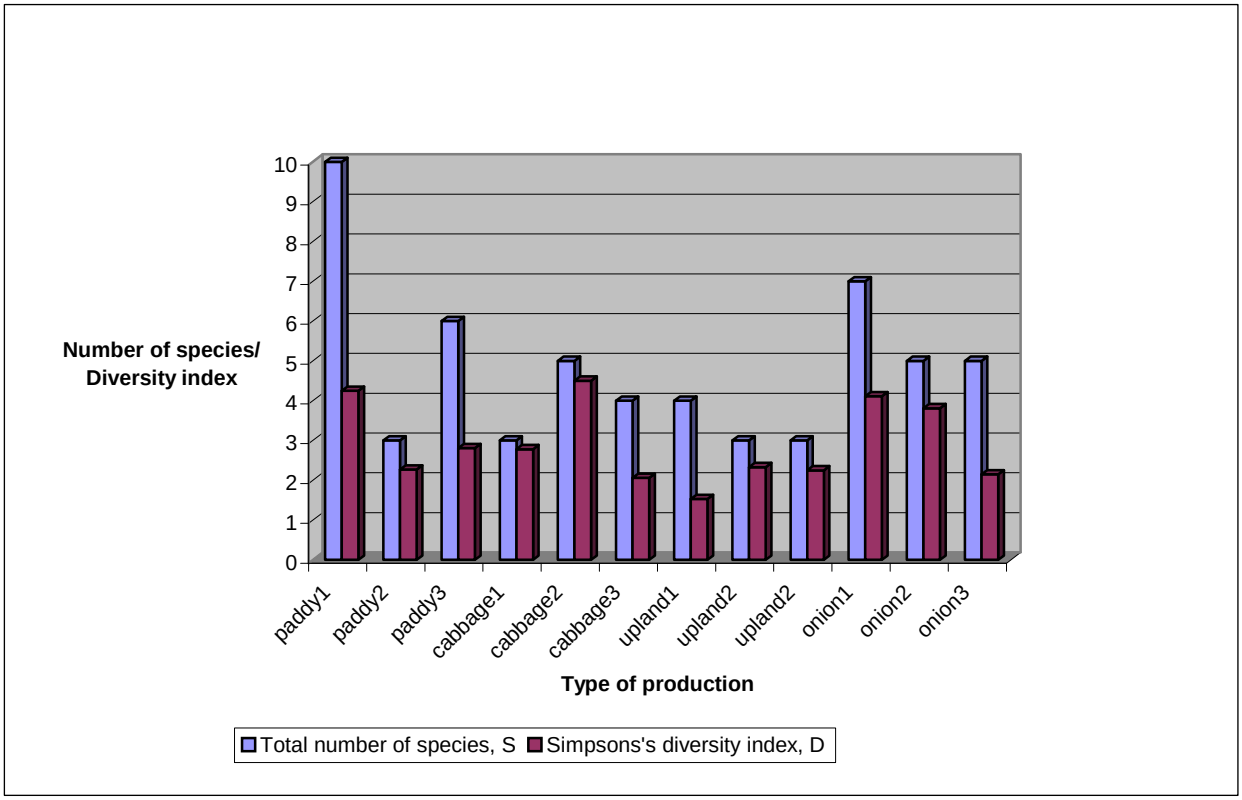
Table 8: Supply of nutrients and pesticides and level of disturbance for each field studied for weed diversity. (source: appendix 5 and table 20)

Field	Nutrient supply and pesticides	Level of disturbance
Paddy rice	Fertilizer + cow manure	+ cows - water 6 months since harvest

Cabbage	Fertilizer + insecticides + herbicides	- cows One month since harvest Some water from irrigation other field
Upland rice	Fertilizer + pesticides left in field from cabbage/onion cultivation only. Where no cabbage → none	- cows - water 7 months since harvest
Red onion	Fertilizer + insecticides + herbicides Many weeds.	- cows + water (irrigation)

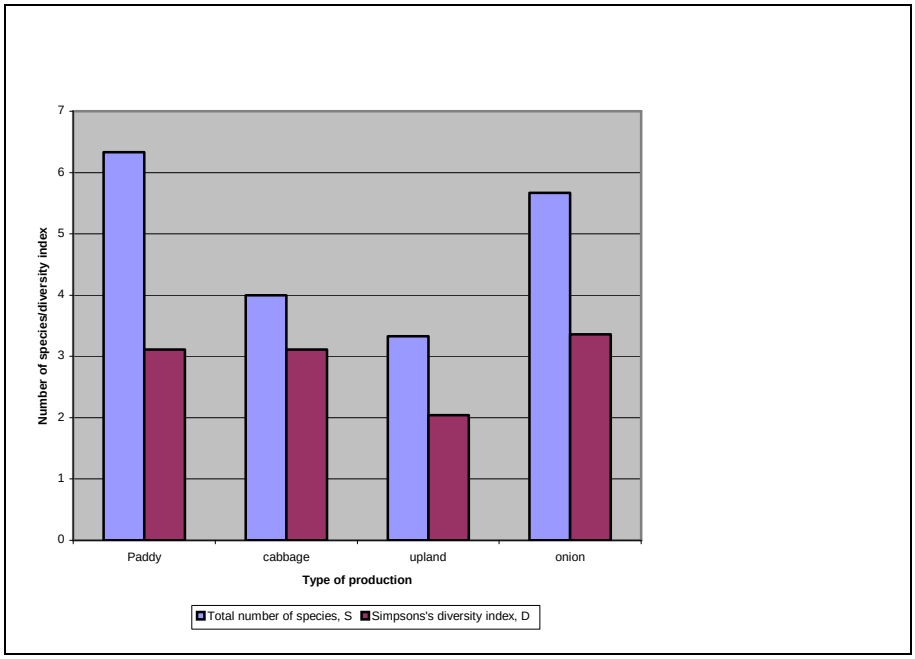
For each plot the species richness and a diversity index have been calculated to see how equal the individuals were distributed among the species. The closer the index value (D) is to the species number (S) the more evenly are the individuals distributed within that plot/field (figure 9).
The diversity index divided by the species number gives the equitability (E) (appendix 6)

Figure 9: Weed diversity index compared to number of species in 3 plots in each field (paddy rice, upland rice, cabbage and onion) (source: appendix 6; weed diversity and index)



As seen there are big differences between each plot in each type of field but as a general tendency the average values of species and diversity index are calculated for each field to compare within fields (figure 10).

Figure 10: Weed diversity index compared to number of species. Average values for the 3 plots from each field (source: appendix 6; weed diversity and index)



Only the onion field was under cultivation whereas the upland rice, paddy rice and cabbage were harvested between 7 or 1 months ago. The results show that the cabbage and upland rice fields are the most diverse but the onion and paddy rice is the most species rich.

Part of the onion field seemed without any weed management at all because of the high number of weeds in some parts only. It is difficult to take the field into consideration because not sufficient information is available concerning actual management. The paddy rice field was left for grazing causing a high level of disturbance and the highest number of species was found there. Especially the plot around the cow dung was very rich in species, which more likely was caused by the extra nutrient input. No herbicides and chemical fertilizers were used and it might have an influence on the species richness. The cabbage field scores the highest at the diversity index of even distribution of organisms, but is not very species rich. The weeds grew tall, as well as in the upland rice, and covered big areas with the same few species. Probably the result shows more critique of the method where of too low number of species will give to equal distribution.
There is no systematic in number of species/diversity index when considering number of months since harvest. It is quite interesting that more species are found at the cultivated onion field than at the just harvested cabbage field or the 7 months fallow upland rice field. But maybe it was because some weed management was done at the onion field and therefore was able to keep out the most aggressive weeds.
It is difficult to conclude much from these data except of a general overview on a non-diverse weed composition covered mainly by a few species which moreover tend to be invasive species. The general health of the crops seems to be effected followed by lower yields and more application of herbicides.

3.2.4 Value of nature [HAJ]

The villagers seem to value nature very much. The approach is the one of nature/indigenous people where the nature is considered extremely important for maintenance of their ways of living (Table 9).

Table 9: Summery of the local value of nature from biodiversity interviews (source: appendix 4)

Question	Young man (+old man)	Old man (+young man)	Young woman	Old woman
What is nature for you?	Beauty, happiness, wildlife, food, money	Food, wood for the houses, shadow, bird voices, watching wild animals in the forest, happiness	Happiness, the stream, fields, shadow, the weather. Colours from the trees to dye the clothes.	Everything around here is nature. Timber to build houses, waterfall.
What do you use from nature?	Wood for houses, firewood, herbs for food and medicine, animals for food	Trees for houses, firewood, water for irrigation, fish for food, medicinal herbs	Food. Fruits, wild bananas, mushrooms, wild vegetables, fish, cotton tree, betel leaves, colours from plants	Colours to dye the thread, wood for houses, firewood. Food, vegetables and herbs from the forest. Fish.
What is most important for you from the nature?	Wood	Land to cultivate rice	Food	Food from the forest. Bananas, ferns, vegetables.

The traditional knowledge is preserved in some extend and passed on to the new generation from their parents. But as a species disappear, they stop using it and will loose knowledge about how to eat it, what it can cure or how to make handicrafts. For example do they buy most of the thread now even though the woman still find the cotton tree and plants to get colours of very high importance. The men tend to find wood for house construction the most important. Land to grow their rice was mentioned by a young farmer and it is interesting since it shows that nature is everything around them and it gives them all what they use and need. Besides the things of more material character they mention a general happiness with the nature and enjoyment of wildlife and plants. It is worth considering that these people find some of the same values of nature as people who have a much more remote relation to their natural surroundings.

3.3 Forest [JM]

3.3.1 The farmer's dependence on forest products

In order to understand the main forest products collected by the farmers, a total of 8 farmers (belonging to 8 different households) were interviewed in the village. The information gathered in the interviews was type of product, main uses, availability of these products and the period of collection. Due to language problems, only some scientific names of the species were identified.

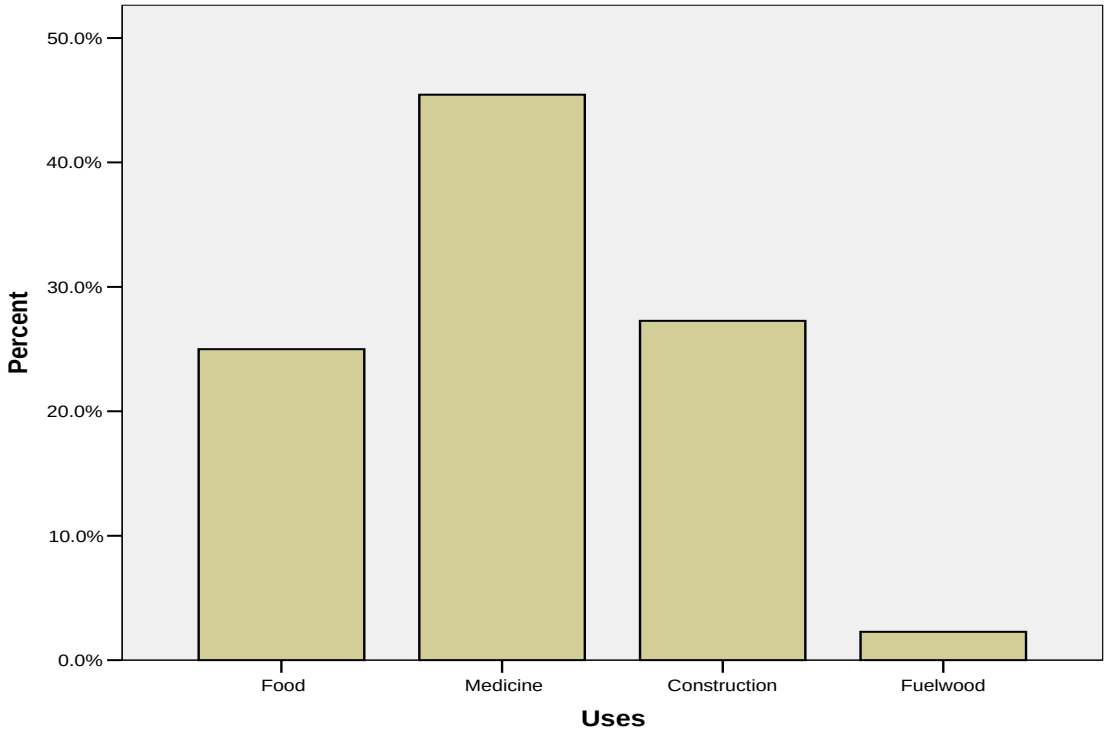
Based on all the data gathered, the farmers of Ban Kayan, besides practicing intensive farming they still depend on forest products, especially trees. The table 10 shows the main tree species used by the farmers in this village (for all the tree species mentioned see appendix 7;1).

Table 10: Main tree species used by the farmers in Ban Kayan

	Species name	Frequency[3]
1	*Delbenia indica*	4
2	*Na Ba Jor*	4
3	*Se Mee*	4
4	*Dalbergia cultrate*	3
5	*Jum Phee Wood*	2
6	*Maniahara achras*	2
7	*Prunus cerasoides*	2
8	*Quercus lamellose*	2
9	*Ta Ba Lar*	2
10	*Tha Kha Lar*	2

In general, the farmers in Ban Kayan use the trees for different purposes. The figure 11 shows what are the main use of all the tree species they mentioned.

Figure 11: Main uses of the forest tree species in Ban Kayan



The figure above shows clearly that, the villagers use the tree for medicinal purposes, followed by the constructions and food purposes. The use of tree as source of medication can be related to the lack of hospitals around the village. The main hospital is located in Chom Thong far from the village, which turns to be difficult to access by the villagers. Thomas et al. (2004) grouped the useful forest product in the following categories: food, fodder, dyes, medicine and fuelwood, where the fuelwood, food and medicine, were ranked the most important.

[3] In this case, the frequency means the number of times each tree species were mentioned by different farmers

One contradictory aspect is that the farmer did not mention fuelwood as an important aspect for their livelihood. Figure 12 shows pile of fuelwood, ready to be used and also a lady transporting a bag containing fuelwood. Even though the village has electricity, the villagers still consume fuelwood, to achieve some basic activities, such as cooking. According to Thomas at al. (2004), fuelwood is collected in large quantities of few species in Northern Thailand. However the gathered data shows that only one species were mentioned for fuelwood purposes and just by one household (see appendix 7;2).

Figure 12: Evidence of fuelwood consumption in Ban Kayan

The uses of different trees for different purpose depend on their availability. The table 11 shows the availability of forest products based on the main uses category. In appendix 7;2 shows the same availability by tree species.

Table 11: Availability of products according to main uses

		Availability			Total
		Plenty	Some	Scarce	
Uses	Food	7	4	0	**11**
	Medicine	12	4	4	**20**
	Construction	3	5	4	**12**
	Fuelwood	1	0	0	**1**
Total		**23**	**13**	**8**	**44**

From table 11, it is clear seen that the villagers think that there are enough tree products for food and medicine, but there are different opinions when it comes to trees for construction. The table 12 bellows shows which tree species are scarce and which are mainly used. Furthermore, the availability of forest tree species is independent on their utility, and is dependent on the number of the households in the villages. If the increase in households continuous the pressure on the forest resources will also increase.

Table 12: Scarce tree species and their utility

Scientific Name	Uses
Dalbergia cultrata	Construction
Jum Phee Wood	Construction

Ma Kor Sa	Medicine
Mar Khao	Medicine
Na Ba Jor	Medicine
Quercus lamellosa	Construction
Se Mee	Construction, Fuelwood
Thue Au Sha	Medicine

When the villagers mention some scarce tree species, as the one mentioned in table 10, it can be a sign that they are worried about the availability of these trees, because the trees are part of their livelihood needs.

3.3.2 The forest species composition

According to Husch et al. (2003), forest composition is an important parameter to describe forest stands, and from an ecological perspective, it can be viewed as having three components: frequency, abundance and dominance.

The data to describe the forest composition were gathered in two different areas: 12 yrs fallow field, and Natural Forest (NF). Table 13 and table 14 shows the parameters of forest composition of the two areas, respectively.

Table 13: Some forest composition parameters of the 12 years fallow plots gathered in Ban Kayan

	Species	Trees/ha	Basal Area (m^2)	Importance Value
1	*Dalbergia cultrate*	222	0.391	121.4
2	*Dimocarpus longan*	37	0.042	40.9
3	*Diospyros glandulosa*	37	0.038	40.6
4	*Lithocarpus sootepensis*	120	0.188	61.3
5	*Quercus eumorpha*	19	0.074	40.7
6	*Schima wallichii*	28	0.052	40.4
7	*Se' Bor Ue*	9	0.011	35.3
8	*Se' Mae La Ngu*	74	0.132	85.1
9	*Se' Mee Wa*	28	0.043	39.8
10	*Se' Per Da*	46	0.073	77.5
11	*Se' Pu Kui*	9	0.011	35.3
12	*Se' Pue Ka Bae*	9	0.053	38.1
13	*Se' Ra*	19	0.048	38.9
14	*Se' Sue Sa*	74	0.210	90.4
15	*Trichilla connaroides*	37	0.036	40.5
16	*Unknown 1*	9	0.014	35.5
17	*Unknown 2*	9	0.019	35.8
18	*Unknown 3*	9	0.023	36.1
Total		**796**	**1.457**	
Mean		**44**	**0.081**	

Table 14: Some forest composition parameters of the Natural Forest of Ban Kayan

	Species	Trees/ha	Basal Area (m^2)	Importance Value
1	*Archidendron clupearia*	8	0.008	34.4
2	*Dalbergia cultrate*	30	0.124	72.3
3	*Invingia malayana*	30	0.111	38.8
4	*Maniahara achras*	30	0.077	71.5
5	*N Due*	8	0.024	34.6
6	*Pha Ya Sear Krong*	8	0.080	35.6
7	*Phyllantus embica*	15	0.029	35.6
8	*Quercus eumorpha*	273	1.211	152.7
9	*Quercus lamellose*	8	0.215	38.0
10	*Schima wallichii*	8	0.105	36.0
11	*Se' Chob Pha*	8	0.010	34.4
12	*Se' Kor Due*	23	0.076	70.6
13	*Se' Kro Koh*	8	0.055	35.2
14	*Se' Kwa*	15	0.040	35.8
15	*Se' Lae Kua*	23	0.597	46.4
16	*Se' Loo Ko*	15	0.241	39.3
17	*Se' Mae La Ngu*	45	0.157	74.7
18	*Se' Mee Kor*	15	0.026	35.5
19	*Se' Per Hor*	8	0.009	34.4
20	*Se' Po Pri*	30	0.467	78.3
21	*Se' Por Bor*	38	0.202	74.6
22	*Se' Pre'*	15	0.023	35.5
23	*Se' Sa Ta Sue*	8	0.331	40.0
24	*Se' So Kwo*	8	0.119	36.3
25	*Se' Su*	8	0.010	34.4
26	*Se' Sue*	15	0.018	68.7
27	*Se' Ta Sue*	8	0.010	34.4
28	*Se' Ter Quer Ro Mue*	15	0.021	68.8
29	*Se' To Pri*	53	0.981	89.9
30	*Se' Tor Bor*	15	0.033	35.7
31	*Se' Tuk Sue*	8	0.159	37.0
32	*Syzygium albiflorum*	8	0.025	34.7
33	*Ter Se' Sui A Qua*	30	0.060	37.9
34	*Unknown 4*	15	0.019	35.4
35	*Unknown 5*	15	0.051	69.3
Total		864	5.724	
Mean		25	0.164	

The table 15 gives a summary of the scarcest trees, based on the farmers opinion and also, shows the most abundant trees in a 12 yrs fallow field, and in the NF.

Table 15: Most scarce and most abundant tree species

Most Scarce Species	Most abundant species	
Farmers information	12 Yrs Fallow	Natural Forest
Dalbergia cultrata	***Dalbergia cultrata***	*Quercus eumorpha*
Jum Phee Wood	*Lithocarpus sootepensis*	*Se' To Pri*
Ma Kor Sa	*Se' Mae La Ngu*	*Se' Mae La Ngu*
Mar Khao	*Se' Sue Sa*	*Se' Por Bor*
Na Ba Jor	*Se' Per Da*	***Dalbergia cultrata***
Quercus lamellosa	*Dimocarpus longan*	*Invingia malayana*
Se Mee	*Diospyros glandulosa*	*Maniahara achras*
Thue Au Sha	*Trichilla connaroides*	*Se' Po Pri*

The tree specie, *Dalbergia cultrata* is the only species which was mentioned by the farmers as scarce, but the data from the fields shows that it is abundant in both 12 yrs fallow field and in NF.

When comparing the number of trees per hectare and the basal area between the 12 yrs fallow field and the NF, the results show that the differences are insignificant (see t-Test results on table 16 and 17).

Table 16: t-Test of Number of trees per ha of each species, between the 12 yrs fallow field and Natural Forest

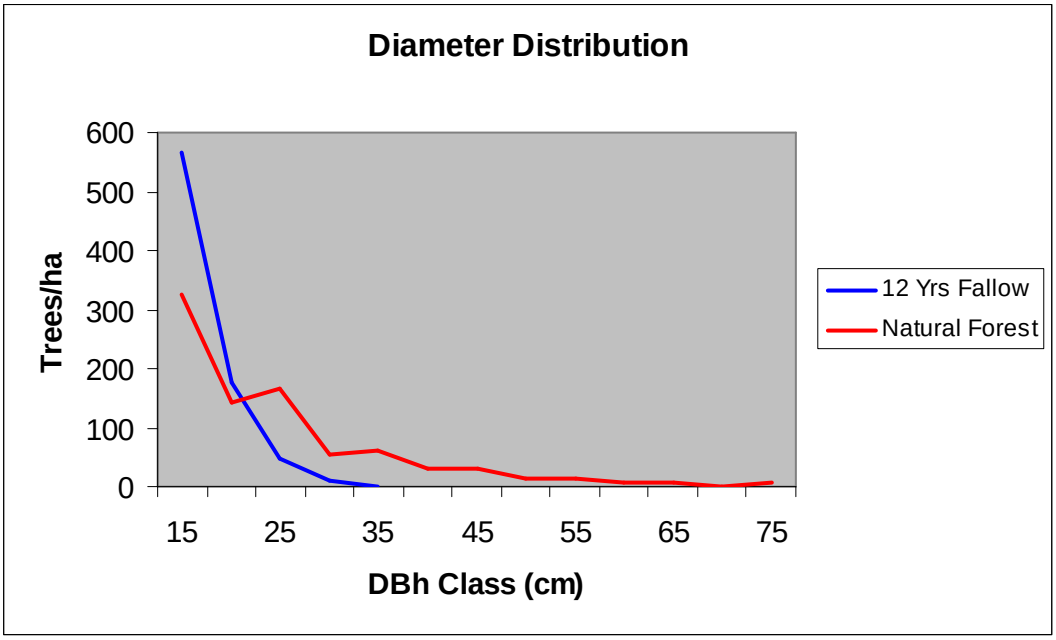
	Fallow 12 Yrs	***Natural Forest***
Mean	44.23868313	24.67532468
Variance	2860.037476	2003.129075
Observations	18	35
Hypothesized Mean Difference	0	
Df	30	
t Stat	**1.330738395**	
P(T<=t) one-tail	0.096650859	
t Critical one-tail	1.697260851	
P(T<=t) two-tail	0.193301717	
t Critical two-tail	2.042272449	

Table 17: t-Test of Basal area (m2) between the 12 yrs fallow field and Natural Forest

	Fallow 12 Yrs	***Natural Forest***
Mean	0.016943678	0.050208445
Variance	9.20061E-05	0.004509061
Observations	86	114
Hypothesized Mean Difference	0	
Df	119	
t Stat	**-5.219134378**	
P(T<=t) one-tail	3.85826E-07	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	7.71651E-07	
t Critical two-tail	1.980099853	

Even though the t-Test shows the difference between the two areas, the diameter distribution (figure 13), shows that the 12 yrs fallow field is still covered by many trees with small size (diameter), which differ from the distribution in the NF.

Figure 13: Diameter Distribution of 12 year fallow area and Natural Forest



The diameter distribution of the 12 yrs fallow field and the NF are typical of uneven-aged forest stand, and both have the inverse J-shaped distribution. Even though, there was not a difference in basal area between the 12 yrs fallow field and the NF, the figure 13 shows that the 12 years fallow field is much younger forest than the NF, especially when looking at the maximum diameter found in the both areas.

3.3.3 Conclusion; forest data

The intensification of agriculture in Ban Kayan has been a positive aspect, regarding to increase in the forest cover, especially in hill areas where the risk for landslide is high.

The intensive agriculture in Ban Kayan brings some economical benefits, but the villagers still find some forest tree species as their source for food, medicine and construction material. The availability of some of these products is dependent on the increment of the people in the village.

The data gathered in the 12 yrs fallow field and in the NF, helps to certify that the species mentioned by farmers as scarce, are not part of the most abundant species, except for the specie *Dalbergia cultrate*. These mentioned species need some special attention, in terms of conservation.

3.4 Nutrient flow and irrigation water [AN & AH]

Different farming systems in Ban Kayan (paddy rice, upland rice, upland rice-cabbage, herbs, onion-cabbage and lettuce) were investigated to know how these cropping systems affect soil properties, parameters shown in table 18. The soil in the fields varies from sandy loam to sandy clay loam. From the analyse of variance (ANOVA) at 95% of confidence there is no evidence that the farming systems are different in terms of N, NH_4, P and K available in the soil, organic matter content, soil pH, NP applied as fertilizer and NP balance.

Table 18: ANOVA Effect of different farming systems on soil properties

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
N-available	32.84348	1	32.84348	0.400151	0.555	6.608
NH_4-available	208.9255	5	41.78511	0.565643	0.726	4.387
P-available	31.35081	5	6.270162	0.897808	0.537	4.387
K-available	2209.709	5	441.9418	0.835583	0.569	4.387
%OM	1.635242	5	0.327048	0.465853	0.790	4.387
pH-lab	0.26	5	0.052	0.528814	0.749	4.387
N-flow in (kg)	5984.17	5	1196.834	1.540824	0.305	4.387
P-flow in (kg)	2320.162	5	464.0323	4.185865	0.055	4.387
K-flow in (kg)	28251.72	5	5650.344	466.2705	0.000	4.387*
EC	0.965291	5	0.193058	13.46667	0.003	4.387*
pH meter	0.205742	5	0.041148	0.175829	0.962	4.387
N balance	36689.13	5	7337.827	4.062803	0.059	4.387
P balance	890.9046	5	178.1809	4.124001	0.057	4.387
K balance	98633.98	5	19726.8	7.253456	0.016	4.387*

Legend: the abbreviation top down mean N, NH_4, P and K in the soil; % of organic matter; soil pH measured in the laboratory; NPK applied as fertilizer; electric conductivity; pH measured using quick test; NPK balances.

However, there is evidence that the type of cropping system in the studied fields have effect on applied potassium, soil electric conductivity (EC) and balance of potassium (K) in the farming system. The systems are different in terms of amount of K applied, how they affect soil EC and also in terms of K net-balance.

Table 19: Test of least significant differences found from ANOVA

	Paddy rice	Upland rice	Upland rice + Cabbage	Herbs	Onion + Cabbage	Lettuce
K-flow in	0a	1.66a	3.75a	0.83a	27.08b	134.4c
EC	0.32a	0.48a	0.896bc	0.64a	1.184b	0.832bc
K-balance	-10.764ab	-7.7a	-135.315bc	0.8183a	-145.46c	121.92abc

The test of differences in table 19 shows that the amount of potassium (K) applied in the onion-cabbage and lettuce farming systems are significant higher (means with same letter are not significant different) than those applied in other farming systems in analyse. The results show that more K is applied in lettuce comparatively with other farming systems. It may be related with the fact that lettuce demands more K relatively to onion and cabbage (appendix 8). The amount applied may justify the positive K balance observed in the same system.

Also the differences observed from ANOVA for K balance in the systems are completely significant (P= 0.05) among the fields where farmers grow upland rice vs. upland rice-cabbage, upland rice vs. onion-cabbage, paddy rice vs. onion-cabbage, upland rice-cabbage vs. herbs and herbs vs. onion-cabbage. Looking for upland rice and upland rice-cabbage fields is found that much more K status is depleted in the system where upland rice is alternated with cabbage than those growing only upland rice. In the upland rice-cabbage system what happen is that, rice is mainly grown with residual nutrients after cabbage harvesting, the farmers do not apply any fertilizer for rice crops (table 20).

On the other hand upland rice-cabbage farming system shows to mine K nutrient in the soil more than herbs farming system which keeps good status of this nutrient. Herbs are grown throughout the year, in the village, with monthly supply of manure, it somewhat may contribute to keep status of nutrients in the soil sustainable.

There are also differences in the extent to which paddy rice and onion-cabbage are mining K in the soil. These differences may be due to the fact that paddy fields are only used to grow rice. From the table 20 is seen that paddy fields are left for long time without been exploited, while in the onion-cabbage farming systems onion is grown in rotation with cabbage, meaning that the field is exploited throughout the year. But it is important to note that no potassium is applied in paddy fields (appendix 8;3), thus other factors as K available in the soil may justify the reduced soil K depletion caused in paddy rice. Onion-cabbage farming system shows to be the most K miner, in comparison with all systems which shows significant differences.

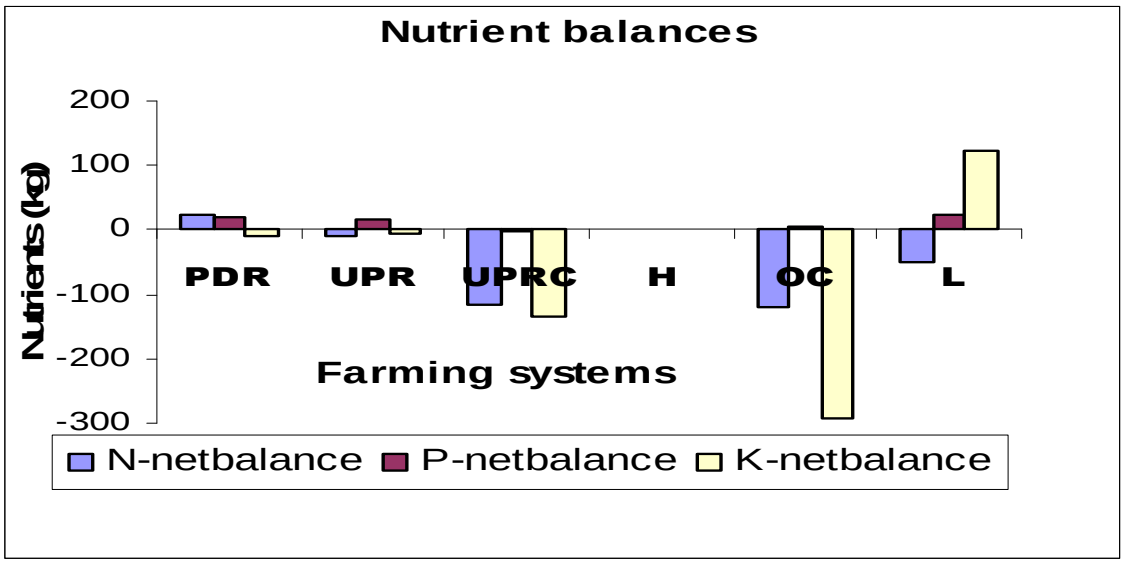
Upland rice-cabbage, onion-cabbage and lettuce farming systems are significant different in terms of soil EC if compared with the remaining systems, however, among themselves there are no significant differences found. The reason for this scenario may be related with the fact that these systems are irrigated and the water used may contribute for deposition of salts, though the test of water quality had found that the water EC is high, with an average ECw =1.15ds/m (Jensen 2006), but the restriction of use for this water for irrigation is classified as slightly (Rowell 1999).

The table 19 tries to give evidences that moving from non-irrigated to irrigated systems (paddy rice to lettuce) the soil EC is increasing. Among irrigated systems there were not found any significant difference, though it would be probable to find the systems onion-cabbage and lettuce with relatively higher EC comparatively to upland rice-cabbage and herbs, as in onion-cabbage system both crops are irrigated, while in upland rice-cabbage only cabbage is watered, thus as much as the soil is watered it may tend to have more salts deposited.

Table 20: Cropping calendar

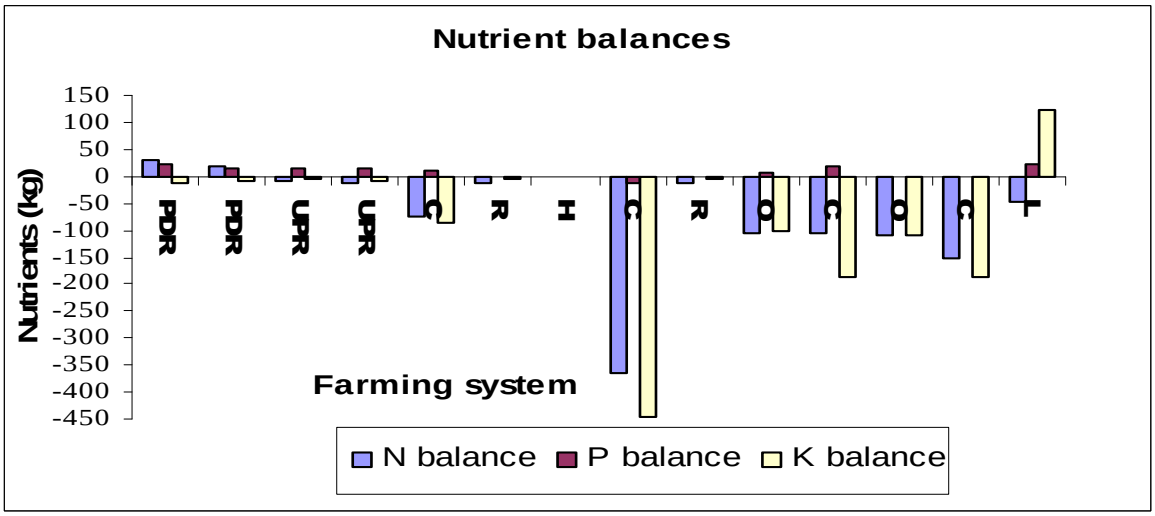
Dry season				Rainy season								Dry season	
	Jan	Feb	March	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Paddyrice	Field free			Land prep	Nursering	planting	Crop growth & maturing				harvesting	Field free
Fertilizer							NP		N			
Upland rice	Field free			Land prep&sowing	Crop growth & maturing						harvesting	Field free
Fertilizer					NP& manure							
Uplandrice* Cabbage	Crop growth & maturing		Harvesting cabbage	Rice period						Nursering cabbage	Land prep	planting
Fertilizer		NPK										NP
Rice*	Cabbage period			Land prep &sowing	Crop growth & maturing						harvesting	Cabbage period
Herbs	Manure applied monthly and harvested weekly											Planting
Onion Cabbage*	Land prep	Planting	Crop growth & maturing	Harvesting	Field free			Cabbage period				
Fertilizer		NPK	NPK									
Cabbage*	Onion period							Land prep/nursering	planting	Crop growth & maturing		harvesting
Fertilizer*									NP	N		
Lettuce	Field free	Nursering	Land prep &planting	Harvesting	Lettuce grown 2nd time						Field free	
Fertilizer			NPK									

Figure 14: Nutrient balances in different farming systems



The ANOVA in the table 18 shows that the systems in the study are only different in K balance. The analyses for figure 14 aim to show the behaviour of NPK in each farming system. The balances for NPK in all farming systems shows that the farmer growing onion-cabbage in rotational system seems to mine the soil much more in potassium followed by nitrogen than the remaining systems. Also it can be seen in those fields where farmers grow upland-rice alternated by cabbage, though the mining extent is a bit lower than the previous. In the fields where farmers grow paddy-rice balances of NP seems to be satisfactory even though depletion in K tend to be observed. Sustainable nutrient balances seem to occur in herb fields where the status of NPK is kept positive after each cropping period.

Figure 15: Nutrient balances for singular crops in the farming systems



Trying to look for singular effect of each crop grown in each farming system in the site (figure 15), with focus on those fields where crops are grown in rotation (upland-rice-cabbage, onion-cabbage). It shows that cabbage is a pioneer miner in NK if

compared with rice crop and onion for these rotational cropping systems, although onion also was registered as miner crop. The rice grown in upland fields seems to be much more exhauster (NK) if compared with rice grown in the basins (K), while the one at upland field after cabbage shows to deplete the soil in all nutrients. It may be due to the fact that it is grown in residual soil fertility. Depletion in N nutrient is observed in lettuce field, where PK status is kept sustainable.

Figure 16: left animal rice straws out and inside the field, left to right respectively


The nutrient balances established in the study do not include at all the amount of straws produced in each farming system. Though for cabbage and lettuce crop residues are left in the soil and incorporated during land preparation, but in paddy rice and upland rice the straw are used as fodder. Here there is an out flow of nutrients not quantified in this balance. The evidences are given in figure 16 showing the destiny of rice straw, meaning that substantial loses in nutrient are more likely to occur when the straw are used out of the cropping site.
Also the guide lines used to quantify status of nutrients in crops may constitute source of error in this balance of nutrients. On the other hand, it would be meaningful to estimate soil erosion in upland rice and upland rice-cabbage farming system, since these fields are relatively sloped, the nutrients may be washed out from the soil by water runoff during rainfall.

Table 21: Water quality test for irrigation

Position	TDS (mg/l)	DO mg/l	Salinity (mg/l)	NO3 (mg/l): 0-10	PO3 mg/l: 0-2	PH	ECw dS/m	Mevinph 0.011mg/l	Carbof 0.011mg/l
Inlet	208	4.33	0.2	0.087	0.013	7.5	0.414	0.007	0.035
Middle	642	1.29	0.6	0.096	0.011	7.6	1.283	0.046	0.035
Outlet	873	4.89	0.9	0.071	0.039	6.8	1.745	0.058	0.048

The soil EC is reasonable good, thus none soil in all farming systems was registered

as saline, EC< 4ds/m from soil EC test (table 19). But the amount of solids dissolved in the tested water and EC are higher than the critical value, thus the water is classified as high saline, ECw > 0.7ds/m (FAO 1985, Jensen 2006). On the other hand it is slight to moderate restricted for irrigation, TDS> 450mg/l (FAO 1985).
The quality status of the water (table 21) may be, somewhat related with agricultural activity, but even though the contamination of water in fertilizer is still far from critical values, shown in the table 19 NO_3 is less than 10mg/l and PO_4 is less than 2mg/l. However the water shows to be contaminated by organophosphate, mevinphos, and carbamate, carbofuran.

3.4.1 Conclusions; nutrient flow and irrigation water

Considering the time of crop permanence in the field and use of fertilizer the farming systems in Ban Kayan may be classified in non-intensified to intensified farming system. The land is free from agricultural activity for long period in paddy rice, upland rice and lettuce, while herbs, upland rice-cabbage, onion-cabbage have long period of crop permanence in the field due to rotation crop system (paddy rice-cabbage and onion-cabbage) and water resources availability that allow the farmers to grow vegetable crops also in the dry season.

All systems in the study are using mainly chemical fertilizers, but the management of soil fertility varies from system to system. The use of fertilizers seems not to be designed according to crop requirements. Thus depletion in soil fertility is occurring due to negative balance between crop demand and supply of fertilizer, though some systems are showing reasonable balance. The systems upland rice-cabbage and onion-cabbage are the most likely to deplete soil fertility status.

Availability of water resources enables the farmers to grow vegetables throughout the year. The impacts of using such water resources on the soil, though it is high saline, are not alarming. Not any soils show signals of salinization.

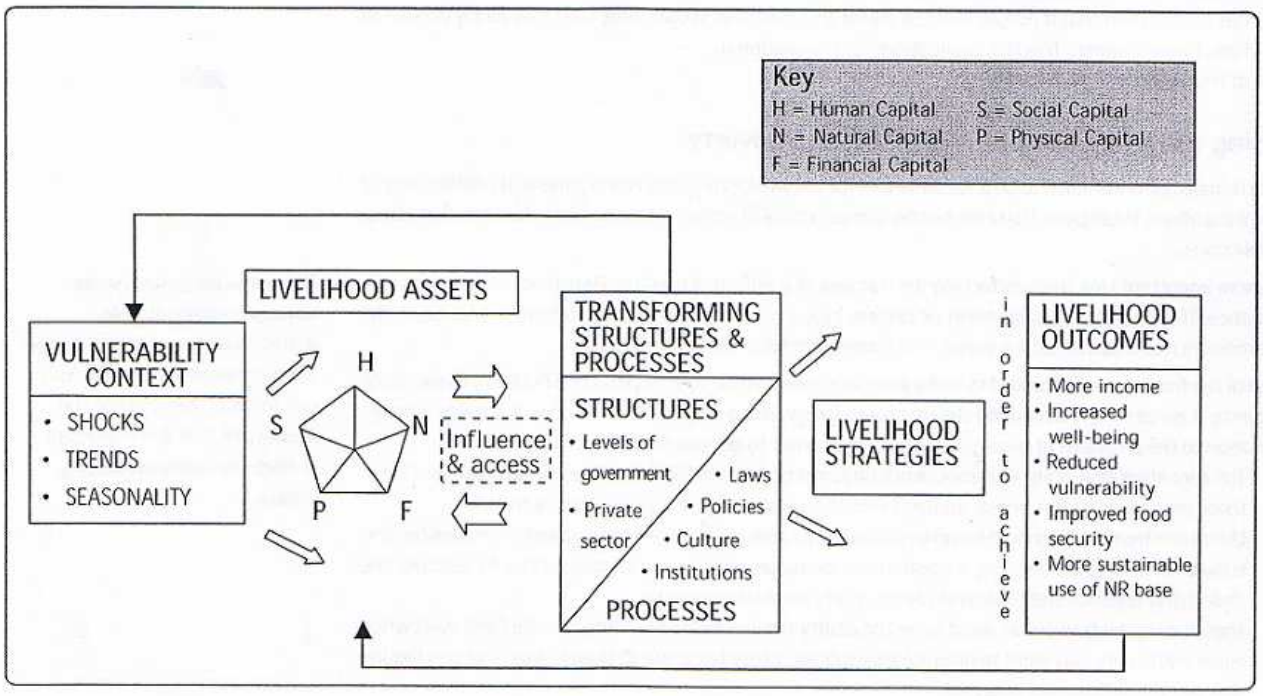
Regarding to soil conservation in all farming systems in the study only paddy rice is showing reasonable tendency to protect the soil against soil erosion, while upland rice and upland rice-cabbage fields are completely exposed to erosion forces, these fields are steep and with their top soil completely lost.

3.5 The livelihood strategies [EJP]

In Ban Kayan's 20 households there are no big differences in the livelihood strategies. All farmers have a subsistence production of rice only for self consumption, and this is the foundation of the livelihood in Ban Kayan. The majority of the households practice subsistence rice production and intensive vegetable farming. But not all farmers have the money or the fields to grow more than rice; this year only two farmers grow upland rice (appendix 3, answer in questionnaire (appendix 1)).

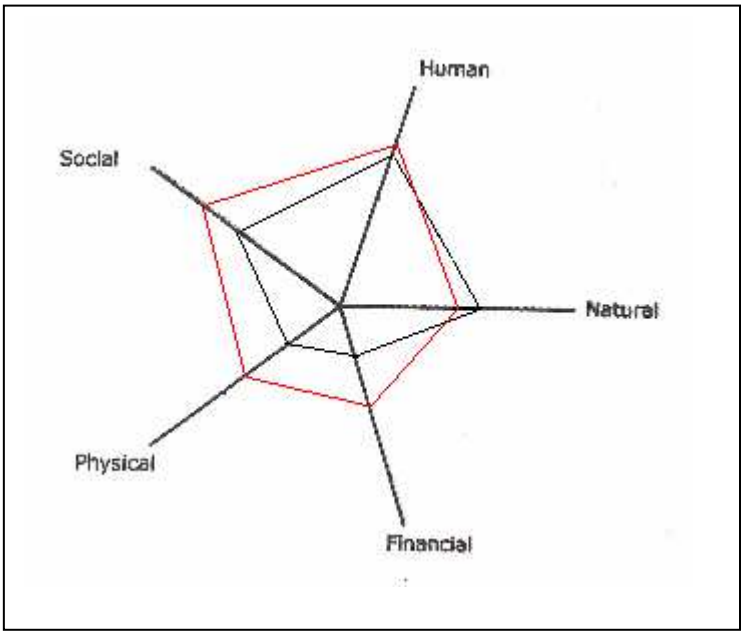
The livelihood strategy of Ban Kayan can be seen through the sustainable livelihood framework (figure 17) developed by the Department for International Development (DIFD) (DIFD 1999).

Figure 17: Sustainable livelihood framework (source: DIFD 1999)



This framework can be used to assess the existing activities role on sustainability of the current livelihood strategy. To do this it's necessary to look at the change over time in DIFD's 5 capitals.
In the analysis by this model the turning point is as well the before and after 1982-84 (box 1) to assess the current livelihood strategy.

Figure 18: The 5 livelihood capitals for Ban Kayan in past (black) and present (red)



As illustrated in figure 18 most of the capitals have increased during the last 20 years. The only capital that has decreased is the natural capital. Before it was easier to access the natural resources and there was no restriction on where to farm and where to make new fields. Now the farmers are not allowed to increase their farm land (appendix 2), and there are more people claiming the right to use the land. According to the village leader (appendix 3) the farmers in Ban Kayan have the amount of land they need. But as well because they are mining parts of the fields the amount of land will not be sufficient in the future. As mentioned earlier the amount of water has decreased, which also effects the current situation in the natural capital.
The reason why the human capital has increased a little is that the new generation of villagers besides getting farming skills and knowledge from their parents also goes to school. An opportunity the old generation did not have.
Since the road came to the village the world opened for the villagers, they then had the chance to reach the market to sell their products. This change led to an increase in the physical as well as the financial capital.
The social network in the village has always been good, but since the RP and the road came the village now has contact to organisations and improved contact to other villages.

There are only a few things the villager themselves sees as not important (box 3) for the way they are living right now. But this also means that the livelihood strategy as it is now is very vulnerable. The most of their livelihood is dependent on the success rate on the production and the prices for the vegetables on the market.
Because of this the villagers are very vulnerable if something happens, whether it is natural shocks, political changes or big epidemics in crops, human or livestock health.

For the villagers in Ban Kayan there is still far until they can achieve a sustainable livelihood strategy. To reach this they need to achieve what DIFD calls livelihood outcomes.

The only point in the DIFD model the villagers has achieved to a certain decree is to get a higher income. This income is still fragile because of the instable prices of the products and the uncertainty not knowing if it is possible to sell the yield.
The four other points they have not managed to achieve. Regarding to the increase in well-being there has been a tendency of the opposite since the villagers started using chemicals.
When looking on the vulnerability the villagers are as mentioned above still very dependent on the natural resources and they do not have any safety net if the entire production once fails. Especially if the rice production fails, the overall food supply will disappear. So by keeping the rice as the main and some times only food, they have not improved their food security.
The final point in DIFD's livelihood outcomes is a more sustainable use of the natural resources. But since the village stopped the rotation system and started cultivating each field every year, the use of the natural resource intensified, and the same is current for other natural resources for example water.

Box 3: Livelihood strategy

Ranking session: 1- Not important
2 - Important
3 - Very important

	Male	Female
Natural capital		
• Trees	2	3
• NTFP	2	3
• Timber	3	3
• Water	3	4
• Field (land)	3	3
• Erosion protection	2	2
• Livestock	2	1[a]
• Wild animals	1	2[b]
Physical capital		
• Road	3	3
• Electricity	2	3
• Water supply – household	3	3
• Water supply – agriculture	2[c]	3
• Farming equipment and tools	3	3
Human capital		
• Knowledge – school (young generation)	3	2[d](>25),3[d](<25)
• Knowledge – experience (old generation)	3	3
• Skills	3	3
• Ability to work/good health	3	3
Financial capital		
• Pension (health care, education fee 1-12 grade)	2	3
• Savings	1[e]	3[f]
• Loans	3	3
• Remittances from family members in the city	-	-
Social capital		
• Neighbour ship	3	3
• Family	3	3
• Labour sharing	3	3
• Contact to other villages	2	3
• Communication with organisations	2	1

[a] Livestock is not important, because the government in periods with bird flue demands that all birds should be killed. There are almost no livestock used in rituals anymore.
[b] The wild animals are important because the forest is important.
[c] The water supply for agriculture is only important, because most of the farming practices is in the rainy season.
[d] A (approximately) 25 year old woman sees school education for her own generation as only important. It is only the new generation for whom education is very important.
[e] Savings are not important, because they don't have any
[f] Savings are very important in the long run, but they don't have so many. It is very difficult to put money aside, but it is important to have some money if something should happen.

4. General conclusion

The changes from subsistence farming to intensive farming, introduced by RP, brought during the past 20 years some modifications to Ban Kayan. Instead of growing only for consumption some of the production is today with the purpose of selling. The villagers are very dependent on this income, since agriculture is the only source of income for all the households. This leaves a big dependence on the natural resources and the use of these.

With the RP fields as exceptions the actual system in general mines the soil for nutrients and each year the yield seems to be less for crops without an extra input of fertilizer. The uses of chemicals, by those who can afford to apply it, have raised some negative impacts on the quality of the water, turning it more saline and polluted. The uses of chemicals, have also originated more invasive and resistant pests and weeds in the fields.

Seen from an economically point of view the RP crops are however not sustainable because the farmers seldom can sell all their outcome. The same happen with cabbage and onions which are not cultivated as RP.
The water, polluted by the chemicals, has become more scarce and leads to problems for themselves as well as conflicts with the lowlanders.

They are very much aware of the degradation of their natural surroundings. They are aware of the loss of forest, biodiversity, poorer soil and water quality, sicknesses and loss of cultural traditions.

The agricultural activity is the only source of income; there is a big dependence on natural resources, such water, land for cultivation and forest products. The forest products include food, construction material and medicine resources. This dependence on forest products have been increasing with the growth of the people living in the village, and it is become notable by scarcity of some forest tree species.

The local villagers are not interested in ruining their nature and their traditional ways of living but they are not interested either in continuing speaking only Karen, never to leave their village and have no material goods from the modern lifestyle.

The answer to our research question:

Are the farming systems practiced in Ban Kayan sustainable livelihood strategies?

Must then be that we do not find the farming systems sustainable and changes need to happen before the systems will be able to continue in a future perspective.

5. Perspective and recommendation

The problems observed reach further out than Ban Kayan. In all the Upper Mae Pae Watershed they seem to cultivate the same vegetables, they have lost forest, biodiversity and water and they have come into debts. I many other parts of the world the same problems are seen as well. Solving problems is never easy but first of all awareness and then knowledge will be the tools. The villagers have awareness but not all the knowledge to see all the impacts in a bigger perspective where they influence each other. Also knowledge of long time effects of the farming system to both nature and their own health seems to be limited.

Economically they will probably need some capital from outside the village. To repay their debts and to make at least some households relying less on farming. To see the cropping systems within the watershed as a whole it could probably be an advantage not to cultivate the same few crops in all the area. Especially cabbage, which attracts many insects to the fields. A more diverse crop choice would both increase biodiversity, health of the system and a better chance to get a reasonable price for their products. Intercropping with legumes could as well help to keep the nutrient status in the soil without adding the same amount of fertilizer. A choice of crop needing only little water (millet, cowpea/lablab as examples) during the dry season would maintain the water level for the joy of both highlanders and lowlanders. But also change in time of irrigation from day to night and use of cover crops (e.g. legumes) or mulch to keep humidity (and nutrient status as well). An important perspective however is to increase the use of fallow to allow the soil to regain nutrients. Both fallow during the dry season, but of more importance break of cultivation for 5-7 years. Fallow periods would also allow new species to inhabit the area, which again would increase the sustainability for of all the system.
Agro forestry could also be a way to combine the cultivation of cash crops with a sustainable use of the area. Coffee plantations in association with shade trees have shown advantages keeping a high level in biodiversity (Wandermeer 2003) and furthermore keep erosion to a minimum as well as harvesting less nutrients each year than annual crops. Also alley cropping with legumes could improve both nutrients level and decrease erosion (Angkasith & Apichatpongchai 2000)

The Royal Project and the TAO are in the area to offer extension, but the first mentioned only consults production according to the Royal Project and the latter seldom comes out in the local area. Another problem is that it does not seem like there is sufficient attention on the problems seeing the watershed as a whole. Supporting the farmers with knowledge on intensive production methods, where methods from their traditional ways of farming and integrated pest management are included, and support to introduce a more diverse production throughout the watershed, would be recommended.

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6. Appendix

Appendix 1: Questionnaire
Appendix 2: Summaries of official interviews
Appendix 3: Interview with Village leader
Appendix 4: Biodiversity interviews
Appendix 5: Farmer interviews (crop production)
Appendix 6: Biodiversity data
Appendix 7: Forest data
Appendix 8: Soil data
Appendix 9: Personal activity calendar
Appendix 10: Synopsis

Appendix 1: Questionnaire

Questionnaires before field trip: □□□□□□□□ □□□□□□□□□□□□□□□
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Subsistent and intensive farming in Ban Na Kayan:its socio-economic and ecological impacts.

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1. □□□□□□□□□□□□□□□□□□□ (Name)..
2. □□□□□□□□□□□□ (address).. ....
3. □□□ (Gender) ( ) □□□ (male) ( ) □□□□□ (female)
   □□□□□ (Age).................................□□
4. □□□□□□□□□□□□□□□□□□□□□□ (How many members in household ?)..................................□□
   □□□□□□□□□□□□□(How many family in the household?) ....
   □□□ (Male)...........□□ □□□□□ (female)...........□□
   □□□□□ □□□□□□□□□ 15 □□(age under 15 years) ....□□
   □□□□□□□□□□ □□□□□ 15-60 □□(Age between 15-60) ....□□
   □□□□□□□□□□□□ 60 □□ □□□□□□□(over 60 years) ....□□
5. □□ □□(How many years have you lived in the village?)..............□□
6. □□□□□□□□□□□□□□□□□□□□□ (Labors in family)
   6.1□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (How many family members work in agriculture?)....................... □□
   6.2□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (Do you employ labors to work in the field?) ………………..
   □□□□□□ □□□□□□ .... □□
   6.3□□□ □□□□□□(Are any of your family members migrated to the city?) .... □□ for work or school ……………………… since when ....
   □□□□□□□□□□□□□□□□□□□□□□□□□□□□□(Do they give you any money from their work?) ....□□□/□□□□□□
7. □□□□□□□□□□□□□□□□□□□□□ (How much of the household income do you get from agriculture?) .... / □□(baht/year)
   □□□□□□□ □□□□□□□□□□□ (Income from) ....
   □□□□□□□□□□□□□(how much?) ....
   □□□□□□□ □□□□□□□□□□□ (Income from) ....
   □□□□□□□□□□□□□(how much?) ....
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   □□□□□□□□□□□□□(how much?) ....
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   □□□□□□□□□□□□□(how much?) ....

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Section 2 Earning benefit from the land

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□□□□□□□□ Number of Fields	□) □□□□□□□□□□□□□ 1. How do you use the field?	□) □□□□□□□□□□□□ (□□□) 2. How many rai (40*40) do you have?	□) □□□□□□□□□□□□□□□□□□□□□□ 3. What is the field use for	□) □□□□□□□□□□□□□□□ (□□□□□□□□□) 4. Which crops do you cultivated?	□) □□□□□□□□□□□□□□□□□□□□□□□□□□□ 5. How do you obtain the land?	□) □□□□□□□□□□□□□□□□□□□□□ (□.□.) 6. Since when have you had the land?	□□□□□
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Notes

1. a) paddy farm b) permanent farm land c) orchard d) rotated farm land e) fallow f)other
3. a) paddy b)mixed crops c) mono crops d) orchard e) agriculture – forest f) livestock g)other
5. a) inherence b) own by themselves c) purchase d) lease e) other
7. a) consume b)consume and selling (how much of each) c) selling
8. a) land license b) NS-3 or NS-3K c) SK-1 d)STK e) SPK f) do not have

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Section 3 Production in the households

1. □□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

crop grew in the past Purpose of Planting Reason for planting Reason for stop planting

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-type of fertilizer -proportion between organic/chemical.					
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Livestock in the past Purpose for rearing Reason to choosing
Reason for stop rearing
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5. □□□□□□□□□□□□□□□□□□□□□□□□□□□□(Livestock in the present)

□□□□ Types	□□□□□□□□□□□□□□□□ how do you rear livestock	□□□□□□□□□□□□□□□□ □□□□□□□□ Purpose of rearing □□□□□□/ □□□□ / □□□□□□ / □□□□□□□□ (□□□) Consume/trade/ labor /ritual	□□□□□□□□□□□□□ □□□□□□ Food source of livestock (□□□□□□□□□□□□/ □□□□) Nature/ buying

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Section 4 Community economic system

1. □□□□□□□□□□□□□□□□□□□□□□□□□ 1.the amount in the household

1.1 □□□□□□□□ (saving money) ( ) □□□□□ (No) ( ) □□ (Yes)

1.2 □□□□□□□□□□□□□□ (valuable things) ( )□□□□□ (No) ( ) □□ (Yes)

2. □□□□□□□□□□□□□□□□□□□□□ (debt of household) ( ) □□□□□ (No) ( ) □□ (Yes)

3. □□□□□□□□□□□□□□□□□□□□□□□□□□□.......................................□□□ □□□ □□ □□□□□□□□ expense in household________baht

3.1 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ expense in agriculture

1) □□□□□□□□□□ □□□□□ □□□□□□ (breed, fertilizer, chemicals) ....□□□ □□□□□□

2) □□□□□□□□□□□□□□□□(labor) ....□□□ □□□□□□

3) □□□□□□□□□□□□□□□□ (transportation) ....□□□ □□□□□□

4) □□□□□□ (other).. .... □□□ □□□□□□

5) □□□□□□ (other).. .... □□□ □□□□□□

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expense in household ___________baht/day __________baht/month ________baht/year

4. □□ (In your household, have you ever thought of reducing the expense, increasing income and reducing debt?)

( ) 1. □□□□□ (No) ( ) 2. □□ (Yes) □□□□□□□□□□□□□□□ (By)..

Quistionnaries during field trip:

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Subsistent and intensive farming in Ban Na Kayan:its socio-economic and ecological impacts.

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7. □□□□□□□□□□□□□□□□□□ (Name)...

8. □□□□□□□□□□□
(address)...
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9. □□□ (Gender) ( ) □□□ (male) ( ) □□□□ (female)
□□□□ (Age)...................................□□

10. □□□□□□□□□□□□□□□□□□□□□ (How many members in household ?)...................................□□
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11. □□□(How many years have you lived in the village?)..............□□

12. □□□□□□□□□□□□□□□□□□□ (Labors in family)
6.4□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (How many family members work in agriculture?)....................... □□
6.5□□□□□□□□□□□□□□□□□□□□□□□□□□ (Do you employ labors to work in the field?) ………………..
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6.6□□(Are any of your family members migrated to the city?)
.... □□ for work or school ……………………… since when
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□□□□□□□□□□□□□□□□□□□□□□□□□(Do they give you any money from their work?)
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13. □□□□□□□□□□□□□□□□□□ (How much of the household income do you get from agriculture?) .... /
□□(baht/year)
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Section 2 Earning benefit from the land

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□□□□□□□□ Number of Fields	□) □□□□□□□□□□□□□ 1. How do you use the field?	□) □□□□□□□□□□□□ (□□□) 2. How many rai (40*40) do you have?	□) □□□□□□□□□□□□□□□ (□□□□□□□□□) 4. Which crops do you cultivated?	□) □□□□□□□□□□□□□□□□□□□□□□□□□□□□ 5. How do you obtain the land?	□) □□□□□□□□□□□□□□□□□□□□□□□□ (□.□.) 6. Since when have you had the land?	□) □□□□□□□□□□□□□□□□□□ 8. Do you have any land license?
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2).

Notes

2. a) paddy farm b) permanent farm land c) orchard d) rotated farm land e) fallow f)other

3. a) paddy b)mixed crops c) mono crops d) orchard e) agriculture – forest f) livestock g)other

5. a) inherence b) own by themselves c) purchase d) lease e) other

7. a) consume b)consume and selling (how much of each) c) selling

8. a) land license b) NS-3 or NS-3K c) SK-1 d)STK e) SPK f) do not have

3

Section 3 Production in the households

1. □□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□
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crop grew in the past Purpose of Planting Reason for planting
Reason for stop planting

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Livestock in the past Purpose for rearing Reason to choosing
Reason for stop rearing

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5. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□(Livestock in the present)

□□□□ Types	□□□□□□□□□□□□□□□□□□ how do you rear livestock	□□□□□□□□□□□□□□□□□□□□□□□□□□ Purpose of rearing □□□□□□□/ □□□ / □□□□□□□ / □□□□□□□□□ (□□□) Consume/trade/ labor /ritual	□□□□□□□□□□□□□□□□□□□□□□ Food source of livestock (□□□□□□□□□□□□□/ □□□□□) Nature/ buying

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Section 4 Community economic system

1. □□□□□□□□□□□□□□□□□□□□□□□□□ 1.the amount in the household
 1.1 □□□□□□□□□ (saving money) ( ) □□□□□□ (No)
 ( ) □□ (Yes)
 1.2 □□□□□□□□□□□□□□□ (valuable things) ( )□□□□□□ (No)
 ( ) □□ (Yes)

2. □□□□□□□□□□□□□□□□□□□□□□ (debt of household) ( ) □□□□□□ (No)
 ( ) □□ (Yes)

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expense in household________baht
 3.1 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ expense in agriculture
 1) □□□□□□□□□□□ □□□□□ □□□□□□ (breed, fertilizer, chemicals)
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expense in household ____________baht/day ___________baht/month _________baht/year

4. □□□□□□□□□□□□□□□□□□□ □□ (In your household, have you ever thought of reducing the expense, increasing income and reducing debt?)

( ) 1. □□□□□□ (No) ( ) 2. □□ (Yes)

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Appendix 2: Summaries of Official interview

Main points from the different official interviews, that's most important for this report.

Agriculture extension interview (Friday 9/3 2007);

The main problems related to agriculture:

6) Lack of knowledge
7) Lack of water in the dry season
8) The prices of products is not stabile
9) The factors (fertilizer, pesticides) is more expensive because of the transportation costs. This results in a smaller profit.
10) Lack of communication with the local people

The farmers are not allowed to increase their field area

There is harmony between the upstream and downstream communities in the use of water.

Changes in biodiversity and wild life:

- Soil gets worse
- Support organic fertilizer EM. Wants to make the soil quality better.
- No difference in the weeds

TAO interview (Friday 9/3 2007);

TAO support in setting up the storage for yield (Red onion) for the farmers to wait until the price of the products is high because of the lower prices faced last year

All the TAOs village representatives meet regularly to discuss their problems related to the budget and other problems (conflicts between the upland and down land villages related to the use of natural resources: water)

Annnual budget for sub-districts: 13-15 million baths: coming from collected taxes, where 20 000 Baths for each high land village
Taxes are collected by TAO

Is there any problem related to farming?
Waste water impact in low land: the TAO is trying to increase the awareness about the excessive use of fertilizers using campaign

No problem with immigration any more – there was 2-3 years ago. The young people goes into town but they come back.

There is not enough water. The quantity is the same, but the population is growing. In the future the TAO will build water reservoir

TAO can not do anything about the low prices, but they can help with improving the farmers yield with more organic crops. Offers at the same time better fertilizer.

TAO just support people to improve their livelihood strategy and TAO can help in negotiating the use of forest.

This year the price of cabbage and onion is ok. Problem with the price on longan this year

TAO can not influence to much on the farming system because they started later (10 years ago) than the RP (started 20 years)
The RP is god. But if they move their work out of the area, they should establish a system so the farmers can keep on carrying out the sustainable farming practices.
RP is a good benefit for the people.

CARE interview (15/3 2007);

Lack of water in the lowland area in dry season is normally being blamed on water use by highland people and cause lowlanders to block the road so highland people cant sell their products on the market.
But its not only the fault of highland people. Other factors such as weather phenomena (el nino) and a increasing demand of water in lowland caused by water intensive cultivation fruit trees also play a role.

The major problem in this area is the lack of water and the resulting conflicts about access to the resource. The respondent identifies 3 reasons for this:

1. Deforestation
2. Fruit plantations (for example Longan, which drinks a lot of water)
3. and larger water phenomena like El Nino.

How does the activity CARE effect the lively hood of people?
They take part in the demarcation of land use areas, thereby reducing forest encroachment in the area.

The ideas of border drawing come from the government, the villagers then discuss and agree about their suggestions for borders and present these ideas for officials. If they reach agreement its fine if not the The National Park Officer is consulted and will have the final say in the matter

When does the land demarcation process *end?*
In this area they will finish within a month. After that IMPECT will use the GPS position to draw borders on a map where after there will be village meeting and discussion.

How is the LD process and when is it supposed to end?
A three-thrust rocket:

1. Record forest area with GPS. In the process they must have a local hearing. All villagers are invited to these meetings, but only the users negotiated about the final demarcation in the field.
2. Impect and the watershed unit will mark the boundary on a map. They are supposed to be finished with the process in the end of this month. After that, Impect will make a “final” map of the negotiation result.
3. Meeting between stakeholders to establish common property documents, which vest the land rights in the village = no individual tenure (this part of the process is still unsure…)

Different Royal Project interviews (10-15/3 2007);

In Mae Pae - The project was established in February 2526.

What were the objectives?

1. Improve the quality of life of the hill tribes.
2. Decrease the opium cultivation and replacing it by other cash-crop
3. To conserve the natural resource

A contract is made between a farmer and the RP. There is two way:

1.
   a. Farmer plants crops.
   b. They return it to the RP
   c. They got a garanteed price
2.
   a. The RP gives to the farmers all agricultural inputs needed (seed etc..)
   b. The farmer can sell elsewhere, but has to ask to RP first.
   c. There is a garanteed price (but the lowest), and the price of the input are deducted from the sale to the RP

The RP is seen as a role model project, know internationally for it success to replace opium by other cash crop.

the villagers it's difficult to evaluate it because if they are not happy, they are not participating in the project. But there are a lot of indirect advantages to the RP. Electricity, better road, cell phone tower

The NP still allow villagers to have agricultural land in the park, but no extension is allowed.

It is not difficult to get farmers to join the project.

When the PR officers decide whether a farmer can be accepted to join the RP they have certain criteria: The farmer must accept the price and quality of the products.

The RP also decide how much of which crops they will buy from the farmer. This depends on the farmers skills ie. an old and skilled farmer will be allowed to grow more products compared to a new farmer. The PR also considers the amount of land the farmer owns and the access to water (reservoir, irrigation).
The RP calculate how many seeds/seedlings, how much fertilizer and pesticites they will give him. They also tell him when to plant and when to add the fertilizer and pesticites. If for one year there is no need for pesticides they RP will take the pesticides they gave out. The RP predicts which and how much fertilizer is needed for one cropping season and go to the field later to check.

The RP supplies the farmer with fertilizer, pesticides, seedlings and plastic to cover the field if necessary. The farmer will pay for this when he receives his payment from the RP. The price the farmers receive from the RP is the market price/fixed price reduced by 25% which covers the transportation and other marketing costs.
The RP also supplies the farmer with advice which is free.
The RP decides when the farmer can sell his products to them.

The main problem for the farmer is the market price, everything else is under control.

Reasons for farmers to join the RP

1) certain markets

2) reduction of the risks of low prices
3) Support by the RP officers
4) Reduction of the cost of transportation
5) Selection of chemical fertilizer and pesticides

Before vegetables are harvested, the RP randomly checks some farms for appropriate chemical input levels (every farmer must be approved).Vegetables are classified at RP office according to quality.

Appendix 3: Village leader interview

7/3, 2007. Interview held in the house of respondent.
Interview with village-leader

I: How did you become the village leader?
R: I was elected by the village in 1996.

I: Is a school in the village?
R: There is a primary school in Ban Bo Na. The secondary school is in another village.

I: Is it a boarding school?
R: No, the kids come home every day.

I: Which different farming systems do you have in Ban Kayan?
R: All farmers have both rice and vegetables. The main vegetables are cabbage, red onion and taro. But this year no taro is sold because of a very low market price. The taro remains in the field. The highest price for cabbage is in the rainy season. Last year the price varied between 10 to 1 bath. This year it is between 7 to 1 bath because of so much cabbage on the market.

I: How many farmers are enrolled by the Royal Project?
R: More or less 30%. 7 households. Mostly they grow herbs. This year noone grows cabbage for the Royal Project.

I: Are the farmers satisfied with the Royal Project?
R: They get more money with the Royal Project so it has changed their lives positively.

I: Do the crops sold to the Royal Project have to be organic?
R: All herbs are produced by organic methods. No fertilizer or pesticides are used. Only compost is used as fertilizer. Before the Royal Project will buy the herbs they will check the products for chemical contents.

I: How is the process if the farmers want more land?
R: Many farmers want more fields to grow more vegetables. But right now they have enough to live. It is important to make a line between the forest and the farmland, because people have enough land as it is now.

I: Can you explain about the local comitee meeting you had this day?
R: It is a cooperation between many NGO's in the area. Some of them help hill-tribe people, National park, Royal Project, watershed organization and village cometees from 15 villages. Together we will point out a village boundary for max. expansion of villages. This project will be an on-going process. It was initiated by the National Park many years ago. They tried to get support from other organizations.
The comitee will discuss if a case happens and a farmer need to get more land.

I: What are the changes in farmland and forest during the past years?
R: Compared with the past the farmland has gone down. 20 years ago there was much less forest. The farmland has declined with about 2/3.

I: Is this village included in the National Park area?
R: No

I: How is the irrigation water situation?
R: All households have to lead the water to the rice-fields. All water is used twice. Rice is the most important. First the water is used in the paddy fields and then for the vegetables.

I: Can you list all the different crops grown in Ban Kayan?

R: Rice (paddy and upland), cabbage, red onion, chili, rosemary, thyme, chamomile, jackfruit, litchi, tamarind, mango, watermelon, pumpkin, beans, maize, taro, eggplant and different ornamentals.
Corn and fruits are mainly grown for the villagers themselves. Most of these crops are grown in the rainy season as well as the upland rice.

I: What are the rules for collection of firewoods?
R: You can collect everywhere in the forest but only small and already dry pieces. It is an old tradition. Two specific species of trees are not used because of cultural reasons.

I: Where did the people in this village come from?
R: This village is about 50 years old. Lu people, an ethnic hill-tribe lived here first. More or less 100 years ago. After then the Karen people came and the first person here had the name Kayan.

I: Which problems do you have related to farming?
R: We have 4 main constrains. Not enough water, a very low price of the products, the transportation is not convenient and fertilizer and pesticides are very expensive. And without those inputs the yield will be very low.

I: Do you use fertilizer for the cabbage production?
R: Yes, we do. An N-P-K with the content 16-20-0. We apply at sowing-time and then again after 20 days.

I: How is the forest management according to firewood and construction material?
R: The villagers have to inform the village leader before cutting any forest.

I: What is evolution of the village?
R: It has grown from 10 to 22 households within the last 20 years.

I: What do the farmers do when the production is very low?
R: It is a problem of the very low price of cabbage but usually the situation is not so bad that the farmers have to do other things.

I: Are pesticides used for cabbage and red onion?
R: Yes, for both. The weeds are burned in the upland rice fields to prepare the land.

I: Which chemicals are used for rice production?
R: For paddy fields only fertilizer is used. First 16-20-0 and next 46-0-0. For upland rice chemicals from cabbage still remain in field so not more is applied.

I: What are the reasons for the decrease in farmland?
R: Intensive farming was introduced by the Royal Project and even though much more people have come to the village the farmland has not increased because of that. But the farmers need to use more fertilizer each year because the soil fertility gets lower each year.

I: How is the straw used after harvest?
R: Straw is used for cattle and as compos-fertilizer.

Appendix 4: Biodiversity interview

Biodiversity 1

8/3-2007

Interview: Changes in Biodiversity.

Respondent: Young farmer (Y) (about 40 years) and additional comments from old farmer (O) (about 70 years)

I: What is your role in the village?
R: I am in the committee of Ban Kayan. We are 20 people. And I am a farmer.

I: What is nature for you?
RY: Nature is beautiful. I am happy when I am in the nature. It gives many benefits. Food and money.
RO: I have lived with nature for a long time. I like the birds and the threes. I am happy with the nature.

I: What do you use from nature?
RY: Wood from the forest to build houses. Look at the birds and eat them too. The plants are used for medicine and for food.
RO: In the past we used to hunt deer and wild pig. And a small kind of deer (barking deer), which is not there anymore. The forest officer tries to preserve the forest now.
We still se some animals but not wild pigs or deer.

I: What is the most and the least important?
R: Wood is the most important and herbs the least.

I: Have you experienced any changes in the surroundings during your life here?
RY: In the past each family grew only rice and vegetables for themselves. Now they also sell to the market.
RO: Before the families moved their houses each year. I do not know why. They could open many fields. There was no road before. People from outside could not come to the village. All was forest in the past and only a little crops on the slope land.
RY: When I was young there were still no road and there was much more forest. We had to walk through the forest to Chom Thong when we were sick. The road came only 20 years ago.

I: Do you remember a period with less forest than now?
RY: No.

I: Has the river changed?
R: There is less water than in the past. In the forest area there was a creek before. It is not anymore. We had more water in the village before.
The smell and appearance of the water is the same.

I: Is the water for irrigation and for household the same?
R: No, it is not the same.

I: Have the plants and animals around the river changed?
R: The plants near the river are the same as before but there are more plants now. The insects are the same.
There are fewer fish in the river but they are still the same size. We still eat them.

I: Have you experienced changes in wildlife?
R: There is less wildlife than before. It started to decrease in mammals and birds about 10 years ago. Butterflies are the same. There are more insects in the crops now and sometimes new species. In the past we had no problems with insects and we used no chemicals in the

past. We started to use the chemicals when the Royal Project started to support us. Now the Royal Project has reduced the use of them but we have a lot of problems in our fields. In the past we had no insects in our paddy rice fields but when we started with the Royal Project vegetables the insects came to the rice as well.
The insects live in the surface of soil and when it rains or we sprinkle they start to eat the vegetables.
Before we did not grow cabbage and onion, but we grew for example this (shows a coriander plant). We also cultivated shallot onion, lettuce, pumpkin, spring bitter cucumber and green peas.

I: Have you experienced any changes in wild flowers and weeds?
R: We had a lot of these red trees before (points at a coral tree). There are not very many anymore. We also have less orchids than before. No new plants have come.
Some of the weeds are more than in the past. Maybe they come together with seeds we buy from the market. With our own seeds the problem is not as big.

I: Are you satisfied with the changes which have happened? What is better/worse than before?

R: There should be more forest. I am not very satisfied with the soil. There are much less nutrients than were there before. We need to add a lot of fertilizer. For that we also need more manure.
But after the Royal Project a lot is much better. We got support to plant crops we can sell. We were only subsistence farmers before. Now we also have a road and a hospital.

I: Do you have any additional indicators which are not mentioned?
R: In the past we could use a small plant to make baskets. Those baskets we used in the house. Now traditions have changed and we do not use it anymore.

Biodiversity 2
8/3-07
Interview: Changes in Biodiversity
Respondents: Value of nature by young farmer (about 25 years) and changes during time by old farmer (about 70 years)

I: What are your roles in the village?
R: Farmers

I: What is nature for you?
R: Nature gives lots of benefits. Food, wood for the houses, shadow, bird voices, watching wild animals in the forest, happiness.

I: What do you use from nature?
R: We cut trees for houses and collect firewood. We use the water for irrigation and to catch fish for food. Collection of medicinal herbs against cough (Emblic leaf flower).

I: What is most/least important for you?
R: Most important is land to grow rice and I do not know the least.

I: Have you experienced any changes in the surroundings during your life here?
R: Forest and agriculture is the same.

I: Has the river changed?

R: There is less water now. It has happened within the last few years. Trees in the forest grow big and use the water therefore there is less water in the river. If you cut the trees there will come more water.
Colour and smell of the water is the same as before.
A few years ago there was a land collapse. A lot of erosion from the upland rice fields. It was caused by a big flood in the rainy season. And since then we had less water in the river.

I: Have you experienced changes in wildlife?
R: There are less of the small deer, birds and many other animals now than in the past. We still see deer. Before we had tigers but not anymore. Last time I saw a tiger was in 1982. I remember because I married that year. The tiger came to at a cow and we ended up trapping the tiger.
We have fewer big trees. Less forest because agriculture has expand to a much bigger area. But it happened before the Royal Project.

I: Have the insects changed?
R: The last 2-3 years we have had a lot of insects. I think they come with the seeds we buy from the market. When I was young and we only grew rice there were never any insects. But now we need a lot of chemicals.

I: What about butterflies in the fields?
R: I did not observe it before so I can not tell any changes. But I think when there are many flowers a lot of butterflies will come.

I: Have you experienced any changes in plants and weeds?
R: Much less trees than before because people cut them to build houses. The red tree (coral tree) is seen less than before as well. We do not see any new species.
There are many different weeds. In the past there were only few weeds in the fields and we ate them with rice. Now there are very many and they spread very fast. This weed (Chromolaena) came after 1981. After opium. When we cultivated opium we had no problems with insects and weeds and we did not use any chemicals. The weeds spread very fast by their seeds. We plant pigweed and gongai in upland rice now. They used to grow by themselves but not anymore. We keep the seeds and plant them because they are important for good rice harvest. Pigweed is planted to sacrifice for a good yield and it looks beautiful in the field. Gongai is used to dry the rice after harvest. Both plants are planted together with upland rice.

I: Are you satisfied with the changes which have happened?
R: It is ok. Time passes and things change. But some day everything will go back and be as before.

I: What is better/worse than before?
R: In the past we had a good life by ourselves. No weeds and no insects. But now we get money.

I: Do you have any additional indicators which are not mentioned?
R: Costumes of dress and marriage have change. And the quality of the soil has gone much worse than before.

<u>Biodiversity 3</u>
11/3-07
Interview: Changes in Biodiversity
Respondent: Old woman (about 70 years)

I: Were you born here in this village?

R: Yes

I: What is nature for you?
R: Everything around here is nature. Timber to build houses, waterfall.

I: What do you use from nature?
R: We get colour from the bark of trees and we use it to dye the thread, which we use to make clothes from. Wood for houses and firewood. Nature gives food, a lot of vegetables and herbs from the forest. In the past people collected more herbs, now they grow more themselves. We get fish from the creek. In the past I ate birds but not anymore since they are gone. Before we also ate a local bug but not anymore.

I: What is most important for you?
R: Food from the forest. Bananas, ferns, vegetables.

I: Have you experienced any changes in the surroundings during your life here?
R: In the past when there were few people we had a lot of forest. But when the number of people increase the forest area decreases.

I: Has the river changed?
R: There was much more water in the river in the past. Also now in the dry season and both in the forest and in the village. Today we have only very little water.

I: Have you experienced changes in wildlife?
R: I saw deer before. Not anymore. And the birds and bugs for eating have gone.

I: Have you experienced any changes in plants and weeds?
R: We had a local lettuce before and soybeans, taro, sweet potatoes and peanuts. We cultivated all of it in the fields for subsistence only. We still cultivate those things.
In general a lot of wild flowers are missing. Liku (grew around the stream), a type of fern and many orchids are missing now. We do not see new species.

I: Are you satisfied with the changes which have happened?
R: I am very sad with the changes. I miss a lot the trees, animals, flowers and animals in the stream.
I: What is better/worse than before?

Biodiversity 4
14/3-07
Interview: Changes in Biodiversity
Respondent: Young woman (about 40 years). Did weaving while talking.

I: Were you born in this village?
R: Yes. I am 39 years old.

I: What is nature for you?
R: I can get colours from the trees to make my clothes. I am very happy to live among nature. The stream, fields, shadow, the weather is nice. It is much better than living in the city.

I: What do you use from nature?
R: Food. It is very important. Fruits, wild bananas, mushrooms, a lot of vegetables natural in the rainy season. We can go fishing in the stream and eat fish with the family. The gum I chew is from a tree. There are two kinds where one is softer than the other. The betel nut from the betel palm we have to buy in the city. The majority of woman chew betel bark. It gives you a red mouth. Woman have done that for a long time. It is a tradition from the ancestors.

Men could smoke tobacco while woman chew betel. People believe it makes the teeth strong and before when they had no toothbrush they could chew betel instead.
The cotton tree in the forest and the colours are also important for making our clothes. The red ornamental in the garden can be boiled to give the red colour and yellow colour we an get from turmeric. In the past we had only black, red and yellow colours. Now we buy most of the thread at the market.

I: What is the most important for you?
R: Everything from the forest. We can make food and desserts.

I: Have you experienced any changes in the surroundings during your life here?
R: In the past there were a lot of trees and water and everything was very fertile. Now there are much less of all of that. It is because of all the people now. When I was born there were only 10 households in this village.
There is not enough water because it is used in the agriculture.
The water was cleaner in the past. I think it has changed because a lot people do agriculture and use chemicals. I can see it with my eyes and sometimes I can feel that my skin become itchy after I shower. I can just feel that is different than in the past.
It is warmer than in the past. Before there were no fire in the forest. Now we have to make fire belts but we have fires anyway.

I: Has the river changed?
R: The stream was bigger before.

I: Have you experienced changes in wildlife?
Answered by a young man (the local translator)
R: There were many insects before. Some were benefits for the plants like bees. Many insects have gone now because of the chemicals. Many birds could have eaten the worms in the cabbage but the birds have gone as well. We still have some small birds, but they like to eat dew in the morning.

I: Have you experienced any changes in wild flowers and weeds?
R: The vegetables are the same and in the rainy season there are a lot. We keep the seeds in the dry season and plant them in rainy season. In the past the trees were very big but now they are small.

I: Are you satisfied with the changes which have happened?
R: I do not like the nature has gone but I have accept the changes. The time goes.

I: What is better/worse than before?
R: In the past we had good lives and lived only with ourselves. We got everything from the forest. But now the life in the past is not good for us. The lifestyle has changed. Now we have the road, school and hospital. It would not be good to live as before now.

I: How has the Royal Project influenced your life?
R: Before we had a lot of problems with opium addicts and thieves. It is better now when the Royal Project offers them occupation. But now the problem is alcohol.

I: Do you have any additional indicators which are not mentioned?

Appendix 5: Farmers interview (biodiversity)

Farmer 1
8/3-2007, Interview held in the field.
Interview with farmer (about 70 years old).

I: Which crops do you cultivate?
R: Herbs, chili, pines for flower decoration, cabbage, red onion, flowers for decoration. In the rainy season I grow upland rice and paddy rice.

I: Do you cultivate the same each year?
R: Yes, the same every year.

I: Why do you choose as you do?
R: The cabbage I decided myself but all the other crops was encouraged by the Royal Project. They give a lot of money. Herbs gives 30 bath/kg and chamomile 60 bath/kg. Pine and Juca (ornamental) give 3-5 bath per branch.

I: Do you use fertilizer in your fields?
R: For the Royal Project fields only manure. The Land Use Management officers tell us we have to use manure on all our fields. For cabbage I use 16-0-0 and after 20 days 13-13-21. For paddy rice I use 16-0-0 and manure. The pines and flowers are organic grown.

I: What kind of weed management do you practice in your fields?
R: For the Royal Project weeds are removed by hand.
For upland rice the weeds are collected and burned as a land preparation before sowing. After that the rice seeds are sown in small holes, covered by soil and herbicides are sprayed. Only one time.
For paddy rice weeds are removed by hand.

I: Is it a problem that you can not use herbicides in the organic production?
R: We have to pull out weeds every day.

I: If cabbage has to be sold to the Royal Project does it also have to be organic?
R: Yes, it has to be organic. But we do not sell cabbage often to the Royal Project

I: Do you find pests a problem in your fields?
R: Pests are a big problem in the cabbage fields and also rice. Worms and insects (bon). We apply insecticides in all fields. Pests are not a problem in the Royal Project fields.

I: Have you experienced any sickness using chemicals?
R: Yes, headache, cough, itching, dizzy. When that happens we have a break and then spray again. These symptoms only happens when we spray. Sometimes we use a mask and the problems are less, but often we do not have a mask. We have to buy it far away and we do not always know where to buy it.
It is the same chemical used for both weeds and insects.

I: In which ways has the Royal Project and intensive farming changed your work and life?
R: It has improved our lives. We have got a lot of money for the herbs but not so much for cabbage. We get better money for selling the cabbage ourselves when produced with the chemicals than without chemicals produced for the Royal Project.
Bias:
Another farmer joined the interview and they were not always so concentrated. They were eager to discuss and tell stories, though.
Both were old farmers. Main interviewee was the old man with the banana-leaf cigar… and additional farmer was old farmer who went with us on the forest walk and who only has the upland rice fields…

Farmer 2
8/3-2007,
Crop production. Interview held in the field.
Interview with farmer (about 40 years old).

I: Which crops do you cultivate?
R: Cabbage, red onion and ornamentals. I also have a paddy field but no upland rice.

I: Do you cultivate the same each year?
R: Yes. I have only grown cabbage and red onion for three years and for ornamentals it is my first year. I have had no harvest yet of the ornamentals. I used to grow upland rice on the fields. The ornamentals I sell to the Royal Project.
I change the type of cabbage each year but rice and red onion are the same.

I: Do you buy seeds for your crops?
R: I use my own seeds for rice. I plant the seeds in a nursery and plant the seedling after 1 month. I buy seeds from the market in Chom Thong district for the cabbage and onion. Also cabbage and red onion are sown by seedlings.
The ornamentals I buy as small plants. 25 bath for one and it can give many branches sold individually.

I: Why do you choose as you do?
R: I know well have to cultivate the cabbage and red onion. I have learned it from my father and mother. And I grow the ornamentals because of support from the Royal Project.
The Royal Project first supported us to grow the cabbage but do they also support to cultivate other crops.

I: Do you get any extension to learn how to cultivate the crops?
R: Yes, people from the market will teach us.

I: Do you use fertilizer and pesticides in your fields?
R: For cabbage and red onion I use herbicides and insecticides. I also use chemical fertilizer but no manure. For paddy rice and ornamentals I use all.
The use of insecticides depends on the season. It is used when there are many insects.
I also do hand weeding.

I: Have you experienced any sickness using chemicals?
R: I feel dizzy sometimes. When the chemicals are very strong I use a mask.

I: In which ways have the Royal Project and intensive farming changed your work and life?
R: More money. But the prices for cabbage and red onion are medium.

Appendix 6: Biodiversity data

1) Sediment residues of insecticides in Kayan Stream

					Guideline note	**Guideline note**
Residue samples	**Organoposphate**	**ppm**	**Carpamate**	**ppm**	**PEL-TWA** Permissible Exposure Limits/*Time-Weighted Average **(ppm)**	**TVL-TWA** Threshold Limit Value/*Time-Weighted Average **(ppm)**
Inlet of Ban Kayan	*Mevinphos*	0.007			0.011	0.011
	Chlorpyrifos	0.025			0.05	0.05
	Malathion	0.015			1	0.74
			Methomyl	Trace	0.375	0.375
			Phosalone	Trace	0.05	0.05
			Cabofuran	**0.035**	0.011	0.011
Middle of Ban Kayan	*Mevinphos*	**0.046**			0.011	0.011
	Mevinphos	**0.058**			0.011	0.011
	Malathion	0.056			1	0.74
	Chlorpyrifos	0.035			0.05	0.05
			Phosalone	Trace	0.05	0.05
			Methomyl	Trace	0.375	0.375
			Cabofuran	**0.035**	0.011	0.011
			Cabofuran	**0.048**	0.011	0.011
Outlet of Ban Kayan	*Chlorpyrifos*	0.038			0.05	0.05
	Malathion	0.035			1	0.74
			Phosalone	0.015	0.05	0.05
			Methomyl	Trace	0.375	0.375

*based on an 8-hour time weighted average (TWA) exposure.

Note : 1) Organophosphate is the synthetic organic insecticide *: Acephate,Chlorpyrifos,Chlorpyrifos-methyl,Diazinon,Dichlorvos,Dimethate,EPN,Fenitrothion, Malathtion,Methamidophos,Mevinphos,Methyl parathion, Monocrotophos,Pirimiphos, Pirimiphos methyl,Phorate,Phosalone,Prothiophos,Profenofos,Trizophos*

Organophosphate were found 3 sub compounds *: Mevinphos, Chlorpyrifos, Malathion*

2) Carbamate is the ester of carbamic acid for compounding the insecticide: *Carbary, Carbofurun, Carbosulfan, Methomyl,Isoprocarb,Pirimicarb, Fenobucarb*

Carbamate were found 3 sub compounds as follow *Cabofuran, Phosalone, Methomyl*

2) **Water pollution index by indicator animals**

Animal	**score**	**Inlet (morning)**	**Middle point (midday)**	**Outlet (afternoon)**
Stonefly nymphs	10		X	X
Flattened mayfly nymphs	10			
Prong-gilled mayfly nymphs	10			
Spiny crawling mayfly nymphs	10			
Caddisfly larvae with sand/gravel cases	10	X		X
Caseless caddisfly larvae	10			
Long-mouthed saucer bugs	10	X		
Dobsonfly larvae	9			
River prawns	8			X
Caddisfly larvae with cases made from leaf	7			
Dragonfly nymphs	6	2x	2x	2x
Damselfly nymphs	6			X
Freshwater limpets	6			
Swan mussels	6			
Pagoda mussels	6			
Lesser water boatman	5	X		X
Greater water boatman	5			
Other water bugs	5	X	2x	X
Adult beetles	5	3x	X	X
Beetle larvae	5			
Flatworms	5			
Other fly larvae	5		X	X
Common net-spinner larvae	5	X		
Swimming mayfly nymphs	5		X	X
Square-gilled mayfly nymphs	4	X		
Freshwater shrimps	4			X
Alderfly larvae	4			
Other snails	3	X		
Pea cockles	3			
Water hoglouse	3			
River crabs	3			
Leeches	3		X	X
Rat-tailed maggots	3			
Non-biting maggots	2			
Segmented worm	1			
Total score		83	50	69

Number of animal		13	9	12
Water quality index		**6,38**	**5,5**	**5,75**
Result		Rather clean water-clean water	Rather clean water	Rather clean water

Water Index Score:
7,6-10 very clean water
5,1 – 7,5 rather clean – clean water
2,6 – 5,0 rather dirty – average
1,0 – 2,5 dirty water
0 very dirty water- no life

Kanjanavanit, O. and Tilling, S. 2002. *Identification guide to stream invertebrates - A guide to freshwater invertebrates of ponds and streams in Thailand.*
printed by amarin printing and publishing public company limited
funded by Danish co-operation for environment and development (danced)

List of species observed in Kayan River

Animal	*Indication	Inlet	Middle point	Outlet
Cased caddisfly larvae	A			X
Long headed caddisfly larvae	A	X		
Common stonefly	A	X	X	
Burrowing mayfly A	A	X		
Saucer bug	A-B			X
Common dragonfly nymph	B	X	X	X
Stocky dragonfly nymph	B	X	X	X
Common damselfly nymph	B	X		
Freshwater prawn	B	X		
Pondskater	C	X	X	X
Square gilled mayfly nymph	C			X
Swimming mayfly nymph	C	X	X	
Leech	C	X	X	
Pond snail	C			X
Freshwater shrimp	C	X		
Water bug	C			X
Lesser water boatman	C	X		X
Water beetle	C		X	X
Diving beetle	C	X		
Water stick insect	C		X	X
Common net spinner	C			X
Fly larvae	C-D	X	X	
Little fish				X
Tadpole		X		
Water spider			X	

*Where A=species who need the cleanest water and D=species who can live in water of poorest quality.

3) Species list – Selected weeds
Ban Kayan, Chom Thong district, Chiang Mai, Thailand

Those which cause biggest problems; those which were mentioned as being seen less now than before and those which have a special importance for the local people. (Based on Waterhouse 1994 and GISP 2004)

Scientific family	**Common name**	**Scientific name**	**Comments**
Amaranthaceae	Pigweed	*Amaranthus sp.* L	Weed/ornamental in upland rice. Sacrifice for good harvest. Not wild anymore but they keep seeds and plant it with upland rice.
Asteraceae	Goatweed	*Ageratum conyzoides* Linn.	White flowers Exotic
Asteraceae	Spanish needle	*Bidens pilosa* L.	Yellow flowers. Exotic. Covers very big areas of upland rice fallow and cabbage fields.
Asteraceae	Chromolaena	*Chromolaena odorata*	White/pale flowers Exotic, introduced to prevent soil erosion. Covers big areas of upland rice fallow and roadside.
Brassicaceae	Chinese mustard	*Brassica juncea var. rugosa*	Less now. Together with upland rice before. Now more seen with cabbage. Food source.
Fabaceae	Coral tree	Erythrina subumbrans	Red flowered tree in fields Not so many as before
Fabaceae	Sensitive mimosa	*Mimosa pudica* Linn.	Exotic Does not cause problems
Fabaceae	Bean, wild	Unknown	Found as weed in upland rice. Might have been used for eating before. Pods with fur, bean alike lablab
Pedaliaceae	Wild sesame Gongai	*Sesamum indicum* L	Use to dry the rice. Do not eat seeds Not wild anymore but they keep seeds and plant it with upland rice.
Poaceae	Itch grass	*Rottboellia cochinchinensis* Lour.	Invasive grass in upland rice fields Exotic Cows eat it when the grass is young and green.
Polypodiaceae	Fern	Unknown species	Covers big areas in cabbage and red onion fields. Locals do not find it a problem. Food source.
Solanaceae	Black nightshade	*Solanum nigrum*	Observed a lot in cabbage fields

4) Species list – Cultivated and wild crops
Ban Kayan, Chom Thong district, Chiang Mai, Thailand

Crops cultivated in the past and present in Ban Kayan. Data sources are interviews, questionnaires, field walks, timeline of crops and observations. Other crops are most likely to have been cultivated as well in the history of Ban Kayan. Some species have been based on local names or names in Thai. The Royal Project introduced as well various ornamentals as cash crops. Those are not mentioned here. (Based on" Vegetables in Northern Thailand")

Scientific family	**Common name**	**Scientific name**	**Comment**	**Period of growing: RP: Royal Project B: before RP S: Same or more now as before L: Less grown after RP**
Agavaceae	Aloe Vera	*Aloe barbadensis Mill.*	Medicin and eat	A
Aliaceae	Onion, red	*Allium cepa*		RP
Anarcadiaceae	Mango	*Mangifera indica Linn.*		A
Apiaceae	Asiatic pennywort	*Centella asiatica Urban*	Grows wild in fields. Used for salad and to make sweet taste in water.	L
Apiaceae	Carrot	*Daucus carota*	Stopped soon after start	RP
Apiaceae	Coriander	*Coriandrum sativum Linn.*		L
Apiaceae	Sawtooth coriander	*Eryngium foetidum*		L
Araceae	Taro	*Colocasia esculenta Schott*	Eat stem and root	A
Araliaceae	Trevesia	*Trevesia palmate Vis.*	Small fruits in umbel eaten as vegetable by old men. With chillipaste.	A

Asteraceae	Spilanthes	*Spilanthes acmella Murr.*	Planted with upland rice before. Gone now. Leaves and flowers eaten.	B
Asteraceae	Chamomile	*Matricaria recutita*		RP
Asteraceae	Romaine lettuce	*Lactuca sativa L. var. Longifolia*		RP
Asteraceae	Lettuce, bitter	*Lactura virosa*		B
Asteraceae	Lettuce	*Lactura sativa*	Smaller now	L
Brassicaceae	Cabbage	*Brassica oleracea*	Started 1992	RP
Brassicaceae	Chinese mustard	*Brassica juncea var. rugosa*	Less now. Together with upland rice traditionally.	L
Bromaliaceae	Pineapple	*Ananas comosus Merr.*		B
Cannabaceae	Hemp	*Cannabis sativa*		B
Caricaceae	Papaya	*Carica papaya Linn.*		A
Cucurbitaceae	Snake gourd	*Trichosanthes anguina Linn.*	Squash like appearance	A
Cucurbitaceae	Chinese-okra	*Luffa acutangula Roxb.*	Squash like appearance	A
Cucurbitaceae	Chayote	*Sechium edule Sw.*		A
Cucurbitaceae	Cucumber	*Cucumis sativus*		A
Cucurbitaceae	Pumpkin	*Cucurbita moschata*		L
Cucurbitaceae	Watermelon	*Citrullus lanatus Mats&Nakai*		A
Dioscoraceae	Yam	*Dioscorea esculenta*		L
Euphobiaceae	Cassava	*Manihot esculenta Crantz*		L
Fabaceae	Millettia	*Millettia brandisiana Kurz.*	Leaf vegetable. Eat with chillipaste.	L
Fabaceae	Erythrina	*Erythrina fused Lour.*	Leaf vegetable	L
Fabaceae	Cowpea	*Vigna Sinensis/unguiculata*	Green, red, black, white	L
Fabaceae	Black bean	*Phaseolus vulgaris*	Smaller than the one they cultivate for RP	B
Fabaceae	Lablab	*Lablab purpureus*	Red bean with big white arillus. Cultivated among many	L

			farmers in the past.	
Fabaceae	Chinese pea	*Pisum sativum*		L
Fabaceae	Red kidney bean	*Phaseolus vulgaris*	Stopped 1996	RP
Fabaceae	Soya bean	*Glycine max Merr*		L
Fabaceae	Tamarind	*Tamarindus indica Linn.*		A
Labiatae	Jamaica thyme	*Coleus amboinicus Lour.*	In paddy fields. Not much anymore. Leaf vegetable.	L
Labiatae	Rosemary	*Rosemarinus officinalis*		RP
Labiatae	Thyme	*Thymus vulgaris*		RP
Moraceae	Jackfruit	*Artocarpus heterophullus Lamk.*		A
Moraceae	Mulberry	*Morus alba Linn.*	Plant for attracting birds in garden	L
Musaceae	Banana	*Musa sapientum Linn.*		A
Oxalidaceae	Wood sorrel	*Oxalis acetosella Linn.*	Vegetable in paddy rice ponds	A
Papaveraceae	Opium	*Papaver somniferum L.*	Started by H-Mong. 1969-1995	B
Pedaliaceae	Sesame, black	*Sesamum indicum L*		B
Piperaceae	Piper	*Piper sarmentosum Roxb.*	Leaf vegetable	A
Piperaceae	Betel pepper	*Piper betel Linn.*	Leaves for chewing	A
Poaceae	Lemongrass	*Cymbopogon citratus Stapf*		A
Poaceae	Wheat	*Triticum aestivum*		A
Poaceae	Corn	*Zea maiz*	Landrace	L
Poaceae	Glutinous rice (sticky)	*Oryza sativa var.glutinousa*	Like the non-sticky more	B
Poaceae	Sugarcane	*Saccharum officinarum Linn.*		L
Poaceae	Upland rice	*Oryza sativa var. Montana*		A
Poaceae	Wetland rice (paddy)	*Oryza sativa var. dura*		A
Polygonaceae	Sorrel	*Rumex acetosa*	Sour leaves. Grows wild in garden.	L

Rosaceae	Peach	*Prunus persica*		A
Rosaceae	Chinese pear	*Pyrus pyrifolia*	Stopped	RP
Rosaceae	Plum	*Prunus domestica*		A
Rubiaceae	Coffee	*Coffea arabica*		B
Ruraceae	Lime tree	*Citrus aurantifolia Swingle*		A
Rutaceae	Kafir lime	*Citrus hystrix*	Leaves for seasoning	A
Sapindaceae	Lychee	*Litchi chinensis*		A
Solanaceae	Chilli	*Capsicum frutescens Linn.*		L
Solanaceae	Eggplant, medium yellow	*Solanum seaforthianum Andr. Exc.*		L
Solanaceae	Eggplant, small green fruits	*Solanum torvum Sw.*		L
Solanaceae	Potato	*Solanum tuberosum Linn.*		RP
Solanaceae	Sweet Potato	*Ipomoea batatas Lamk.*	Easy to cultivate Less now	L
Solanaceae	Tobacco	*Nicotiana tabacum L.*		A
Solanaceae	Tomato	*Lycopersion esculentum Mill.*		L
Zingiberaceae	Pain ginger	*Zingiber zerumbet Smith.*	Grows wild in forest. Take home to garden. Eat flowers.	L
Zingiberaceae	Ginger	*Zingiber officinale Roscoe*	Plant with upland rice	L
Zingiberaceae	Turmeric	*Curcuma domestica Valeton.*	For stomach ache and for colouring clothes.	L

5) **Weed diversity and index**

Paddy field plot 1 (flat terrace but cow dung)

Poaceae 3
Poaceae 17
Poaceae 3
Asteraceae (goat weed) 5
Orchidaceae 1
Other 18
Other 1

Other 7
Other 2
Other 3

Paddy field plot 2 (flat terrace)

Poaceae 21
Other 17
Other 3

Paddy field plot 3 (contour line)

Asteraceae (thistle) 4
Poaceae 24
Other 3
Other 18
Other 1
Other 1

All paddy plots were very dry but different. 3 representatives. Grasses in area. Very low plants and difficult to tell what it was because of heavy grazing by cows. Rice straw left on field.

Cabbage field plot 1 (got some irrigation water from onion field)

Solanaceae (black nightshade) 2
Asteraceae (spanish needle) 2
Asteraceae (goat weed) 1

Cabbage field plot 2
Solanaceae (black nightshade) 4
Asteraceae (spanish needle) 2
Asteraceae (goat weed) 2
Asteraceae 2
Polygonaceae (rumex) 2

Cabbage field plot 3

Asteraceae (spanish needle) 2
Asteraceae 8
Poaceae 1
Other 1

Old cabbage field harvested 1 month ago. Very tall weeds. Do not well cover soil. Should use for cowgrazing but they don't.

Upland rice plot 1

Asteraceae (chromolaena) 1
Asteraceae (spanish needle) 74
Cyperaceae 17
Convolvulaceae 2

Upland rice plot 2

Fern 1
Asteraceae 4
Other 2

Upland rice plot 3

Asteraceae (spanish needle) 5
Asteraceae (chromolaena) 7
Poaceae (bamboo) 1

Very dry with very tall weeds. Not so diverse and not full covered at ground. Some parts of field tilled others didn't. Very steep and loose soil in many parts. Nearest forest more shrubs/small trees. Not all harvested at same time.

Red onion plot 1

Araceae (taro) 4
Asteraceae (spanish needle) 9
Asteraceae (goat weed) 1
Crucuferae 1
Ranunculaceae 1
Other 1
Other 1

Red onion plot 2
Cruciferae 2
Asteraceae (spanish needle) 3
Asteraceae (goat weed) 6
Other 3
Other 1

Red onion plot 3
Araceae (taro) 1
Asteraceae (spanish needle) 20
Asteraceae (chromolaena) 1
Asteraceae (thistle) 6

Very diverse level of weeds (management?). Some places big and dense onions other places almost no onions. Some places very dense weed cover. Intercropping with taro or leftovers from last year?

Diversity index

Plot	Total number of species, S	Simpsons's diversity index, D	D/S=Equitability	Level of evenne
paddy1	10	4,25	0,425	low
paddy2	3	2,27	0,756667	high
paddy3	6	2,81	0,468333	low
cabbage1	3	2,78	0,926667	very high
cabbage2	5	4,5	0,9	very high
cabbage3	4	2,06	0,515	average
upland1	4	1,53	0,3825	low

upland2	3	2,33	0,776667	high
upland2	3	2,25	0,75	high
onion1	7	4,11	0,587143	average
onion2	5	3,81	0,762	high
onion3	5	2,15	0,43	low

Average values

Plot	Total number of species, S	Simpsons's diversity index, D		
Paddy	6,33	3,11	0,491311	low
cabbage	4	3,11	0,7775	high
upland	3,33	2,04	0,612613	average
onion	5,67	3,36	0,592593	average

*Criteria for evaluation of evenness. Decided by Helle.
Below 0,5: low
Between 0,5-0,7: average
Between 0,7-0,9: high
Above 0,9: very high

Appendix 7: Forest

Intensive and Subsistence Farming in Ban Na Kayan, Northen Thailand: its socio-economic and ecological impact

Interview guide

Farmers Dependence on the Forest Products

Date: __/__/2007

Time: __:__

Interviewer:_____

Interpreter:_____

Location:_____

I. General Information of the Interviewee

Name: _____

Male (__) **Female** (__) **Age:** (__)

How long do you live in the village?

0 – 5 yrs (__) **5 – 10 yrs** (__) **> 10 yrs** (__)

II. Forest Products:

Do you collect Products in Forest? **Yes** (__) **No** (__)

Description of the products and its use (please feel in the table bellow)

III. Comments

_____

_____

_____

_____

_____

_____

Table 1. Description of the products and its use

Name		Type of Plant	If tree, which part	Uses	Availability	Period of collection
Local Name	**Sci./English Name**	**1. Tree 2. Shrubs**	**1. Leaf 2. Bark 3. Root 4. Fruits 5. Wood/Timber 6. Branches 7. Flowers**	**1. Food 2. Medicine 3. Sell 4. Construction 5. Other**	**1. Plenty 2. Some 3. scarce**	**1. Yearly 2. Monthly (specify) 3. Daily**

Data referred to the farmers dependence on Forest (trees) products.

Table 1. List of Tree species used by the Farmers in Ban Nha Khayan Village

	Species name	Frequency[4]	Percent
1	*Delbenia indica*	4	9.1
2	*Na Ba Jor*	4	9.1
3	*Se Mee*	4	9.1
4	*Dalbergia cultrata*	3	6.8
5	*Jum Phee Wood*	2	4.5
6	*Maniahara achras*	2	4.5
7	*Prunus cerasoides*	2	4.5
8	*Quercus lamellosa*	2	4.5
9	*Ta Ba Lar*	2	4.5
10	*Tha Kha Lar*	2	4.5
11	*Dee Mee*	1	2.3
12	*Kair Flower*	1	2.3
13	*Kam Lang Shua Khong*	1	2.3
14	*Ma Kor Sa*	1	2.3
15	*Ma Lik Mai*	1	2.3
16	*Mar Khao*	1	2.3
17	*Schima wallichii*	1	2.3
18	*Se Chae*	1	2.3
19	*Se Ree*	1	2.3
20	*Se Sae*	1	2.3
21	*Se Ya Cha*	1	2.3
22	*Sen Au Tee*	1	2.3
23	*Thor Phar Chee*	1	2.3
24	*Thor See Kor*	1	2.3
25	*Thue Au Sha*	1	2.3
26	*Thue Si Bue*	1	2.3
27	*Thue Si Kewar*	1	2.3
Total		**44**	**100**

[4] In this case, the frequency means the number of times each tree species were mentioned by different farmers

Table 2. Availability of Tree species according to the main uses mentioned by the farmers

		Availability			
Uses	**Species**	**Plenty**	**Some**	**Scarce**	**Total**
Food	Delbenia indica	2	2		4
	Kair Flower	1	0		1
	Ma Lik Mai	1	0		1
	Schima wallichii	0	1		1
	Ta Ba Lar	2	0		2
	Tha Kha Lar	1	1		2
Total		**7**	**4**		**11**
Medicine	Dalbergia cultrata	2	0	0	2
	Kam Lang Shua Khong	0	1	0	1
	Ma Kor Sa	***0***	***0***	***1***	***1***
	Maniahara achras	2	0	0	2
	Mar Khao	***0***	***0***	***1***	***1***
	Na Ba Jor	3	0	1	4
	Prunus cerasoides	1	1	0	2
	Se Ya Cha	1	0	0	1
	Sen Au Tee	0	1	0	1
	Thor Phar Chee	1	0	0	1
	Thor See Kor	0	1	0	1
	Thue Au Sha	***0***	***0***	***1***	***1***
	Thue Si Bue	1	0	0	1
	Thue Si Kewar	1	0	0	1
Total		**12**	**4**	**4**	**20**
Construction	***Dalbergia cultrata***	***0***	***0***	***1***	***1***
	Dee Mee	0	1	0	1
	Jum Phee Wood	***0***	***1***	***1***	***2***
	Quercus lamellosa	***0***	***1***	***1***	***2***
	Se Chae	1	0	0	1
	Se Mee	1	1	1	3
	Se Ree	0	1	0	1
	Se Sae	1	0	0	1
Total		**3**	**5**	**4**	**12**
Fuelwood	Se Mee	1	0	0	1
Total		**1**			**1**

Note: The species with red font are the scarce species.

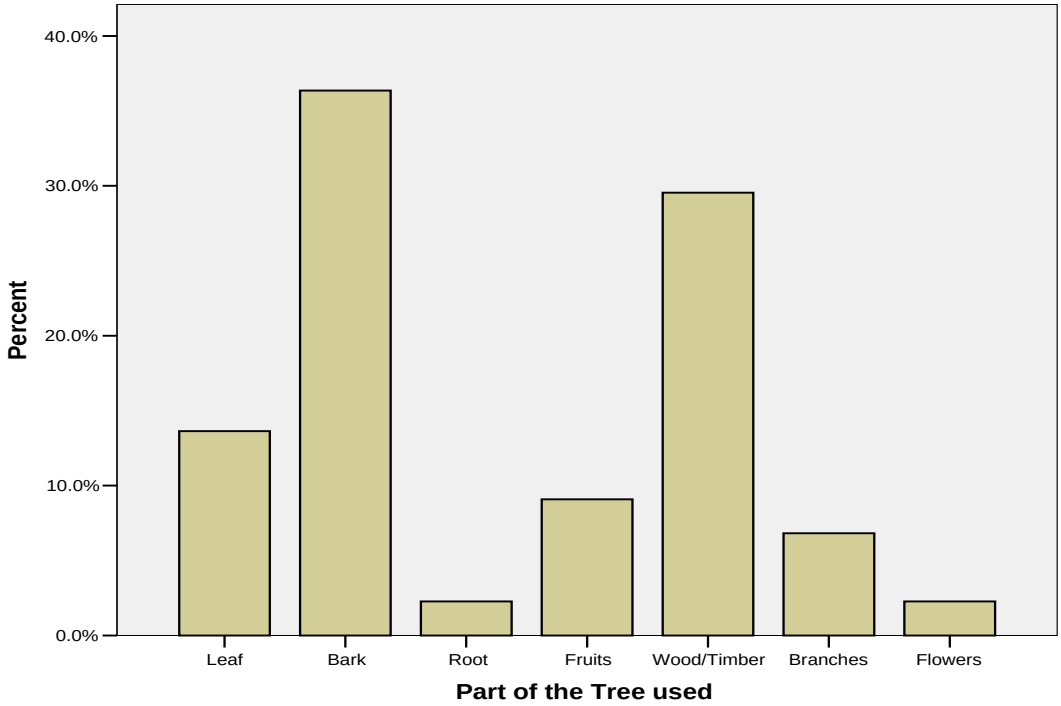

Figure 1. Parts of the tree used by the farmers

Appendix 8: Soil

Table 1: Nutrient requirements of common vegetables

Vegetable	Nitrogen (N)			Phosphorus (P)			Potassium (K)		
	H	M	L	H	M	L	H	M	L
Cabbage		x		X			x		
Lettuce		x		X	x		x	x	
Onions		x	x		x	x		x	X

Nutrient Use	N	P	K
High (H)	**1.5kg + per 100m sq**	**0.4kg + per 100m sq**	**2.0kg + per 100m sq**
Medium (M)	**0.5-1.5kg per 100m sq**	**0.2-0.4kg per 100m sq**	**1.0-2.0kg per 100m sq**
Low (L)	**Less than 0.5kg per 100 m sq**	**Less than 0.2kg per 100 m sq**	**Less than 1.0kg per 100 m sq**

Source: modified from http://www.backyardgardener.com/veg/nurt1.htm

Table 2: nutrient requirements for crop in the study

Crop	Yield ton/ha	N (kg/ha)	P(kg/ha)	K(kg/ha)
Cabbage summer	70	181	22	141
Onions	48	107	17	88
Lettuce summer	58	224	15	448
Rice		110	34	156

Source: modified from http://www.hortnet.co.nz/publications/guides/fertmanual/vege2.htm#I6

Table 3: Soil proprieties

Farming system	N-availab	NH4-availab	P-availab	K-availab	**%OM**	**PH-lab**	**N-flowin (kg)**	**P-flowin (kg)**	**K-flowin (kg)**	**Ec**	**PH meter**	N net	Pnet	K net
Paddyrice	4.875	2.805	1.86	56.16	4.57	5.2	70	30	0	0.384	5.64	28.24	22.8	-14.04
Paddyrice	3.25	9.55	1.24	24.96	2.29	5.5	39	20	0	0.256	5.68	16.728	16.16	-7.488
Uplandrice	12.92	3.74	6.22	49.92	2.29	5.2	18.28	20.24	3.32	0.448	5.39	-9.56	15.44	-6.04
Uplandrice	3.25	9.55	3.11	24.96	3.74	5.5	16	20	0	0.512	5.96	-11.84	15.2	-9.36
Cobbage*	0.8125	2.3875	0.7775	6.24	2.94	5.1	23.5	27.5	7.5	0.704	5.18	-75.5	12.5	-85.5
Rice*	0.8125	2.3875	0.7775	6.24	2.94	5.1	0	0	0	0.704	5.18	-13.92	-2.4	-4.68
Herbs	2.395	0.4675	0.7775	6.24	3.27	5.3	0.57	0.06	0.83	0.64	5.68	0.5352	0.054	0.8183
Cobbage*	28.74	5.61	9.33	74.88	4	6.1	111	60	0	1.088	6.75	-364.2	-12	-446.4
Rice*	28.74	5.61	9.33	74.88	4	6.1	0	0	0	1.088	6.75	-13.92	-2.4	-4.68
Onion**	1.625	0.935	1.555	12.48	2.82	5.4	19.5	19.5	31.5	1.152	5.89	-104.5	6.3	-100.5
Cobbage**	1.625	0.935	1.555	12.48	2.82	5.4	92.5	50	0	1.152	5.89	-105.5	20	-186
Onion**	4.845	1.4025	2.3325	18.72	2.82	5.4	14.14	13.12	22.66	1.216	5.76	-109.86	-0.08	-109.34
Cobbage**	4.845	1.4025	2.3325	18.72	2.82	5.4	45	30	0	1.216	5.76	-153	0	-186
Lettuce	6.46	9.55	3.735	37.44	2.42	5.7	41	37.5	134.4	0.832	5.96	-48.6	22.14	121.92

Appendix 9: Personal activity calendars

Field work in Ban Kayan: 6-15 of March 2007

Daily activities, Helle

6/3	Meeting with village leader, introduction to village Group meeting
7/3	Village, farm and forest walk with local farmers Interview with village leader
8/3	Walk in fields with farmer Interview crops with old farmer and young farmer Interview biodiversity with old farmer and young farmer Observed soil sampling by Asma, Arsenio, Don and O Group meeting
9/3	Wedding in neighbour village. Invited by our village to experience local traditions Water samples in outlet of Kayan stream. Observed. Water quality indicator animals. Collection of invertebrates. 4 questionnaires
10/3	Water samples in inlet and middle point of Kayan stream. Observed. Water quality indicator animals. Collection of invertebrates. Literature study Group meeting
11/3	Group meeting: planning midterm presentation Interview biodiversity with old woman Midterm evaluation Planning PRA session Data analysis (interviews)
12/3	PRA with men in village (timeline history and crops, ranking of livelihood assests, ranking of crops choice, seasonal calendar, map of village) Group meeting Data analysis (interviews)
13/3	Walk in gardens around the village and fields with local farmer focusing on local crops grown for subsistence Weed diversity in 3 plots in paddy rice field and in 3 plots in cabbage field Data analysis Group meeting
14/3	Excursion to mountain in Ban Kayan with upland rice and invasive grass Mapping of fields in research area for weeds Weed diversity in 3 plots in upland rice field and 3 plots in red onion field Literature study Interview biodiversity with young woman Group meeting
15/3	PRA session with woman in village (timeline for crops, daily activity plan, ranking of livelihood assests) Interview with CARE Weed identification Social gathering with presentation of our work and good bye in village.

Daily activities, Emilie

6/3	Meeting with village leader, introduction to village Group meeting
7/3	Village, farm and forest walk with local farmers Interview with village leader (interview leaded by Emilie)
8/3	Village mapping – walk alone in village, draw the village and taking GPS coordinates of all houses. Observed briefly soil sampling by Asma, Arsenio, Don and O Village mapping – made a big map of the village to use in the PRA session later on in the week. Group meeting
9/3	Interviews in Chom Thong • TAO • Agriculture Extension • National Park Stomach flu – didn't go to the village making questionnaires as planed. Made summery of the interviews instead
10/3	Stomach flu, stayed in Base Camp – start data analysis on the answers from the first questionnaires and read articles
11/3	Group meeting: planning midterm presentation Informal talk with village leader Questionnaires with villagers Midterm evaluation Planning PRA session with Helle Questionnaires with villagers
12/3	PRA with men in village (timeline history and crops, ranking of livelihood assests, ranking of crops choice, seasonal calendar, map of village) Group meeting Data analysis (questionnaires)
13/3	Observed the walk in gardens around the village and fields with local farmer Data analysis (questionnaires) Group meeting
14/3	Data analysis (questionnaires and PRA) Group meeting
15/3	PRA session with woman in village (timeline for crops, daily activity plan, ranking of livelihood assests) Interview with CARE Data analysis (PRA) Social gathering with presentation of our work and good bye in village.

Daily activities, Arsenio and Asma

Date	Arrival in the village and brief interview with local leader	Walk to the forest	Soil sampling	Water test	Soil conservation description	PRA-section	Interview	Soil analyze	Meeting with the villagers
60307									
70307									
80307									
90307									
100307									
110307									
120307									
130307									
140307									
150307									

Activity calendar, Monteiro

	April 2007									
	Dates									
Activities	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Arrival in the Village and Interview with local leader										
Walk in the Forest										
Data Collection: Forest Composition										
Wedding in the Village										
Data Collection: Forest Composition										
PRA Section										
Interview: Farmers Dependence on Forest Product										
Introduction of Data/Identification of Scientific names of Forest species										
Meeting with all the villagers: Last Day										

Appendix 10: Synopsis

SLUSE

nterdisciplinary Land Use and Natural Resource Management (ILUNRM)

400006

Group 3

Synopsis

INTENSIVE FARMING AND ECOLOGICAL IMPACT IN BAN NA KAYAN, NORTHERN THAILAND

Arsenio Ndeve[1] (ADK06019) - Agronomist

Emilie Just Petersen[2] (EM07049) - Geographer

Helle Ansine Jensen[1] (ADK06014) - Biologist

José Monteiro[1] (ADK06031) - Forester

Mst Asma Huq[1] (EMA06008) - Agronomist

Denmark, February 2007

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[1] Copenhagen University, Faculty of Life Science
[2] Copenhagen University, Institute of Geography and Geology

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1. Background

Thailand is one of the Southern-east Asia countries that have agriculture as main economic source for development. According to the National Economic and Social Development Board of Thailand (Sompolvorachai 2004), it is estimated that 55.67% of Thailand's labor force is engaged in agriculture. The land area available for agriculture has in the last years been declining caused by increase in population and at the same time the land demand for growing population pressures the production of domestic food (FAO 1999).

According to Thai agriculture department (Apai and Navanugraha 2004), evidence has shown that farming patterns in Thailand are still based largely on mono-cropping practices with a large amount of agrochemical use, natural resources degradation and too much pollution. These patterns have also led to increased soil erosion, lose of soil organic matter and soil fertility depletion (Apai and Navanugraha 2004). To cope with the pressure the farming strategy is changing by using newly developed technologies and the demand of vegetables has been growing annually. In the peri-urban and irrigated areas, like the Chiang Mai region, the main source of income is from vegetable production (FAO 1999). According to FAO (1999) actual vegetable yields are far below the potential yield, hence knowledge on use of agrochemical and irrigation frequencies is required to reduce collateral impacts immerging from these activities.

The study will be done in the Ban Na Kayan village, which is located in the southern part of one of the sub-watersheds to the Upper Mae Ping watershed. The village is lying in the bottom of a narrow valley adjacent to intensively cultivated step hill sides. In this area there is plenty of water in the rainy season. A stream which provides water into the Ping River runs through the village (Mingtipol et al. 2007).

Ban Na Kayan consist of 22 households with a population around 100 people, but the village experiences labour migration. Some of the farmers produce cabbage, onions and other vegetables characterized by a substantial use of fertilizers and pesticides (Mingtipol et al. 2007).

2. Research question

Is intensive farming a sustainable livelihood strategy for the households in Ban Na Kayan and what are the ecological impacts of this farming system?

2.1 Research sub-question

- What are the main livelihood strategies in Ban Na Kayan?
- Why and how do farmers practice intensive farming?
- What are the ecological impacts of intensive farming?

3. General objective

Investigate the socio-economic and ecological impacts raised from the intensive farming in Ban Na Kayan

3.1 Specific objectives

- Identify the livelihood strategies and their flexibility
- Understand the reasons for practicing intensive farming
- Estimate the nutrient flow in the cropping system
- Estimate the irrigation water quality that may lead to soil salinization
- Investigate the effect on water in the stream from chemical use in the fields
- Investigate changes in diversity of flora and fauna on field and area level
- Explore regenerating pattern of forest species in the fallow fields

4. General definitions

Intensive farming: A method of farming that uses large amounts of capital or labour to obtain the maximum yield from a limited area of land (AllWords 2003)

Ecological Impact: The effect that a human-made or natural activity has on living organisms and their non-living (abiotic) environment (UNDP 2006)

Sustainable livelihood: A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (DIFD 1999;1).

Flexibility: An indigenous response to environmental risks, and it offers freedom of manoeuvre that can be lost in the process of intensification. Loss of flexibility is, therefore, one of the cost of intensification (Adams & Mortimore 1997;152).

5. Methodology

Ecological impacts of intensive farming can be many and to get a clearer picture the research is done by several methods within four different disciplines. This will lead to a general knowledge of most of the aspects which comprises the livelihoods of the local people in Ban Na Kayan.

Identify the livelihood strategies and their flexibility

In the beginning of the field work questionnaire will be conducted to 22 households to identify the different livelihood strategies for each household (appendix 1). Before submitting the questionnaire to the households, a pilot survey will be carried out. This is necessary to ensure that the questionnaire is clear and cover the objectives.
The questionnaire will give a picture of the extent of intensive farming among the farmers. After the questionnaire, a stratified random sample will be taken. The stratification will then lead to interviews (appendix 2), which will be addressed to the selected farmers, in order to understand their livelihood strategies.

Understand the reasons for practicing intensive farming

To understand the farmer's reasons for practicing intensive farming a group of methods within Participatory Rural Appraisal - PRA (Selener et al. 1999) will be used (appendix 3).
A time line will give an overview of the history of the area and different reasons caused by specific events during the times past. Furthermore a village map created either on the ground or on paper will give all participants in the PRA-session a general idea of the study area. A transect walk together with the local people will also help to get a picture of land use of the village.
The overview of the importance of intensive farming will be achieved with discussions within two focus groups divided by gender and through a ranking session of the importance of intensive farming with all participants.

Besides collecting information within the farmer's focus groups, interviews will be addressed to the identified employees of the Agriculture Department in the village or in Chiang Mai (appendix 4). The triangulation of the information obtained with the two groups (farmers and the department of agriculture) shall give a much clear situation of the farming system.

Estimate the nutrient flow in the cropping system

Intensified cropping system may lead to soil nutrient status depletion, meaning sometimes a negative balance between input-output. Thus it is important to estimate nutrient flow to know if the intensive cropping system in Ban Na Kayan is sustainable.

Nutrient flow will be estimated through nutrient balances (NPK). The boundary will be set at field level. An interview will be conducted for each individual farmer to know all sources of nutrients, as well as the amount of harvested products and to estimate the amount of stover and their destinies (appendix 5). Information regarding crop plant population in the field will be collected as well, and total dry matter produced in the system will be estimated. Plant samples for nutrient analyses will be harvested or probably secondary data will be consulted for the process. At the end, the nutrient balance will be established by knowing nutrient flow in-out.

Also, soil samples will be taken at different depths, depending on types of crops grown in the site, to estimate status of soil nutrients (NP) using Kjeldahl and Olesen methods (Rowelle 1999), respectively. The basis of this idea is to compare nutrient status among cropped (intensified and non-intensified) and non-cropped area along the same site. This procedure will be dependent on actual conditions found locally, hence may be or not carried out.

Estimate the irrigation water quality

Irrigation water may lead to soil salinization through continuous deposition of salts. Generally intensified systems are high demanding in inputs like fertilizer, pesticides and irrigation needs. Continuous use of low irrigation water quality contributes to soil salinization. So it is important to estimate the irrigation water quality to have an idea of soil salinization.

Water samples will be harvested from water sources used for irrigation, to estimate electrical conductivity, pH and sodium absorption rate (SAR).
Sodium will be estimated by flame photometry and calcium plus magnesium (Ca+Mg) by titration.
Also soil samples from a highly intensified field will be collected to estimate soil salinity, pH and observations of soil structure.

Investigate the effect on water in the stream from chemical use in the fields.

The methods used are general measurements of the water quality to investigate if it is healthy. Temperature, pH, dissolved oxygen, nitrogen, phosphor and electric conductivity will be measured on three plots along the river to see if there is any difference according to distance from the fields and/or village. The found results will be compared with results from literature for not cropped areas. This research will only be carried out if the stream provides sufficient water to measure the water quality and biodiversity.
If the water level is sufficient and the water is quiet the depth of sight can be determined by using a secci-plate. The result will tell us about the amount of algae and sediment dissolved in the water.
In addition to the physical perspective, the local people will be asked about their uses of the river and which observations of changes they have done (appendix 6). It will provide knowledge of the recent history of the water quality.

Observations on plant communities, invertebrates and vertebrates in the stream will be done in a general level by using field guide material and help from local people and students from Thailand. Collections of living material will be enhanced also from the three different plots.

Investigate changes in diversity of flora and fauna on field and area level

Intensification of land will often lead to a lower biodiversity, since less niches and habitats are available. Because different organisms interact with each other in different ways a decline in some species often leads to decline in others as well. A decrease in biodiversity can therefore affect the livelihood of people who depend on certain living organisms that might be affected in an indirect way.

Biodiversity can be influenced in all levels from microorganisms in soils, to plant communities in the field and to wildlife in forest, open land and river.

The main methods used for these investigations will be collections of plants and knowledge provided through interviews with local people about uses of natural resources and observed changes of both plants and wildlife.

The change in biodiversity will be investigated by comparison of different areas cultivated in the same way as the time period surveyed. Interviews with people who are able to remember the areas diversity years back and the possible changes over time will lead to knowledge of the changes in biodiversity (appendix 6).

A quantitative analysis on flora within fields cultivated in different levels of intensification according to the development of intensive farming (from non-cultivated to heavily intensified) will lead to data telling us about potential diversity losses within certain plant communities. These plants might be wanted or unwanted from a farming and/or a livelihood point of view.

The general level of wild plant species and weeds on fields and surroundings will be observed. Thereafter wild plants are going to be collected/noted/photographed in a replica of three plots of $1m^2$ on a non-cultivated field, a low-intensified field and a highly intensified field. Depending on conditions of the research area a transect can be done running from non cultivated land to cultivated land.

Scientific name and life form will be noted for each plant and a frequency analysis will be done for appropriate species (Warncke 1996).
Observations and collection/trapping of soil organisms from fields from non-cultivated to heavily cultivated fields will be done in a smaller scale.
Interviews will be held with representatives of the local people telling about changes in flora and fauna, the uses and importance to them (appendix 7).
Different methods grouped as Participatory Rural Appraisal (PRA) will be conducted with local people in the village to provide additional knowledge of changes in diversity of wildlife and plants and the general importance (mapping and timeline) (appendix 3).
Observations, interviews and PRA-methods (annual calendar, mapping, time line) will also be used to give information on which crops the farmers cultivate and an analysis on the different niches provided and the diversity within the cropping choice will be considered.
The agricultural area will furthermore be mapped by using GPS.

Explore regenerating pattern of forest species in the fallow fields

In order to explore the regeneration pattern of the abandoned field, it is important to divide the fallow period in classes. The fallow period classes can be obtained through interviews done to the farmers. Three fallow period classes can be primarily defined: 2–5 yrs; 5–10 yrs; >10 yrs, but the most accurate classification will be based on the information obtained in the interviews with the farmers. Information regarding the cultivation period of the fallowed fields, shall also be gathered through the interviews.

In each of the classes, three sample fields shall be selected to gather the regeneration. In each fallow field, one 10x10 m plot will be established and the diameter and height of trees with diameter above 5 cm will be gathered. The scientific name of the species shall be identified.

In order to compare the regeneration pattern with an untouched area, three random 20x20 m plots will be established in the forest and the diameter and height of trees

with diameter above 10 cm will be gathered. Inside the 20x20 m plots, 10x10 m plots will be established and the diameter and height of trees between 5-10 cm will be gathered. The scientific name of trees will also be identified, through a local guide. The abundance and dominance of species of the two different areas will be presented as results of the data collected.

Understanding the regeneration of the fallow fields can give a good prediction of the status of the forest species abundance and composition, therefore helping to elaborate on the impacts of intensive farming on the forest species diversity.

6. Plan of activities

Activities	March 2007 Date 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Responsable
Walk in the Village																						All
Questionnaire/Interview: overview																						All
Analizing the questionnaire/Interviews																						All
Data collection	Data Collection																					
Observations and selection of research area for biodiversity studies																						Helle
Observations on plants & animals in the stream																						Helle
Water quality tests in the stream																						Helle
General observations and identification of common wild plants and crops in the area																						Helle and Emilie
Collection and identification of plants in 3 plots and/or transect																						Helle
Put out trapping containers for soil invertebrates																						Helle
Observation and identification of collected soil invertebrates																						Helle
Interviews with key persons – water quality in stream, biodiversity and crop cultivation																						Helle
Mapping agricultural area – GPS																						Helle and Emilie

Interview: Livelihood strategy																							Emilie
Water quality																							Arsenio and Asma
Soil analyses																							Arsenio and Asma
Interview: Nutrient Flow																							Arsenio and Asma
regeneration in the forest																							Monteiro
Regeneration in the fallow fields																							Monteiro
Data analyses																							All
Session of PRA methods																							All

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8. Appendix

Appendix 1: Questionnaire

Appendix 2: Interview guide – Livelihood strategy

Appendix 3: Guide for PRA session

Appendix 4: Interview guide – Agriculture Department

Appendix 5: Interview guide – Nutrient flow

Appendix 6: Interview guide – Diversity change

Appendix 7: Interview guide – Crops and cultivation practice

Appendix 8: Material list

8.1 Questionnaire

All 22 households in Ban Na Kayan will be surveyed.

Informant's data:

Name:

Age:

Sex: male or female

Date:

Location:

GPS coordinates:

Socio economic information

1. How long time have you lived in village?
2. How many members are there in the household?
3. What are you occupation/ economic activity (farmer or other)?
4. Which sources of income contributes to the household?
5. Are any of your family members migrated to the city – to find other work?
    a. If yes – are they sending money to you?
6. Is it the family or hired labour that does the work in the fields?
7. Do you have any children in school?

Field/cropping information

8. How many fields are you cultivating?
9. What are you cultivating on your fields?
    a. What kind of crops?
    b. How many fields with vegetables?
    c. Do you have more than one crop on each field?
    d. How many times are you cultivating each field per year?
10. How many fields do you have in fallow?
    a. How long have the fields been in fallow
    b. How long have the fields been cultivated before fallowing
11. Do you rotate the production on the field or between your fields?
12. What do you do with the crops after harvesting?
    a. To use in the household

    b. Fore sale

13. Do you have any animals?
    a. Do they grass the field that’s not cultivated?
    b. Do you feed them with crops, straws, fodder?
14. Do you have accesses to:
    a. fertilizer
    b. pesticides
    c. manure
15. Where are the fields located?
16. Do you own or rent you fields?
17. Where is the water source located from the household and from the fields?

8. 2 Interview guide – livelihood strategy

Informant: selected farmers based on the questionnaire.

Interviewer: Emilie

Questions:

The questions for these interviews depend on the answers in the questionnaire. As a minimum we need more details on:

1. Labour
    a. Human
    b. Animal
    c. Mechanical
    d. Periodical or yearly need
2. Capital
    a. From Non-farm activities
    b. From Cash crops
    c. To school feed
3. Accesses
    a. to market
    b. to fertilizer
    c. to tolls and machines
4. Crops
    a. Varieties
    b. Increase or decline in yield – why
    c. Pest
5. Food
    a. self-sufficient
    b. need to buy
6. Uncertainties
    a. Drought
    b. Pests
    c. Changes in market access, wages, policies
    d. Hazards

8. 3 Guide for PRA-session

Time line:

The time line will provide historical and present events and major ecological changes that influence the development of agriculture.

Village map:

The village map can give a general overview of the perception of the community on the physical allocation of the natural resources in the area, and also an estimated distance of these resources from the houses and fields. Beside this information, the map can also give an indication of the most important resources in the village. Crops, wild plants and wildlife observance will also be included as information in the map.

Transect walk:

The transect walk will give a tri-dimensional overview of the village map.

Focus Group discussion:

The group discussion will be a very good source to triangulate the information obtained through the interviews/questionnaires. The triangulation will also be based on the ranking process, a cropping calendar and an overview of annual activities in the community.

8.4 Interview guide – Agriculture Department

Informant: employ in The Agriculture Department in the village or in Chiang Mai

Interviewer:

Questions:

1. What assistance does the department gives to the farmers?
2. What are the main problems related to the agriculture system in the village?
3. Are there any other institutions involved in the development of agriculture in the area?
    a. Which?
    b. What are their main goals?
4. Are there any regulations for agricultural practice?
    a. Weed and pest management
    b. Fertilizer use
    c. Certain kind of crops
    d. Distance to water source
    e. According to field size
5. Do the farmers follow the regulation?
6. To what extend is intensive farming practiced by small scale farmers?
7. Which crops are cultivated in the area?
8. Which crops are the most common in intensive farming?
9. Have you observed any changes in weeds species?
    a. Exotic plants
10. Have you observed any changes in wildlife?

8.5 Interview guide – nutrient flow

Informant: Farmers growing vegetables according to the questionnaire

Interviewer: Asma and Arsenio

Questions:

1. What type of fertilizer do you use in your field?
2. How do you apply the fertilizers?
3. What type of fertilizer do you use?
4. How much fertilizer do you use?
5. How do you choose to cultivate certain crops?
6. How much water do you need to cultivate your crops?
7. How often do you irrigate your crops?
8. How much water do you need for each irrigation?
9. Is the water good to be used for irrigation`?
10. Do you have any irrigation system?
11. How do you do to irrigate your crops?
12. What do you do with your crops after harvest?
13. How many times do you cultivate your plot per year?

8.6 Interview guide - Diversity changes

Informant: 40 years old man (farmer) and woman + 60-70 years old man (farmer) and woman – all should have lived in the village most of their lives and where both high and low intensified farming systems are represented

Interviewer: Helle

Questions:

1. What is your role in the village?
2. Can you point out fields cultivated like the way it was when you were a child, young and well grown up?
3. What is nature for you?
    a. what do you value most of nature?
    b. how do you use nature?
4. What do you use from nature/surroundings?
    a. fish, mammals, birds, trees, herbaceous plants?
    b. in which way do you use it?
    c. What is most and least important for you?
5. Have you experienced any changes in the surroundings during your life here?
    a. in what way?
    b. other crops?
    c. cut down forest?
    d. village grown?
6. Has the river changed?
    a. amount of water
    b. smell and appearance?
    c. plants and animals?
    d. fish?
7. Have you experienced changes in wildlife?
    a. mammals, birds, other?
    b. do see some species more/less than before in your life?
    c. Which animals do you observe in general?
8. Have you experienced any changes in vegetation?
    a. Some you do not see any more?

    b. Some you see less/more?
    c. New species?
    d. Which species/types do you observe?
9. Are you satisfied with the changes in crops, use of surroundings, change in plants and animals?
10. Does it make any difference for you?
    a. what is better?
    b. what is worse?
11. Can you explain what have happened in the village when major changes in biodiversity happened?
    a. Why did it happen?

8.7 Interview guide - Crops and cultivation practice

Informant: 4 farmers, different ages. Both high and low intensified farming systems are represented.

Interviewer: Helle and Emilie

Questions:

1. Which crops do you cultivate?
    a. Mono/intercropping
2. Do you cultivate the same each year?
    a. Same cultivars?
3. Why do you choose as you do?
4. Do you find weeds a problem in your fields?
    a. which types?
    b. what kind of weed management do you practice?
    c. for which crops are weeds a problem?
5. Do you find pests a problem in your field?
    a. which types?
    b. what kind of pest management do you practice?
    c. for which crops are weeds a problem?
6. In which ways have improved managements methods changed your work and life?

8.8 Material list

- Beaker, funnel, shaking bottles, Whatman No 125, filter paper (sup-objective 3)
- Calliper or diameter tape – to measure diameters of trees with diameter above 10 cm (sup-objectivee 5)
- Conductivity standards (sup-objective 1)
- Conductivity standards (sup-objective 2)
- Electrical conductivity meter & conductivity cell (sup-objective 1)
- Electrical conductivity meter & conductivity cell (sup-objective 2)
- Field guide material (plants and animals in steams) (sup-objective 2)
- Flame photometer & sodium filter, soil auger, bucket, burette, Hcl (sup-objective 1)
- Flora and fauna books (sup-objective 4)
- GPS (sup-objective 4, 5)
- Guide for PRA-session (sup-objective 7)
- Magnifying glass (sup-objective 4)
- Materials for PRA (sup-objective 4, 6)
- Measuring tape (sup-objective 4, 5)
- Pachymeter – to measure the diameter of the regenerated trees with diameter less then 10 cm (sup-objective 5)
- Pipette, test tube, balance, distilled water, spectrophotometer (sup-objective 3)
- Pipette, test tube, balance, distilled water, volumetric flask, Na(PO3)6 (sup-objective 1)
- Polyacrilamide solution, distilled water, NaHCO3,H2SO4 (sup-objective 3)
- Questionnaire (sup-objective 6)
- Regulations for farming in Northern Thailand (sup-objective 7)
- Rope (sup-objective 4)
- Secci plate (sup-objective 2)
- Semi structured interview guide (sup-objective 2, 4, 6)
- Small containers (sup-objective 4)

- Thermometer, pH-paper, dissolved oxygen-meter, field test kit for N and P. (sup-objective 2)
- Water collector, beaker, thermometer, funnel, filter paper, Nacl (sup-objective 1)