Livelihood Strategies and Consequences of Agricultural Intensification in Ban Huai Sompoi and Ban Pa Kia Nai Ob Luang National Park, Northern Thailand

Final Report
Interdisciplinary Land Use and Natural Resource Management

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1. Introduction 3
1.2 Definitions & indicators 5
1.3 Definitions 5
1.4 Indicators of sustainability 6
2 Methodology 8
2.1 Social science methodology 8
2.1.1 Sampling strategy 8
2.1.2 PRA 9
2.1.3 Questionnaires 9
2.1.4 In-depth interviews 9
2.2 Economic methodology 9
2.3 Natural science methodology 10
2.3.1 Soil erosion 10
2.3.2 Soil fertility 10
2.3.3 Statistics 12
3 Critique of methodology 12
3.1Economic sustainability 12
3.2 Natural science methods 13
3.2.1 Statistics 13
3.2.2 Soil erosion 14
3.3.3 Soil fertility 14
4 Results and discussion 15
4.1 Livelihoods of the villagers 15
4.1.1 Non-Timber-Forest-Products 16
4.1.2 Off-farm activities 17
4.1.3 On-farm activities 18
4.2 Rice Cultivation 19
4.3 Rice inputs and yields 20
4.4 Cabbage cultivation 21
4.5 Cabbage inputs and yields 23
4.6 Summation of differences between rice and cabbage cultivation 27
5 Assessment of the economic sustainability 29
5.1 On farm economy 29
5.2 Marketing analysis of cabbage 31
5.3 Economic snapshot on the household economies 42
5.4 Effect of changes of cash crop prices on income 46
6 Soil erosion results 47
7 Soil Fertility 49
7.1 Laboratory analysis 50
7.8 Summation of soil fertility 54
Perspectives 54
8. Conclusion: 55
9 References 59

1. Introduction

Scarcity of natural resources has been an issue of growing concern for Thailand in the last decades. Thailand's population including immigration almost tripled from the 1950s to the early 1980s, setting the natural resources under pressure (*Lakanavichian*, 2001). In order to respond to the growing demand for food from the fast growing population, more land had to be taken into cultivation, which to a large extent has been done by clearing forests. Expansion of agricultural land is viewed as the most important cause of deforestation (*Szirmai*, 1996). In order to limit the negative consequences of deforestation, the Thai state has increased the area under conservation. In 1964 the Thai government passed the National Forest Reserve Act. It pointed out different areas in Thailand that should be included in the reserved areas. The resulting National Forest Reserves are split into three different zones: The Conservation, Economic and the Agricultural Zone. Where the former is the one with most restrictions on the land use. Different areas which fall under this category include National Parks, Wildlife Sanctuaries and Watershed areas *(Onchan et al. 1998).* The area where our study has been carried out, Ob Luang in Northern Thailand, is no exception to the country's conservation policy. Ob Luang became Thailand's 68th National Park in 1991, after having been a Forest Park from 1966 to 1991 (RFD, 2002).

The paradox is that Hill tribes – mainly the Hmong and Karen - were already living in Ob Luang before it became a National Park, which means that today they live in an area under strict conservation. According to the map of the Park that we were given during the course, they are granted specific limited areas within the "excluded zones" of the National Park, allowing them to cultivate these areas for their livelihoods. These areas are officially state owned, however permanently occupied and cultivated. The existence of the National Park is setting pressure on the agricultural practises of the locals by limiting their amount of agricultural land. The Karen have (like the other hill tribes of Thailand) traditionally been practising shifting cultivation (*Eliot & Bickersteth*, 2003) (*Aagaard & Jørgensen*, 2001). This is a cultivation method where land under natural vegetation is cleared and then cropped for a few years. Shifting cultivation is an extensive form of agriculture which requires large areas of land as well as a long fallow period to enable soil fertility recovery, prevention of erosion, weed control and limiting spread of diseases and pests (*Szirmai*, 1996). Some Karen villages still maintain long fallow periods of up to 10 years, but land limitation and population pressure has resulted

in a reduced fallow period for many areas. This is likely to result in soil degradation and weed problems since the re-growth of vegetation is essential. In our study area the amount of land the villagers can cultivate is fixed, which requires intensification of agricultural practices. This may have negative impacts on the environment and tends to make the farmers market dependent.

Our study area was the two villages, Ban Huai Sompoi and Ban Pa Kia Nai (from here on called Sompoi and Kia Nai), located in the Mae Tia Watershed in the Chomthong district of the Chiang Mai province of Northern Thailand. The watershed is about 70 km from Chiang Mai and only a few kilometres from Chomthong town. It is one of a hundred watersheds in the Chiang Mai Basin. Hilly and mountainous areas occupy 85 % of the watershed with a small proportion being flat and terraced. Most soils in the area are classified as being erosive (*Boonyawat*, 1986). The warm/rainy season lasts from April-November and the cool/dry season lasts from December-March. Both Sompoi and Kia Nai are located outside the boundary of the Ob Luang National Park, however they are still inside the forest Conservation zone. Conservation zones, as the name implies, include areas that should be preserved and protected. When the area including our two villages was classified as a Conservation zone the villagers had already been settled in the area for generations. Therefore the villages were excluded from the conservation zone and STK certificates were given to the farmers allowing temporary cultivation rights to the land. The flatlands are used for paddy rice cultivation and the steep hills are used for upland rice and cash crop cultivation, with the main crops being cabbage, red onion and taro. The produced cabbage is sold at a market located in Chomtong town about half an hours drive from the villages. The main source of income for the villagers is from cash crop cultivation in the rainy season, while the remaining time is used for forest and off-farm activities.

The main task of our research was to study the livelihood strategies of the villagers, and how they are affected by the National Park. Special emphasis was on agricultural intensification that was initiated in the late 1980s in Northern Thailand (*Jørgensen and Aagaard*, 2001). The Thai government has implemented development plans to substitute opium cultivation with legal cash crops. Opium was grown without chemical inputs and giving high profits to the farmers. Today their cash crop production requires a lot of inputs that they need to buy on the market. Our villages' main cash crop is cabbage,

and therefore, most information was gathered concerning this crop, both on the production side and on the marketing side.

The main occupation of the villagers is agriculture. Therefore, this study will focus on the agricultural intensification that has taken place in recent years due to land limitation. Our research question is therefore:

To what degree are the livelihood strategies of the villagers economically sustainable, and to what degree are their agricultural practices environmentally sustainable?

1.2 Definitions & indicators

In order to asses the degree of sustainability we have chosen certain indicators of sustainability and defined concepts related to our research question.

1.3 Definitions

Agricultural intensification

Boserup (1981) has defined different vegetable food supply systems according to their length of fallow: Bush-fallow is a system with 2 or more consecutive cropping seasons followed by a fallow period of 8-10 years, short-fallow is characterised by 1-2 cropping seasons followed by 1-2 years fallow, annual cropping is one crop cultivated per year followed by a few months fallow and multi-cropping is two or more crops in the same field with no fallow period (*Szirmai,* 1996). We define agricultural intensification as a change from a bush-fallow system to either a short-fallow, annual cropping and/or multi-cropping system. Also included in our definition is that intensive farming requires a higher input of labour per area unit and dependence on external inputs such as seeds, chemical fertilizers, pesticides and herbicides.

Livelihood strategies

We define livelihood strategies as the choices of activities taken by the villagers in order to provide them with the money, building materials and food needed to cover their basic needs. This encompasses the choice of which crops to grow and for what purpose (own consumption or for selling), and the amount of time spent on- and off-farm as well as in the forest.

1.4 Indicators of sustainability

Economic sustainability

The assessment of the economic sustainability of the villagers' livelihoods has two components.

1) First we analyse the **cabbage marketing chain**, which has a strong influence on the sustainability of the villagers' livelihoods.
2) Then we assess the **costs and incomes** related to their livelihoods, and see how sustainable they were in 2004. By sustainable we mean a gross income of 2 US$ a day per adult farmer, which represents a minimum standard of living and is the poverty line used by the World Bank in middle-income economies such as Thailand (World Bank, 2004). The World Bank has also defined a limit of extreme poverty: 1 $US per day. Our definition of extreme poverty is that the total net income (defined later) of the farmer is positive.

Soil erosion

The farming systems in the mountains area of Northern Thailand have led to the growing concern about the sustainability of current production methods. In this context soil erosion is mentioned as a major constraint. The Northern region of Thailand is very vulnerable to soil erosion due to its steep slopes and highly erratic precipitation (Hazarika & Honda 2001). Cultivation of tillage demanding crops such as upland rice and cabbage leads to greater erosion rates than maize and beans (Turkelboom *et al* 1997). Both of the tillage-demanding crops are cultivated in our villages, and especially cabbage is cultivated by many of the farmers.

Soil fertility

We have chosen examine levels of the three most important nutrients N, P and K, the percentage of soil organic matter (SOM) and the pH in the soils of our study area. Our definition of sustainable soil fertility is that at least a moderate amount of N, P, K and SOM is present in the soil and that the soil pH is not below 5,5 (Marschner,2002). A moderate level is defined according to the Guidelines for Thailand soils (see appendix 0).

2 Methodology

2.1 Social science methodology

2.1.1 Sampling strategy

In our villages there are 132 households, which constitute a population of 768 people. Sompoi is the largest having a total of 97 households and a population of 638. In Kia Nai there was a total of 35 households and a population of 132. We had planned to make a total of 21 questionnaires in the two villages, with 7 farmer respondents from each of the following economic groups: rich, middle and poor households. Because of the different sizes of the villages different sampling sizes were planned to be taken. In Sompoi we wanted 5 from each economic group and from Kia Nai we wanted 2. However we got the impression that no rich people were living in Kia Nai, therefore the grouping was later changed.

We asked the village headmen in Sompoi and Kia Nai to point out farmer respondents from the three different groups. This means that what we used a non-probability sampling (Rea & Parker, 1997). We saw it as important that all social classes were represented in our survey. Since we were only able to make a small sampling, we saw this as the best strategy for this purpose. Our village headman was used as a key-informant identifying the respondents. So the sampling strategy in use must be classified as snowball sampling (Rea & Parker 1997). The advantages of this method are that we use the knowledge of the villagers. It would be difficult for us to assess who in the villages fall under our classification of rich, middle, and poor. The farmers themselves have a much better understanding of this relative term. Also in order to answer our research question this stratified non-probability sampling method was very useful. By using this strategy we get a general picture of the livelihoods of the different social classes. We don't know the composition of social classes in the village, i.e. the number of rich, middle and poor farmers. However each group can be analyzed separately and compared to each other. We also asked the village headmen in Sompoi and Kia Nai to assemble a group of 4-5 farmers emphasising that they be with different economies (rich, middle and poor households), so as to represent the entire community. This was in order to undertake a PRA.

2.1.2 PRA

We conducted three PRA sessions. One was done in Kia Nai and two in Sompoi. We used methods such as community mapping, trend analysis, cropping calendars and seasonal activity calendars to get information about their livelihoods. We also investigated the changes in certain parameters over the years using a trend analysis method. This was done by drawing a community timeline, with the year of important events in the past on the x-axis and the parameter we wanted to know about on the y-axis. The parameters investigated were fertiliser use, pesticide use, price of cabbage, production costs, soil fertility & yield.

2.1.3 Questionnaires

Through questionnaires we wanted to assess the current farming systems and land use, the amounts of fertiliser, pesticides & herbicides that the villagers apply, the production costs and what soil conservation methods are practised. Respondents to the questionnaire were pointed out by the Headman so there was an equal amount of poor, medium and rich farmers.

2.1.4 In-depth interviews

In-depth interviews were conducted as semi-structured interviews and the objective was to assess both the current land use and the changes that had occurred. We knew the topics that we wanted information about but the questions were somewhat improvised. Some interviews were conducted to gain information about the step-by-step cultivation of cabbage and rice. Other interviews had a more broad topic range, gathering information about issues such as activities on- and off-farm, forest use and the role of GOs and NGOs.

2.2 Economic methodology

In order to analyse the marketing chain of cabbage, we have used open-ended interviews with key economic agents of the chain. Starting with farmers in Sompoi as well as middlemen and drivers from the village. Then we have been to Chom Thong to interview the two whole sale buyers of the town.

The assessment of the economic sustainability of the villagers' livelihood startegies has been done with help of the questionnaire which gave us detailed informations on 18 selected farmers' cost and income structure related to a) their **on-farm economy** from the different crops they were growing in 2004; b) their **off-farm economy** which is the money they earn from working outside their own land; c) their benefits from **NTFPs.** Other indicators are also analysed in the assessment such as their **expenditures** during the year, the level of their **debts** and **savings.**

2.3 Natural science methodology

2.3.1 Soil erosion

In order to determine the level of soil loss pr. year for the area we have used the Universal Soil Loss Equation (USLE): A = R * K * LS * C * P

Where A is the soil loss pr. year calculated in Mt/ha, R is the rainfall factor, K is the soil factor, LS is a topographic factor combining length and slope of the fields, C is the cropping factor and P is the conservation factor (Jensen 2003). Each term in the equation is dealt with specifically and can be found in appendix 1, where information on how values are estimated and calculated is described.

2.3.2 Soil fertility

In order to assess the fertility of the soil in Sompoi & Kia Nai, we have chosen to rely on quantitative methods in the field in order to get a picture of the current state of land use as well as how it has changed over time. These methods include collecting soil samples & analysing the soil for content of organic matter, nitrogen, phosphorous, potassium and measuring the pH. By taking samples from intensively cultivated land, plots that have been fallow for different periods of time, multi-purpose forest plots and conservation forest plots we wish to compare results from soils that have been utilised in different ways and attempt to answer this part of our research question.

Forest		Shifting cultivation		Current Farming --
No land use	→	Extensive land use	→	Intensive land use

Figure 1: the arrows indicate intensification in land use.

Soil sampling for the forest category was done in two separate locations: the multi-purpose [1]& the conservation forest[2]. Three replicates were taken in the multi-purpose forest and three were taken in the conservation forest. For the shifting cultivation category we took samples from plots of 6 & 20 years of fallow. We were not able to find a plot that had been fallow for 7-10 years which was the length of time used in the traditional farming practices of the Karen hilltribes before 1952 (Prasit, 2002 and interview with headman, Kia Nai on 15/1, appendix 2). We therefore decided to compare only the forest and the current land use data from the laboratory analysis. One sample was taken in each of the locations. The current farming category consists of samples from three cabbage fields, one from a 3 year fallow cabbage field and one from a 1 year fallow cabbage field. The soil pH was measured directly in the field.

Table 1: Because we had trouble locating proper fallow fields representing the shifting cultivation category, we only have two replicates for this category.

Category	Replicates
Forest	6
Shifting Cultivation	2
Current Farming	5

A composite soil sampling method was used. Ten soil sub-samples were collected randomly in each plot and placed in a bag. We mixed the contents of each bag thoroughly and half a kilo was withdrawn, representing the plot. The composite sample was used to test for content of SOM, N, P and K. The pH was measured both directly in the field, using the Thai soil kit, and in the laboratory.
N, P and K analysis was done both by using the Thai soil kit and in the laboratory. The content of SOM was determined in the laboratory.

[1] Trees and bamboo are allowed to be cut in the forest and NTFPs may be collected, but what is taken is only for household consumption.
[2] The villagers cannot cut trees. They can cultivate in the area but must not expand the farmland.

We used the Guidelines for Thailand soils (see appendix 0) to evaluate differences between results from the Thai soil kit method and the laboratory analysis as well as interpretation of the laboratory data.

2.3.3 Statistics

Our data was analyzed using the Mann-Whitney U-test to identify differences between the groups using our laboratory data (Fowler, 2003).

3 Critique of methodology

3.1Economic sustainability

For the marketing analysis, due to the time and geographical limitation of our study, we have not been able to follow the cabbage market to end consumer. It has to be emphasized that the marketing chain of cabbage is a sensitive issue in the region because it involves a lot of money. An example of this is that the husband of one of the buyers in Chom Thong has been shot and killed. This could indicate that these two buyers have a lot of market power and that they probably are the only ones "allowed" to buy cabbage in town.

Furthermore, there seems to be moral issues at the village level, especially from middlemen who do not want to be seen as exploiting poor farmers. This could be observed by contradicting interviews, and several middlemen not wanting us to know that they were middlemen. This suggests that the information that we got from the interviews must be taken with a lot of caution, and are a combination of information from several interviews and our critical and logical sense.

We have tried to get data at the Department of Agricultural Extension of Chom Thong on prices and quantities of cabbage in the district, but in vain. This would have allowed us to confirm the trend that has characterized the recent years: falling cabbage prices due to an increase in production.

Respondents to the questionnaire were giving us detailed information about their incomes, production costs, savings, debts etc. only from memory. They never consulted any notebooks, papers or bank notes. We were amazed that they were able to give us all these numbers, but our impression is that they were quite good at remembering the large quantity of data that we expected from them. Furthermore, one of our Thai counterparts, Nok, who conducted most of the questionnaires, was really good at

obtaining data out of the respondents. It can be quite sensitive to ask about people's incomes, levels of debt, etc. But Nok really had an ability to make people comfortable and willing to share information. When this is said it is impossible to verify that the data collected is exact. It is hard to crosscheck, and respondents had to quantify not only cash flows but also collected NTFPs that they probably do not weigh every time they return from the forest. Therefore, the data has to be taken with caution. But assuming that most people had a good knowledge of their inflows and outflows, the fact that 18 respondents gave information and that we took the average afterwards balances for errors. What is important for us is to get the overall picture of the villagers in- and outflows.

3.2 Natural science methods

3.2.1 Statistics

Since we have a limited amount of replicates in each group, i.e. forest and current land use, we were not able to establish whether if our data was normally distributed. A non-parametric test should, however, always be used if the requirements for a parametric test are not fulfilled (*Fowler et al*, 2003). Therefore in our case a non-parametric test is the only possible option to do any kind of statistical analysis. A non-parametric test has less power (reliability) than a parametric test. However non-parametric tests do not take the distribution of data into account and the variances of the different groups need not be the same. Non-parametric methods are frequently more suitable for processing biological data (as in our case) and are also simpler to use (*Fowler et al*, 2003).

Due to time constraints we were only able to take a limited number of soil samples. Ideally we should have taken 3 replications of a composite sample in each field and sampled in more fields. This would have allowed us to examine the variance within each field. If the variances turned out to be the same and the data was normally distributed, we could have used a parametric test to examine our data. Using a parametric test would have given us more reliable results. This would, however, not have left sufficient time for us to investigate the other aspects of livelihoods and sustainability of the agricultural production.

3.2.2 Soil erosion

When using the USLE-equation our conclusion is that the fields should be managed differently than is the case. However it is important to bear in mind that we are calculating a very rough estimate of the soil loss, which may not show the real picture. The best way to assess the soil erosion would be to measure the actual soil erosion on location. This would require that we were able to make direct measurements during the rainy season, which was not possible because our field work was during the dry season. While we did use on field measurements of permeability, soil texture, % slope and length of slope, some of the factors like C and P are table estimates. Therefore we rely on that these have been modified to suit Northern Thailand conditions, but we cannot be entirely sure.

The respondents to our questionnaires informed us that they had never observed any landslides. Most respondents had observed gully erosion (9 farmers) and soil sedimentation at the bottom of the slope (8 farmers). One farmer said he had observed a landslide last year (Mr. Kitipong, appendix 2). We did not see any evidence of very severe soil erosion when on location in the fields, however we did observe minor root exposure on two of the three cabbage fields. It should be noted that our study was conducted in the dry season, and the situation might be different in the rainy season. We should, however, be cautious to base our conclusion only on the information that we can withdraw from the USLE-equation. It seems that the severity of the soil erosion in the area is not as bad as calculated and the USLE-equation is most likely over-estimating the soil loss.

3.3.3 Soil fertility

The problem with the Thai soil kit is that the nutrient level is determined qualitatively by the person performing the analysis. The level of the nutrient is determined by comparing the colour of the extraction fluid with a colour chart. Accordingly there is a high risk of getting different assessments on the level of the nutrient under investigation. Therefore we have not analysed this data in the report.

When we compare the results from the laboratory with the Thai soil kit analysis, there is a clear inconsistency. Some of the differences can be explained. The laboratory test gives the total N in the soil. The soil test kit only gives the amount of the plant available nutrients NH_4^+ and NO_3^-. The values from the soil test kit and the laboratory analysis of N are therefore not comparable. Yet the values of K and P should give the same results, no matter which of the two methods was used. The results from

both methods showed the same pattern for P. The cabbage fields had higher values than the forest plots. The values, however, were not in the same range. The two different methods did not yield any similar pattern for the K values (appendix 3).
Another difficulty is that there is generally a big variation between soils, which makes it hard to compare and group the soil samples together. Furthermore, we did not have enough time to collect as many replications as we would have liked. Especially the shifting cultivation group is lacking replicates, because these plots were hard to locate.

We have chosen to look at the agriculturally most significant macronutrients (N, P & K) since these are the constituents of the compound chemical fertilisers used in our study area. However 16 elements are essential for plant growth. They are classified as being either micro- or macronutrients according to their relative concentration in plant tissue. It would have been relevant to test for magnesium deficiencies which can occur in fields with high potassium levels like in our case. Magnesium is a micronutrient which is part of the ring structure of the chlorophyll molecule and thus has an important function in photosynthesis (internet1) (*Taiz und Zeiger*, 2002). Unfortunately we did not receive our results in time to examine this and our budget was not sufficient to allow for plant analysis.

4 Results and discussion

4.1 Livelihoods of the villagers

The Karen households generally have a diversified livelihood strategy doing activities falling into these three overall groups: On-farm, Off-farm and Non-timber-forest-products collection. In Kia Nai we made a time use diagram. We wanted the farmers to estimate which of the three previously mentioned groups, they spend most of their time on. The result is shown in figure 2.

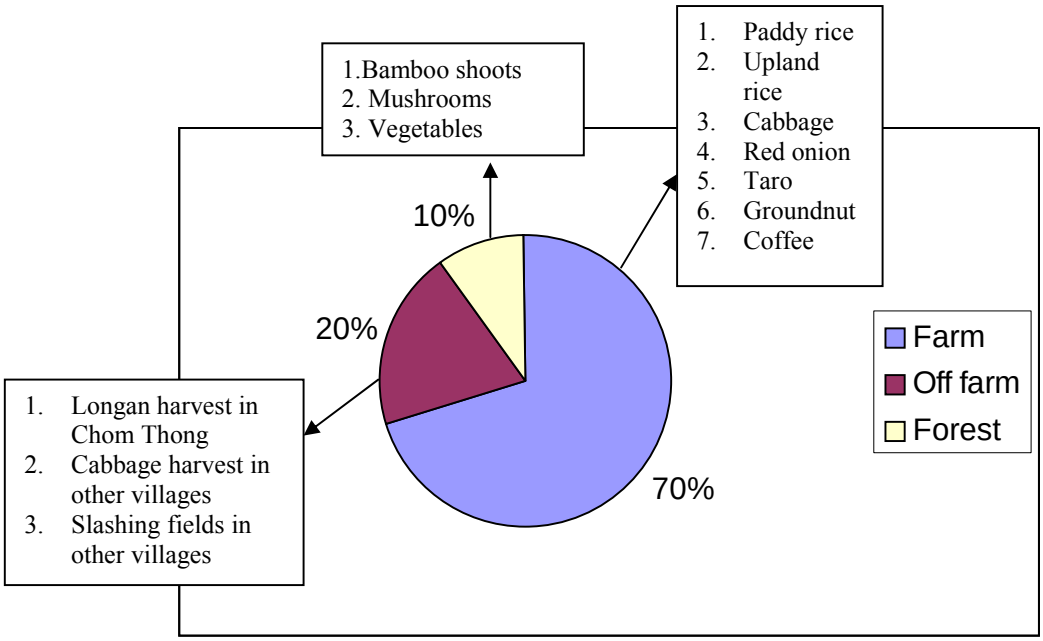


Figure 2: Time use over the year with ranking of crops and activities (PRA done in Kia Nai)

During the PRA session in Sompoi conducted on 22/1, the villagers drew a seasonal activity calendar, showing what time of year they spent time in the forest, on-farm and off-farm. They were asked to rate their activities in each of these categories as either low, medium or high for each month of the year. **Figure 3** shows the result from the PRA conducted.in Sompoi on 21/1.

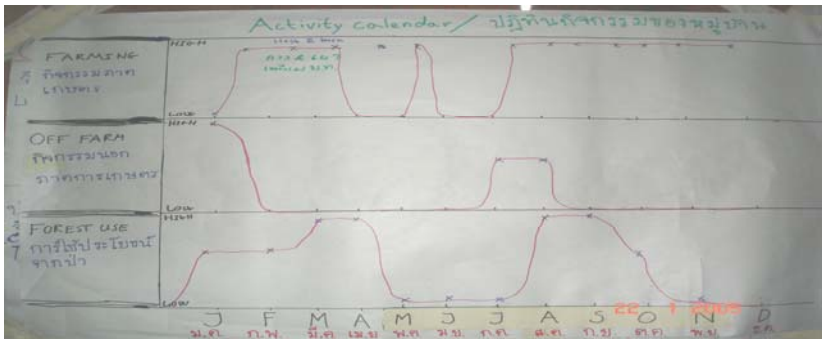
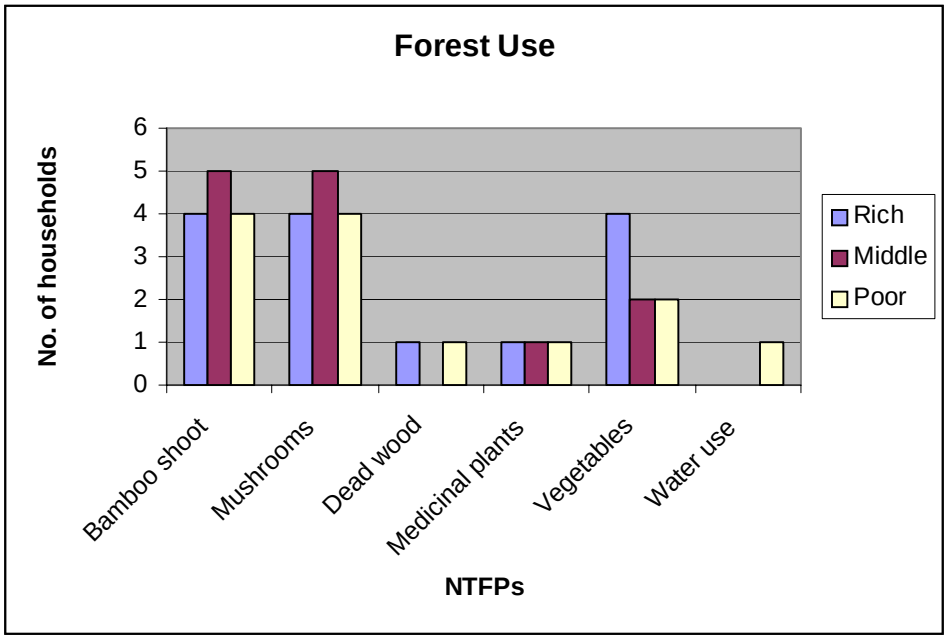


Figure 3: Activity calender (PRA Kia Nai)

4.1.1 Non-Timber-Forest-Products

From figure 2 we can see that NTFP collection is the activity the farmers use the least of their time on (only 10%). However in the questionnaire we found that all respondents, except for one, went to collect NTFPs. This shows that the forest is of importance to their livelihood. From figure 2 we can see that bamboo shoot collection was ranked as the most important forest product, followed by mushrooms and wild vegetables.

This ranking is also supported by the findings from our questionnaires (see figure 4). In all the groups (poor, medium and rich) bamboo shoots and mushrooms were the products that most of the farmers collected followed by vegetables (i.e. banana flowers). In all income groups the products from the forest were only used for household consumption.



F**igure 4:** NTFPs collected based on responses from the questionnaire. Rich n=5, Middle n=6 and Poor n=7

In January and February many different products are collected in the forest and the activity is on a medium level. Vegetables are collected in March and April (high activity). Mushrooms and bamboo shoots are collected in August and September (medium level) (see **figure 3**).

4.1.2 Off-farm activities

The participants generally estimated that they used twice the amount of time doing this activity compared to the forest collection (see figure 2). Furthermore they ranked their off-farm income sources. Longan harvest in Chom Thong was ranked as most important, followed by cabbage harvest in neighbouring villages and slashing fields in neighbouring villages (see figure 2).From the questionnaire we found that the activities were very diversified among the farmers (see figure 5). Different activities

were mentioned: handicrafts such as weaving were done by the women, transporting people and products, wage from the service sector (working in restaurants and in the Chom Thong marketplace), off-farm labour (slashing and harvesting in fields in other villages), in-farm labour (working for other farmers in the village) and trading. Some did not have any off-farm activities

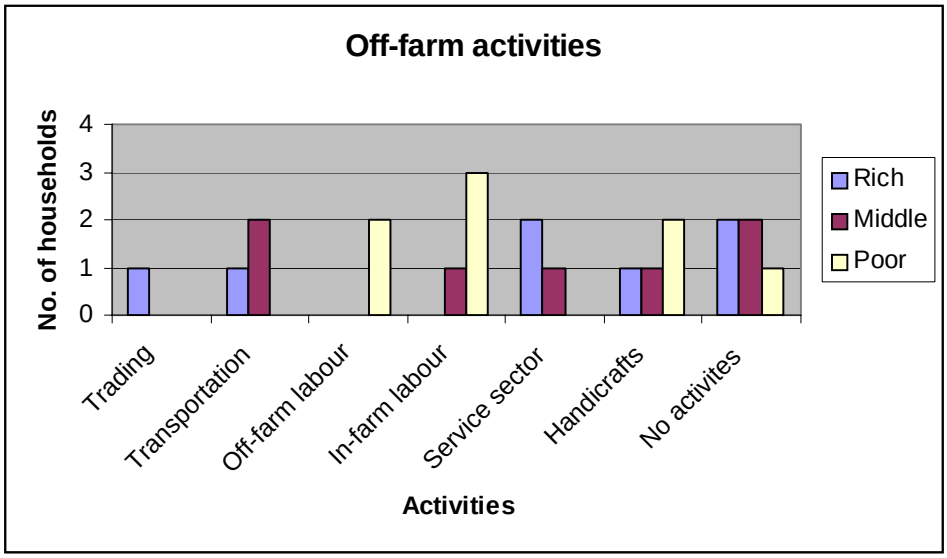


Figure 5: Off-farm activity distribution of rich, middle and poor income farmers based on the questionnaire.

In January handicrafts are produced (high activity) and in July and August villagers work in the lowlands harvesting longan (medium activity) (see figure 3).

4.1.3 On-farm activities

Figure 2 shows that by far the most time is spent on on-farm activities (70 % of their working time). Based on this, on-farm activities must be seen as very important for their livelihoods. The figure illustrates which of the crops they defined as most important. In Kia Nai the villagers rank the two different kinds of rice as the most important crops, followed by cabbage, red onion, taro, groundnut and coffee. This also shows that they see cabbage as the most important cash crop. We have obtained information from TAO (Tambon Administration Office) about the areas used for different crops in both villages. We added the cultivated areas of the two villages together, giving us information for the entire study area This information is illustrated in figure 6.

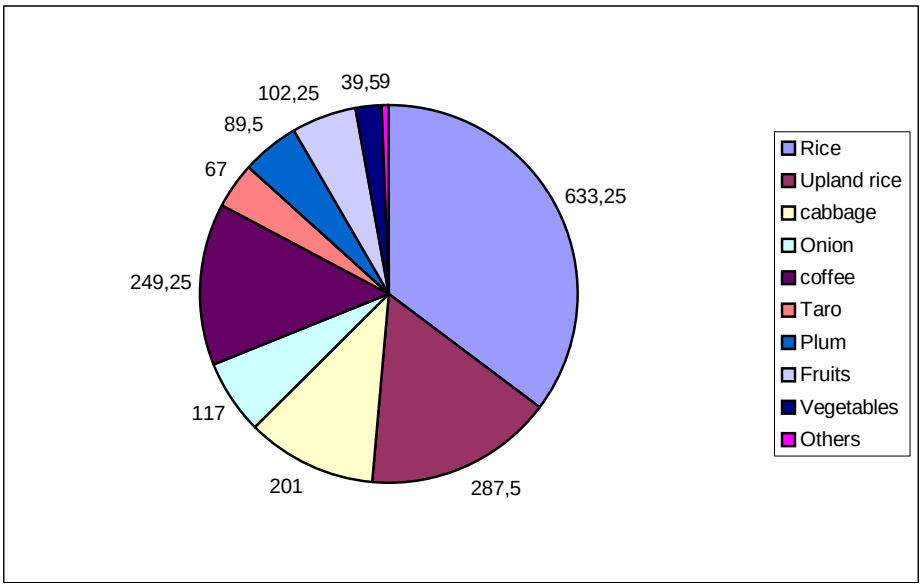


Figure 6 Total cultivated area of both villages

From February through March the fields are slashed and burned. Soil preparation, planting, weeding, harvesting, etc. takes up the rest of the year and the activity is on a high level from February to December. There are practically no on-farm activities in January (see figure 3).

A cropping calendar for each crop is included in appendix 4. In the following section we will describe the cultivation of both cabbage and rice. Paddy rice cultivation has not changed much in recent years and only a few respondents use fertilisers and pesticides. We wish to compare their traditional paddy rice with the newly introduced cash crop, cabbage.

4.2 Rice Cultivation

Two types of rice are cultivated in our study area: Upland rice and paddy rice. There are major differences between the two. Upland rice is grown as a normal rainfed cereal crop which implies that the seeds are sown directly and the fields are not flooded (no use of seedbeds). Yields seldom exceed 240 kg/rai (Espig & Rehm, 1991), while paddy rice cultivation in our study area produced 835 kg/rai on average (questionnaire).

The cropping calendar, in table 2, shows the period when paddy rice is cultivated.

Table 2 : Cropping calendar for paddy rice. Red indicates the growing period, yellow is the land preparation and blue is the harvest period for the general paddy rice cultivation in Sompoi and Kia Nai.

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growing period												
Land preparation												
Harvest												

Paddy rice is cultivated each year on terraces. In May seeds are sown in a seedbed and the soil is prepared using a ploughing machine. Soil preparation takes two days pr. rai. In the past buffaloes were used as draft power and soil preparation took up to one month. In June seedlings are transplanted. Few farmers apply fertiliser, instead manure from buffaloes and cows is used. When the fields are not cultivated (dry season) the animals graze on the fields. During cultivation they are released into the forest areas. Weeding is done one month after transplanting. This activity is performed only once and takes five days (one person pr. rai). During harvest 20 people pr. rai work each day. The rice is then stored in a ”rice house” to dry for one year. The processing is done using a traditional farming tool called a ”chomo chomo”. (interview with headman, Kia Nai on 24/1, appendix 2 and the PRAs conducted the 15/1 and 22/1 in Sompoi,).

4.3 Rice inputs and yields

We have compared the yields of paddy rice in our villages (questionnaire) with averages from Chiang Mai and Thailand. Figure 7 illustrates that the yield in our study area is clearly higher than the average yield for Thailand and Chiang Mai. This proves that they are well adapted to the cultivation of their main traditional subsistence crop.

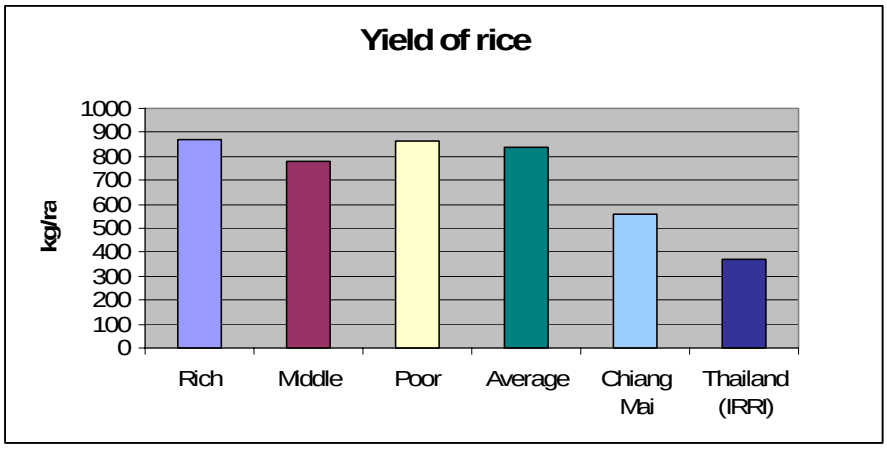


Figure 7: Yields of rice for rich, middle, poor income and the average yield for all groups as well as the average yield in Chiang Mai province (Agricultural statistics of Thailand, crop year 2002/03) and Thailand (IRRI)

Chemical fertiliser is only used by 1/3 of the farmers and compared to cabbage this crop does not need as much fertiliser. The average fertiliser application for all groups per rai was 11,2 kg.

Pesticides were only used by one farmer. All the other questionnaire respondents did not use any pesticides. The calculations of all values can be found in appendix 5.

4.4 Cabbage cultivation

Cabbage is classified as a cold-season crop, but heat-tolerant varieties are grown in the warm season in tropical areas, since warmer temperatures prolong the vegetative stage of the crop. Cabbage can be grown on most soil types but soils that retain moisture well are preferred when the precipitation is approximately 450 mm per year (FAO 2002*)*. Average annual rainfall in the Chiang Mai province is 1321,9 mm and the soils in our study area are predominantly sandy clay loams, which means they have a moderate infiltration rate. Under high rainfall conditions as in our research area, sandy or sandy loam soils are preferable, since they have good drainage (FAO, 2002). Seed germination is best at a soil temperature of 55 – 60 ° F (Hong). Cabbage cultivation requires large inputs of fertiliser and pesticides and these are often applied in very large amounts to protect against nutrient deficiencies and pests. Overuse of fertiliser is common in Asian countries, where fertiliser is relatively cheap, and this overuse can be detrimental to both crop and environment. Cabbage, though, is one of the more efficient

nitrogen users, with leaching losses of only 30-40 kg N/ha compared to spinach and leek which has losses of up to 200 kg N/ha (Vegetable sector in Thailand, 1996). The variety of cabbage grown in our study area is *Brassica Oleraceae* var *capitata* (interview with Royal Project 17/1, appendix 2)

Cabbage can be grown twice a year if there is a sufficient amount of water. However in our research area it is only possible to grow a second crop of cabbage, when irrigating the field. Most villagers in Kia Nai and Sompoi only grow one cabbage crop per season.
From our questionnaires we found that the villagers had two sources of water: rain and access to a natural stream through channels. All respondents were dependent on rainfall, however not all had access to the stream (see table 3).

Table 3: Access to the natural stream of farmers from different social classes

Income group	No. of respondents	Access to natural stream
Rich	5	4
Middle	6	5
Poor	7	2

Table 3 shows that almost all rich and middle income farmers had access to the stream, but only 2 out of 7 poor farmers had access. There might be a correlation between access to water and cabbage yield, and thus indirectly income. Sprinkler irrigated cabbage fields were only found on two locations during our visit. This practice was not widespread among the villagers.

Generally the villagers have a standard way of cultivating cabbage. In the following section a description of the system will be given and compared to rice cultivation in order to illustrate the intensification. The following section is based on information gathered from PRA held in Ban Huai Sompoi the 15/1 2005 as well as interviews with the village headman of Ban Pa Kia Nai (24/1) and Mr. Kitipong from Sompoi (appendix 2)

After the rainy season begins a seedbed is made. Normally the most fertile part of the field is used for this activity. Some villagers prepare the soil using slash and burn others just slash (questionnaire

information). From May till June the soil is prepared using a spade and the seeds are sown by hand in the seedbed, which is part of the field. One month after sowing the seedlings are transplanted to the field. Planting is done by making a hole with a stick, adding fertiliser (100 kg), then a little soil and finally the seedling. The distance between plants is 30 cm. After transplanting the field is examined for pests every week. One and a half months after transplanting 100 kg of fertiliser pr. rai is applied. Every farmer in the questionnaire used a fertiliser with the composition 16-20-0 (N,P,K) when growing cabbage. This activity takes two days if there are no problems with insects. In August the plants are examined. If the plants are mature the cabbage is harvested. Ten people (exchange labour[3]) is used for the harvest. If the yield pr. rai is 5000 kg, it will take 5 days to harvest (one truck load everyday of 1000 kg). Table 4 shows the following activities during cabbage cultivation: growing period, land preparation and harvest.

Table 4: Cropping calendar for cabbage. Red indicates the growing period, yellow is the land preparation and blue is the harvest period for the general cabbage cultivation in Sompoi and Kia Nai.

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growing period												
Land preparat.												
Harvest												

4.5 Cabbage inputs and yields

In the following section we are going to compare the fertiliser use and yields of cabbage in our villages, with values from FAO (converted from ha to rai) (FAO 2002). The yields we compare with are worldwide yields and fertiliser inputs for the cultivar *Brassica Oleraceae* var *capitata* which is the cabbage variety cultivated in our villages.

The calculation of yields and inputs are done by using the information from the questionnaires. Here information was gathered about field size used last year for cabbage cultivation, their inputs of fertiliser in cabbage, and their yields of this crop. The respondents were as mentioned previously categorised

[3] Villagers help each other in period of harvest (exchange of working hours, not money)

into three groups: Rich, middle and poor. The calculation of average yields and input of fertiliser for the three groups can be found in the appendix 5.

The average amount of fertiliser use pr. rai for all groups was 140 kg. What we can see from figure 8 is that it is actually the poor farmers that seem to apply the highest amount of fertiliser (156kg of 16-20-0). The rich and the middle groups applied 132,5 and 127,3 kg/rai respectively. The higher amount of use in the poor group could be because of a more poor quality of soil, compared to the other groups. Another possibility is that the poor farmers are not as skilled farmers as the other groups.

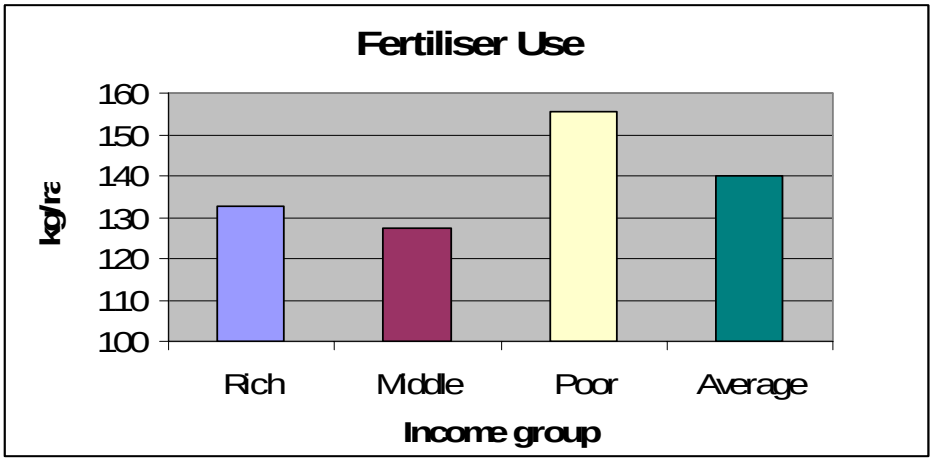


Figure 8: Average fertiliser use pr. rai

Figure 9 shows the amount of N applied. The pattern is naturally the same as for fertiliser use. FAO has set the range for recommended application of N to be between 16 and 24 kg/rai. In our graph we have used the maximum recommended application of N. The poor farmers apply even more N.

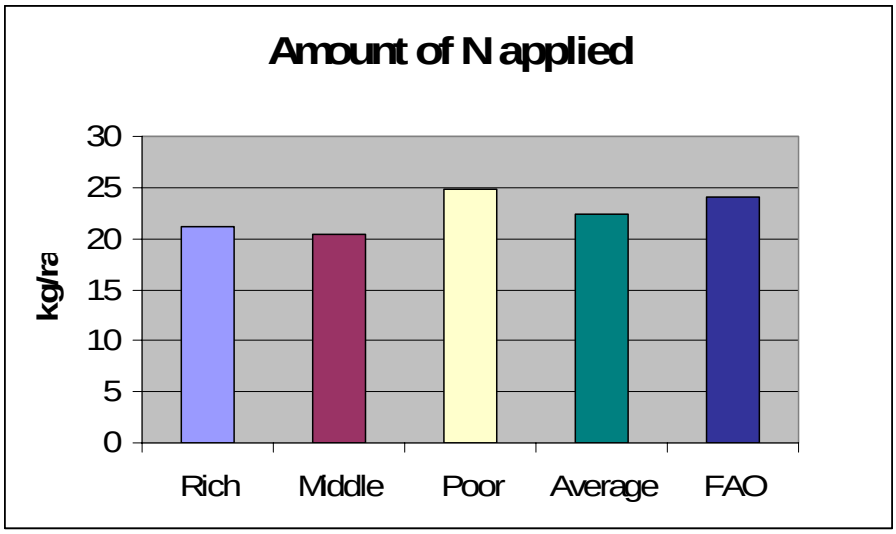


Figure 9: The amount of N applied in fields of all income groups, average amount for all groups and N requirement from FAO.

The amount of P applied on average for all income groups is about 1,5 times higher than FAO's recommended maximum amount (range 8-10 kg). Our soil fertility analysis showed that the average level of P in the study area was very low (compared to guidelines for Thailand soils) and that the pH was at such a low level that aluminium toxicity could occur. If the plant available P is bound to aluminium oxides, then more fertiliser is needed.

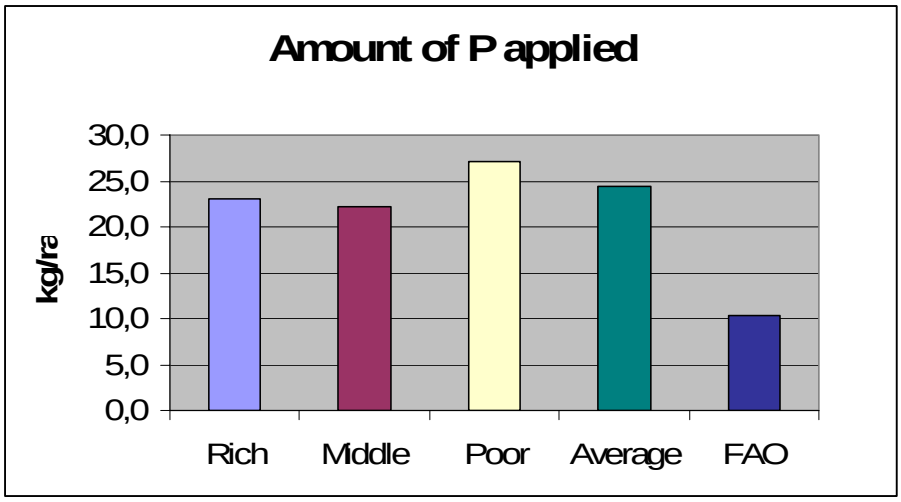


Figure 10: The amount of P applied to the fields of rich, middle and poor income farmers, the average amount for all groups, and P requirements from FAO.

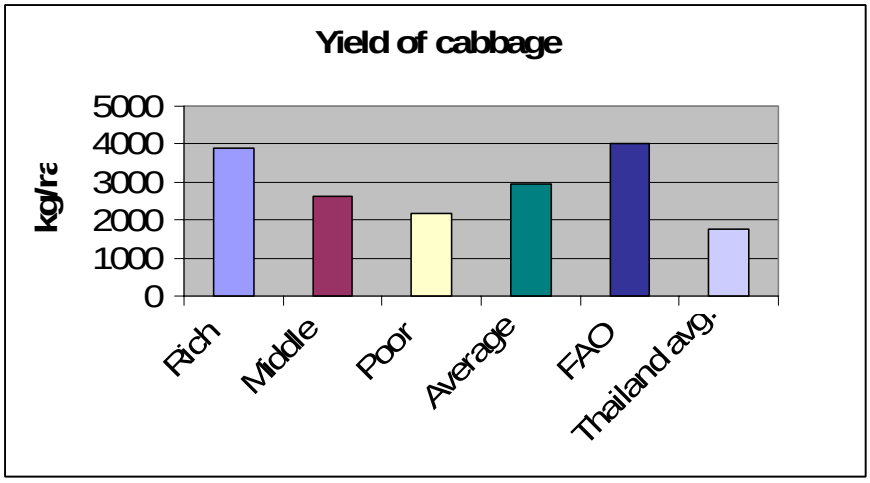


Figure 11: Yield of cabbage for rich, middle, poor farmers and average yield from all groups as well as FAO (1999) potential yield under favourable conditions and the Thailand average.

The yields in figure 11 show that the middle and poor farmers have yields that are 1500-2000 kg below the worldwide normal yield of cabbage and considering the amount of especially P applied, the fertiliser application does not produce the potential yield when compared to FAO (FAO, 1999). With regards to P, this may be due to either aluminium toxicity or that the farmers are poorly skilled. However the rich farmers are producing an amount that is very close to a normal yield according to FAO.

Still, the yields for all income groups are higher than the average production of cabbage in Thailand, which is 1775 kg/rai (Statistics 1990-2000). This confirms the general perception that the natural conditions in the highlands of Northern Thailand are the most favourable place for cabbage cultivation in Thailand. The cooler temperatures reduce the number of pest generations (Rushtapakornchai & Vattanatangum, 1985) and diseases, the temperature is optimal for cabbage cultivation and head quality is high (FAO, 1999).

Last year 2/3 of the respondents used insecticides. On average they use 310 ml of insecticides pr. rai on their cabbage fields. The poor respondents used more insecticides (367 ml pr. rai) than the other two

income groups (285 and 264 ml pr. rai). This could be because they lack skills in proper pest management. All calculated values can be found in appendix. 5.

4.6 Summation of differences between rice and cabbage cultivation

Paddy rice cultivation follows a more traditional, low input farming practice, where chemical fertiliser is only used in the farming system by 1/3 of the respondents. Instead of chemical fertiliser, manure is used as input of nutrients. Only one respondent used insecticides.

Cabbage cultivation is a high input farming system. Chemical fertilisers were applied by all respondents in all groups. The poor used the largest amount of chemical fertiliser. Insecticides were used by 2/3 of the respondents, where the poor respondents used the largest amount. Compared to rice, insecticide use was more integrated in the cabbage farming system. From interviews we learned that at least some farmers check their fields for pests and only apply insecticides if necessary. Therefore more than 2/3 of the respondents may actually apply insecticides.

4.7 Shifting Cultivation Vs. Intensive agriculture

During our PRA in Kia Nai we asked the villagers to compare shifting cultivation with the current intensive farming practice. We asked them to list the advantages and the disadvantages for both agricultural practices. The result is shown in figure. What can be extracted from the table is that the villagers clearly see more environmental benefits from their traditional farming system. In the traditional farming system there was a higher SOM content, less weeds and a higher level of soil fertility. Furthermore there was no need for chemical inputs and they were able to cultivate a variety of crops in the same area. It seems that the villagers are very familiar with this farming practice and that it is an integral part of their culture. The only drawback they mentioned was that this cultivation practice required large amounts of land and some farmers did not have access to areas of sufficient sizes.

Table 5 : Result of PRA ranking from Kia Nai on 23/1

Shifting cultivation	**Agricultural intensification**
Benefits. / Pros. 1. The increase of yield due to more SOM, less weeds. 2. Level of soil fertility increases. 3. No need for chemical substance. 4. Be able to plant variety of crops in the same area (crop-switching).	Benefits. / Pros. 1. Gain income. 2. Be able to afford stuffs for comfortable life. 3. Better livelihoods.
Drawbacks. / Cons. 1. Limitation in land-farmers with limited area can't manage to shift their cultivation area.	Drawbacks. / Cons. 1. Most villagers lose their benefits (started to become severe in 2004). 2. Soil fertility declines. 3. High cost of inputs. 4. Debt (started in 2003) with the 1 million baht Fund. 5.Soil erosion.

According to the villagers the benefits of intensive farming is that they have an income, making them able to purchase commodities and lead a more comfortable life. However they linked many detrimental effects to this farming practice such as decline of soil fertility, soil erosion, loss of benefits, high cost of inputs, and debt.

It must be noted that they did not rank the lack of money as a major drawback of their traditional farming practices. It therefore seems that it is of minor importance for them to have funds for purchasing a car, television, etc.

5.1 On farm economy

Out of the 18 respondants to our questionnaire, 17 were growing rice, 15 were growing cabbage and red onion, 5 coffee and 3 taro. Their average cost, income and profit structure is illustrated in figure 12. Inputs are costs related to seeds, fertilizers, pesticides and agricultural tools. Own labour is not calculated in our model, which means that profits are without the farmer's wage.

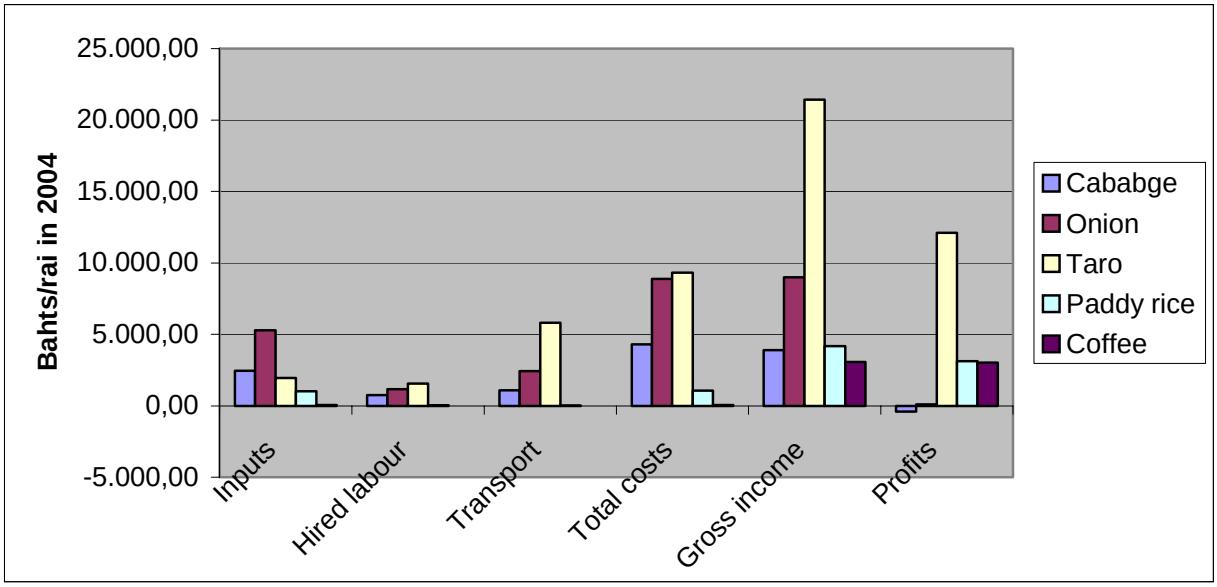


Figure 12: Average Costs, Income and Profits per rai for the main crops produced in Sompoi and Kia Nai in 2004 (Questionnaire: for details see appendix 6 to 11)

The outcome of figure 12 will be analysed from the most profitable crop to the less profitable crop.

Taro

Taro is cultivated on 67 rai in the two villages put together, or on 4% of the total agricultural land (see figure 6). In that sense it can be seen as a marginal crop. Yet, taro was the crop giving the highest profit per rai, namely 12,111 bahts. Total income was 21,428 bahts per rai, which is by far the highest income compared to the other crops. The costs of producing taro have also been the highest of all crops, namely 9,313 bahts/rai, which could explain the farmers' reluctance to plant that crop since it requires quite big investments. This is underlined by the fact that 2 of the 3 farmers who planted taro were rich farmers. The main part of the total costs is transportation costs, which indicates that the market for selling taro is far away from the village. Transportation costs of taro are more than 2 times the cost of transporting cabbage. This makes it more difficult for farmers not owing a pick-up to produce taro. The costs of other inputs are quite similar to cabbage.

Rice

Rice is by far the most important crop for the farmers. Rice is grown for own consumption and is the stable crop of the Karen people. It has therefore a high value to them. The way we have valued it is explained on p.35. The costs of producing rice are low compared to other crops since only a few chemical inputs are being utilized. Machines have substituted labour, meaning that labour costs are saved but machine costs have emerged. But it has released time for the farmers to do other activities.

Coffee

Coffee is grown on 250 rais in the two villages together, and is a crop of growing interest to the farmers. Five farmers of our questionnaire produced coffee in 2004. Again this seems contradictory with the fact that it had quite high profits, namely 3,008 bahts/rai on average. But it might be explained by the fact that coffee only starts to generate an income 3 years after planting. This implies that the farmers are able to invest, spend some of their time during 3 years before getting any profit from it. Poor farmers will typically not have incitements enough to plant that crop. This is supported by the fact that only 1 farmer out of the 5 from the questionnaire who grew coffee was poor. But coffee is interesting for the farmers because it has very low production costs. Furthermore, it can be grown in the community forest under agro-forestry, and thereby not require specific land and compete with other crops. This has been observed in the field. Another advantage of coffee is that it can be sold directly to the buyer of the village: teacher Kham who then processes it and sells it to the hospital of Chom Thong

where it is used for detoxication. Overall, the big advantage of coffee production is that that the total costs are close to zero.

Red onion

Red onion is grown on 117 rais of land or 7% of the agricultural area (see figure 6), making it the second main cash crop of the villages. Red onion yielded small profits in 2004, namely 289 bahts/rai. Despite positive average profits, 10 farmers out of the 15 who grew onion suffered economic loss. This seems due to the fact that the production costs were high compared to other crops, mainly due to high seed prices, which were more than 4 times more expensive than for cabbage. Transportation costs were also higher than the ones for cabbage, since red onion is sold on a market further away than Chom Thong.

Cabbage

On average, there has been economic loss on cabbage in 2004. Out of the 15 farmers who grew cabbage, only 7 had a negative profit but it outweighted the positive profits. The advantage of cabbage for the farmers is that there is a market where they can sell the cabbage. In Chom Thong, they can sell their cabbage to 2 different buyers. The following chapter will look further into how cabbage is marketed.

5.2 Marketing analysis of cabbage

5.2.1 The price problem

When asked in the questionnaire what the major constraint of growing cabbage was, all respondants answered: **the price**. During PRAs, we found out that the price of cabbage was 15 bahts/kg when the village started to grow cabbage. It has been falling since, and last year prices were at their lowest levels so far; namely 1.3035 bahts/kg.

The market price of a product depends of supply and demand. The demand will depend on the retailers in Bangkok etc. who depend of the end consumer. For example there are periods where the demand increases such as during the vegetable festival and the Hmong New Year, where the price gets high due to the higher demand.

The supply will depend on the quantity supplied on the market, and thereby on the number of farmers producing cabbage as well as the area devoted for cabbage growing. According to our interviews, cabbage production has increased sharply in recent years due to the economic crisis where people became unemployed and returned to agriculture. This combined with an increased import from Laos should, according to our interviews, be the main reasons of an increased supply in recent years and thereby causing the fall in prices. Statistics confirm the increase of *Brassica oleraceae L.var.capitata* production in Thailand: the planted area under cabbage in 1994 was 45 408 rai; it has been increased by 39.2 percent to reach 63 220 rai in 1998 with a production of 188,914 tons (FAO, 1998). If the trend of increasing area devoted to cabbage has continued, the last years of decreasing prices that everybody was talking about seems to be explained by the statistics. But actual statistics on price trends of cabbage have not been found. The only statistics on prices that we found were average farmer prices of cabbage in Chang Mai Province shown in figure 13.

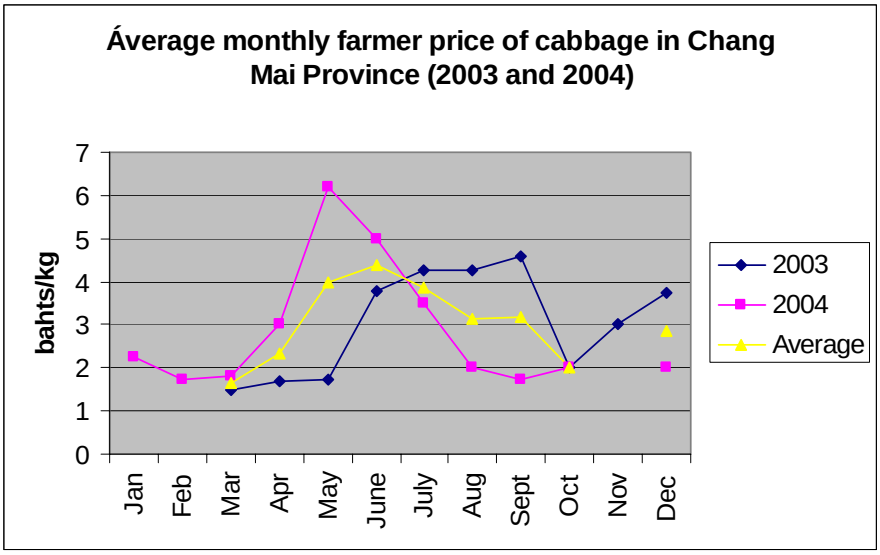


Figure 13:Average monthly farmer prices of cabbage in Chang Mai Province (2003 and 2004)
Source: Agricultural and Co-operatives of Chang Mai (2005)

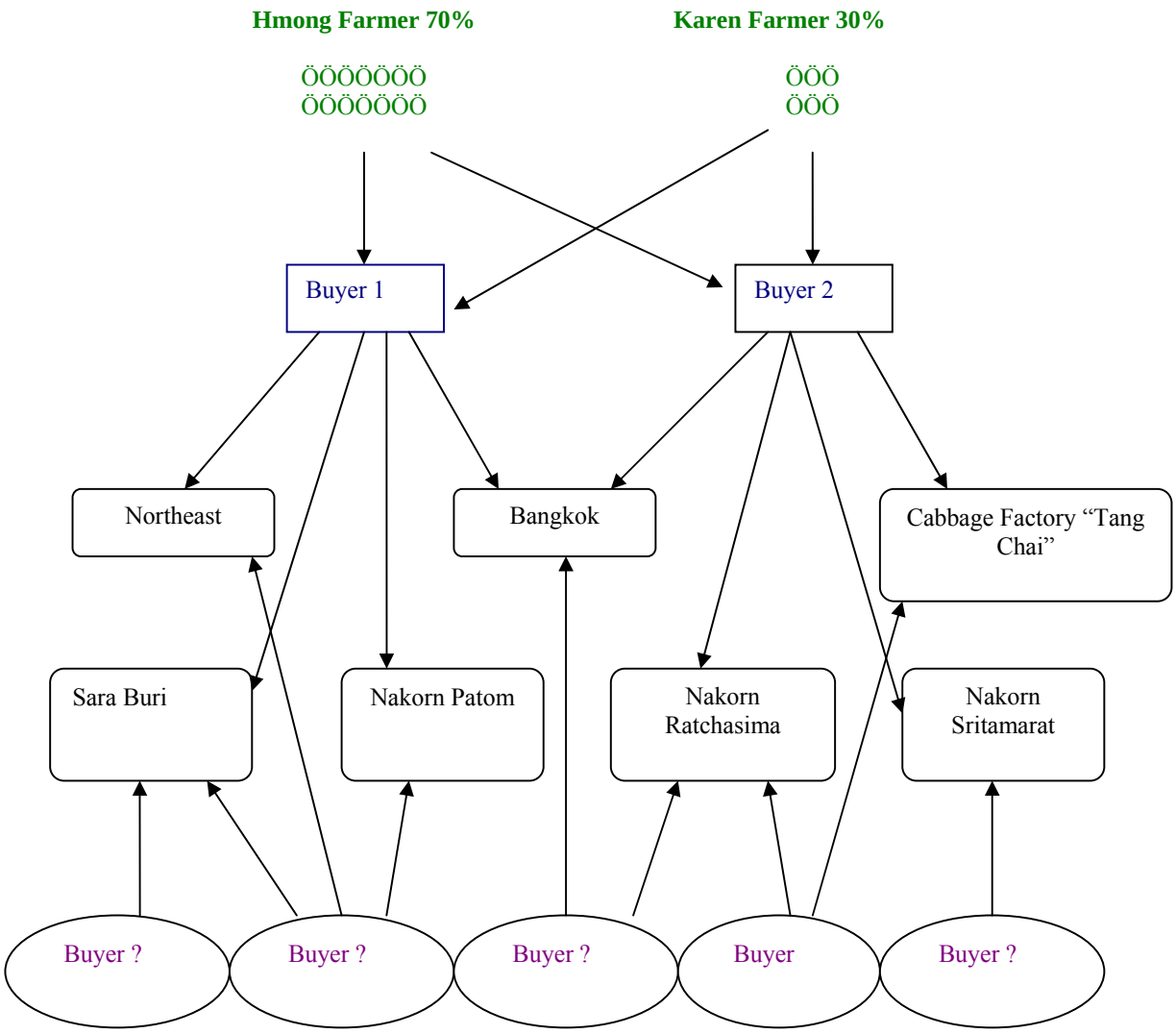
Price fluctuations over only two years is not enough to see any trend of falling prices over time. But what it could be used for, is to see if there is any pattern of periods of low and high prices. This could be used by the farmers to plan when to plant their seeds, if for example they knew that they could harvest in periods of high prices. Figure 13 shows that prices are highly fluctuating, but also that there is not really a season price for cabbage from year to year. For example in May the price was 1.75 b/kg

in 2003 and rose to 6.2 b/kg in the same month in 2004. Prices increased between June and September 2003 while they were decreasing in the same period the following year. This makes it hard for farmers to predict when they should plant if they want to get the highest price. Altogether prices seem unpredictable and farmers are price takers. What also can be noticed from figure 13, is that farmer prices on average in Chang Mai Province in 2004 seemed higher than the 1.3035bahts/kg received by the farmers in Sompoi.

5.2.2 Organisation of the cabbage chain

A closer analysis of the cabbage chain can help understanding why the prices paid to the farmers are low. Though, it must be said that the organisation of the chain is complex. Therefore, it is not easy to get an exact picture of how the market is functioning. If an analysis was made, like setting up a model; the assumptions should be carefully studied because wrong assumption would give wrong results.
The market of cabbage is characterized by many small farmers in the highlands producing cabbage and selling it to the only two buyers of Chom Thong. In the villages there are two ways for the farmers to produce cabbage. Either they produce for a middleman who drives the cabbage to Chom Thong, or they produce for themselves and are dependent of a driver to deliver the cabbage to the market, in case they do not own their own pick-up. The cabbage is transported to the market in pick-ups with a capacity of 1,400 kg of cabbage. When the buyers have bought the cabbage it is loaded on 12,500 kg trucks that will drive the cabbage over long distances to factories or other retailers in Bangkok, Sara Buri province, Nakom Patom province, Nakom Ratchasima province or the “Tang Chai” cabbage factory where it is conditioned in cans before being sold to the final consumer. This marketing study of the cabbage chain focuses mainly on the chain between the farmers of Sompoi and the two buyers of Chom Thong.
The marketing chain is illustrated in figure 14.

Figure 14 Marketing chain of cabbage



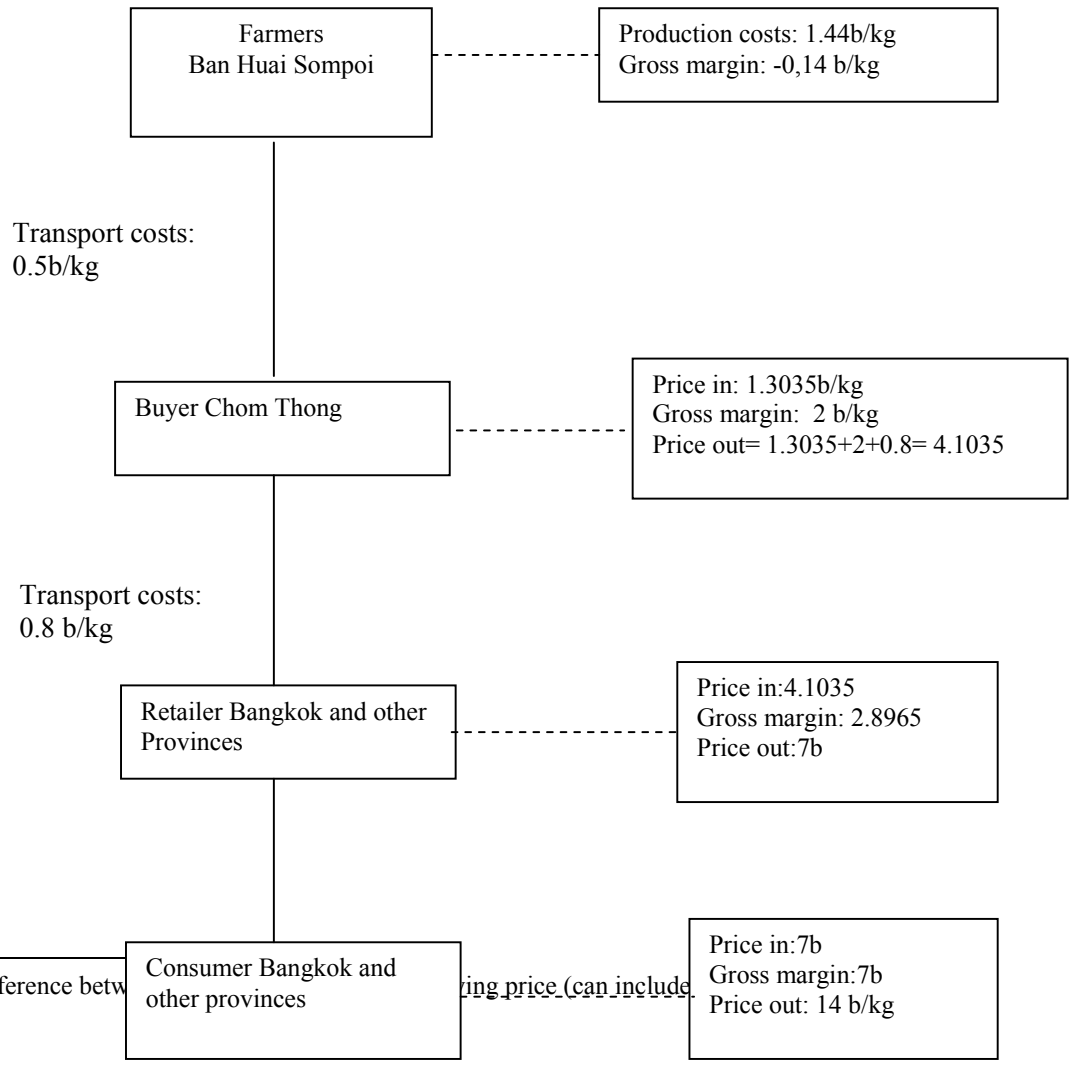
We will now describe the process when a farmer or a middleman wants to sell his cabbage to the buyers. The day before cabbage is ready to be harvested, the farmer will phone his or hers buyers and inform them about the amount of cabbage they are ready to harvest. If the buyer needs the cabbage and is willing to buy it, they agree that the cabbage will be harvested and delivered the following day. It should be emphasized that when the middleman phones to the buyer, he does not get any information on the price he will get for his cabbage the following day. He can only know the price of the day he is phoning, by asking one of his relatives who sold cabbage that day. But prices of cabbage seem to have a high volatility, and can drop more than 50 stangs[4] per kg from one day to the other. For example, a middleman showed us a few selling coupons, and the price was 4.48 b/kg. on 14/09/03 and dropped to 3.98 baht per kg on 15/09/03, which is a fall of 50 stangs or 11.2% overnight. This means that the middleman does not have any chance to predict the price he will get, and is at the mercy of the daily and highly fluctuating market price.
If the buyer does not need the cabbage, the middleman can only try the other buyer in town and if none of them want the cabbage the middleman has no choice but to leave the unharvested cabbage in the field, and phone again the following day. From the moment the cabbage needs to be harvested, it can only stay in the field between seven and ten days. Cabbage is a fresh product, giving even more power to the buyers. This is an extra pressure put on the farmers but so far, they have almost always been able to sell their cabbage, but often at a very low price in these periods of high supply. The fact that cabbage is a fresh product gives extra power to the buyers. And it reduces the power of the farmers: they cannot conserve the cabbage when prices are low and sell it when prices are high.

The two buyers in Chom Thong buy their cabbage from many small producers localized in the highlands around the town. On a market with only two buyers and many small producers, the market power is in the hands of the buyers. The day we interviewed both buyers, the market price was equal in both places, namely 3.50 bahts/kg. This indicates that they agree prices together in order not to compete each other. If they do so, the two buyers have monopsony power, which means that they are able to set the price of what they are buying. By reducing the quantity they buy from the farmers, they depress the price paid to them. That would leave farmers with unsold cabbage and force them to accept lower prices. The smaller quantity available on the market will increase the price the buyer will sell its

[4] 50 stangs= 0.5 bahts

product to. So the buyer will buy the cabbage cheaper from the farmers than under free competition and sell it to a higher price to the retailers in Bangkok. The question now is if the two buyers in Chom Thong really have the monopsony power. Are there not other wholesale buyers in the area? And to know how much power the Chom Thong buyers have on the whole Thai cabbage market, on should know how many other wholesalers there are on the market, as well as what the power structure between them is. These other buyers are illustrated in figure 14. We have not been able to find out the latter. But what could indicate that the buyers of Chom Thong have a kind of monopsony power, is that Sompoi's farmers received a lower price for their cabbage than average farmers in Chang Mai Province. Why do they not sell their cabbage to their wholesale buyers? Probably because they are too far away, and that transportation costs would be too high. Figure 15 shows the margins[5] at each level of the chain.

Figure 15: Margins in the cabbage chain (questionnaire, interviews, contacts in Bangkok)



[5] Difference betw ing price (can include

Figure 15 shows that the further down the marketing chain you get, the higher the margins. This is typical for food products. Farmers,who are doing the hard work, often hardly get their costs covered while the final seller, like supermarkets, double the prices. What is interesting to notice in figure 23, is that the buyers in Chom Thong make 2 bahts/kg of profits, while the farmers make none, and even a negative one in 2004. If the farmers could jump the buyer chain and directly sell to retailers in Bangkok or other Provinces at a price of 4.1035. This would require that they organised themselves, maybe with other villages, and invested in a truck . A closer cost-benefit analysis should be made to find out if this could pay off. In theory, if the buyers of Chom Thong had monopsony power and that the link is jumped, there would now be free competition and the quantity produced would increase and the price of cabbage (the 4.24bahts/kg) would fall. Other problems could occur due to the fact that cabbage is a fresh product that decays quickly and requires well organised logistics. If the truck brakes down, a whole load of cabbage could be lost.

We will now look closer at the organisation of cabbage production in Sompoi. What is the role of the middleman and what does it imply for the farmers?

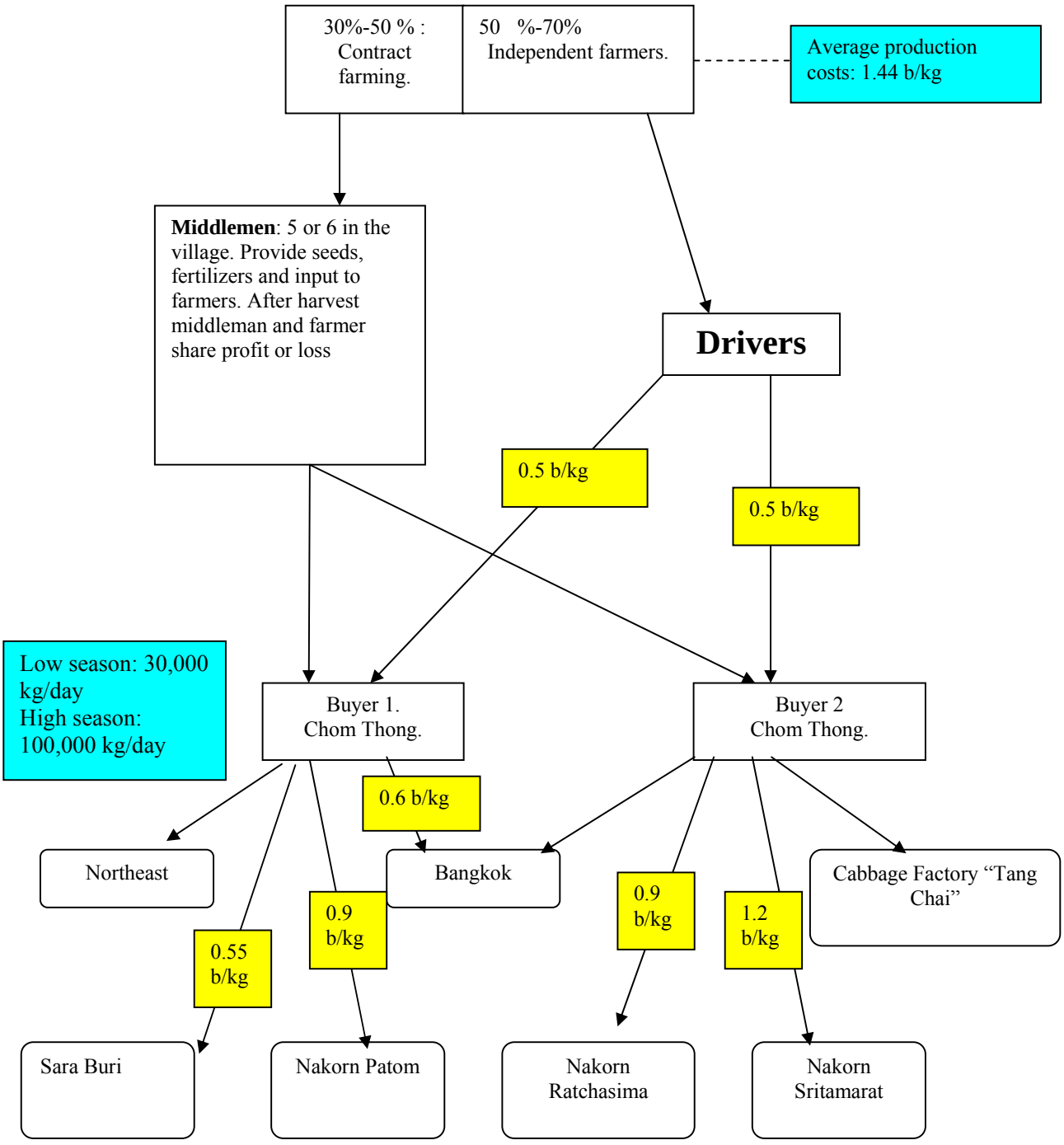
5.2.3 Contract farming (see figure 16)

According to our information, between 30% and 50% of Sompoi's farmers are under contract farming with a middleman. There should be five or six middlemen in the village, and two outside the village, namely in Chom Thong, one of them being one of the buyers. Middlemen only practice contract farming with the farmers that they trust. At the beginning of the cabbage growing season, middlemen provide inputs to the farmer such as seeds, fertilizers and pesticides. After the harvest, the farmers are bound to sell all their production to their middleman. Then the cabbage will be transported to Chom Thong by the middleman, where it will be sold to the two buyers of the town. When the cabbage is sold in Chom Thong, the middleman knows the price per kg he got and the quantity he sold. Buy multiplying those two values together he gets the total income. From that total income has to be deducted the price of inputs (seeds, fertilizer, pesticides) and transportation, which gives the profit. If it is positive the profit will be shared fifty-fifty between the middleman and the farmer under contract. If it is negative there is loss, which also is shared between the farmer under contract and the middleman.

The middleman will lose the value of the inputs he paid and the farmer will lose for the time of his or her work in the field, which is his or her opportunity cost[6].

[6] Money they could have earned by working somewhere else

Figure 16: Contract farming and non-contract farming in the cabbage chain



Since prices of cabbage have been very low in the last growing season (1.3035 b/kg. on average), middlemen have lost a lot of money and will from now on only provide seeds to the farmers under contract. Farmers will themselves have to provide fertilizers and pesticides, with their own money or by borrowing money. This indicates that middlemen suffered loss last year, which was confirmed by the interviews.

5.2.4 Non contract farming: "independent" farmers

Between 50% and 70% of all farmers in Sompoi are not under contract in their cabbage production. Of those, some produce cabbage independently of any middlemen, and some do not produce cabbage at all. Those who produce cabbage will themselves buy their inputs, either with their own money or by borrowing. Farmers in the village have access to several funds for credit such as the one million baths per village fund. This easy access to credits has last year had unfortunate effects on the farmers since the market price was so low and that almost all farmers suffered loss on cabbage and were indebted. The fact that farmers got indebted is very much criticized in the village, but if prices were high enough those credits would have been a success and would have made farmers more willing to be independent from any middleman.

5.2.5 Perspectives on cabbage chain

Contract farming is often seen as a form of exploitation of the farmers by middlemen who often make a lot of money on the expense of the farmers. The farmers are the ones doing the hard work, and will only be rewarded with half of the profit. Independent farmers on the contrary, will be rewarded with the whole profit. In case of loss due to low prices, farmers might lose less under contract farming than if they were independent, but a loss will always be seen as negative and unwanted.
In the case of cabbage in our area, it seems that middlemen do not have so much power as they maybe wished to have, due to the market power being in the hand of the two buyers enjoying the monopsony status together.

Many farmers in Sompoi are actually very isolated from the market since they do not own a pick-up. They are therefore very dependent of their drivers, and seem scared of not being able to sell their products. Even if prices were very low last year, the farmers do not shift to other cash crops for the

coming cropping year, scared of not being able to sell their products. Many of the farmers we interviewed will still grow cabbage next year, and just hope for a better price. In general, it can be said that farmers owning a pick-up and thereby being in direct contact with the market have a large advantage compared to farmers being isolated in the village. The farmers who owe a pick-up can not only gain money from transporting cabbage or other cash crops, but can also gain a lot of off-farm income such as transport of people, buy inputs for farmers etc.

If the market price is so low that there is loss, contract farming is not as bad for the farmers as independent farming. If the price is high and there is profit, then it is better for the farmers to sell their cabbage themselves on the market. But they will also bear the risk of not being able to sell their cabbage on the market because of lack of demand, which they also are very afraid of, according to several interviews with farmers.

The future of the cabbage producers does not look very bright. Falling prices, combined with the market power being in the hand of the buyers are external factors farmers hardly can control. Even if we have not been able to find clear statistics on cabbage production and prices in recent years, everything indicates cabbage that cabbage has reached a situation of overproduction. Lately, Thailand has opened up its markets to neighboring countries under the Association of South East Asian Nations (ASEAN) partnership (Beijing Times, 2004).
This has also given them access to new markets and could become a new opportunity for Thai cabbage farmers if they are competitive. If the contrary is true, the situation will be worse for the farmers.

A parallel could be drawn with pig production in Denmark. Danish farmers are very good at producing pigs, but in recent years they are facing falling prices due to an overproduction of pigs. Their reaction to decreasing prices is not to stop production, but actually to increase it. By increasing their production units, they make economies of scale and decrease their marginal costs. Farmers in Northern Thailand cannot increase production due to land limitation, but what they can do is to become better farmers and minimize their production costs. How do the Karen farmers react to falling prices? Our interviews with Karen farmers showed that they were not planning to stop cabbage production. They will grow on a smaller area, and try to limit production costs, and most of all, hope for a better price! Our visit in a

Hmong village, where the production is much more intensive, showed that they were using less fertilizers and pesticides than the Karen farmers. Hmong farmers are growing 3 croppings of cabbage in a row, and react more like the Danish farmers: the prices are falling, and they become better farmers.

Cabbage production does not seem sustainable due to the market power of the buyers, and due to the recent years falling prices.

In order to verify this statement, we now look closer into the livelihood economy of the farmers, with special focus on cabbage and its importance for their income.

5.3 Economic snapshot on the household economies

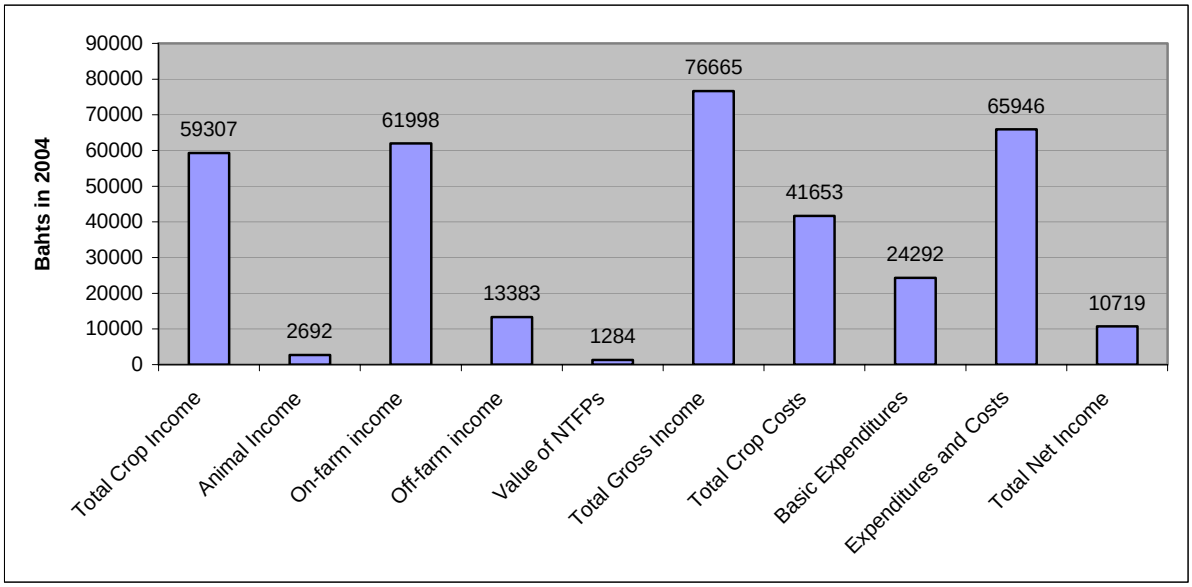


Figure 17: Snapshot on the average economic situation of the households of Sompoi and Kia Nai in 2004 (see appendix 12)

Explanation of figure 17:

Total crop income is the income the farmers have generated from their crop production. It does not only include cash crop income, but also an economic valuation of their subsistence crops (see appendix 11).

Animal income is the value of their animal production in 2004.

On-farm income is the addition of total crop income and animal income. In 2004, it amounted 61,998 Bahts or 80% of their total income. The way we have assessed the on farm economy requires a brief explanation. We have not only accounted for the income generated in money by the cash crops, but also defined an economic value to subsistence farming in order to include its value to the farm income. In Karen culture subsistence farming is extremely important and it would give an incomplete image if one only looked at what they sell on a market when assessing the economic sustainability of their farming system. The same method of valuation has been applied to assess the value of NTFPs. Technically this it is done by multiplying the quantity of the subsistence crop produced by the single household with the market value in the village of that crop. From that value is subtracted the costs associated with the production of that subsistence crop, for example if fertilisers or other inputs have been applied. The cost of labour has not been included in our calculations. That would have been the opportunity cost of the farmer. What could she or he have earned by working somewhere else?

Off-farm income is the average income the villagers earned outside their farms. In 2004, off farm income reached 13,383 bahts which is 17% of their total income.

NTFPs or Non Timber Forest Products have been valued in the same way as rice. Respondants have been asked how many kilos of bamboo shoots, mushrooms, fruits and vegetables, fishes, medicinal plants, dead wood etc. they have collected during the year from the forest. Then we have asked two key informants about the unit price of these products. It is the price in the village they should pay if they had to buy for example a kilo of mushrooms from their neighbours. This method is not completely precise, since it is hard for people to quantify exactly the amounts they have been collecting. But 18 villagers have responded, giving us an average which amounted at 1,284 bahts or 2% of their total income.

Total gross income, the sum of on-farm income, off-farm income and NTFPs, amounted 76,665 bahts. To set this total income into perspective, we can calculate how many US dollars a day it represents to the farmers. According to (Universal Currency Converter), 76,665 bahts is equal to 1999 $US. And 1999/365= 5.477. We have 2.222 active adults on average per household, which makes it 5.477/2.222=

2.465 $US per day. This means that every farmer on average earned 2.465 $US per day in 2004, which is above the poverty line of the World Bank.

Total crop costs are the summation of all costs related to the production of their crops (see appendix 6 to 10)

Total expenditures are the amount of expenditures the farmers have had in 2004 to cover their basic needs. This includes what they have spent for buying food, on medicine, schooling for their children, transportation, belief and religion.

Total net income is the difference between the total income and the total expenditures and crop costs of the farmers. It gives a measure of what value the farmers have left when they have paid for their basic needs. If positive, it means that the farmers have a surplus. If negative, it can definitely be said that their economic situation was not sustainable in 2004. We define it as the level of extreme poverty. On average, total net income was 10,719 bahts which indicates that on average, the basic needs of the farmers were covered.

If we look at the same indicators as above, but separate them between rich, medium, poor farmers as well as farmers from Ban Pa Kia Nai a more complex picture emerges. This is done in figure 18.

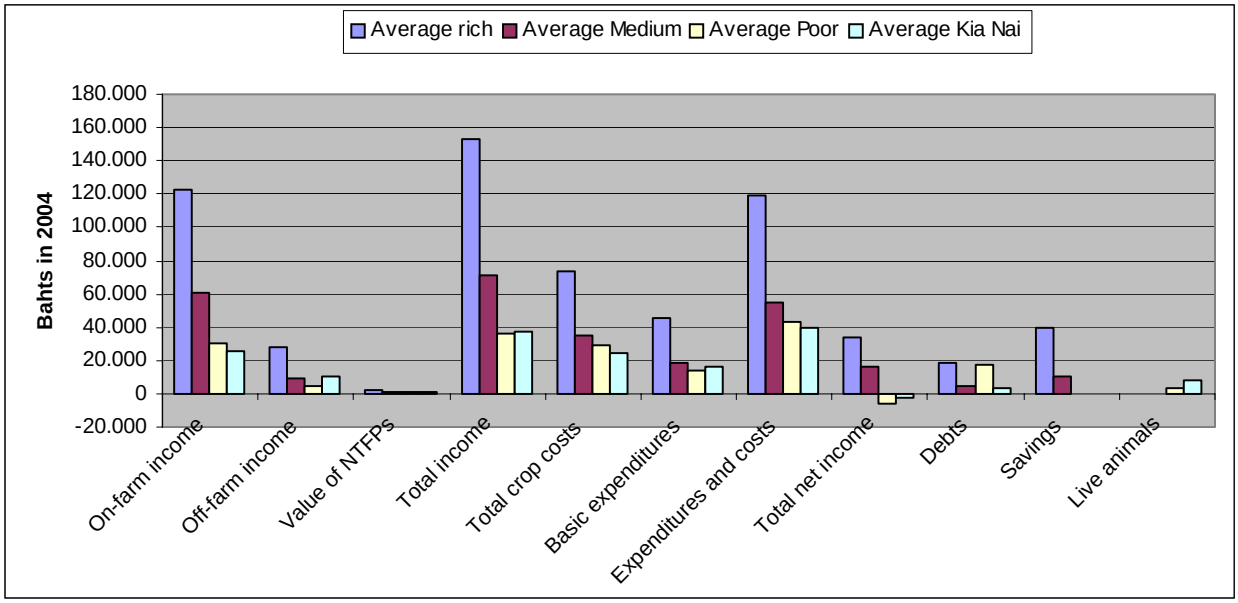


Figure 18: Economic situation divided by income groups

Figure 18 clearly shows that disparities exist between the different income groups of farmers. Total income averaged 152,702 bahts for the rich farmers or 5.44 $US per day, putting them well above poverty line. Their basic needs were covered with a surplus of 33,794 bahts. For the medium farmers, total income averaged 2.54 $US per day, with a net income surplus of 16,792 bahts. For the poor farmers the picture is quite different: their basic needs have not been covered in 2004, putting them under our limit of extreme poverty. They suffered a deficit of 6,224 bahts on average. Their total income averaged US $ 1.007 per day, which is right on the extreme poverty limit of the World Bank. The villagers of Ban Pa Kia Nai also suffered a deficit in 2004, of 3,018 bahts. The level of debts is quite even in Sompoi for the different categories, which indicates good access to credits, even for the poor. Though if you compare the average yearly income of the poor with their levels of debt, you see that they would need almost two years of income to pay back their debts, and much longer with the interests, which sets them in a critical situation. Only rich farmers have monetary savings. The only form of savings that the poor have is in animals, which is a kind of investment for them. There seems to be no big difference in the value of NTFPs between the different income groups.Data from the questionnaire shows that the poor on average have less land than the rich. To compensate for that, they could use the forest more.

5.4 Effect of changes of cash crop prices on income

One way of setting the income of the farmers into perspective is to compare it to the GDP per capita of Thailand. This is done in figure 19.

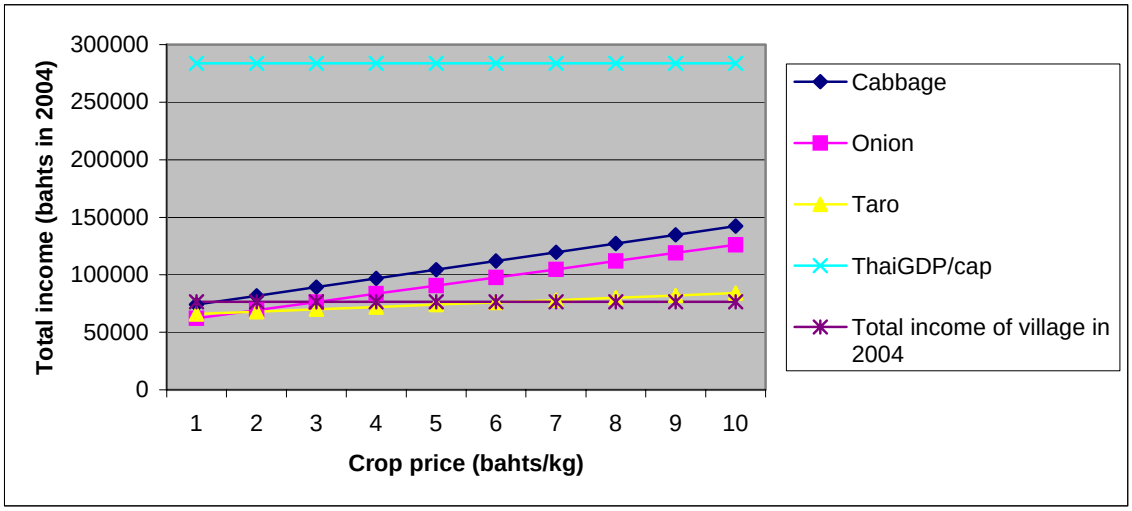


Figure 19: Income of village compared to Thailand's GDP per capita and effect of main cash crop prices on villager's total incomes.

First figure 19 shows the big difference between Thailand's GDP per capita (283,670 bahts) and the villagers' total income (76,665 bahts). GDP per capita is 3.7 times bigger than the average income of the villagers, showing their relative position in the Thai society. Next, the figure shows what happens to the income of the villagers if, all other things being equal, the price of the single crop changes. Note that only one crop price can change at the time, all the rest keeps unchanged. For example, if the price of cabbage increased to 10 bahts/kg, and nothing else changed, the total income of the villagers would reach 142,380 bahts which is an increase of 85%. But still there, the income would be far below the national GDP per capita. Figure 20 also shows that of all main cash crops, cabbage has the strongest effect on the farmers' income, making it relevant to focus more on that crop and its level of prices. It is now interesting to focus only on that crop and see how changes in cabbage prices influence the levels of incomes of rich, medium and poor farmers. This is shown in Figure 20.

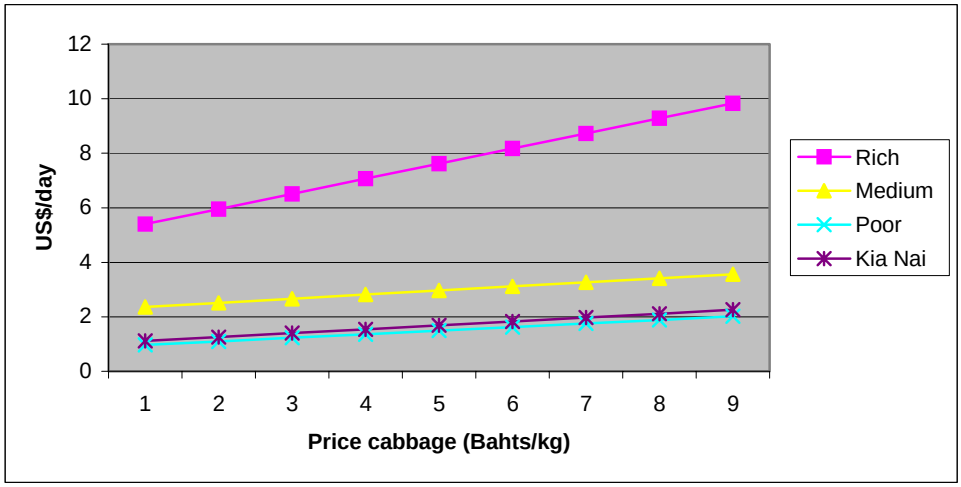


Figure 20: Effects of changes in cabbage prices on the income of rich, medium and poor farmers, as well as farmers of Kia Nai.

In 2004, the price of cabbage was 1.3035 bahts per kg on average. At that price, poor farmers and farmers from Kia Nai had an income around 1 $US per day and lived in extreme poverty. For them to come above the poverty line of middle income countries of 2 $US per day, they would need a price of cabbage of around 9 bahts/kg. This seems quite unrealistic, knowing that the average price in 2004 has been 1.3035 bahts/kg, and that the trend of the last years have been falling prices.

6 Soil erosion results

The results are listed below in table 6 The soil loss from the different plots is calculated using USLE and compared to the Classification of the erosion levels for Thailand, which can be found in appendix 1.

Table 6: Results from using the USLE equation

Soil type	Soil loss (t/rai)	Erosion level
Disturbed forest 1	0,35	Very slight
Disturbed forest 2	0,15	Very slight
Disturbed forest 3	0,04	Very slight
Conservation forest 1	0,77	Very slight
Conservation forest 2	1,72	Slight
Conservation forest 3	1,33	Slight
Fallow (cabbage) 1 y slash + burn	14,44	Slight
Fallow (cabbage) 3 y	32,54	Moderate
Fallow area 6 y	33,08	Moderate
Fallow area 20 y	2,05	Slight
Cabbage (slash + burn)	126,32	Very severe
Cabbage 1	248,84	Very severe
Cabbage 2	369,14	Very severe
Cabbage 3	119,87	Very severe
Paddy rice (Mr. Janoi)	17,57	Moderate
Paddy rice (Mr. Boonleart)	6,70	Moderate

When looking at the values a clear pattern emerges. We see that there are no problems with soil erosion in the forest areas. The range in severity here is from very slight to slight (0,04-1,72 t/rai).

The fallow areas have larger erosion levels classified from being slight to moderate (2,05-33,08 t/rai). Our results confirms the general knowledge that cultivated areas seem to promote higher erosion levels when compared to the forest areas. All the fallow areas have higher amounts of soil loss than the forest areas.

Cultivated areas include the cabbage fields previously cultivated, the one which is slashed and burned and the two paddy rice fields.

In the fields where paddy rice is cultivated a lower erosion level is found compared to the cabbage fields. The soil conservation practice of terracing reduces soil erosion (appendix 1). The level of erosion is moderate in both cases being comparable to the erosion level of the fallow fields.

The information that it is important for us to withdraw from the table, is that severity of erosion falls into the highest possible category for all our cabbage plots. It is therefore important that changes are made in the cultivation practices. The farming system of cabbage cultivation from a soil erosion point of view seems to be unsustainable based on the USLE calculations.

7 Soil Fertility

The results from our soil fertility analysis using the two different methods (in-field soil test kit and the laboratory analysis) are in Appendix 3. In the statistical analysis of the laboratory data, only the level of P was found to be significantly different in the two groups compared. We did find certain trends in the results when comparing single plots with each other. This will be discussed in the following sections. It should be noted that these trends are not supported by a statistical analysis.

7.1 Laboratory analysis

SOM (%)

In our statistical analysis of the laboratory data, we used the six forest plots (multi-purpose and conservation forest) and compared them with six cabbage plots (the three currently cultivated fields, the slashed & burned field and the one and three year fallow fields). Our hypothesis was that the SOM would decline as the land use intensified. There was however no significant difference between these two groups, when we used the Mann-Whittney U-test. However, certain trends are evident. The field that had been slashed and burned and was ready to cultivate had a high value, almost reaching very high. This would explain our findings from the questionnaire, where half of the respondents claimed to practice slash and burn. We were also told that slashing and burning is essential for improving soil conditions (interview with Headman of Sompoi). The 6 and 20 year fallow fields also have very high and high values, respectively compared with the moderate to high values found for the cabbage fields currently cultivated, the 1 year fallow and the 3 year fallow fields. This indicates that the length of fallow is important in order to restore the amount of organic matter. The %SOM in the forest plots ranges from moderate to high and is comparable to the percentage in the cabbage plots. This can be explained by the fact that vegetation in grasslands such as fallow fields has a relatively high proportion of root matter, which contributes more efficiently to humus formation than forest leaf litter (*Brady & Weil*, 1998). The cultivated fields (the 1 year fallow, the slashed and burned field and cabbage 1, 2 and 3) all have a % of SOM that is moderate to high (see figure 21). The level of SOM in the entire study area, which we have estimated by calculating the average of all plots was 2,86 % is moderate.

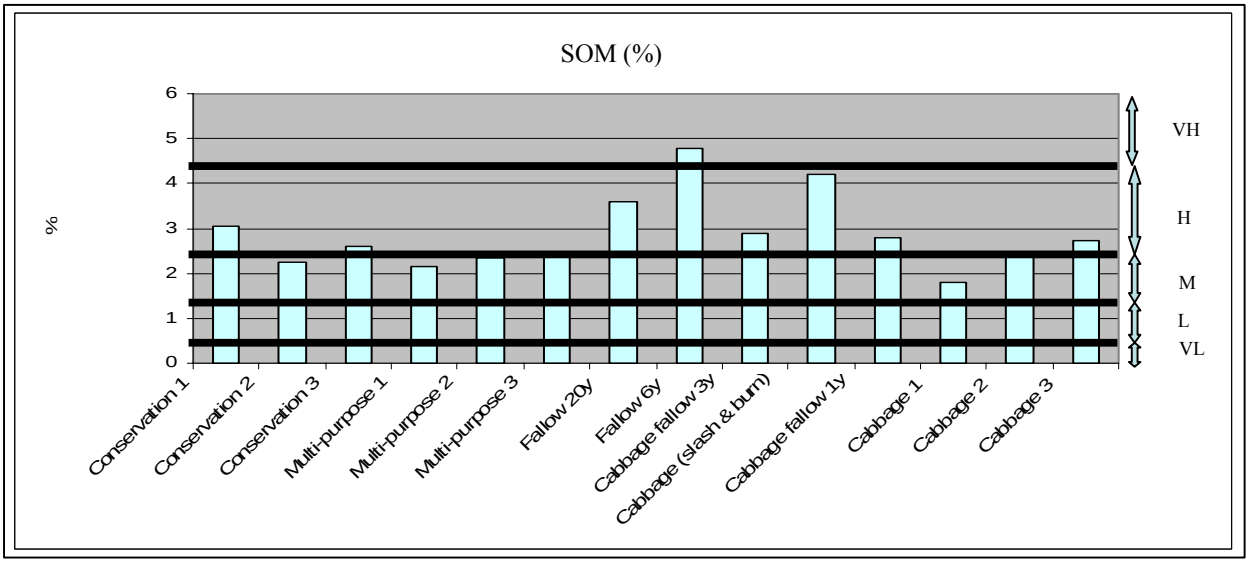


Figure 21 : The % SOM content in the different plots

7.2 N (%)

Except for the 6 year fallow and the slash and burn field, which are higher than the rest (0,239 and 0,211, respectively) (see figure 22), the results for N from the laboratory are not very different. There was no significant difference between the forest and the current land use categories (Appendix 13). The very high percentage of N in the slashed and burned field could be because this practice releases N to the soil. The cultivated fields have %-levels of N that are moderate to very high. The level of N in the study area was estimated as 0,143 %, which is high.

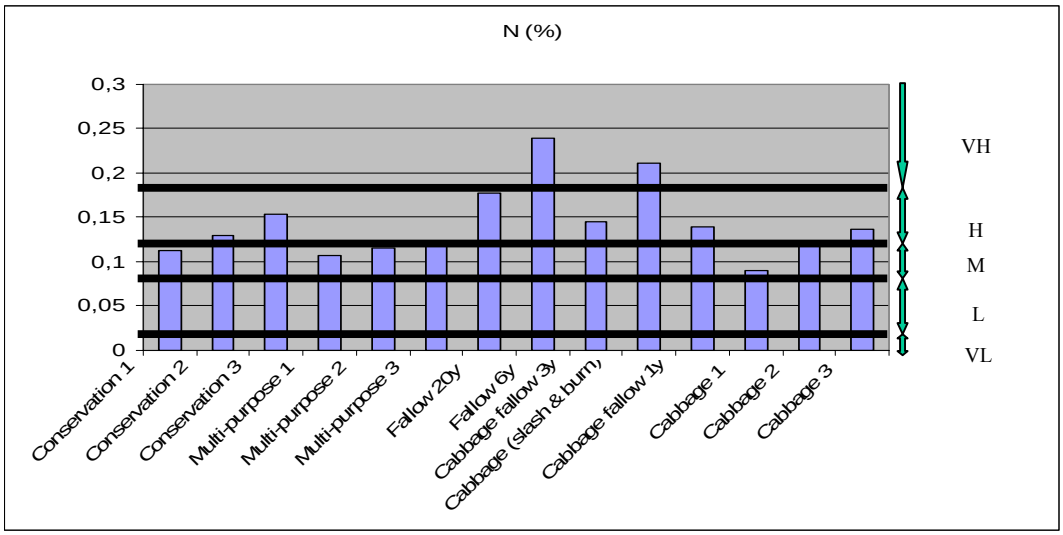


Figure 22: The % N content in the different plots

7.3 K (ppm)

K values in all samples are very high according to the guidelines for Thailand soils (see graph). There was no significant difference between the forest and cultivated land plots (Appendix 11). The 6-year fallow and the slashed and burned field are higher than the rest, except for one of the conservation forest plots. This indicates that the practice of slash and burn supplies large amounts of nutrients to the soil and that length of fallow is important in regenerating plant available potassium.

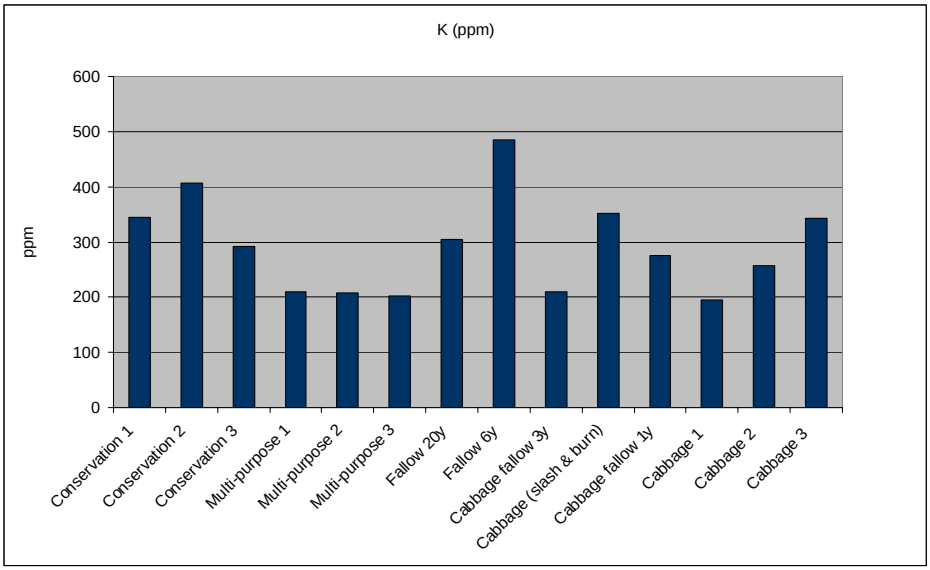


Figure 23: K levels on the different plots. Values over 120 ppm are classified as very high

7.4 P (ppm)

The level of P is significantly higher in the cultivated land plots compared than in the forest plots (see appendix 13 and figure 24). The results for P show that all values are very low except for the three cabbage fields and the 3 year fallow, which are low. This again indicates that fertiliser application generates a larger pool of available P in the soil. Although the level of P is higher in the cultivated fields, it seems that there is a need for a higher amount of fertiliser to obtain at least a moderate level of available P (10-15 mg P/kg). The level of P in the study area was estimated as 2,87 ppm which is very low.

Fejl!

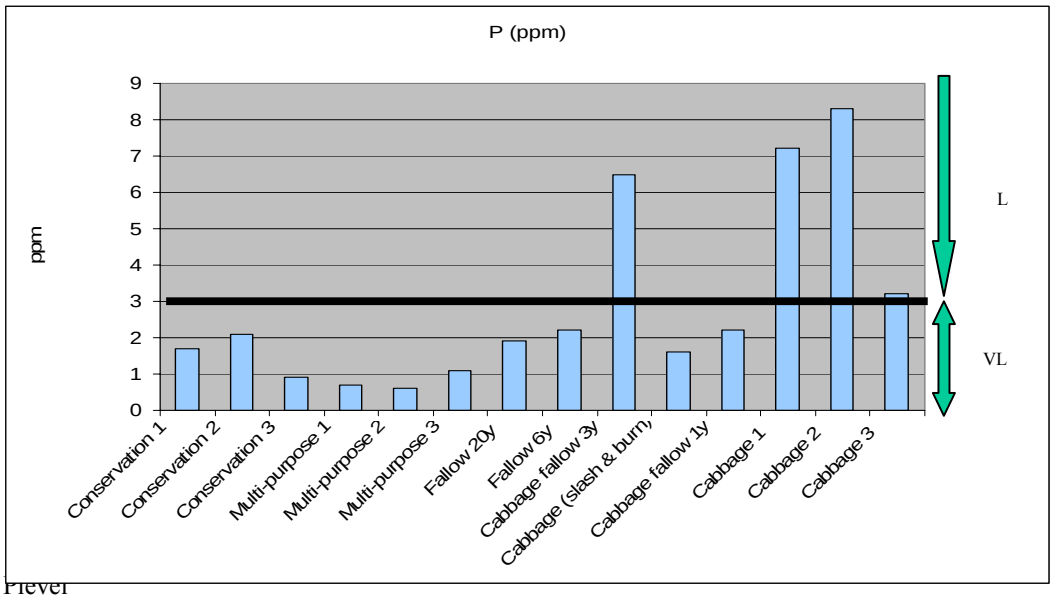


Figure 24: Plevel

7.5 pH

The pH in all plots is below 6. The optimal pH for cabbage cultivation is between 6 and 6.5. Low pH can have negative effects on crop yield and our results show that the pH in all plots is below the lower limit of the optimal value. There is no significant difference between the forest and the cultivated plots (Appendix 13).

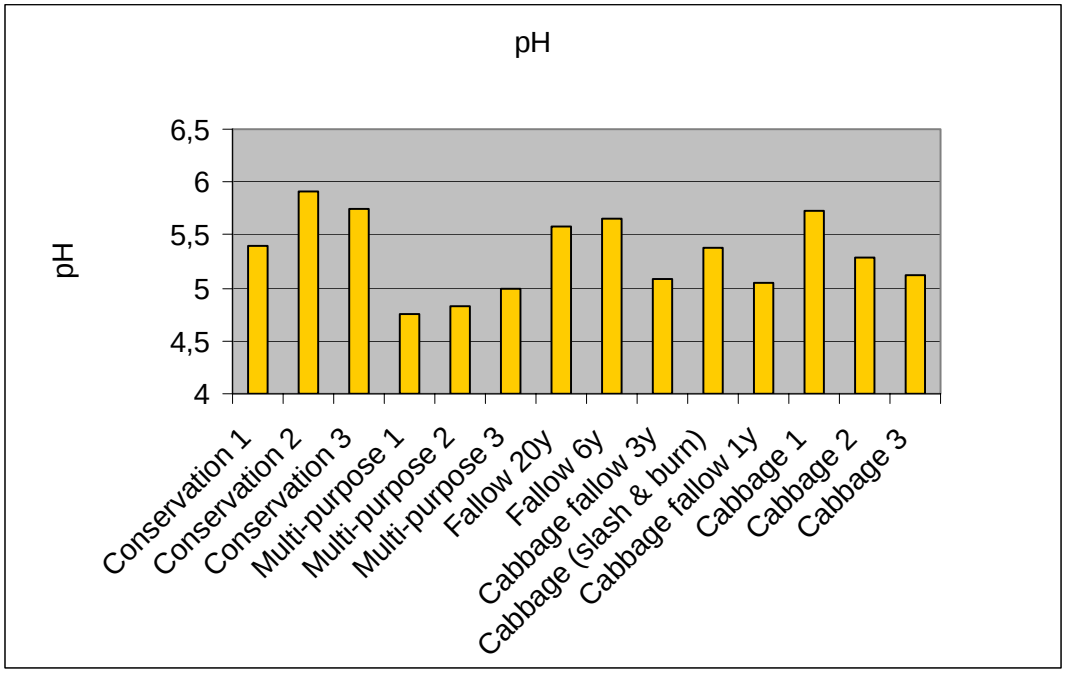


Figure 25: The pH values for the different plots.

7.8 Summation of soil fertility

A sufficient amount of SOM and N is present in the cultivated fields and the amount of potassium is very high. The limiting factors for cabbage growth seem to be the level of phosphorous and the pH. Phosphate fixation is low, and plant available P is high in the pH range of 6-7. Above and below this range, P is bound by oxides of iron and especially aluminium, which are prominent in clayey Ultisols, which are found in Northern Thailand (Hansen, 1991). When bound P is removed from the plant available pool. When the pH is below 5.5, cation exchange sites on clay particles are occupied by aluminium and acts as a strong adsorber of phosphate (Marschner, 2002). When the pH increases to around 6, the solubility of iron and aluminium phosphates increases, making P more available (Brady & Weil, 1998). We conclude the N, K and the percentage of SOM are adequate. However, the pH is well below optimal growth conditions and the level of P is insufficient.

Perspectives

The laboratory results show that the pH is below 5.5 in all cabbage plots. Not taking the economic perspective into consideration, liming could be recommended as a solution, since it affects the amount of available P. However, the materials may not be affordable or available to the farmers. A proper cost-benefit analysis would be necessary to determine this possibility.

8. Conclusion:

In recent years, prices of cabbage have been decreasing. In 2004, they reached record low levels causing economic loss to many farmers. The reason for the decreasing prices seems to be an overproduction of cabbage in Thailand. Furthermore, the farmers of Sompoi and Kia Nai, as well as many other small producers from the highlands around Chom Thong, sell their cabbage on a market where only two whole sale buyers operate, which locates the market power in the hands of the buyers. These are able to pay a lower price to the farmers than if there was free competition on the market. They have the possibility to reduce the quantity they buy from the farmers. That would leave farmers with unsold cabbage and force them to accept lower prices. The fact that cabbage is a fresh product that decays in a short period of time empowers the buyer and weakens the farmers. One solution for the farmers could be to organise themselves, buy a truck and directly sell to the retailers in Bangkok and other provinces. This solution is not without any risks and requires high organisation and logistic skills from the villagers.

At the village level, the farmers are either producing cabbage for a middleman or for themselves. If they produce for a middleman, he will provide inputs such as seeds, fertilisers and pesticides on credit to the farmers. After the cabbage is sold, profits would be shared fifty-fifty between the farmer and the middleman. This is no optimal situation for the farmer who will see half of his profits disappear after a season of hard work in the field. From next year on, due to the loss of 2004, middlemen will only provide seeds on credit to the farmers. How the profits will be shared is unknown. The way the market is structured would lead us to the conclusion that cabbage production was not economically sustainable from a marketing point of view.

When looking at the farmers' economic situation in 2004, we mainly looked at their total net income, which is the value the farmers have left after having paid for all their basic expenses. We also

compared the income of the farmers to the Thai GDP per capita and to the level of poverty set by the World Bank (2 $US per day in middle-income economies such as Thailand).
We found out that national GDP per capita was 3.7 times higher than average income of the villagers, showing that the villagers are economically marginalised from the Thai society. Even if total net income was positive on average for the respondents, great disparities were observed between the different income groups. While rich farmers had an income of 5.44$ US, or well above poverty line, poor farmers were not able to cover their basic needs. Their net income was negative and their total income was at 1$ US per day, the level of extreme poverty set by the World Bank. We then analysed which impact an increase in prices of the different cash crops had on total income. It turned out that an increase in cabbage prices had the strongest effect on income. But to lift poor people out of poverty, a price of 9 bahts/kg would be needed. This seems unrealistic based on the marketing study and the fact that the price was 1.3035 bahts/kg last year. Defining the agricultural practices of the villagers as sustainable or not seems not possible. We focused only on the most important cash crops. From that point of view it is rather unsustainable. But the pricture seems more complex. The farmers grow several crops, change strategies and adapt. It is not a static model. Villagers could use more time in the forest, save costs on hiring labour and still enjoy their lives.

The farmers of the village should definitely not only focus only on one crop, which they by the way are not doing. Their livelihood strategy is to produce several crops, which is a risk spreading strategy. Of the crops grown in 2004, taro was giving the highest profits. So that crop would maybe worth planting next year as well, even if the production costs are high compared to the other crops. Coffee seems very interesting, due to low production costs and possibilities for growing it in the community forests. The biggest constraint is that coffee does not generate an income the first three years. New crops could be identified as part of the diversification strategy. Though, one has to be sure that there also is a market for it. It is always attractive to be the first to grow a new crop, where the price is high. Then, when many producers get into business the price will decrease and finally production costs will not be covered anymore. This seems to have been the case for cabbage in Thailand. But looking at the economic side is not enough when searching new opportunities. The environment also has to be able to bear the production. Our assessment of the environmental consequences of agricultural intensification has focused on soil erosion and soil fertility.

By estimating the annual soil loss using the USLE, we have found the level of erosion on cultivated cabbage fields to be very severe. In the study area we only observed minor root exposure as an indication of soil erosion on two of the cultivated fields visited. Half of the respondents from the questionnaire had seen signs of soil loss. The fact that many respondents have lived in the village up to ten years and have been able to cultivate cabbage on the slopes indicates that the USLE seems to be overestimating the severity of erosion in the area.

Percentage of SOM in the cultivated fields was moderate to high, which means that there is a sufficient potential source of nutrients. All levels of N in the cabbage plots were in the range from moderate to high. Given the tropical conditions which induce high mineralization rates this N will most likely be made plant available in a relatively short time. The amount of K was found to be very high for all our plots. This indicates that there is a large buffer capacity of this nutrient and that supply is not needed. The very high value of K could, however, also have an adverse effect by interfering with the uptake of Ca and Mg in plants. These nutrients are important for crop growth and deficiencies of these would reduce the yield.

The level of P in the cultivated fields ranges from low to very low. The average pH for the both the cultivated fields and the entire study area is below 5.5. The low pH values could or may already have caused aluminium toxicity in the soil, which induces binding of available P. Liming might alleviate this problem by raising the pH. Compared to FAOs value for P-requirements of cabbage, the amount of P applied by the farmers on average is 2.5 times higher, with the poor respondents applying the highest amount. This further indicates that of the nutrients examined, P is the limiting factor for growth of cabbage at our study area.

The poor-income respondents to the questionnaire were applying the largest amount of fertiliser (N and P) and pesticides. Still, they had the lowest yields of all income groups, though their yields exceeded the average for Thailand. There could be several reasons for this. Maybe the poor farmers own low fertility soils. Another possibility is that they are not skilled in intensive agricultural practices and focus mostly on subsistence farming. One strategy for the Karen farmers could be to minimise their

production costs. This could be accomplished through training and education, giving them the proper farming skills.

The Karen culture seems to have had difficulties to adapt to agricultural intensification. What really seems to matter to them is to have a good rice harvest. Their culture is not based on money and mass consumption. They seem very good at producing subsistence crops, in a way that takes care of nature. Cabbage growing has been introduced from outside, with massive use of chemicals. The Karen never eat the cabbage they grow for selling, well aware of its contents of pesticides. They grow their own varieties of cabbage, in an organic way. The future for them might be to specialise at what they are good at, namely organic production. Furthermore, it seems to be a growing market in Thailand.

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Appendix 0

Guidelines for Thailand soils

Class / Rating	Very low	Low	Moderate	High	Very high
OM (%)	**< 0.5**	**0.5-1.5**	**1.5-2.5**	**2.5-4.5**	**>4.5**
N (%)	**<0.02**	**0.02-0.08**	**0.08-0.12**	**0.12-0.18**	**>0.18**
P, Bray II mg P/kg	**<3**	**3-10**	**10-15**	**15-45**	**>45**
K, mg K/kg	**<30**	**30-60**	**60-90**	**90-120**	**>120**

Appendix 1

Soil erosion

Here is given a description of how the different values were calculated. The values for all the fields can be found in the calculation and result table at the end of this appendix.

R factor

The rainfall factor can be calculated from the annual rainfall by using the following equation:
$R = 8.276 * P - 215.058$
The unit for R is Mt/ha and P is the annual rainfall measured in cm (Samram 1984 & Dumronghamvitaya 1985).

To calculate the R-factor we have used annual rainfall data from Chiang Mai from 2000-2002 (Agricultural statistics of Thailand for crop year 2002-2003). We have taken the average for the 3 years: (1133.1 + 1220.4 + 1612.3) / 3 = 1321.9 mm

P in cm = 1321.9 / 10 = 132.2 cm
R = 8.276 * 132.2 cm – 215.058 = 879.03 Mt/ha

K factor

The soil factor is calculated for each individual plot as follows:
$K = 2.1 * M^{1.14} * 10^{-6} (12 - OM) + 0.0325 (SSC - 2) + 0.025 (PPC - 3)$
M is the particle size, OM is the organic matter content in %, SSC is the soil structure code, PPC is the permeability class (Jensen 2003).
M is found by doing soil texture analysis in the laboratory; here we find the content of silt, clay & very fine sand:
$M = (100 - \%clay_{<0,002\ mm}) * (\%silt_{0,05\text{-}0,002\ mm} + \%\ v.f.\ sand_{0,1\text{-}0,05\ mm})$ (Jensen 2003). From each of the plots the specific K-value is calculated (see the calculation table).
Content of %SOM has been determined in the laboratory. The measured infiltration rates are necessary to determine the PPC and the soil texture can give us a rough estimate of the SSC.
PPC is both determined in the laboratory and in the field. See the PPC classes below

Table Profile permeability classes (modified from Jensen 2003)

PPC class	**Infiltration rate**	
	General	Basic (cm/hr)
1	Rapid	>12
2	Moderate rapid	6-12
3	Moderate	2-6
4	Moderate	0.5-2
5	Slow	0.1-0.5
6	Very slow	<0.1

Table: The Soil Structure Codes (SSC) (Jensen 2003).

SSC	What kind of soil structure
1	Very fine granular
2	Fine granular
3	Medium or coarse granular

4	Blocky, platy or massive

SSC is qualitatively determent by looking at photos of the soil profile from the individual plots.
The different K-values can be found in the soil erosion results

LS factor

By using the length of the slope and the slope (in %) we can determine the LS.
Calculation of LS:
$LS = (L/22.13)^k (0.0065 S^2 + 0.045 S + 0.065)$, k = 0.5 for slopes above 5%. In all of our observations the slope was much larger than 5%. The LS-values can be found in the appendix about soil erosion

C & P factors

We have obtained C and P factor values for different crops from the Department of Land Development (Ministry of agriculture 2002).

Table The P and C factors for different crops/vegetation

Crop/vegetation	P factor	C factor
Paddy rice	0.1	0.280
Vegetables	1	0.250
Hilly evergreen forest	1	0.001
Agroforestry (coffee)	-	0.004
Mixed cropping	1	0.225
Cabbage	1	0.6
Fallow (1-2 years)	1	0.25
Coffee orchard	1	0.3
Maize	1	0.502
Groundnut	1	0.406

Crops grown in hilly areas use a P-factor of 1 (ARS-USDA 1975), which means we assume they use no soil conservation methods, except for paddy rice fields which are terraced. This correlates with our observations in the field and the replies from our questionnaires.

By using different cropping factor we can determine which crops are best suited to be cultivated in order to minimise soil erosion. This could be determined in connection with an economic analysis of these crops.

Erosion classes

We have obtained information from the Department of Land Development about different classes of soil erosion which we can use to determine the extent of the problem of soil erosion in our study area (Ministry of agriculture 2002).

Table Classification of the erosion levels for Thailand

Erosion level	Loss (t/rai)
Very slight	0.01
Slight	1.01 – 5
Moderate	5.01 – 20
Severe	20.01 – 100
Very severe	100.01 – 966.65

References:

"Soil erosion in Thailand", Department of land development, Ministry of Agriculture and Cooperatives, 2002, 39 pages.

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"Erosion control parameters for slope areas in the USLE-equation – Case study of Mae Sa Watershed, Chiang Mai Province", Nipon Thangtham & Apinon Korporn, 1997, Journal of Agriculture, 32: p. 41-51.

Calculation and result table

soil type	%clay	%silt	%sand	% very fine sand	% very fine sand + silt	M	%OM	Soil structure
Disturbed forest 1	25	12	63	20	32	2400	3.051	fine granular
Disturbed forest 2	30	5	65	18	23	1610	2.25	fine granular
Disturbed forest 3	24	3	73	20	23	1748	2.586	very fine granular
Conservation forest 1	20	13	67	22	35	2800	2.146	fine granular
Conservation forest 2	17	13	70	26	39	3237	2.327	fine granular
Conservation forest 3	16	13	71	31	44	3696	2.379	fine granular
Fallow (cabbage) 1 y (slash + burn)	36	2	62	13	15	960	2.793	fine granular
Fallow (cabbage) 3 y	24	9	67	14	23	1748	2.896	very fine granular
Fallow area 6 y (Huai Sompoi)	22	12	66	16	28	2184	4.784	fine granular
Fallow area 20 y	17	16	67	21	37	3071	3.595	fine granular
Cabbage (slash + burn)	29	7	64	28	35	2485	4.215	coarse granular
Cabbage 1 (Pa Kia Nai. Mr. Wittaya)	20	16	64	18	34	2720	1.81	fine granular
Cabbage 2 (Pa Kia Nai. Mr. Kowit)	26	19	55	20	39	2886	2.401	fine granular
Cabbage 3 (Pa Kia Nai. Mr. Boonleart)	23	21	56	20	41	3157	2.741	fine granular
Paddy rice (Mr. Janoi)	17	16	67	37	53	4399	1.06	coarse granular
Paddy rice (Mr. Boonleart)	15	13	72	27	40	3400	2.302	fine granular

soil type	SSC	Permeability cm/hour	PPC	K	R	Length of slope (m)	Slope %	LS	C	P
Disturbed forest 1	2	25.1	1	0.0841018	879.0292	40	55	29.84978	0.001	1
Disturbed forest 2	2	23.5	1	0.04268414	879.0292	40	50	24.95941	0.001	1
Disturbed forest 3	1	17.8	1	0.01578579	879.0292	40	43	18.84694	0.001	1
Conservation forest 1	2	43.3	1	0.12603216	879.0292	40	67	43.3694	0.001	1

Conservation forest 2	2	65.8	1	0.15386523	879.0292	40	92	79.61869	0.001	1
Conservation forest 3	2	35.7	1	0.18585981	879.0292	40	73	51.07301	0.001	1
Fallow (cabbage) 1 y (slash + burn)	2	3.9	3	0.048543	879.0292	30	30	8.458737	0.25	1
Fallow (cabbage) 3 y	1	6.2	2	0.03754927	879.0292	39	50	24.64544	0.25	1
Fallow area 6 y (Huai Sompoi)	2	19.6	1	0.04710997	879.0292	40	50	24.95941	0.2	1
Fallow area 20 y	2	45.3	1	0.11682303	879.0292	40	50	24.95941	0.004	1
Cabbage (slash + burn)	3	5.3	3	0.1538808	879.0292	40	50	24.95941	0.25	1
Cabbage 1 (Pa Kia Nai. Mr. Wittaya)	2	6.9	3	0.1761173	879.0292	18	50	16.74328	0.6	1
Cabbage 2 (Pa Kia Nai. Mr. Kowit)	2	4.9	3	0.17749376	879.0292	39	50	24.64544	0.6	1
Cabbage 3 (Pa Kia Nai. Mr. Boonleart)	2	5.9	3	0.18965155	879.0292	22;44	50;16.7	(18.5 ;3.7) 7.49	0.6	1
Paddy rice (Mr. Janoi)	3	1.8	4	0.38458463	879.0292	40	33	11.60044	0.28	0.1
Paddy rice (Mr. Boonleart)	2	1.3	4	0.24116603	879.0292	40	25	7.061636	0.28	0.1

The red values in the length of slope column are estimated values. A common field length in our study area was 40 m. The red values in the slope % column were estimates since slope measurements were not made on these locations. The red C-factor values are estimates: we gave the 20 year fallow a value close to the value for agroforestry and the 6 year fallow a value closer to a 1-2 year fallow field.

soil type	soil texture	A (t/ha)	A (t/rai)	Erosion class
Disturbed forest 1	sandy clay loam	2.206733	0.353077	very slight
Disturbed forest 2	sandy clay loam	0.936492	0.149839	very slight
Disturbed forest 3	sandy clay loam	0.261523	0.041844	very slight
Conservation forest 1	sandy clay loam	4.80472	0.768755	very slight
Conservation forest 2	sandy loam	10.76859	1.722974	slight
Conservation forest 3	sandy loam	8.344114	1.335058	slight
Fallow (cabbage) 1 y (slash + burn)	sandy clay	90.2351	14.43762	moderate
Fallow (cabbage) 3 y	sandy clay loam	203.3674	32.53878	severe
Fallow area 6 y (Huai Sompoi)	sandy clay loam	206.719	33.07504	severe
Fallow area 20 y	sandy loam	12.81551	2.050482	slight

Cabbage (slash + burn)	sandy clay loam	844.038	135.0461	very severe
Cabbage 1 (Pa Kia Nai. Mr. Wittaya)	sandy loam	1555.239	248.8382	very severe
Cabbage 2 (Pa Kia Nai. Mr. Kowit)	sandy clay loam	2307.141	369.1426	very severe
Cabbage 3 (Pa Kia Nai. Mr. Boonleart)	sandy clay loam	749.1914	119.8706	very severe
Paddy rice (Mr. Janoi)	sandy loam	109.8064	17.56903	moderate
Paddy rice (Mr. Boonleart)	sandy loam	41.91629	6.706606	moderate

Appendix 2

Semi-structured interviews

Semi-structured interview conducted the 15/1 in Ban Pa Kia Nai

Interviewee: Village headman of Ban Pa Kia Nai

Info about farming: In the old days fallow periods of 7-10 years were common. The farmers than made no use of fertilizers in their farming system.
Today the fallow period is much reduced one reason is that the land used for cultivation is included in the National Park, if it has been fallow for more then three years. Introduction of cabbage came after this law about fallow periods. If there is a sufficient amount of water cabbage can be grown the whole year through.

Forest: The conservation of the forest reduces the water that is available for the fields. The trees use the water. The forest fires helped to make the water available. Now the villagers are doing fire prevention and conservation. This leads to less water available for cultivation. The village headman pointed out that this point of view was common among the villagers.

Problems: The law about fallow forces the farmers to change their farming strategy. This interviewee pointed out that the yields in rice had been falling over the years. And the reduced water availability

The interview was done in Ban Huai Som Poi 17/1.

Topic: Cabbage cultivation

Name: Mr. Kitipong Panaparprai (speaks English, no interpreter needed).
This interviewee was later interviewed in a more formal way. This interview was more like a conversation.
How he cultivates cabbage: He has a few plots used for cabbage cultivation (a total of 1/2 rai).
First he starts making a seedbed approximately 4X4 meters. The plot is slashed and burned, three days after this activity he uses a spade to make the last field preparations. He said he used the most fertile part of his field for the seedbed. The way the cabbage seeds were sown in the seedbed was by hand. He was not so good at it, so his brother normally did it for him. After this activity he starts prepare the

field. When the cabbage had three to four leaves they were transplanted to the large field (approx. 1/2 month after sowing in the seedbed). To plant the seedlings in the seedbed he used a planting stick. He makes a hole with the stick then he puts fertiliser a little soil and at last the seedling. It was important that the seedlings root was not in direct contact with the fertiliser, because it would make the plant sick. He used 100 kg of the fertiliser (16-21-0) for the transplanting. Later in the growing season he uses a 100 kg of the same fertiliser type again. After transplanting he would go and look in his field one to two times every week for pests. Some years he used pesticides some he did not.
In his field he made use of soil conservation methods. He makes channels surrounding his fields and one running through the field (see figure). They are approx. one hand in depth and ½ meter width.
In august he normally harvested. The yield was approx. 2000 kg/((1/2)rai) but varies a little bit from year to year.

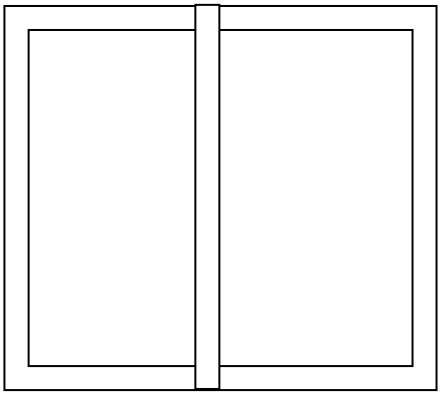

Figure: Field with channels surrounding the field and one running through the field.

Future: He would like to try to cultivate potatoes and ground nut. Last year he said that 4-5 growers were cultivating ground nut. He would like to grow potatoes but nobody in the village is cultivating it, so he is reluctant to start. There is nobody he can ask for help.
Semi-structured interview conducted 18/1

Name: Mr. Kitipong Panaparprai (speaks English, no interpreter needed)
No. of people in household: 6 (he has been living in Ban Huai Sompoi for 10 years).

Farming: Cabbage, red onion. He shares one plot of rice with his father-in-law. He Has 1 plot of coffee (120 plants) and 2½ plots equal in size of cabbage and onion.

Other activities: Shopkeeper, driver.

Fertiliser: 2 bags used for cabbage (N, P, K = 16-20-0). 2 bags for onion. Manure used on paddy rice. Price of fertiliser: 420-450 baht/bag.

Yield: 50 bags of rice (a stable yield). Stable yield of cabbage and same amount of fertiliser applied since the beginning.

Price: Unstable prices for cabbage and coffee.

Income: Owner of a small shop and working as a driver transporting onion and cabbage. Every Thursday he drives people to Chom Tong (earning 40 baht) and buys products to sell in his shop at the same time. Farming is the biggest source of income for the villagers.

Weeding: Weeding is done by hand.

Pests: Problems with insects. Worms leave holes in the leaves and reduce the price of the crop. He uses pesticides 4 times in three months, sprays every plant. Wears a tank on his back & sprays, but checks plants for insects first. He uses 1 bottle for each field (380 baht/bottle). Prices of fertiliser and pesticides are going up every year. A natural rise in cabbage prices → everybody grows more cabbage → prices fall.

Coffee & peanut: Waits 3 years and then harvests coffee. Cows often graze and eat the crop. Now a fence is being built. There are good prices on peanut. He is considering growing it next year.

Farm activity: From May until November.

Royal Project: Has been given advice about liming the soil and how to solve pest problems. If he has problem he contacts them. Meetings are held by the Royal Project about bio-control, soil acidity, etc. One family member pr. Household must attend the meetings. His brother-in-law has been given vegetables to grow and the Royal Project does quality control. There are no real benefits from the Royal Project.

Quote: "You must help yourself before you get help from others".

Erosion: He has observed landslides. The situation hasn't changed in the last 10 years.

Major problems related to agriculture: Insects (he doesn't know the species and thus which pesticides to use). RP promotes organic pesticides and their recommendations don't always work well. Plant diseases are a small problem. Plant rot is found in dry areas.

Forest use: The forest is used for collection of dry wood, bamboo shoots, mushrooms, setting up of rat traps, wild banana. Last month he went rat trapping every afternoon. In the rainy season mushrooms and bamboo are collected.

Animals: His father-in-law has chickens, pigs and cows. He hopes to inherit these.

The interview was done in Ban Huai Som Poi.

Topic: Cabbage cultivation

Name: Mr. Kitipong Panaparprai (speaks English, no interpreter needed).
This person was later interviewed in a more formal way. This interview was more like a conversation.
How he cultivates cabbage: He has a few plots used for cabbage cultivation.
He starts by making a seedbed approximately 4X4 meters using a spade. He said he uses the most fertile part of his field for the seedbed. The way the cabbage seeds are sown in the seedbed is by hand. He is not so good at it, so his brother normally does it for him. After this activity he starts to prepare the field also using a spade. When the cabbage has three to four leaves they are transplanted to the large field (approx. 1 month after sowing in the seedbed). To plant the seedlings in the seedbed he uses a planting stick. He makes a hole with the stick then he puts fertiliser, a little soil and at last the seedling. Planting distance is approximately 40 cm. It is important that the seedling's root is not in direct contact with the fertiliser, because it would make the plant sick. Fertiliser is used when planting and later in the growing season. After transplanting he goes and looks in his field one to two times every week for pests. Some years he used pesticides some he did not. In august he normally harvests.

Semi-structured interview conducted the 24/1

Name: Mrs. Lake Jaranratanakamon
Age: 57
Address: 212 (living in Ban Huai Sompoi)
No. of people in household: She lives alone. Her husband passed away and her son-in-law works at the school in Ban Huai Sompoi.

Crops: She has two areas, one is used for coffee & banana, the other for peanut. Last year she grew red onion and lost money on it. She has grown cabbage occasionally during the last 15 years. She has never grown opium.

Before Thai-Norway: She didn't plant much except for rice. She used the forest for collecting vegetables & banana flower. She mentioned that the villagers did whatever Thai-Norway recommended.

Forest use: She doesn't use the forest much now.

Royal Project: They haven't been much help. The crops they have introduced are hard to cultivate (i.e. plumb).

Last year: She grew one area of taro and one area of coffee. The yields were low (1000-2000 kg/rai). 4-5 years ago coffee yields were high, now they are declining.

Fertiliser: She doesn't use it anymore because she can't afford it.

Manure: She uses manure for coffee. She no longer has cattle so she buys manure from her neighbours (10 baht/sack). The yield is not as good as when she used fertiliser.

Coffee: She sells coffee to a middleman for 7 baht/kg. The price has fallen to 6 baht/kg this year.

Handicrafts: For her own use, but she sells it for 200 baht/piece of clothing.

Pesticides: She uses insecticides. 3 years ago she started using Neem Tree pesticides introduced through a program which promotes organic pesticides.

Herbicides: No herbicides used. All weeding is done by hand.

Fallow: No fallow periods. She cultivates her areas continuously year after year.

Preparation of soil: 2 weeks of slashing, then she waits for the rain and then starts planting.

Major problems related to agriculture: The price for the products and insects.

Future: She will continue growing coffee.

Semi-structured interview conducted 24/1

Name: Mrs. Cheka Tunlamanai
Age: 45
Address: 12/4 (living in Ban Huai Sompoi).
No. of people in household: 4 (she, her husband and 2 children).

Crops: 2 areas, one with rice & cabbage, one with coffee. Last year she couldn't sell her cabbage due to lack of rain. She lost 10000 baht last year on cabbage. She had loaned the money from a man. She did the labour, he did not work, they shared the profits. 15 years ago she grew rice and opium. Cabbage cultivation is done after harvest of rice, followed by slash & burn and 1 month soil preparation by hand.

Pesticides: She uses chemical pesticides, spraying the whole field. In the past she didn't use pesticides.

Yield: Yield is lower, but fluctuates from year to year.

Fertiliser: She uses more and more every year. She will continue use even though prices are higher.

Royal Project: They don't come to the village much.

Forest: Uses it less than before.

Fallow: She uses the same areas continuously. No fallow periods.

Biggest problems: The price for her products and water availability.

Future: She will cultivate red onion, rice and will maybe stop cultivating cabbage.

Semi-structured interview conducted the 24/1 in Ban Pa Kia Nai

Topic: Description of the farming system and the activities involved.

Interviewee: Village headman of Ban Pa Kia Nai

Cabbage cultivation:
From May till June: Prepare soil. Slash and burn (this activity takes 3 days for one rai (one person)).
From May till June he spends everyday in the field. He prepares the soil with a spade.
He uses part of his field as a seedbed (the same place every year). The seeds are sown on the seedbed.
June: The seedlings are transplanted to the field (1 month after sowing).
Procedure for planting in the field: Make a hole with a stick, put fertiliser in, followed by a little soil and then the seedling. Distance between plants is 30 cm. 100 kg of fertiliser is used. After transplanting he goes every week to look for pests.
July: After approx. 1.5 months after transplanting he puts 100 kg of fertiliser (he uses 200 kg pr rai of N,P,K 16-20-0 for one season). This activity takes two days (last year he had no problems with insects).
August: He looks once a week in the field and if the plants are mature he harvests the cabbage.
Harvest: Ten people (exchange labour). One rai: If the yield is 5000 kg it will take 5 days to harvest (One truck load everyday of 1000 kg).

Rice cultivation (Paddy rice on terraces):
May: Starts sowing in a seedbed just like cabbage. He uses a ploughing machine to prepare the soil in the field. This activity takes two days pr rai. In the past he used a buffalo for this activity and back then it took one month.
June: Transplanting. 20 people work one day pr rai (exchange labour). He uses no fertiliser.
July: One month after transplanting he weeds. Weeding is done only once, and takes five days (one person pr rai).
Harvest: 20 people work one day pr rai. The rice is dried for one year in a "rice house". Processing is carried out using a "chomo chomo" .

Semi-structured interview conducted in Ban Pa Kia Nai 24/1

Name: Singham Kaewtid (has lived in the village for 14 years).
Family: 1 wife and 3 children

Crops: Red onion, cabbage and upland rice. Has been cultivating cabbage for many years, but has only been cultivating red onion for the last 3 years.

Activities throughout the year:

January – March : Stays home and does nothing
April: Soil preparation
May: Cabbage and red onion is planted
June-July: The field is monitored
August: Cabbage and onion is harvested
October: Upland rice is harvested
November-December: He works a little off-farm for a few days.

His wife makes handicraft.

Upland rice:
Yield: 20-30 buckets (1 bucket is 13 kg).
4-5 households grow upland rice in the village.
How they grow: Slash and burn is performed in April. Dry-seeding is done 2-3 days later without fertiliser use. The field is weeded every 4-5 weeks and harvest is in October.

Semi-structured interview conducted on 24/1

Interviewee: Mrs. Samporn Komutpanaprai
Family: 1 husband & 1 child.

Activities throughout the year:

January - February: Handicraft.
March: Sowing is started.
April: Soil preparation for cabbage. Works with her husband in the field.
August: Harvest.

Forest: Ranked as very important for this household. Forest products are collected in March and April when they are not active in the field. In the dry season they collect fire wood (the roof of the house was made of leaves from the forest).

Field: 2 plots, one used while the other is fallow. Slash and burn is used. They reduce weeds by burning the field. They were supported economically by relatives to be able to grow cabbage. They have had problems with weeds (many different species) and birds in the field.

They also grow upland rice. They told us that not many villagers cultivate upland rice.

Semi-structured interview conducted on the 24/1
Name of interviewee: Mr. Suan.
Age: 33 years (all spent in Ban Huai Sompoi).
Household: 4 people

Crops: No crops grown at the moment. He grows cabbage and rice in the rainy season. Quote: "If the price of cabbage is good it is good." Plumb and coffee give stable prices.
Income: He sometimes works in Chomtong. He works in the market and in restaurants. He prefers working in the city to cabbage cultivation.
Farming practice: He uses a spade for soil preparation. This activity lasts one month. He has grown cabbage for 5-6 years. Fertiliser: 4 sacks/rai (1 sack = 50 kg). There are no pests in the rainy season since they are afraid of the rain. He would like to grow something other than cabbage. Before cabbage he only grew rice and he didn't use fertiliser or pesticides. He uses no soil conservation methods and has no problems with erosion. He both hires labour and works himself during the entire growing period.
Forest use: Collects mushrooms and bamboo shoots.
Royal Project: They recommend growing certain vegetables & fruits. Some villagers take their advice. No projects initiated by outside organisations seem to have had any impact in Ban Huai Sompoi, except TAO which are responsible for roads, the water tank and the football field.
Future: Less cabbage will be cultivated. There have been no changes in the last 10 years. If anything will give a good price the villagers will grow it.
Differences between Ban Pa Kia Nai and Ban Huai Sompoi: none.
Religion: It is becoming more important.
Handicrafts: the Queen encourages production of handicrafts. His wife makes handicrafts and he does woodcutting (making animals and flowers). This was promoted by an organisation.
National Park: It has no effect on him. Quote: "They did and told him nothing".
Childhood: It wasn't as comfortable as now. There were no roads, poorer facilities, lower quality of living.
Water: Water availability hasn't changed much over the years.

Appendix 3: Results from soil fertility analysis

Results of the Thai soil kit analysis

Sample plot	NH_4^+	NO_3^-	P	K	pH
Conservation 3	L	VL	VL	M	7
Multi-purpose 1	L	0	L	L	4.5
Multi-purpose 2	L	0	VL	L	5

Multi-purpose 3	L	VL	L	H	5.5
Fallow 20y	L	0	VL	H	5.5
Fallow 6y	VL	0	VL	H	6
Cabbage fallow 3y	VL	0	H	H	5
Cabbage fallow 1y	VL	VL	M	L	5
Cabbage 1	VL	VL	VH	L	6
Cabbage 2	VL	VL	M	L	6.5

Results from laboratory tests

Sample plot	N (%)	P (ppm)	K (ppm)	OM (%)	PH
Conservation 1	0.113	1.7	344	3.051	5.39
Conservation 2	0.129	2.1	406	2.250	5.92
Conservation 3	0.153	0.9	292	2.586	5.75
Multi-purpose 1	0.107	0.7	210	2.146	4.76
Multi-purpose 2	0.116	0.6	208	2.327	4.83
Multi-purpose 3	0.119	1.1	202	2.379	5.00
Fallow 20y	0.178	1.9	304	3.595	5.58
Fallow 6y	0.239	2.2	486	4.784	5.66
Cabbage fallow 3y	0.145	6.5	210	2.896	5.08
Cabbage slash & burn	0.211	1.6	352	4.215	5.38
Cabbage fallow 1y	0.139	2.2	276	2.793	5.04
Cabbage 1	0.0905	7.2	196	1.810	5.73
Cabbage 2	0.120	8.3	258	2.401	5.29
Cabbage 3	0.137	3.2	342	2.741	5.12

Appendix 4: Cropping calendars

Rice

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growing period												
Land preparation												
Harvest												

Taro

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growing period												
Land preparation												
Harvest												

Red onion

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growing period												
Land preparation												
Harvest												

Coffee

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growing period												
Land preparation												
Harvest												

Les Coffee – Viva La France!

PRA conducted 14/1 in Sompoi

Appendix 5: Average fertiliser use, insecticide use and yield for paddy rice

		kg/rai		mL/rai		kg/rai	
	Plant area in rai	fertiliser 16-20-0	Total fertiliser 16-20-0	Insecticide mL	Total insecticides	Yield	Total Yield
Rich	4	6	24	0	0	1000	4000
Rich	2	25	50	0	0	1000	2000
Rich	6	0	0	0	0	400	2400
Rich	2	0	0	0	0	900	1800
Rich	6	30	180	0	0	1200	7200
Rich	20		254		0		17400
Middle	3	0	0	25	75	450	1350
Middle	4	0	0	0	0	800	3200
Middle	2	0	0	0	0	1200	2400
Middle	4	0	0	0	0	1000	4000
Middle	2	0	0	0	0	800	1600
Middle	5	20	100	0	0	600	3000
Middle	20		100		75		15550
Poor	0	0	0	0	0	0	0
Poor	3	15	45	0	0	700	2100
Poor	4	0	0	0	0	1200	4800
Poor	2	0	0	0	0	1000	2000
Poor	0	0	0	0	0	0	0
Poor	4	0	0	0	0	900	3600
Poor	5	50	250	0	0	600	3000
Poor	18		295		0		15500

Average fertiliser use, pesticide use and yield for cabbage

	Average area used for cabbage cultivation	Average fertiliser amount/rai		Average insecticide/rai	Average yield/rai (kg)
Rich	4,0	12,7		0	870
Middle	3,3	5,0		12,5	777,5
Poor	3,6	16,4		0	861,1
		Average fertiliser use per rai(kg)	Average fertiliser use /ha	Insecticide ml/rai	Average yield/rai
	All grouped together	11,2	69,9	0,4	835,3

Average fertiliser use, pesticide use and yield for cabbage

	Plant area in rai	Quantity/ rai Fertiliser 16-20-0 (kg) /rai	Total fertiliser use in kg	Quantity /rai Yield/rai	Total yield	Quantity/rai Seed in cans	Total can use	Quantity/rai Insecticide ml	Total Insecticide use
Rich	0	0	0	0		0		0	
Rich	5	250	1250	2500	12500	2	10	0	0
Rich	4	75	300	4000	16000	3	12	150	600
Rich	2	100	200	2000	4000	3	6	300	600
Rich	9	100	900	5000	45000	3	27	500	4.500
Rich	20		2650		77500	11	55	950	5.700
Middle	1	100	100	4000	4000	3	3	100	100
Middle	2	100	200	2400	4800	3	6	300	600
Middle	4	100	400	2000	8000	4	16	500	2.000
Middle	2	200	400	4000	8000	3	6	100	200
Middle	0	0	0	0	0	0	0	0	0
Middle	2	150	300	2000	4000	3	6	0	0
Middle	11		1400		28800	16	37	1.000	2.900
Poor	2	200	400	2000	4000	5	10	750	1.500
Poor	2	150	300	4500	9000	3	6	300	600
Poor	4	100	400	3000	12000	3	12	300	1.200
Poor	2	200	400	0	0	3	6	400	800
Poor	0	0	0	0	0	0	0	0	0
Poor	5	200	1000	1000	5000	3	15	500	2.500
Poor	3	100	300	3000	9000	4	12	0	0
Poor	18		2800		39000	21	61	2.250	6.600

Average fertiliser use, pesticide use and yield for paddy rice

	Average fertiliser amount/rai	Average seed cans/rai	Average insecticide use	Average yield/rai	Average yield/ha	P/rai (kg)	P/ha (kg)	N/rai (kg)	N/ha (kg)
Rich	132,5	2,8	285	3875	24218,8	23,1	144,1	21,2	132,5
Middle	127,3	3,4	263,6	2618,2	16363,6	22,1	138,4	20,4	127,27273
Poor	155,6	3,4	366,7	2166,7	13541,7	27,1	169,2	24,9	155,55556

Average area used for cabbage	Average fertiliser amount/rai	Average fertiliser amount per ha	P/rai (kg)	P/ha (kg)	N/rai (kg)	N/ha (kg)
3,3	139,8	873,7	24,3	152,0	22,4	139,8

Average seed cans/rai	Average insecticide use /rai	Average yield/rai	Average yield/ha
3,1	310,2	2965,3	18533,2

Appendix 6: Costs, incomes and profits of cabbage

Cabbage

Name	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
Mr.Suwan Swangratanachaiyong	-	-		-		-		
Mr.Chi Wongpanapisut	5	5.940	29.700	2.500	12.500	1	12.500	-17.200
Mr.Jaboo Thongboo	4	5.000	20.000	4.000	16.000	1	16.000	-4.000
Mr.Anupong Sampankunakon	2	3.220	6.440	2.000	4.000	3	12.000	5.560
Mr.Virat Vagisurinon	9	4.500	40.500	5.000	45.000	1	45.000	4.500
Mr.ju Kamkiriwong	1	4.260	4.260	4.000	4.000	2	8.000	3.740
Mr.Vorapot Chonmakpai	2	4.690	9.380	2.400	4.800	3	14.400	5.020
Mr.Dikue (Kitipong)	4	2.710	10.840	2.000	8.000	1	8.000	-2.840
Mr.jorhea Duangjaipaiwan	2	6.270	12.540	4.000	8.000	2	14.400	1.860
Mr.Duangchan Swangratanachaiyoung	2	5.900	8.850	2.000	3.000	2	4.500	-4.350
Mr.Chansom Vajisureenon	2	5.450	10.900	4.500	9.000	2	15.300	4.400
Mr.Nu Saksitvorakul	4	3.980	15.920	3.000	12.000	1	12.000	-3.920
Mr.Tapoi Kusolrungroj	2	3.600	7.200	0	0	0	0	-7.200
Mr.Chiwa Punsuthairungroj	-	-		-		-		0
Mr.Surachai Kamchaika	-	-		-		-		0
Mr.Vittaya pongsakornpaisan	2	3.040	6.080	2.000	4.000	3	12.000	5.920
Mr.Tula Banchasawan	5	3.910	19.550	1.000	5.000	1	5.000	-14.550
Mr.Sri Klongkajonekiri	3	2.000	6.000	3.000	9.000	1	9.000	3.000
Total	48,5		208.160	41.400	144.300		188.100	-20.060
Average	3,233		13.877,333		9.620		12.540	-1.337,333

Average price/kg	1,303534
Production Costs/kg	1,442550
Cost/rai	4.291,959
Income/rai	3878,35052
Profit/rai	-413,608
Average yield	2975,25773

Appendix 7: Costs, incomes and profits of onion

Onion

name	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
Mr.Suwan Swangratanachaiyong	5	9.310	46550	2.000	10000	4,5	45000	-1550
Mr.Chi Wongpanapisut	1	6.185	6185	1.000	1000	5,5	5500	-685
Mr.Jaboo Thongboo	4	9.700	38800	3.000	12000	5,0	60000	21200
Mr.Anupong Sampankunakon	1	8.660	8660	2.500	2500	4,0	10000	1340
Mr.Virat Vagisurinon	7	8.450	59150	4.000	28000	3,0	84000	24850
Mr.ju Kamkiriwong	2	9.820	19640	3.000	6000	3,0	18000	-1640
Mr.Vorapot Chonmakpai	2	9.720	19440	3.000	6000	5,0	30000	10560
Mr.Dikue (Kitipong)	-	0	0	-	0	-	0	0
Mr.jorhea Duangjaipaiwan	5	9.590	47950	4.000	20000	2,0	40000	-7950
Mr.Duangchan Swangratanachaiyoung	-		0	-	0	-	0	0
Mr.Chansom Vajisureenon	2	10.137	20274	3.700	7400	4,0	29600	9326
Mr.Nu Saksitvorakul	4	10.910	43640	5.000	20000	1,5	30000	-13640
Mr.Tapoi Kusolrungroj	1	7.260	7260		0		0	-7260
Mr.Chiwa Punsuthairungroj	2	10.310	20620	2.000	4000	3,0	12000	-8620
Mr.Surachai Kamchaika	-	0	0	-	0	-	0	0
Mr.Vittaya pongsakornpaisan	2	5.470	10940	1.000	2000	2,0	4000	-6940
Mr.Tula Banchasawan	3	7.340	22020	2.000	6000	2,0	12000	-10020
Mr.Sri Klongkajonekiri	2	5.320	10640	1.500	3000	2,0	6000	-4640
Total	43		381769	37700	127900		386100	4331
Average	2,866667		25451,267		8526,667		25740	288,7333

Average price/kg	3,018765
Production Costs/kg	2,984902
Cost/rai	8878,349
Income/rai	8979,07
Profit/rai	100,7209
Average yield	2974,419

Appendix 8: Costs, incomes and profits of taro

Taro

Name	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
Mr.Suwan Swangratanachaiyong								
Mr.Chi Wongpanapisut								
Mr.Jaboo Thongboo								
Mr.Anupong Sampankunakon	5	8.120	40.600	3.000	15000	8	120000	79.400
Mr.Virat Vagisurinon	5	10.690	53.450	4.000	20000	5	100000	46.550
Mr.ju Kamkiriwong								
Mr.Vorapot Chonmakpai			0					
Mr.Dikue (Kitipong)			0					
Mr.jorhea Duangjaipaiwan			0					
Mr.Duangchan Swangratanachaiyoung	0,5	7560	3.780	2000	1000	5	5000	1.220
Mr.Chansom Vajisureenon								
Mr.Nu Saksitvorakul								
Mr.Tapoi Kusolrungroj								
Mr.Chiwa Punsuthairungroj								
Mr.Surachai Kamchaika								
Mr.Vittaya pongsakornpaisan								
Mr.Tula Banchasawan								
Mr.Sri Klongkajonekiri								
Total	10,5		97830	9000	36000		225000	127170
Average	3,5		32610		12000		75000	42390

Average price/kg	6,25
Production Costs/kg	2,7175
Cost/rai	9317,143
Income/rai	21428,57
Profit/rai	12111,43
Average yield	3428,571

Appendix 9: Costs, incomes and profits of paddy rice

Paddy rice

Name	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
Mr.Suwan Swangratanachaiyong	4	1.670	6680	1.000	4000	5	20000	13320
Mr.Chi Wongpanapisut	2	880	1760	1.000	2000	5	10000	8240
Mr.Jaboo Thongboo	6	400	2400	400	2400	5	12000	9600
Mr.Anupong Sampankunakon	2	400	800	900	1800	5	9000	8200
Mr.Virat Vagisurinon	6	1.000	6000	1.200	7200	5	36000	30000
Mr.ju Kamkiriwong	3	437	1311	450	1350	5	6750	5439
Mr.Vorapot Chonmakpai	4	800	3200	800	3200	5	16000	12800
Mr.Dikue (Kitipong)	2	760	1520	1.200	2400	5	12000	10480
Mr.jorhea Duangjaipaiwan	4	2.800	11200	1.000	4000	5	20000	8800
Mr.Duangchan Swangratanachaiyoung	-	0	0		0		0	0
Mr.Chansom Vajisureenon	3	900	2700	700	2100	5	10500	7800
Mr.Nu Saksitvorakul	4	250	1000	1.200	4800	5	24000	23000
Mr.Tapoi Kusolrungroj	2	400	800	1.000	2000	5	10000	9200
Mr.Chiwa Punsuthairungroj		0	0		0		0	0
Mr.Surachai Kamchaika	2	2.150	4300	800	1600	5	8000	3700
Mr.Vittaya pongsakornpaisan	5	2.550	12750	600	3000	5	15000	2250
Mr.Tula Banchasawan	4	270	1080	900	3600	5	18000	16920
Mr.Sri Klongkajonekiri	5	800	4000	600	3000	5	15000	11000
Total	58		61501	13750	48450		242250	180749
Average	3,6		3843,8		3028,1		15140,6	11296,8

Average price/kg	5
Production Costs/kg	1,26937
Cost/rai	1060,362
Income/rai	4176,724
Profit/rai	3116,362
Average yield	835,3448

Appendix 10: Costs, incomes and profits of coffee

Coffee

name	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
Mr.Suwan Swangratanachaiyong								
Mr.Chi Wongpanapisut	4			400	1600	8	12800	12800
Mr.Jaboo Thongboo	1			500	500	10	5000	5000
Mr.Anupong Sampankunakon								
Mr.Virat Vagisurinon								
Mr.ju Kamkiriwong	0,5			20	10	7	70	70
Mr.Vorapot Chonmakpai								
Mr.Dikue (Kitipong)								
Mr.jorhea Duangjaipaiwan	1			800	800	9	7200	7200
Mr.Duangchan Swangratanachaiyoung								
Mr.Chansom Vajisureenon	2	250	500	50	100	10,0	1000	500
Mr.Nu Saksitvorakul								
Mr.Tapoi Kusolrungroj								
Mr.Chiwa Punsuthairungroj								
Mr.Surachai Kamchaika								
Mr.Vittaya pongsakornpaisan								
Mr.Tula Banchasawan								
Mr.Sri Klongkajonekiri								
Total	8,5		500	1770	3010		26070	25570
Average	1,7		100		602		5214	5114

Average price/kg	8,66
Production Costs/kg	0,166113
Cost/rai	58,82353
Income/rai	3067,059
Profit/rai	3008,235
Average yield	354,1176

Appendix 11: Detailed farmer costs and incomes

no		Name	Crop	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
5	rich	Mr.Virat Vagisurinon	cabbage	9	4.500	40.500	5.000	45.000	1	45.000	4.500
			onion	7	8.450	59.150	4.000	28.000	3	84.000	24.850
			coffee								
			taro	5	10.690	53.450	4.000	20.000	5	100.000	46.550
			rice	6	1.000	6.000	1.200	7.200	5	36.000	30.000
		Total income		**27**	**24.640**	**159.100**	**14.200**	**100.200**	**14**	**265.000**	**105.900**
6	medium	Mr.ju Kamkiriwong	cabbage	1	4.260	4.260	4.000	4.000	2	8.000	3.740
			onion	2	9.820	19.640	3.000	6.000	3	18.000	-1.640
			coffee	1			20	10	7	70	70
			taro								
			rice	3	437	1.311	450	1.350	5	6.750	5.439
		Total income		**7**	**14.517**	**25.211**	**7.470**	**11.360**	**17**	**32.820**	**7.609**
7	medium	Mr.Vorapot Chonmakpai	cabbage	2	4.690	9.380	2.400	4.800	3	14.400	5.020
			onion	2	9.720	19.440	3.000	6.000	5	30.000	10.560
			coffee								
			taro								
			rice	4	800	3.200	800	3.200	5	16.000	12.800
		Total income		**8**	**15.210**	**32.020**	**6.200**	**14.000**	**13**	**60.400**	**28.380**
8	medium	Mr.Dikue (Kitipong)	cabbage	4	2.710	10.840	2.000	8.000	1	8.000	-2.840
			onion								
			coffee								
			taro								
			rice	2	760	1.520	1.200	2.400	5	12.000	10.480
		Total income		**6**	**3.470**	**12.360**	**3.200**	**10.400**	**6**	**20.000**	**7.640**

no		Name	Crop	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
1	rich	Mr.Suwan Swangratanachaiyong	cabbage	-	-		-		-		
			onion	5	9.310	46.550	2.000	10.000	5	45.000	-1.550
			coffee								
			taro								
			rice	4	1.670	6.680	1.000	4.000	5	20.000	13.320
		Total income		**9**	**10.980**	**53.230**	**3.000**	**14.000**	**10**	**65.000**	**11.770**
2	rich	Mr.Chi Wongpanapisut	cabbage	5	5.940	29.700	2.500	12.500	1	12.500	-17.200
			onion	1	6.185	6.185	1.000	1.000	6	5.500	-685
			coffee	4			400	1.600	8	12.800	12.800
			taro								
			rice	2	880	1.760	1.000	2.000	5	10.000	8.240
		Total income		**12**	**13.005**	**37.645**	**4.900**	**17.100**	**20**	**40.800**	**3.155**
3	rich	Mr.Jaboo Thongboo	cabbage	4	5.000	20.000	4.000	16.000	1	16.000	-4.000
			onion	4	9.700	38.800	3.000	12.000	5	60.000	21.200
			coffee	1			500	500	10	5.000	5.000
			taro								
			rice	6	400	2.400	400	2.400	5	12.000	9.600
		total imcome		**15**	**15.100**	**61.200**	**7.900**	**30.900**	**21**	**93.000**	**31.800**
4	rich	Mr.Anupong Sampankunakon	cabbage	2	3.220	6.440	2.000	4.000	3	12.000	5.560
			onion	1	8.660	8.660	2.500	2.500	4	10.000	1.340
			coffee								
			taro	5	8.120	40.600	3.000	15.000	8	120.000	79.400
			rice	2	400	800	900	1.800	5	9.000	8.200
		total imcome		**10**	**20.400**	**56.500**	**8.400**	**23.300**	**20**	**151.000**	**94.500**

no		Name	Crop	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
9	medium	Mr.jorhea Duangjaipaiwan	cabbage	2	6.270	12.540	4.000	8.000	2	14.400	1.860
			onion	5	9.590	47.950	4.000	20.000	2	40.000	-7.950
			coffee	1			800	800	9	7.200	7.200
			taro								
			rice	4	2.800	11.200	1.000	4.000	5	20.000	8.800
		Total income		**12**	**18.660**	**71.690**	**9.800**	**32.800**	**18**	**81.600**	**9.910**
10	poor	Mr.Duangchan Swangratanachaiyo	cabbage	2	5.900	8.850	2.000	3.000	2	4.500	-4.350
			onion								
			coffee								
			taro	1	7.560	3.780	2.000	1.000	5	5.000	1.220
			rice								
		Total income		**2**	**13.460**	**12.630**	**4.000**	**4.000**	**7**	**9.500**	**-3.130**
11	poor	Mr.Chansom Vajisureenon	cabbage	2	5.450	10.900	4.500	9.000	2	15.300	4.400
			onion	2	10.137	20.274	3.700	7.400	4	29.600	9.326
			coffee	2	250	500	50	100	10	1.000	500
			taro								
			rice	3	900	2.700	700	2.100	5	10.500	7.800
		Total income		**9**	**16.737**	**34.374**	**8.950**	**18.600**	**21**	**56.400**	**22.026**
12	poor	Mr.Nu Saksitvorakul	cabbage	4	3.980	15.920	3.000	12.000	1	12.000	-3.920
			onion	4	10.910	43.640	5.000	20.000	2	30.000	-13.640
			coffee								
			taro								
			rice	4	250	1.000	1.200	4.800	5	24.000	23.000
		Total income		**12**	**15.140**	**60.560**	**9.200**	**36.800**	**8**	**66.000**	**5.440**

no		Name	Crop	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
13	poor	Mr.Tapoi Kusolrungroj	cabbage	2	3.600	7.200	0	0	0	0	-7.200
			onion	1	7.260	7.260		0		0	-7.260
			coffee								
			taro								
			rice	2	400	800	1.000	2.000	5	10.000	9.200
		Total income		**5**	**11.260**	**15.260**	**1.000**	**2.000**	**5**	**10.000**	**-5.260**
14	poor	Mr.Chiwa Punsuthairungroj	cabbage								
			onion	2	10.310	20.620	2.000	4.000	3	12.000	-8.620
			coffee								
			rice								
		Total income		**2**	**10.310**	**20.620**	**2.000**	**4.000**	**3**	**12.000**	**-8.620**
15	medium	**Mr.Surachai Kamchaika**	cabbage								
			onion								
			rice	2	2.150	4.300	800	1.600	5	8.000	3.700
		Total income		**2**	**2.150**	**4.300**	**800**	**1.600**	**5**	**8.000**	**3.700**
16	medium	**Mr.Vittaya pongsakornpaisan**	cabbage	2	3.040	6.080	2.000	4.000	3	12.000	5.920
			onion	2	5.470	10.940	1.000	2.000	2	4.000	-6.940
			rice	5	2.550	12.750	600	3.000	5	15.000	2.250
		Total income		**9**	**11.060**	**29.770**	**3.600**	**9.000**	**10**	**31.000**	**1.230**

no		Name	Crop	planted area	Costs/ rai	Total costs	quantity/ rai	Total Quantity	price/ kg	total income	Profit Loss
17	poor	**Mr.Tula Banchasawan**	cabbage	5	3.910	19.550	1.000	5.000	1	5.000	-14.550
			onion	3	7.340	22.020	2.000	6.000	2	12.000	-10.020
			rice	4	270	1.080	900	3.600	5	18.000	16.920
		Total income		**12**	**11.520**	**42.650**	**3.900**	**14.600**	**8**	**35.000**	**-7.650**
18	poor	**Mr.Sri Klongkajonekiri**	cabbage	3	2.000	6.000	3.000	9.000	1	9.000	3.000
			onion	2	5.320	10.640	1.500	3.000	2	6.000	-4.640
			rice	5	800	4.000	600	3.000	5	15.000	11.000
		Total income		**10**	**8.120**	**20.640**	**5.100**	**15.000**	**8**	**30.000**	**9.360**

Appendix 12:

Numb adults /household	Head of Household	Land Owned	Total crop income	Total crop costs	Total crop profits	Animal Income	Total farm Income	Off-farm income	NTFPs Valuation	Total Income
2	Mr.S. Swangratanachaiyong	**9**	65.000	53.230	11.770	0	65.000	30.000	3.310	98.310
2	Mr.C. Wongpanapisut	**12**	40.800	37.645	3.155	0	40.800	21.000	3.400	65.200
2	Mr.J.Thongboo	**15**	93.000	61.200	31.800	200	93.200		500	93.700
2	Mr.A. Sampankunakon	**10**	151.000	56.500	94.500	0	151.000	49.200		200.200
2	Mr.Virat Vagisurinon	**27**	265.000	159.100	105.900	0	265.000	40.000	1.100	306.100
10	**Total rich**	**73**	**614.800**	**367.675**	**247.125**	**200**	**615.000**	**140.200**	**8.310**	**763.510**
2	**Average rich**	**15**	**122.960**	**73.535**	**49.425**	**40**	**123.000**	**28.040**	**1.662**	**152.702**
	US$/day per adult									**5,4478**
2	Mr.ju Kamkiriwong	**7**	32.820	25.211	7.609	250	33.070	1.600	635	35.305
2	Mr.Vorapot Chonmakpai	**8**	60.400	32.020	28.380	0	60.400	19.000	1.200	80.600
2	Mr.Dikue (Kitipong)	**6**	20.000	12.360	7.640	48000	68.000	15.825	400	84.225
2	Mr.jorhea Duangjaipaiwan	**12**	81.600	71.690	9.910	0	81.600		3.000	84.600
8	**Total medium**	**33**	**194.820**	**141.281**	**53.539**	**48.250**	**243.070**	**36.425**	**5.235**	**284.730**
2	**Average Medium**	**8**	**48.705**	**35.320**	**13.385**	**12.063**	**60.768**	**9.106**	**1.309**	**71.183**
	US$/day									**2,5400**
2	Mr.D. Swangratanachaiyoung	**2**	9.500	12.630	-3.130	0	9.500	450	700	10.650
2	Mr.Chansom Vajisureenon	**9**	56.400	34.374	22.026	0	56.400	8.100	350	64.850
5	Mr.Nu Saksitvorakul	**12**	66.000	60.560	5.440	0	66.000	6.800	560	73.360
2	Mr.Tapoi Kusolrungroj	**5**	10.000	15.260	-5.260	0	10.000	8.320	1.900	20.220
2	Mr.Chiwa Punsuthairungroj	**2**	12.000	20.620	-8.620	0	12.000		2.200	14.200
13	**Total poor**	**30**	**153.900**	**143.444**	**10.456**	**0**	**153.900**	**23.670**	**5.710**	**183.280**
2,6	**Average Poor**	**6**	**30.780**	**28.689**	**2.091**	**0**	**30.780**	**4.734**	**1.142**	**36.656**
	US$/day									**1,0077**
2	**Mr.Surachai Kamchaika**	**2**	8.000	4.300	3.700	0	8.000		250	8.250
3	**Mr.V.Pongsakornpaisan**	**9**	31.000	29.770	1.230	0	31.000	36.000	1.000	68.000
2	**Mr.Tula Banchasawan**	**12**	35.000	42.650	-7.650	0	35.000	1.000	1.100	37.100
2	**Mr.Sri Klongkajonekiri**	**10**	30.000	20.640	9.360	0	30.000	3.600	1.500	35.100
9	**Total Kia Nai**	**33**	**104.000**	**97.360**	**6.640**	**0**	**104.000**	**40.600**	**3.850**	**148.450**
2,25	**Average Kia Nai**	**8**	**26.000**	**24.340**	**1.660**	**0**	**26.000**	**10.150**	**963**	**37.113**
	US$/day									**1,1790**
	Total		**1.067.520**	**749.760**	**317.760**	**48.450**	**1.115.970**	**240.895**	**23.105**	**1.379.970**
	Average		**59307**	**41653,333**	**17653**	**2692**	**61998**	**13383**	**1284**	**76665**
	US$/day		**2,4645**							

Numb adults /household	Head of Household	Basic expenditures	Expenditures and costs	Total net Income	Debt	Savings	Live animals
2	Mr.S. Swangratanachaiyong	73.560	126.790	-28.480	4.000		
2	Mr.C. Wongpanapisut	9.925	47.570	17.630	6.000		
2	Mr.J.Thongboo	46.400	107.600	-13.900			
2	Mr.A. Sampankunakon	26.680	83.180	117.020	60.000		
2	Mr.Virat Vagisurinon	70.300	229.400	76.700	25.000	200000	1000
10	**Total rich**	**226.865**	**594.540**	168.970	95.000	200.000	1.000
2	**Average rich**	**45.373**	**118.908**	**33.794**	**19.000**	**40.000**	**200**
2	Mr.ju Kamkiriwong	16.440	41.651	-6.346	20.000		
2	Mr.Vorapot Chonmakpai	18.200	50.220	30.380	15.000		3000
2	Mr.Dikue (Kitipong)	22.000	34.360	49.865	8.000		
2	Mr.jorhea Duangjaipaiwan	19.640	91.330	-6.730	30.000		10250
8	**Total medium**	**76.280**	**217.561**	67.169	73.000		13.250
2	**Average Medium**	**19.070**	**54.390**	**16.792**	**18.250**		**3.313**
2	Mr.D. Swangratanachaiyoung	6.615	19.245	-8.595	6.000		12000
2	Mr.Chansom Vajisureenon	43.240	77.614	-12.764	15.000		1500
5	Mr.Nu Saksitvorakul	0	60.560	12.800	35.000		
2	Mr.Tapoi Kusolrungroj	10.360	25.620	-5.400	9.500		200
2	Mr.Chiwa Punsuthairungroj	10.740	31.360	-17.160	20.000		6000
13	**Total poor**	**70.955**	**214.399**	-31.119	85.500		19.700
2,6	**Average Poor**	**14.191**	**42.880**	**-6.224**	**17.100**		**3.940**
2	**Mr.Surachai Kamchaika**	11.200	15.500	-7.250	0		
3	**Mr.V.Pongsakornpaisan**	48.360	78.130	-10.130	6.000		100
2	**Mr.Tula Banchasawan**	3.600	46.250	-9.150	2.000		10000
2	**Mr.Sri Klongkajonekiri**	0	20.640	14.460	7.000		20000
9	**Total Kia Nai**	**63.160**	**160.520**	-12.070	15.000		30.100
2,25	**Average Kia Nai**	**15.790**	**40.130**	**-3.018**	**3.750**		**7.525**
	US$/day						
	Total	**437.260**	**1.187.020**	**192.950**	**268.500**	**200.000**	**64.050**
	Average	**24292**	**65946**	**10719**	**14917**	**11111**	**3558**

Appendix 13: Statistical analysis

Analysis of P.

Forest	Current land use
1,7	6,5
2,1	1,6
0,9	2,2
0,7	7,2
0,6	8,3
1,1	3,2

Forest	Ranking forest values	Current land use	Ranking of current land use values
0,6	1	1,6	5
0,7	2	2,2	8
0,9	3	3,2	9
1,1	4	6,5	10
1,7	6	7,1	11
2,1	7	8,3	12
R1:	23	R2:	55

U1	2
U2	34

The table of U-values shows that there is a significant difference (p. 240 in Fowler)

Analysis of N.

Forest	Current land use
0,113	0,145
0,129	0,211
0,153	0,139
0,107	0,0905
0,116	0,12
0,119	0,137

Forest	Ranking forest values	Current land use	Ranking of current land use values
0,107	2	0,0905	1
0,113	3	0,12	6
0,116	4	0,137	8
0,119	5	0,139	9
0,129	7	0,145	10
0,153	11	0,211	12
R1:	32	R2:	46

U1	11
U2	25

The table of U-values shows no significant difference (p. 240 in Fowler)
Analysis of K.

Forest	Current land use
344	210
406	352
292	272
210	196
208	258
202	342

Forest	Ranking forest values	Current land use	Ranking of current land use values
202	2	196	1
208	3	210	4,5
210	4,5	258	6
292	8	272	7
344	10	342	9
406	12	352	11
R1:	39,5	R2:	38,5

U1	18,5
U2	17,5

The table of U-values shows no significant difference (p. 240 in Fowler)

Analysis of OM.

Forest	Current land use
3,051	2,896
2,25	4,215
2,586	2,793
2,146	1,81
2,327	2,401
2,379	2,741

Forest	Ranking forest values	Current land use	Ranking of current land use values
2,146	2	1,81	1
2,25	3	2,401	6

2,327	4		2,741	8
2,379	5		2,793	9
2,586	7		2,896	10
3,051	11		4,215	12
R1:	32	R2:		46

U1	11
U2	25

The table of U-values shows no significant difference (p. 240 in Fowler)

Analysis of pH.

Forest	Current land use
5,39	5,08
5,92	5,38
5,75	5,04
4,76	5,73
4,83	5,29
5	5,12

Forest	Ranking forest values	Current land use	Ranking of current land use values
4,76	1	5,04	4
4,83	2	5,08	5
5	3	5,12	6
5,39	9	5,29	7
5,75	11	5,38	8
5,92	12	5,73	10
R1:	38	R2:	40

U1	17
U2	19

The table of U-values shows no significant difference (p. 240 in Fowler)

Appendix 14
Activity calendar

Schedule of the activities performed by the individual group members

Date	Activities	Group members
Tuesday, 11 January	Collaborating together with the Thai students working on coming up with a joint overall research question. Icebreaking activities.	All group members
Wednesday, 12 January	Completed group work on the common research question. Work was initiated on a diagram showing the interdisciplinary linkages between the overall focus issue and our research question. Presentation of the Diagram for our group. List prepared for the needed equipment in the field. In the evening the Diagram was modified and improved. Initiated work on questionnaire	The presentation was done by Mr. Mads. Andreas and Troels prepared the list with the Thai students. The improvement of the diagram was done by all Danish group members.
Thursday, 13 January	Left the university and went to the base camp. Notes were taken during introduction given by the key informants. Left the base camp and went to the village. The improved diagram was presented to the Thai students and finalised.	All group members. Evening meeting led by Mads.
Friday, 14 January	Field work. All Danish and Thai group members went to the village headman, introducing ourselves, our research topic and asking him to point out the questionnaire respondents in the three categories (rich, middle and poor income). Group walk from our home in Ban Huai Sompoi to the sub-village of Ban Pa Kia Nai, making useful observations for further research. Later in the evening a PRA session was carried out.	All group members. The PRA was carried out by the Thai student Nok and Little.
Saturday, 15 January	Field work. The soil group visited Ban Pa Kia Nai, taking soil samples, measuring pH, infiltration rate, slopes, making soil profiles at three cabbage fields and one rice field. And a short	The Danish part of the Soil group (Troels and Andreas). The Danish part

	interview was done with the village headman of Ban Pa Kia Nai at the same occasion. The economic group did community mapping together with the Headman and key informants in the morning, and an informal transect walk in Ban Huai Sompoi in the afternoon. Work on elaborating the questionnaire. Arrival of Mr. Mogens: Presentation of what we had done so far.	of the economic group (Mads). All group members All group members
Sunday, 16 January	A transect walk was done in Ban Huai Som Poi. This activity took the whole day. Finished work on the questionnaire	The whole group participated. All group members
Monday, 17 January	This day soil samples were taken from disturbed and undisturbed forest a total of six plots was visited. Questionnaires conducted in Sompoi An interview was conducted with an employee at The royal Project	Andreas visited all six plots, while Troels only went to the disturbed forest. Mads and Nok The Royal Project was visited by Troels and Mads.
Tuesday, 18 January	Samples were taken from a fallow field and an agro-forestry plot with Coffee. Interview with Kitipong Panmaphri. Questionnaires conducted in Sompoi Interviews with rich farmer Mr. Suan and village Headman on the topics contract farming and marketing of cabbage.	Andreas & Troels Andreas & Troels Mads and Nok Mads and Nok
Wednesday, 19 January	Preparations for midterm: what methods have we used? How is the group co-operation? Put the research question of our group in relation to the common research? Work that should be done. In the evening the activities was playing cards, drinking beer and singing karaoke. All participated.	These themes were dealt with by the economic and the soil group. All Danish members were active during the presentation and the two thai students Tom and Nok also presented.
Thursday, 20 January	Day off. We visited Doi Inthanon, the highest peak in Thailand. We also went to see the Royal Project research	All Danish group members.

	station there. Left very late in the evening for the village.	
Friday, 21 January	Collected soil cores from previously mentioned cabbage fields. Went to Chom Thong to investigate cabbage marketing chains. Interviews with the two buyers and informal conversations with Hmong farmers. Interview with National Park officer at base camp. Questionnaires conducted.	Troels and Andreas Mads and Nok Mads All group members
Saturday, 22 January	One interview was conducted. Preparations were made for the PRA held the following evening with farmers from Ban Huai Sompoi. Interview with Teacher Kham on contract farming. Questionnaires conducted	Troels and Andreas interviewed. All prepared for the PRA. Andreas was leading the PRA together with Nok. Mads and Nok All members
Sunday, 23 January	Andreas went to collect more soil samples from 6 & 20 year fallow fields. Troels stayed at home working together with Jang calculating infiltration rates. Soil analysis was done using the Thai soil kit. Modifications were done for the next PRA that was held in Ban Pa Kia Nai in the evening. Interview on contract farming and marketing with UN Man Interview with English driver on contract farming/marketing	Andreas made soil analysis. Troels modified the PRA. All group members participated in the PRA. It was lead by Nok, Little and Andreas. Mads, Nok and Pui Mads
Monday, 24 January	This day in-depth interviews were conducted in Ban Huai Som Poi and Ban Pa Kia Nai. Excursion to Hmong village Final community meeting	Troels conducted 3 interviews in Ban Pa Kia Nai and Andreas conducted 2 interviews in Ban Huai Sompoi. Mads All members
Tuesday, 25 January	Preparation of the debriefing note. Data analysis	All group members
Wednesday, 26 January	Preparation of the debriefing note: data analysis and presentation.	All group members

Thursday, 27 January	Presentation	Presentation was done by all danish group members and Nok.

Appendix 16 Synopsis

Livelihood Strategies and Consequences of Agricultural Intensification in Ban Huai Sompoi and Ban Pa Kia Nai , Ob Luang National Park, Northern Thailand

Synopsis in
Interdisciplinary Land Use and Natural Resource Management

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November 2004

1. Introduction 3
2. Methods and delimitation 101
2.1 Methods 101
2.2 Delimitation 102
3. The farming systems of the Karen hill tribes in the Northern region of Thailand 102
3.1 Changes in the farming system of the Karen 102
3.2 Methods related to the assessment of farming systems 103
4. Soil Fertility 103
4.1 Methods to determine soil fertility in rice and cabbage cultivation 103
4.2 Soil sampling 104
4.3 Crop requirements 104
4.4 Soil Organic Matter 104
4.5 Nutrients 104
4.6 pH 104
5. Erosion 104
5.1 Erosion in the Northern region of Thailand 105
5.2 Methods to assess the soil erosion (Young, 1989) 105
5.3 Methods to assess the soil conservation methods implemented in the study area 106
6. Pests and Pesticides 106
6.1 Use of pesticides 106
6.2 Pests 106
7. Commodity Chain Ananysis 107
7.1 A global method of analysing a commodity chain 107
7.2 Methods to obtain information on the cabbage chain 108
7.3 Already available in the litterature 108
8. References 111

1. Introduction

Scarcity of natural resources has been an issue of growing concern for Thailand in the last decades (Lakanavichian, 2001). Thailand's population growth and immigration almost tripled from the 1950s to the early 1980s, setting the natural resources under pressure (Lakanavichian, 2001). In order to respond to the growing demand for food from the fast growing population, more land had to be taken into cultivation, which to a large extent has been done by clearing forests. In order to limit the negative consequences of deforestation, the Thai state increased the area under conservation, with the creation of Natural Parks, Forest Parks, Watersheds, Wildlife Sanctuaries etc... (Lakanavichian, 2001). The area where our study will take place, Ob Luang in Northern Thailand, has been no exception to the country's conservation policy. Ob Luang became Thailand's 68th National Park in 1991, after having been a Forest Park from 1966 to 1991 (RFD, 2002).
The paradox is that Hill tribes – mainly Hmong and Karen - were already living in Ob Luang, which means that today they live in a National Park under conservation. According to the map of the Park that we were given, they are granted specific limited areas that are classified as "exceptions" to the National Park, allowing them to cultivate these areas for their livelihoods. All other things being equal, the existence of the National Park is setting pressure on the agricultural practises of the locals. The population is growing, while the amount of land is fixed, which requires intensification of agricultural practices, which can have negative impacts on environmental conditions.

The villagers of *Ban Huai Sompoi and Ban Pa Kia Nai*, where our study will take place belong to the Karen hill tribe. Thailand has 11 different hill tribes accounting approximately 800.000 people, of these the Karen tribal group is the largest numbering 270.000 (Eliot & Bickersteth, 2003).
The main task of our research will be to study the livelihood strategies of the villagers, how they have developed in recent years and how they are affected by the National Park. Special emphasis will be on agricultural intensification that has taken place in the late 1980s in Northern Thailand (Jørgensen and Aagaard, 2001). The Thai government has implemented development plans to substitute opium cultivation with cash crops, turning the economies of the hill tribes from subsistence economies to market economies (Jørgensen and Aagaard, 2001). How has this change affected the livelihood of the villagers? Our villages' main cash crop is cabbage, and therefore, a thorough study of cabbage will be done, both on the production side and on the marketing side.
The group's ambition of the field trip is to find out how living conditions and livelihood strategies have changed for the villagers after the Park being under conservation and agricultural intensification has taken place. We will try to identify the villagers' largests problems related to their farming practices and the way these affect their livelihoods. We will try to assess if their agricultural practices are sustainable, both economically and environmentally.

This synopsis will attempt to identify, based from a litterature study, the potential problems that the farmers are facing. Several topics/issues will be analysed, with suggestions to methods to be used to analyse the importance of the problem for the farmer. The topics that will be analysed are:

- Farming systems
- Soil Fertility
- Erosion
- Pests and pesticides
- Marketing Chain

2. Methods and delimitation

2.1 Methods

First, it should be pointed out that we so far have not been in touch with the Thai students that we will be working with. Therefore, this synopsis draft is focusing on possible issues for the farmers, and we are aware that it will not necessarily be topics that we will deal with together with the Thai students. We intend to collaborate to a large degree with the Thai students, and therefore we are ready to change focus if necessary. By being broad, we hope that some of the topics dealt with in this synopsis will be worked with in Thailand.
Some of the methods we intend to use are:
A general questionnaire on livelihood strategies for the villagers of *Ban Huai Sompoi and Ban Pa Kia Nai* will be made. The questions will be on livelihood strategies and living conditions before the end of the 1980s and after. This questionnaire will help us in understanding the major changes in recent years for the villagers.

Before handing out the questionnaire, a thorough open-ended interview with the head of the village will be planned, in order to get an overview of how the village is functioning, how it is affected by the National Park, etc. Here we intend to use participatory approaches such as making him/her draw a map of the village, including natural resource mapping. He/she should also, on this map, point out where large and small cabbage farmers live, where rich and poor farmers live, so that we afterwards can design a representative sampling strategy of the villages' 87 households. We will then also know who else we want to interview.
Another questionnaire will also be made, more specifically related to cabbage production and marketing. The purpose is to get thorough knowledge on their production practises as well as marketing strategies. To reach that goal, we also intend to make a transect walk of the village with a cabbage farmer who has to be selected. The person has to have very good knowledge of the village and its inhabitants. We think the transect walk also will help us in identifying major concerns for the farmers, and of course it will contribute to our understanding of their farming practices.
A seasonal calendar of the farmers' agricultural practices will also be done in a participatory manner, which will also contribute to the above mentioned purpose.

2.2 Delimitation

In order to delimit our study, we have chosen only to look at cabbage as cash crop. Even if the village is growing other cash crops, we have decided that it is better to focus on the cash crop of the highest importance for the villagers' livelihoods. We intend to assess how sustainable their production practices of cabbage are, both from an economic and environmental point of view.
We are aware that all the assessments we want to make in the field on cabbage might not be easy due to the season we are coming in. But since cabbage is so important, we think that it is of higher relevance to the villagers, and will do our best to optimize our analysis while we are there.
Once again, we are prepared to shift focus if our focus area does not harmonize with the one of our fellow Thai students.

3. The farming systems of the Karen hill tribes in the Northern region of Thailand

3.1 Changes in the farming system of the Karen

The Karen have (like the other hill tribes of Thailand) traditionally been practising shifting cultivation (Eliot & Bickersteth, 2003) (Aagaard & Jørgensen, 2001). This is a cultivation method where land under natural vegetation is cleared and then cropped for a few years. After the cultivation phase, follows a period of fallow where the soil is left to regenerate. The clearing is done by using the slash and burn technique (cutting down and burning the vegetation) (Aagaard & Jørgensen, 2001) and (Nair, 1993). The slash and burn method is utilising that most of the nutrients in tropical forest is stored in the above ground vegetation and by burning the vegetation the nutrients are released and can be used by the crop (Aagaard & Jørgensen, 2001).

The shifting cultivation method the Karen traditionally has been practising is called established or rotational shifting cultivation (Aagaard & Jørgensen, 2001). This cultivation method is characterised by one to two years of cultivation followed by a fallow period lasting from 7-20 years. These cultivators are unlike the pioneer shifting cultivators having a permanent village and then they have fields under cultivation and fallow. Major crops paddy rice, upland rice and maize (Aagaard & Jørgensen, 2001).
The upland rice is rainfed and grown on the slopes while the paddy rice is grown in water (Norman *et al*, 1995).

However since 1980's the highland environment has been changing rapidly. There has been a steady increase in the pressure on land through (Turkelboom, 1997):
1. Natural population growth of the hill tribes
2. Immigration from lowland and other countries
3. Government land use planning and reforestation schemes

This has resulted in a lack of available land for fallow and a more intensive use of the agricultural land (Wangpakapattanawong, 2002) and (Turkelboom, 1997).
Accelerated water erosion, nutrient depletion, increase in weed problems and soil borne diseases has therefore become more wide spread in the Northern Thailand (Turkelboom, 1997).
At the same time recently constructed permanently accessible roads has played a major role in the spread of new cash crops such as cabbage (Turkelboom, 1997).

The cultivation methods and use of cabbage and rice are very different. In our research areas rice is grown mainly for own consumption and cabbage is grown as a cash crop. Rice is cultivated with low input of chemical fertilisers, while the cabbage is produced with a high input of commercial fertilisers and pesticides.

Our main focus is on the intensive cultivation of cabbage and not on the rice growing.

3.2 Methods related to the assessment of farming systems

In the villages we are visiting there has been an agricultural transformation from subsistence farming to commercial farming of vegetables (rice is produced for own consumption). What we would like to assess is if the new more intensive cultivation methods are sustainable. We would assess this by looking at the soil fertility, weed, pest and disease records and soil erosion.
Qualitatively estimates of these can be collected by talking to the farmers.
Asking about the cabbage production, precipitation, weed infestation, pest and diseases occurrence over the last ten years, could maybe help us to identify patterns such as weed, pest and disease resistance development, soil fertility loss backed up by the soil tests. As our main crop of interest maybe not is cultivated, when we are visiting much of our information must be gathered through interviews and questionnaires. A big effort must therefore be put in the development of these.

4. Soil Fertility

4.1 Methods to determine soil fertility in rice and cabbage cultivation

A soil fertility evaluation is a way of determining a soil's ability to supply nutrients to the crop. Such an evaluation is usually aimed at giving fertilizer recommendations for farmers. Our focus is on the cash crop cabbage and, to a lesser extent, the subsistence crop rice. Evaluating soil fertility can give clues as to whether the agricultural practices are sustainable, both economically and ecologically. In our study, however, a number of problems arise. We will be in Thailand during the dry/cool season when cabbage is not grown and will have less than a month's time to collect samples and conduct field analysis. This limits the number of soil tests we can conduct and will most likely rule out plant analysis. It will most likely be possible to obtain some rough data of the inputs (fertilizer and manure) and outputs (how much is harvested) through interviews. Several scenarios may be possible. Some farmers may have livestock and rely on manure as a source of input, others may only use chemical fertilizer and those who can afford both will probably mix the two. Chemical fertilizer has advantages because it is much more concentrated than manure, you know the exact amount being put in the field and it is available to the plant immediately (*Ahn*). Studies on cabbage production in Japan have shown that considerable more leaching of NO_3^- occurs when using chemical fertilizer, especially in periods of heavy rainfall. This can be an environmental problem (contamination of groundwater) as well as an economic one (less nutrients are taken up by the crop) (*Maeda et al*, *Nyamangara, 2003*). Manure is less concentrated and contains a whole range of elements, including trace elements and may contain weed seeds, pathogens and insects. The content of plant nutrients may vary according to the type of animal, its health and age, and the quality of its food (*Ahn*). The supply of nitrogen to the plant is more stable, since manure is slowly decomposed, thus minimizing risks of leaching. Studies on maize production in Zimbabwe have shown that the best solution when wanting to minimize leaching and optimize yields is to use combinations of organic and chemical fertilizer (*Nyamangara, 2003*).

4.2 Soil sampling

The approach we will most likely use in our fertility evaluation is soil sampling, as described in *Ahn*. After a plot or field has been chosen, 10-20 soil samples are taken from a depth of 15 cm. The samples are then mixed into a composite sample, from which 500 g is extracted. The extract can then be examined in the laboratory, which we may have access to at Chiang Mai University. If not, the sample will be brought back to Denmark.

4.3 Crop requirements

Cabbage is classified as a cold-season crop, but heat-tolerant varieties are grown in the warm season in tropical areas, since warmer temperatures prolong the vegetative stage of the crop. Cabbage can be grown on most soil types but fertile soils that retain moisture well are preferred. The optimal pH for cabbage cultivation is between 6 and 6.5, and low pH can have negative effects on crop yield. Seed germination is best at a soil temperature of 12,8 – 15,6 ° C (*Hong*, 1991). Cabbage cultivation requires large inputs of fertilizer and pesticides and these are often applied in very large amounts to protect against nutrient deficiencies and pests. Overuse of fertilizer is common in Asian countries, where fertilizer is relatively cheap, and this overuse can be detrimental to both crop and environment. Cabbage, though, is one of the more efficient nitrogen users, with leaching losses of only 30-40 kg N/ha compared to spinach and leek which has losses of up to 200 kg N/ha (*Nath et al*, 1999).

4.4 Soil Organic Matter

One of the most important factors influencing soil fertility is the amount of soil organic matter (SOM). The SOM pool is a potential source of nutrients for plants. How much is available for uptake depends on the activity of micro-organisms in the soil which decompose the SOM, making nutrients available in inorganic forms that can be taken up by plants. The microbial activity is affected by abiotic factors such i.e. pH and temperature (*Ahn*). The SOM pool and the fluxes involved serve many purposes other than nutrient availability. The extent of water retention in the soil, detoxification of compounds from pesticides and alleviation of soil erosion is determined by the SOM pool and the processes involved in its transformation (*Woomer et al*). Determining the amount of SOM and measuring microbial activity, if possible, should be a priority in our soil fertility evaluation.

4.5 Nutrients

The amount of available nitrogen is difficult to determine since the inorganic ions (nitrate, NO_3^- and ammonium NH_4^+) are very mobile and are either quickly taken up by the plant or lost through leaching. Mineralization rates and amount of nitrogen released under anaerobic and aerobic conditions can be measured but this would require time, materials and a laboratory. Phospherous, however is an immobile nutrient, and some simple extraction methods can be used to determine the available amount. The Olsen sodium bicarbonate extraction method is the most widely applied and will most likely be available to us in the field. The Olsen method can also be used to determine the amount of exchangeable and soluble potassium.

4.6 pH

pH can regulate the microbial activity as well as increase the presence of metal oxides which can bond with phosphorous, thus removing it from the available pool. Measurement of pH is therefore also very important in a comprehensive evaluation.

5. Erosion

5.1 Erosion in the Northern region of Thailand

Erosion is the wearing away of the earth's surface by the agent of wind, water, or movement in response to gravity. Erosion can be divided into natural erosion and human induced erosion. Human activities such as deforestation, cultivation road building and overgrazing can accelerate the erosion dramatically (Toy *et al*, 2002).

The farming systems in the mountains area of the Northern Thailand has led to the growing concern about the sustainability of the current production method and soil erosion is mentioned as a major constraint. The Northern region of Thailand is very vulnerable to soil erosion due to its steep slopes and high and erratic precipitation (Hazarika & Honda, 2001). Tillage demanding crops such as upland rice and cabbage lead to greater tillage erosion rates than maize or beans (Turkelboom *et al*, 1997).

5.2 Methods to assess the soil erosion (Young, 1989)

When we arrive in the research area the monsoon that brings the most erratic rainfall has all ready occurred. An estimation of soil erosion in the area is therefore probably best done through modelling. Also the crop that we want to investigate is not grown in the area in the period that we are visiting (Treue personal contact).
We could get an estimate of the possible soil loss by using The Universal Soil-loss Equation (USLE). This equation is designed to predict erosion for a specific site this could in our case be a field. But if we make use of the model, we have to be aware that it can give unrealistic values of soil loss in the tropics. Therefore reflection on the A-value is needed (is the value realistic). Further more we are dependent on information about the R and K value, this could maybe be found in the Chiang Mae university, if not proper estimates would be hard to make.
The USLE equation: **A = R*K*L*S*C*P**

- **A** is the estimated soil loss (tons/ha/year)
- **R** is the rainfall factor
- **K** is the soil erodibility factor
- **L** is the slope length factor
- **S** is the slope steepness factor
- **C** is the cover-management factor
- **P** is the supporting practices factor

R, the rainfall factor, is the energy of all rain storms (E) * the maximum 30 minutes intensity (I_{30}). Normally this data is hard to get for a given area. As a rough approximation the R value can be obtained by taking half the value of the mean annual rainfall.
Chunkao et al., (1981) summarising 15 years of hydro-ecological research in three small watersheds in Chiang Mai district describe a monsoonal climate, with mean annual rainfall of just over 2.000 mm (Preechapanya, ?). A very rough R value would therefore be 1000, but definitely we should try to get a better and more precise value.
K, the soil erodibility factor, describes the resistance of the soil to erosion. K=1 no resistance against erosion K= 0 a theoretic soil that is totally resistant.
The soil erodibility factor (K) is determined empirically with the aid of a nomograph that requires laboratory derived assessments of particle size distribution, percent organic matter, soil structure and permeability (Orr, 2001).

L*S, topographic factor. Here we have a table based on Wischmeier and Smith that can be used for slopes not exceeding 50 %. Field measurements should be done on slope length and slope in degrees of the field assessed.
C is the cover-management factor. Giving the ratio of soil loss from a specific crop cover and management to that from bare fallow.
This value is estimated as the cover factor times the management factor. The cover factor for Seasonal Horticultural Crops is estimated to be 0,5. The management factor can be found in the tables (Stone, 2004). Which kind of management is practised under cabbage cultivation should be investigated through interviews or questionnaires.
P is the supporting practices factor, ranging from 1 to 0,05 for well maintained terraces. Information should be gathered through interviews and questionnaires.

The use of USLE could be a valuable tool to assess the severity of erosion in the given fields. The table below is specified for Malaysia but could probably also be used for Thailand.
The table (Hui, 2003).

Table 3: Classification for Soil Erosion Risk for "Hill Slope Areas"

Soil Erosion Loss Range (t/ha/yr)	Classification (Risk)
< 50	Low
50 – 100	Moderate
100 – 150	High
> 150	Critical

Source: (Roslan and Tew, 1995)

5.3 Methods to assess the soil conservation methods implemented in the study area

This could be done through field observations, interviewing the local farmers and giving them questionnaires. Are they aware of how to control soil erosion. The farmers could be grouped according to how many different soil conservation methods they had implemented, and analysis on implementation of soil conservation methods in the area could be done.

Some soil conservation methods:
Mixed cropping, Alley cropping /contour hedgerow, mulche to the field, minimum and zero tillage (Norman & Douglas, 1994)

6. Pests and Pesticides

6.1 Use of pesticides

Cash crops such as cabbage generally require larger inputs of pesticides than less intensive crops. Opium cultivation in combination with rice and/or maize requires very little amounts of pesticides or none at all. Studies on highland stream areas in the Doi Inthanon National Park area, also in Northern Thailand, showed that chemical levels were above the safety level for human consumption in some areas (*Tungittiplakorn & Dearden,* 2002). Pesticides can cause damage to the health of the farmer who is applying it, soil and water may be contaminated and residues can build up in the vegetables grown (*Rowell*).

Interviewing the farmers about the level of pesticide use and other control measures taken in our study area should give us relevant information that can be used to identify problems in pest management, both in terms of environmental risks and economic considerations. It will also be our objective to gain knowledge of the safety procedures involved when the farmer applies the pesticides. Through our own water sampling and toxicity tests (if this is possible) and/or similar procedures conducted in the area previously, we will know more about the level of contamination. Contact with the water management group will also provide insights into not only the level of water contamination but also the social conflicts that may exist as a consequence of polluted water.

6.2 Pests

Larvae of *Plutella xylostella*, the diamond back moth (DBM), is the most threatening pest of crucifer crops such as cabbage worldwide. It is considered a major problem in Central and Northern Thailand and its ability to thrive has been linked to a lack of naturally occurring enemies. Many parasitoids do exist and every stage of DBM's lifecycle is attacked. The heavy use of insecticides often applied, however, kills off these natural enemies. At the same time, overuse of new and effective insecticides has resulted in resistance in DBM. Resistance can develop within one or two growing seasons.

Studies have shown that sprinkler irrigation systems can successfully control DBM attacks. The water drowns and washes away the larvae feeding on the leaf surface and disturbs adult moths, forcing them to fly *(Talekar et al,* 1988). This method of irrigation would not be suitable when applying insecticides and is more wasteful than the drip-irrigation

method (*Rowell*). Intercropping cabbage with dill, garlic and especially tomato have also proven to successfully control DBM-populations. The insects are kept away by the repellent odour of each of these crops (*Talekar et al*, 1988).

Safe control products such as the bacteria Bt in combination with the presence of larval parasitoids such as *Cotesia plutella*, which is the dominant parasitoid of DBM in Thailand, have provided successful controls in lowland crucifer fields of Thailand (*Rowell*). Intercropping with garlic, dill or tomato and use of sprinkler irrigation might also be a beneficial combination.

A full evaluation of the extent of the pest problem in our study sites will depend on whether or not cabbage is grown when we are there. Symptoms of the DBM are easily seen, appearing as small windows on the leaves where the larvae has fed (*Rowell*). Interviews with farmers will provide us with information about their experiences with pests and diseases during the growing season.

7. Commodity Chain Analysis

7.1 A global method of analysing a commodity chain

According to our informations, cabbage is the most important cash crop for the villagers of *Ban Huai Sompoi and Ban Pa Kia Nai.* An economy that mainly relies on one cash crop is vulnerable to external factors such as price fluctuations, problems related to transportation, supply of inputs such as fetilisers, seeds, pesticides. Commodity chain analysis can help identify potential bottelnecks in the chain that would be of great importance to the farmers of the village. Therefore, we will make an analysis of the cabbage chain, based on the French "filière" approach, that was developed by researchers at the Institute National de la Recherche Agronomique (INRA) and the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) (Jensen *et.al*, 2000) . A "filière" is defined as all the economic agents that directly contribute to the production, then to the transformation and transportation of the same product to the final market (Duteurtre *et.al* 2000).
A commodity chain analysis consists of analysing each transaction stage between production and consumption. Each stage can be subject to particular operation constraints (Duteurtre *et.al* 2000). In order to do that, the behaviour and market power of each economic agent at each level of the chain have to be analysed.

A global method of analysing a commodity chain can be set up in a scheme as follows:

Stage	Objectives	Methods for collecting the information
1) Delimitation of the filière	• Indentification of the agents and their function • Estimation of prices and quantities • Construction of the chain graph • Construction of a flow map	• Litterature study • Interviews with operators
2) Typology of the actors	• Strategy analysis	• Sample interviews
3) Analysis of accountancy	• Analysis of revenues and margins; allocation of value-added and capital accumulation	• Price notation on the market • Analysis of agents' accountancy
4) Analysis of the organisation of the filière	• Comprehension of relationships between actors and rules that apply for these relationships	• Life stories • Open interviews with relevant persons

(Duteurtre *et.al* 2000)

1) **Delimitation of the filière:**
This stage consists of supplying a precise definition of the analysed product (a), to delimit the height of the filière (b), its width (c), its thickness (d), its geographic and spatial delimitation

a) Definition and caracteristics of the product: define the product's perishability, its status in the diet, its substitutes in the diet, the length of the production cycle, the product's technological aptitude etc...

b) Height of the filière: Production, commercialisation, distribution, consumption
c) Width of the filière: The different relevant sub-systems of the filière: artisanal, industrial, farmer sub-sectors...)
d) Thickness of the filière: An operator's behaviour can only be understood if all his/her activities are considered. Often, implicated actors are involved in several filières.

2) Typology of the actors

Economic agents at each level of the chain have their own objectives that can differ or brake the achievement of other agents' objectives. Only when the system works perfectly, all agents can meet achieve their objectives. Examples of economic agents can be: producers, transporters, middlemen supplying pesticides, fertilizers or other inputs, and retailers.
The study of the agents' strategies inside a filière helps identifying bottlenecks, power relations and brakes to the markets well functionning (Duteurtre *et.al* 2000).

3) Analysis of accountancy

The analysis of accountancy of a filière consists of the study of the prices of the products (producer prices, wholesale prices, consumer prices), of the costs in the filière, of the accountancy of the agents and their margins.

4) **The organisation of the filière**

The study of the organisation of the filière consists of analysing the nature of the relationships between agents within the filière, and the rules that apply for their relationships (contracts, conventions, power relations).

7.2 Methods to obtain information on the cabbage chain

First, we must admit that the ambition of the commodity analysis is not to get a complete analyse of the cabbage chain. Since our field trip is not in the cabbage high season, it might not be easy to interview all the economic agents of the chain. For example, we will not be able to observe ourselves how many trucks leave the village every day. We weill to a high degree have to rely on interviews, which of course is not optimal. We plan to go to the wholesale market where our villagers sell their cabbage and interview the different economic agents. According to Samata & Kawashima (2004), cabbage was traded at Mae Ho in January 2003. Mae Ho is less than 40 km from Ob Luang. Therefore, we hope be able to get there and do our research. Though it must be said, that the cabbage produced in the dry season is produced with irrigation, which we do not know if our villages have invested in. But the fact that cabbage is traded allows us to make the market analysis, which can be useful for our villages even if they do not grow cabbage in that season.
Though we intend to interview cabbage farmers in our villages, on how they get their inputs, if they get access to credits, who they sell their cabbage to, what price they get per kg according to the month they sell the cabbage, how the cabbage is transported to the market, which markets they sell on, etc.. Litterature studies will help us analyse other parts of the chain. For example we expect/hope that annual price fluctuations of cabbage will be available in Thailand, or at Chang Mai university, or at relevant governmental institutions. A few studies have been made by Europeans on the cabbage market in Northern Thailand, and we will try to get them. So far, we have only managed to get abstracts from these studies. By putting this puzzle together, we hope to be able to understand how the cabbage is marketed from producer to consumer, see who gets what margin, and may be able to identify bottlenecks in the chain.

7.3 Already available in the litterature

1) Delimitation of the filière:

Indentification of the agents and their function:

- the producers coming mainly from the highland ethnic minority villages, transporting the cabbage by pick-up trucks from their own villages to obtain cash by trading cabbage,
- the middle agents, in other words merchants, mainly coming from the large markets in the country and transporting cabbage by large size trucks to large markets in metropolitan areas.
- (3) another group of "middle agents" who invest their money for the cabbage production, and who are also involved in cabbage trading by providing the producers with all of the necessary materials for cropping, and

- the store owners of the trading place who offer market space and facilities(e.g. weighing machines) for the buyers and producers of cabbage

(Samata and Kawashima, 2004)

Quantities: Merchants' big trucks: 12,000 kg
Pick-up truck: 2,000-2,500 kg

Price information: Farmers will inform themselves before harvest on actual cabbage prices by calling the wholesaler in Chang Mai. and farmers will set the amount and price on the telephone, according greatly to the wholesalers' demands, which depends on demand in Bangkok. The exact time of harvest and the selling price of cabbage depend on wholesaler decision. The cabbage market is dependent in wholesale trade and price signals are coming from Bangkok. (Hruzova, 2002).

2) Typology of the actors

The store owners, at the same time, operate other businesses such as gas stations, grocery stores, and restaurants. There are number of agents, which can be companies, associations or individuals, who invest in the cabbage cultivation in the highland areas around Mae Ho and Mae Sariang (located less than 40 km from Ob Luang). They offer to villagers such materials required for cabbage cultivation as seed, fertilizer and pesticide. Producers in turn offer their labour and land. In general, during the harvest period, the investors come up to the cabbage field in the highlands to collect and transport the cabbage to Mae Ho. The transportation costs are counted as extra expenditure in the production. The profit is shared fifty-fifty between the investor and the producer. If they do not make profit, the investor will lose all his or her money, while the producer would not lose money but suffer the opportunity cost. The investor is often rich farmers from outside the village.

3) Analysis of accountancy

Margins: Retailers have the highest share of final cabbage price(Hruzova, 2002).

4) **The organisation of the filière**

The trading of cabbage is usually conducted under a commission system. Buyers and producers of the cabbage have to pay a commission fee to the store owners. For instance, the store owner collects 1 baht per kg of cabbage from both producers and buyers. (Samata and Kawashima, 2004)

Prices: fluctuation of cabbage production sometimes leads to oversupply in the markets of Chiang Mai and thus the price decreases. (Hruzova, 2002).

Processing and exports: Cabbage processing is not wide spread in Thailand. And also the export of these processed products is very low. Cabbage is common vegetable in most of the Asian and European countries and there is no need to export this vegetable. The processing of cabbage is low because there are just few possibilities how to process cabbage in comparison with fruits. (Hruzova, 2002).

Economic agents:
There are number of agents, which can be companies, associations or individuals, who invest in the cabbage cultivation in the highland areas around Mae Ho and mae Sariang. They offer to villagers such materials required for cabbage cultivation as seed, fertilizer and pesticide. Producers in turn offer their labour and land. In general, during the harvest period, the investors come up to the cabbage field in the highlands to collect and transport the cabbage to Mae Ho. The transportation costs are counted as extra expenditure in the production. The profit is shared fifty-fifty between the investor and the producer. If they do not make profit, the investor will lose all his or her money, while the producer would not lose money but suffer the opportunity cost. The investor is often rich farmers from outside the village.

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