SLUSE Joint Basic Course 1999 - 2000

Field Study Report, Location 2.2

Ban Klang Thung, Mae Yom Watershed, Phrae Province, Northern Thailand.

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Prepared by:

Rikke Donchil Holmberg, ED1172. Dep. of Biology, University of Copenhagen

Morten Helsted Johansen, ED0989. Dep. of Economics, University of Copenhagen

Lars Arne Jensen, L9035. Agronomy, Royal Ag. and vet. University

Supervisors:

Anders Aalbæk: Dep. of Economics and Natural Resources, Royal Ag. and Vet. University.

Torsten Müller: Dep. of Agricultural Sciences, Royal Ag. and Vet. University.

Peter Oksen: Dep. of Geography and Int. Dev. Studies, University of Roskilde.

1 Introduction

The field study was carried out in the village Ban Klang Thung (BKT) (624500E, 2043500N, 5045IV), which is situated in the irrigated lowland in the Mae Yom Watershed. The area is positioned inbetween the mountain ranges constituting the boundary of the Mae Yom Watershed, and is characterised by a slightly undulating valley bottom consisting of alluvial deposits, pertaining soils from the Nan series (SOIL MAP, 1979), well suited for cultivation. Due to plate tectonic movements, a compression led to an upwards movement of the sediment in the valley bottom. These phenomena are responsible for the slight differences in field elevation that can be observed in this area, Na don representing the slightly high undulating mounds, and Na loom the low-lying areas. This distinction between Na don and Na loom is important for the water distribution in the area since the fields in Na don do not recieve as much water as the fields in Na loom, and these conditions are therefore putting a natural restriction to what can be grown in the different fields. No fields within the BKT village boundary are upland fields, and no villagers cultivate upland fields in other places.

Although situated close to the larger Mae Yom River and its major irrigation canals, getting water from this source never has been a possibility as the village and its surrounding fields are situated at a higher elevation. Depending on water distributed into an irrigation scheme from the smaller Mae Song River, the agricultural production in the area traditionally has been vulnerable to fluctuations in climatic conditions. In order to minimize waters role as a limiting factor for the agricultural production, a medium-scale reservoir, Mae Song Reservoir (MSR) (630115E, 2045980N, 5045IV) was constructed on the Mae Song River in 1995. By increasing the water supply to BKT and the surrounding areas, it enables farmers to expand their agricultural production. Prior to construction of the reservoir, only few farmers were able to grow crops in the dry season. Construction of a reservoir requires large amounts of investments, and has large social and environmental impacts on the area, and therefore it is relevant to look at whether these impacts have good effects on a long term basis.

The above information has lead to the following objective for the field work:
How does the change in water supply affect the land use strategies and livelihood security in Ban Klang Thung? Can these changes be characterised as sustainable?

change in the natural conditions upon which their land use and livelihood is based. The traditional crop to grow in the village is sticky rice, or a cash crop such as maize before the MSR, if the field was positioned far from the irrigation canal. Today sticky rice is grown by all farmers, often followed by a dry crop such as maize, chili, tobacco or cabbage. The sticky rice grown today is restricted to two varieties, Kow pee and Kow Doe (Gor Kor 10 and Gor Kor 6, respectively), both introduced after the construction of the reservoir and recommended by the government. Furthermore, also a new variety of maize is taking over and for both rice and maize contract farming has started to appear with distribution of seed packages through companies, of which Monsanto and Cargill were mentioned. The general impression of the livelihood in the village after working there was that there was a well developed infrastructure in terms of roads, electricity, and water, and that the people generally seemed to have a good health standard.

2 Methodology

With the focus of the field study being the availability of water for the farmers in the village of Ban Klang Thung, and the importance of this resource for their land-use strategies and livelihood security, the aim of the methodology is to employ an array of methods, covering both social and Natural scientific aspects, in order to be able to examine and illustrate this focus from as many angles as possible, and ultimately be able to evaluate the findings on the basis of selected indicators of sustainability.

To cover the objectives, the following methods have been chosen:

Social Science:

- Structured Interviews
- Semi-structured Interviews
- Participatory Ranking and Scoring

Natural science:

- Transects and Geographic Maps
- Soil sampling

The team in the field consisted of 3 Danish students, 4 Thai students, 2 interpreters and several supervising teachers. Both Danish and Thai students worked as interviewers, doing approximately half the interviews each. Teachers were present during the first interviews as observers and as

advisers after the interviews. In either case, the interview went through the interpreter, and answers were written in both languages. Most often, the work in the village and in the sub-district was dependent on an interpreter, and work was therefore often limited to two groups. When possible, as for instance with soil sampling, no interpreter was necessary and work was done in three groups. Following, the reasoning for choosing the above methods will be explained one by one.

2.1 Structured Interviews

Before arrival in Thailand it was the intention to distribute questionnaires to all the villagers in order to collect as much information as possible, and on the basis of these select key individuals for further interviews. However, after discussion with the Thai students, who argued that many farmers would be unable to complete the questionnaires, it was agreed upon to do structured interviews instead. This approach was agreed upon, because it was seen as a simple, practical method of collecting data and information, and also as a means to identify issues that the farmers might find problematic for their land use or livelihood.

A part of the interview was designed to generate quantitative data about the individual farmer's land use and livelihood strategies. All the questions in this part were closed ended questions. The questions would generate information on the following issues.

- General information on the households.
- Agricultural practises last year in terms of which crops, which inputs required and outputs generated.
- Water availability.
- Household economy.

Also some questions were asked open ended in order to get as many impressions as possible about the farmers attitude towards the Mae Song Reservoir, and how the Reservoir has affected the land use and what changes or problems it has lead to.

29 structured interviews were completed in Ban Klang Thung, constituting a representative sample of the agricultural households in the village. The interviewees were selected randomly on the basis of a list obtained from the headman, on which the agricultural households were listed. Every 5th household was chosen this being the only criteria for selection.

2.2 Matrix Scoring and Ranking

To get a non-monetary estimate of the importance of different crops grown in the village and the major problems or limitations connected to their cultivation, the participatory scoring and ranking was carried out with some farmers in the village. This method was included in the social scientific approach in order to be able to compare and supplement data obtained from other sources in as many ways as possible. This method is a part of the Participatory Rapid Appraisal (PRA), a concept developed in order to involve the local population in assessing problems and solutions to these. After a rising criticism of the way development work was being implemented, the concept of PRA began to appear (OKSEN, 1997).

The wanted information was a ranking of the major crops grown in the village, rice, maize, chili and tobacco on the basis of their importance as food, for income, and their labour- and water requirements. The aspect of market possibilities for the crops was added during the workshop in the village. Furthermore, we were interested in a ranking of some of the problems/limitations connected to the cultivation of each crop. These were water distribution, pests, price of products and money needed for investment. To obtain this information we used two different schemes and had the participants fill out them both. By doing this we got a comparison between the major crops as well as information on single crops at a time.

For the participatory scoring and ranking, a group of 5 adults, representing 3 households, were present. Due to time constraints these were chosen randomly during a walk in the village and therefore do not represent a predetermined set of criteria. However, they were all farmers in Ban Klang Thung and were knowledgeable about the general information we were looking for. The 5 persons were for each crop/criteria given a total of 16 stones. Their task was to rank the importance of the crop/criteria giving stones representing the level of importance. In this way there was no limitation to a certain amount of stones in a single square, the participants just had to come to an agreement on how many stones to place.

2.3 Semi-structured Interviews

Semi-structured interviews with key informants were used in order to get a better understanding about the structure of the village and the different organisations and authorities important to the land use strategies employed by the farmers in the village. The semi-structured interviews were also

meant as a means to crosscheck information obtained from different sources, as well as a way to find out to what degree these organisations communicate, among themselves and with farmers.

For each interview a set of relevant questions were prepared, and a small group, typically a Danish student, a Thai student and an interpreter went to do the interview. If the key persons in the village also were farmers, the interview contained the general questions from the questionnaire as well as the more specific questions prepared. Another example of this approach is from the interview with the head of the reservoir, who answered the same set of questions as were distributed to some of the farmers at the water-meeting, in addition to some specific questions prepared.

The following persons and institutions were interviewed:

- Headman: To get an overview of the structure within the village, the village boundaries, and his help in order for us to choose agricultural households for the structured interviews.
- Or Bor Tor (local organisation): To find out the functions it performs in the village
- Local Irrigation Co-operation: To get information about the water distribution to and within the village boundaries, to get information about the importance of the reservoir, and also guidance to be able to walk along the transect.
- Agricultural Co-operation: To find out about the economic possibilities of the farmers, the co-operations role in the farmers choice of market for their products, the trend in prices of agricultural products, and the ability to compare their services to the ones given by the Bank of Agriculture.
- Bank of Agriculture: To find out about the economic possibilities of the farmers, the trend in prices of agricultural products, and the ability to compare their services to the ones given by the Agricultural Co-operation.
- Agricultural Extension: To get information about which crops and inputs the officer recommends the farmers to use, and whether the reservoir has meant new possibilities/recommendations relevant. Also to find out how many officers are available for farmers in the area.
- Development Officer: The development officer was the official source of data on the village, and these covered population- and household numbers, level of education, rai cultivated, infrastructure etc. This information was obtained in order to be able to cross-check and compare these data obtained from other sources.

- Royal Irrigation Department (RID), head of reservoir: To find out at what intervals water is released from the reservoir annually, how it is estimated how much water is needed in the area, his opinion on water distribution, whether the reservoir has caused changes in farming practices, ecology and whether companies have any influence on how much water is released.

Prior to the field work it was still unknown which institutions were present in the area, and therefore key-persons and institutions which could provide important information was identified as the fieldwork progressed and provided a better insight in the water- and agricultural situation in Ban Klang Thung.

2.4 Transects and Maps

In order to meet the question of whether MSR has brought any changes in land use with it, two transects were carried out. One transect went from Fai Thung Pai and downstream to the other side of the village, a distance of approximately 5 km. The transects met at a 90° angle in the heart of the village, with the other transect having a length of approximately 2.5 km. The transects had the purpose of describing the changes in land use upstream to downstream. Along these transects, twenty-one positions were monitored with a GPS, each position indicating a change in land use or field elevation. Soil samples were taken at some of these positions. This was done in order to make a land use map from this year based on direct observation, and compare it with a land use map from 1984, which is based on aerial photographs. To aid the observations from the transects, a drive was taken around the area to confirm observations made for the land use map. From these maps it should be possible to see whether there has been any changes in land use within the last fifteen years. Furthermore, a map of the irrigation scheme covering the area benefiting from water diverted at Fai Thung Pai also was drawn, based on a map from the reservoir office.

2.5 Soil Science

Since the agricultural production is crucial for the village and depends to a large extent on the soil quality, it is important to get a picture of the soil properties in the area. The soil fertility indicators that can be evaluated from the soil properties are both biophysical in terms of soil quality (pH, plant available N/P/K, and EC), as well as socio-economic in terms of the soil being fertile enough to obtain food security (SEAMED, 1995).

With the available equipment and test kit, it was possible to measure the plant available content of Nitrogen, Phosphorous and Potassium (NPK), pH, electric conductivity (EC), and to estimate the soil texture.

The following strategies were used to choose the fields in which to take the soil samples.

- Samples were taken in fields along the transects, from rice fields in Na don and Na loom, from fields under different cultivation systems, and from fields with plants that obviously had nutrient deficiencies. The aim of this strategy was to see whether there is a change in soil properties along the transect going from upstream to downstream.

- To take samples in three selected fields (A, B and C) under different cultivation systems in the preceding cropping season. Selection of the fields was based on information from the structured interviews. The cultivation systems were: Field A - one rice crop; Field B - two consecutive rice crops; Field C - rice followed by tobacco. The aim of this strategy was to see whether different cultivation systems have any effects on the soil properties. Sampling was done in only one field representing each cultivation system.

In each field four samples were taken, mixed, and from this, a subsample was taken to represent the entire field. The depth of samples from fields with annual crops were 0-30 cm, whereas in fields with perennial crops, two individual samples were taken, 0-30 cm and 30-60 cm. Subsamples were airdried in the shade, crushed, and sieved through a 0.2 mm sieve before analysis.

To test the subsamples content of plant available NPK and pH; the Kasetsart University Soil Test Kit was used. The chemical forms of NPK tested are NH_4^+-N, NO_3^-N, P_2O_5, and K_2O, and values were given as *very low, low, medium, high, very high*, not as exact values. Even though the test kit is not giving exact values, it is easy to use in the field and it quickly gives an estimate of the plant available NPK. Soil pH and EC was measured in a 1:2 soil:water suspension. The suspension was shaken 30 times and left standing 5 minutes to sedimentate, this was repeated five times. After the last sedimentation, values were measured in the water phase of the suspension. Values of pH are given in intervals of 0,5 pH-unit. In addition, an Oakton Pocket pH-meter was used giving exact values in intervals of 0,1 pH-unit. To measure the EC, a Milwaukee Pocket EC-meter was used.

3 Results

3.1 Structured Interviews

The information from the structured interviews is presented according to the field the findings are going to be used in.

3.1.1 General Information.

To get an impression of the general family structure and level of education in the village, some general questions were included in the structured interviews.

Table 3.1: General findings from the structured interviews. Percentages given are based on 29 completed interviews. The age distribution in households is calculated from a total of 108 people in the 29 households. The information from the development officer is representing the whole village.

General Findings	# of interviewed	%	Development Officer (%)
Female	13	45	42
Male	16	55	58
Born in BKT	22	76	-
Avg. # of people in household	3,7		
Under 15	21	19	19
Between 15 and 50	57	53	57
over 50	30	28	24
Education	27	93	
$<4^{th}$ grade	4	14	100
4^{th} grade	19	66	100
$>4^{th}$ grade	6	21	5
Tenure			
Own*	13	45	98
Rent	9	31	0
Own* + rent	6	21	2
Own* + rent + free land	1	3	-

*: The average size of the owned by farmers was approximately four rai.

The general findings about the family structure fit well with the information from the development officer, whereas the information on education and tenure are somewhat deviating. The issue of title deeds fell beyond the scope of the project, and was not looked further into.

3.1.2 Water

Water availability for the individual farmer was supposed to be increased due to the building of MSR, and some questions were therefore asked in order to find the major water source to the village and the villagers opinion about the water availability.

Table 3.2: The number of interviewed used to calculate the % can vary from the actual number of 29, since some of the structured interviews have incomplete data. Water source percentages therefore are based on 28 interviews and water availability on 24 interviews.

Criteria	# of interviewed	%
Water source		
only MSR	22	79
MSR and Mae Yom River	5	18
only Mae Yom River	1	3
Water availability		
Increased	22	92
Same	2	8
Less	0	0

As shown in table 3.2, 97% of the farmers receive water from the Mae Song Reservoir, and 79% of the farmers have this as their sole source of water. The importance of the reservoir for the agricultural production in Ban Klang Thung is thus obvious, as are any implications the reservoir might bring with it.

3.1.3 Economy

To estimate household economy, the farmers were asked about income and expenses, both on- and off-farm. On-farm components considered are selling of crops, fertilisers and pesticides, seeds, animals, repairing equipment, labour, transportation, milling, renting and consumption. Off-farm components are income from any source other than agriculture and expenses on food, education, clothes, religion, electricity, phone, and water.

Table 3.3: Income and Expense data on basis of 29 interviews. All figures are in Bath.

	On Farm		Off Farm		Total	
	Total:	**Average**	**Total:**	**Average**	**Total:**	**Average**
Income	1,042,000	35,900	491,200	16,900	1,533,200	52,900
Expenses	627,600	21,600	616,000	21,200	1,243,600	42,900
Net Income	414,400	14,300	-124,800	-4,300	289,600	10,000

In Table 3.3 income on-farm is calculated on the basis of the aggregated income from the selling of all crops and a shadow price given to the part of the rice yield not sold. The expense figure includes all expenses for both sectors. The shadow price for rice (5.13B/kg) is calculated as average price for last year's sale. The expense for milling rice and renting land is often paid in rice and therefore given a monetary value. Milling expense is typically 10% of the total rice yield, whereas for renting it varies. By giving rice a shadow price it is possible to compare it to other cash crops.

The aggregated total income for all 29 interviews amounted to 1,560,000 Bath last year of which 68,5% was on-farm income and 31,5% was off-farm income meaning that agriculture is the main

income generator in this sample. Figures obtained from all 29 interviews are included in the calculated averages, as the averages would be based on fewer interviews, and not representing the sample as a true representation of the entire village if extreme figures were removed.

As seen from Table 3.3, off-farm income is approximately half the on-farm income, whereas expenses are similar. Off-farm income sources such as working as a wage labourer in agriculture, sewing socks, being a carpenter or having money sent from children was mentioned, and the size of these incomes varied a lot. The typical wage for one days agricultural labour is 80 Bath, but very often the harvest is done without renting labour though since many of the farmers help each other for free.

The largest share of the off-farm expenses is on food. A household spends in average 17,400B per year on food, ranging from 0 to 73,000B per year. Consumption of rice is not included in this figure.

Other findings from the interviews are that the average net-income per year is 10,000B, and that 45% have loans with an average of 29,000B. Almost everyone borrows money from the Bank of Agriculture.

Table 3.4: Crops contribution to total income and potential income per rai.

Crop	Contribution to On-farm Income %	Potential Income (B/Rai)	Expense on fertiliser (B/rai)
Kow Pee Rice	29%	3,200	190
Kow Doe Rice	5%	2,800	190
Maize	12%	2,000	230
Chili	10%	6,800	380
Cabbage	4%	4,300	670
Tobacco	5%	4,600	-
Other Crops	3%	1,400	-

Table 3.4 shows that Rice, Maize and Chili are the most important income sources, generating together 57% of the total income, whereas cabbage, tobacco and other crops are less important. However, cabbage, tobacco and especially chili have a higher potential income per rai, also if the expenses on fertiliser are taken into account. The shadow pricing of rice is included in the share of contribution to on-farm income.

3.1.4 Agriculture

In this part of the structured interviews, the farmers were asked questions about their agricultural practices in last years cropping season, which crops they grew, how many rai with each crop, how the crops yielded, how large a share of the yield was sold, and how much fertiliser was applied. The results from these questions are shown in Table 3.5

Table 3.5: Showing last years crops grown by 29 farmers in Ban Klang Thung, # of farmers growing each crop (rice crops divided into Na don and Na loom), total area (rai), yield (kg/rai), % of yield for sale, and amount of Nitrogen, Phosphorous and Potassium (NPK) applied (kg/rai). Minimum and maximum amount of NPK is given in brackets. The dark cells for groundnut refers to no information.

Crop	# of farmers	Area (rai)	Yield (kg/rai)	% for sale	Fertiliser N/P/K (kg/rai)
Kow Pee Rice	25	139		43	5.8 (1.9-17.0) / 2.4 (1.0-6.5) / 0.0
Na don	9		698		
Na loom	12		695		
Kow Doe Rice	6	29		69	3.9 (2.7-5.0) / 2.1 (1.5-2.7) / 0.0
Na don	2		500		
Na loom	4		445		
Maize	12	92	959	100	16.4 (4.6-46.0) / 0.2 (0.0-1.5) / 0.0
Chili	8	23	98	100	10.2 (3.8-15.2) / 3.5 (0-6.5) / 6.7 (0-12.5)
Cabbage	5	14	2397	100	12.9 (7.5-20.0) / 5.6 (3.3-8.7) / 5.2 (0-9.3)
Tobacco*	3	16	1704	100	4.6 / 0.0 / 0.0
Garlic	4	4	149	38	3.8 (3.0-7.5) / 2.2 (1.3-3.3) / 2.9 (0-6.2)
Eggplant*	1	2	325	100	11.3 / 4.9 / 9.3
Cucumber*	1	1	3000	100	7.5 / 3.3 / 6.2
Soybean*	1	4	90	100	4.0 / 2.2 / 0.0
Groundnut	1	2			
Tamarind*	2	14	12,5	100	5.6 / 2.4 / 4.6

*: Only one farmer gave information on or grew this crop.

All farmers grew rice last year, often followed by a cash crop in the dry season, of which the largest share was maize and chili. Except for garlic, the entire yield from cash crops was sold, generating a substantial income. The figures for the yields are calculated as the average of the yield rai^{-1}, and figures for fertiliser are calculated as the average amount of NPK applied in various forms and amounts $crop^{-1}$ rai^{-1}. The different kinds of fertiliser used were 16/20/0, 46/0/0, and 15/15/15.

Furthermore, farmers were asked if they grew the same crops before the construction of MSR, and if they did, whether the yields had changed. It turned out that all farmers had been growing rice before MSR, 21 farmers have had an increasing yield after MSR, three farmers have the same yields, and three farmers have had less yield. Maize was grown by eight farmers before MSR, of these only 1 has had an increasing yield, and three have the same yield. For the rest of the cash crops, no farmers but one who grew cabbage had grown any of them before MSR.

Another finding from the agricultural questions was that MSR had made it possible for the majority of the interviewed farmers to grow crops in rotation in one cropping season, typically one rice crop followed by a cash crop, most often maize or chili. The farmers said that they now can grow any crop they like. This was not possible before MSR due to a shortage of water in the dry season.

3.2 Participatory Scoring and Ranking

As described above, 5 adults, representing 3 households, were present for the workshop. The following tables are the results of their discussion and evaluation of the importance of different crops and the major difficulties in their cultivation. The questions the participants were asked to discuss for table 3.6 were: "How important are these crops as food, income source?" "How are the labour/water requirement of these crops?" "Level of investment to grow these crops?" and "How big is the market for these crops?".

Table 3.6: 16 stones distributed for each column (vertically).

	Food	Income	Market possibilities*	Water requirement	Investment	Labour requirement
Rice	10	4 – surplus sold	4 – can be stored if low prices	10	7 - many steps, all require money	8 - many steps, all require many people
Maize	2	5	5	2	3	2
Chili	4	3	3	2	2	2
Tobacco Not main now	0	4	3	2	4	4

*Sum = 15. One stone given to groundnuts.

In the second scheme the participants were asked to discuss requirements and constraints of the individual crops: "When growing this crop, what is the most important problem/constraint?"

Table 3.7: 16 stones distributed for each row (horizontally)

	Water distribution	Pests	Market prices	Money for investment
Rice	5	5 - golden snail	3	3
Maize	3	2	7	4
Chili	3	5 – weevil	6 - very unstable, 20-40 Bath	2
Tobacco	2	2	6	6
Groundnuts	3	5 rats, small ant	6	2

Maize, chili, tobacco and groundnuts are all dry crops, but still require a well managed water supply. Tobacco was said not to be a main crop in the village anymore, primarily because the prices has been falling continuously and the merchants do not guarantee a minimum price for this crop.

This crop furthermore has high requirements to inputs and labour (table 3.6). Maize, on the other hand, has a guaranteed minimum price, but the farmers have to sign a contract with the merchants representing the selling company (Cargill mentioned).

Growing groundnuts was mentioned as having great potential, but this is risky since the prices are very unstable, the quality of the nuts are very much dependent on the amount of water present (less is better), nuts are prone to pest attack, and no price-guarantee is offered to the farmers. A successful harvest will provide the farmer with a high income though, and many farmers feel tempted to grow this crop.

The forum developed into a general discussion/interview about the agricultural conditions and production in the village, and in the following the major points are summarized.
Farmers prefer Na don over Na loom because it gives them the opportunity of growing crops other than rice. Prices of land are therefore higher for Na don, and again dependent on vicinity to roads.
Examples of prices for land were estimated as follows:

Na loom away from road:	40,000B/rai
Na don away from road:	50,000B/rai
Na don near road:	70,000B/rai

It was estimated that about 70% of the farmers in the village own all or a part of the land they cultivate, and that average farm size is 5-6 rai. On the question of whether people cared differently for their land if they owned it or rented it, it was said that farmers who cultivate on rented land take less care. Estimated middle class income was around 20,000 B/year, with less than 5,000 B/year as poor and up to and around 60,000 B/year as rich. Farmers expressed that they have no power to bargain with the merchants who come and buy their products, and that there are increasing problems with pests.

The overall conclusion from the participatory ranking and scoring of the crops grown in the village and the major difficulties associated hereto is, that rice is the most important crop in the village, and the price of products the major problem in production. But as they said, "price is an everlasting problem", and the water made available by the MSR is crucial for the production of all the products.

3.3 Semi-structured Interviews.

For the results section, the major points from the individual key persons interviewed are presented.

Initially, the headman expressed utmost satisfaction with the MSR, saying it was 100.000% perfect. However, the following are his viewpoints on the agricultural situation in the village after the construction of the MSR.

All water comes from the Mae Song River, and now from the reservoir. The land near the river gets more water. Mae Yom River can not serve as a water source because it is too low lying.
Sandy soils are common, not so much acidic soils. Saline soils might be a problem in the future due to chemical fertilisers, which the villagers use instead of compost/manure because it is convenient.
Estimated increases in rice yields after the reservoir was from 12 hap/rai to 17 hap/rai
420 kg/rai and 595 kg/rai, respectively. He also feels the system has been damaged because of pesticides, and described the cycle as villagers killing birds - no birds to take pests - increased use of pesticides - increased washout - no fish. Birds used for food and sale.
Last year was the first attempt to grow two consecutive rice crops. The yield was about 50% of the first harvest. He does not think the villagers will keep growing the second rice crop. One extension officer is available in the district. The villagers still use old farming traditions because the local officers are new and the farmers do not trust/listen to him. An estimated 50% of the villagers rent the land. People owning the rented land live here or in another village. Buying land is possible.
When selling crops, a buyer comes to village or they go to Bank of Rice. That is what he suggests them to do because they have a weight that is stable and can be trusted. The reservoir has ended migration by providing opportunities for people to work and live in BKT permanently.

The member from the local organisation, Or Bor Tor, interviewed, stressed that the reservoir has made more water available for the villagers and has led to higher yields. Prior to the reservoir, it was necessary for some to rent land in other villages, but this is not the case anymore because of the increased yields. Also he said that some constraints in the agricultural production are the falling prices of products and the appearance of pests. A further improvement could be obtained by extending the existing irrigation scheme with new canals. The functions of the organisation in the village are mainly in infrastructure, but if individual farmers have questions about cultivation, they also ask Or Bor Tor officers.

The local irrigation officer explained that the reservoir is distributing water all year round, but the amount of days it is open varies according to the season. The water distribution in the area is the same as before the reservoir that is, no new canals have been made in order to improve the irrigation scheme, but the old canals have been made bigger. It was the officer's opinion that the existing amount of canals was sufficient. He also explained that golden snail and the use of pesticides had only appeared after the reservoir, and that the biodiversity in the fields had decreased. He approved of the reservoir because of the increased water availability, the increased yields and the higher income. Enough water to grow two rice crops in Na loom, but this crop has a low yield and grain quality.

Interviews were conducted with officials from both Bank of Agriculture (BA) and the Agricultural Co-operation (AC). The major functions of them both are to lend money to farmers for agricultural purposes as well as acting as merchants, selling agricultural inputs to and buying products from the farmers. The AC is a non-profit NGO, and a criterion for being a member is to make a deposit in the bank. The distribution of the profits back to the members is determined by how much the individual member is using the bank for saving, and buying and selling products. Although AC is a NGO, it still receives support from the government. Loans all have the same interest rate. The BA has different interest rates for different groups of members, and the grouping is, among other things, determined by the tenure of the land and whether the farmers have savings. BA primarily receives money from Bank of Thailand (80%), but also from banks outside of Thailand, e.g. German banks, Bank of Japan and the World Bank. Initially, the BA was established to protect farmers from idle moneylenders. The structured interviews showed that the majority of farmers use BA, and upon the question why, the AC officer said that BA had been in the area for a lot longer than the AC, that BA gives better support to families in connection with funerals, that the conditions for becoming a member are stricter in AC and that some people also can borrow money for non-agricultural purposes in BA.

The officer at BA said that he had not felt that the incomes of the people in BKT had risen that much, but was positive towards the reservoir because of the higher potential for people to grow a larger variety of crops, and mentioned contract farming of a new variety of maize by Cargill. The increased yields are good despite the fact that the prices on agricultural products have been falling. Also, flooding does not occur anymore.

The agricultural extension officer explained that there are 11 officers to cover the 12 villages in the subdistrict. The officer is contacted through farmer groups, of which there were not many in BKT. The officer was of the opinion that the headman in BKT neglected the agriculture in the village. She gave numbers of how many rai was cultivated in BKT in the wet and dry season respectively. Not a big area is cultivated in the dry season, but she believed that especially the farmers growing a second rice crop would increase. The officer felt that the existing amount of canals for irrigation were sufficient. Recommendations from the government on the problem of golden snail were to use $CuSO_4$ but money to fight this and other pests were lacking. Farmers are encouraged not to use pesticides, but to handpick golden snail and feed them to livestock. Farmers also reject to use protection when spraying pesticides; they are advised about help if accidents occur. The different kinds of fertilisers used for different crops were described, no micronutrients applied. Soil tests were conducted annually, but from the same field the last five years. The 2 varieties of rice grown in the village, Kow Pee (Gor Kor 10) and Kow Doe (Gor Kor 6) are both recommended by the government and not grown prior to the construction of the reservoir.

Official status reports are made for all villages in the subdistrict annually, and these were obtained from the development officer. The reports contain listings covering aspects such as general population information, water resources, education, infrastructure, agriculture, institutions, occupation etc. We got the report from 1994, the year before the construction of the reservoir and from 1999. The development officer also mentioned that the headman in BKT neglects problems in agriculture, but that this does not pose a problem for the farmers because they can get help from the development officer directly. The officer mentioned visiting the village twice a month.

At a water meeting between the head of the reservoir, which is a RID-officer, and the farmers from the area benefiting from the reservoir, an interview was made with the officer, and seven questionnaires were completed by farmers. Both the officer and the farmers said that the reservoir is releasing the most water from June to November and least water from December to May. The officer thinks that there are enough irrigation canals for the area but that the major problem of water is the fact that the farmers do not understand the water distribution. The farmers have to plant the same crops at the same time in order to be able to maximise their production and their benefit from the reservoir. The officer mentioned that flooding no longer is occurring, whereas the farmers focused on golden snail, hemiptera and rats as the major changes in agriculture after the reservoir.

On the question of whether companies have any influence on the amount of water released from the reservoir and what the farmers grow, the farmers mentioned Cargill for maize production and Monsanto for rice production. The officer said that he plans water distribution after what they suggest the farmers to grow.

The officer said that around 15% of the water from the reservoir are not diverted and run directly into the Mae Yom River after the diversion point of the large irrigation canals.

The officer recommends the farmers to use natural pesticides and fertilisers (compost and manure) because they are cheaper and not as harmful to the health. Natural pesticides are extracts from the Sadaw tree, also known as the Neem tree. It had not been observed growing in the area.

3.4 Transects and Maps

Figure 3.1 shows the positions of the lines with the twenty-one positions, where coordinates and soil samples were taken, are marked.

Figure 3.2 is a map showing the irrigation scheme for the area benefiting from water diverted at Fai Thung Pai. The map is a copy of a map hanging at the MSR office.

Figure 3.3 is a hand drawn copy of the 1984 aerial photograph showing different types of land use within the village boundaries. There are several areas of open space.

Figure 3.4 is the product of the transect and direct observation, showing the land use within the village boundaries in October 1999. As can be seen from the map, almost all the open spaces are now under cultivation, with only 2 small open spaces left.

It should be noted that the changes in land use which have occured between 1984 and 1999 can have happened independently of the MSR, but are an indicator of intensified use of the agricultural area.

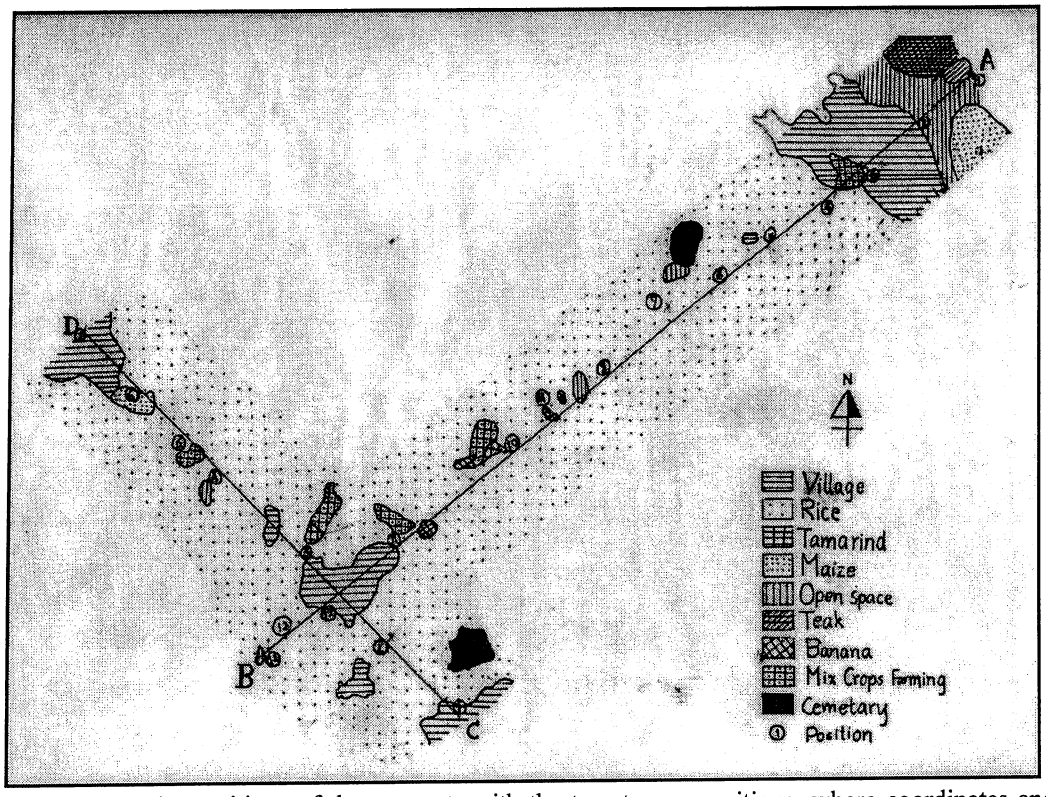

Figure 3.1: The positions of the transects with the twenty-one positions, where coordinates and soil samples were taken, are marked.

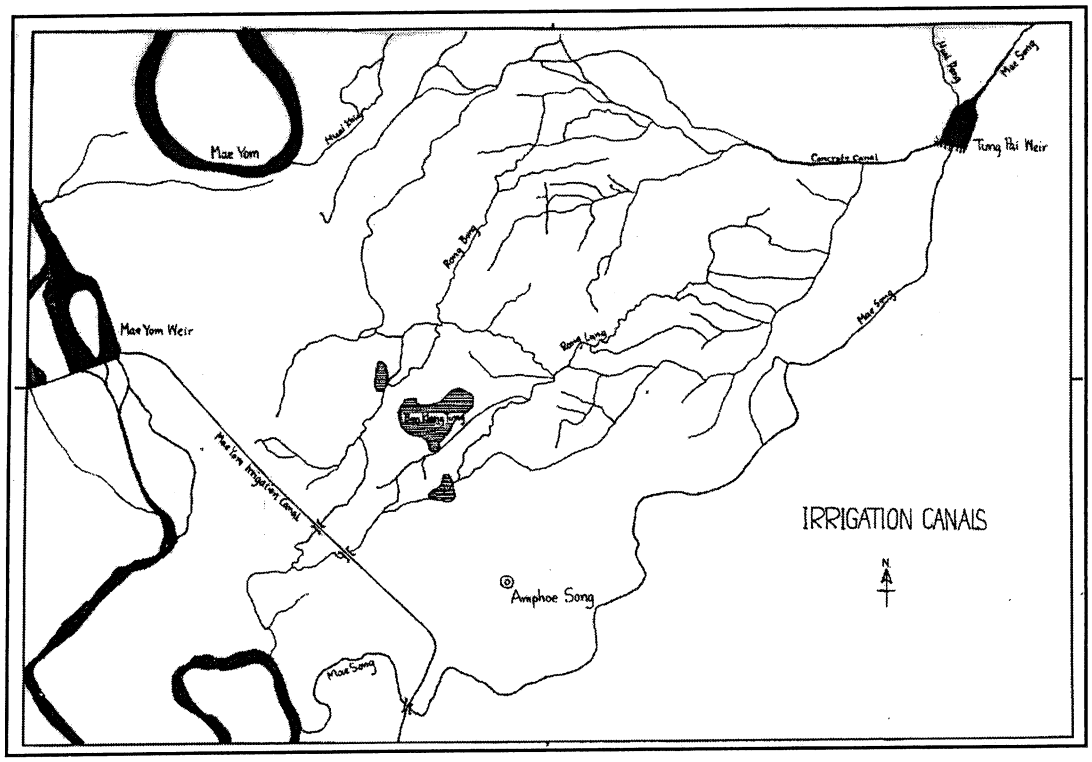

Figure 3.2: The irrigation scheme for the area benefiting from water diverted at Fai Thung Pai. The map is a copy of a map hanging at the MSR office.

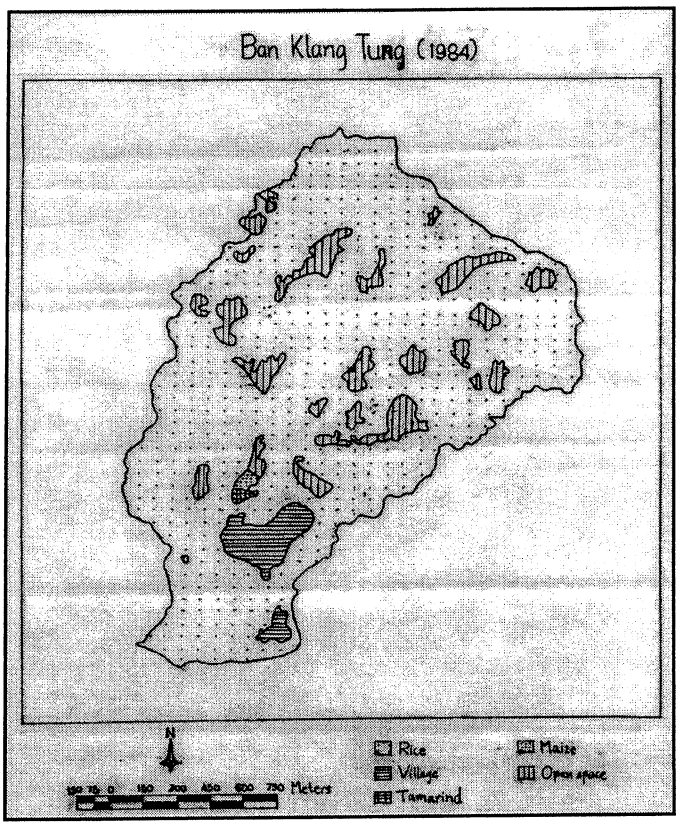

Figure 3.3: A hand drawn copy of the 1984 aerial photograph showing different types of land use within the village boundaries. There are several areas of open space.

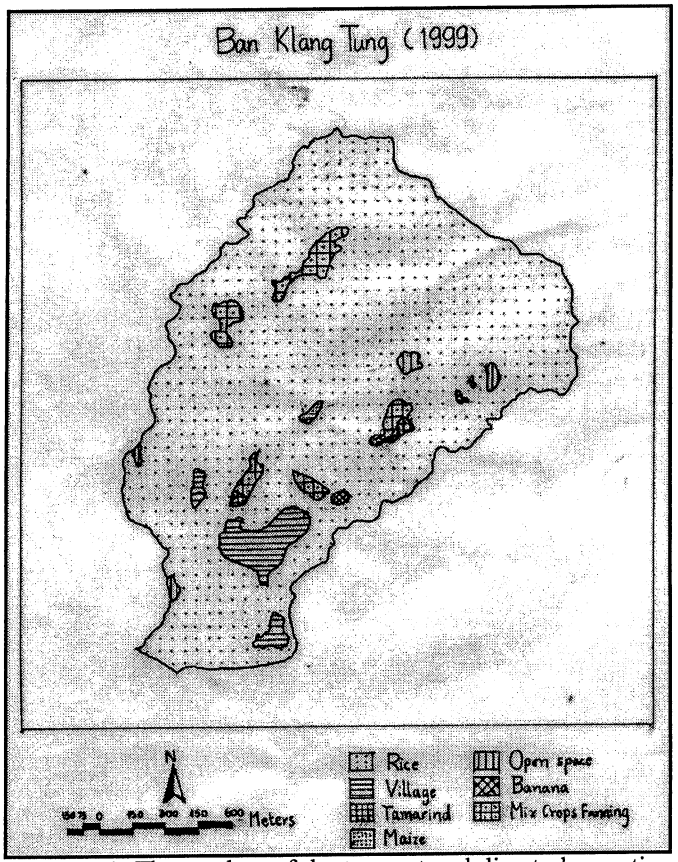

Figure 3.4: The product of the transect and direct observation, showing the land use within the village boundaries in October 1999. As can be seen from the map, almost all the open spaces are now under cultivation, with only 2 small open spaces left.

3.5 Soil Samples

3.5.1 Plant available N/P/K

From the analysis of the soil samples, it was possible to estimate the plant available NPK in the various soils under various cultivation. The results are shown in Figure 3.1.

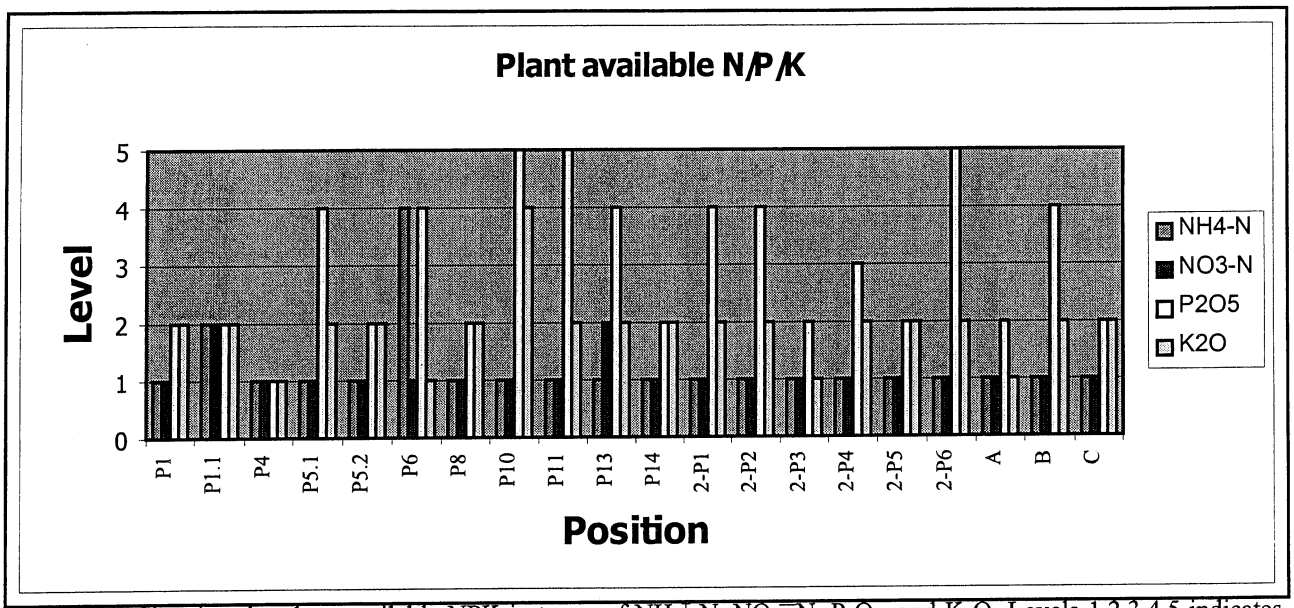

Figure 3.1: Showing the plant available NPK in terms of NH_4^+-N, NO_3^-N, P_2O_5, and K_2O. Levels 1,2,3,4,5 indicates level of plant available nutrients as being Very low, Low, Medium, High, and Very high, respectively. Values are from samples taken along transects, and from selected fields A, B, and C.

Figure 3.1 shows that nearly all samples had a very low to low content of Nitrogen both in the form of NH_4^+ and NO_3^-. Also Potassium is only available in very low to low amounts, whereas the content of plant available Phosphorous seems to be relatively more adequate than both N and K in nearly all samples. The range of the levels are shown in Table 3.8.

Table 3.8: Ranges of nutrient content in PPM.

	NH_4^+-N	NO_3^--N	P_2O_5	K_2O
Very low	0-5	0-10	0-3	0-40
Low	5-15	10-20	3-6	40-60
Medium	15-30	20-30	6-9	60-80
High	30-50	30-50	9-12	>80
Very high	>50	>50	>12	

3.5.2 pH values

For all soil samples, pH was measured in the soil suspension, using both the Kasetsart Testkit and an Oakton pocket pH-meter. The results is shown in Figure 3.2.

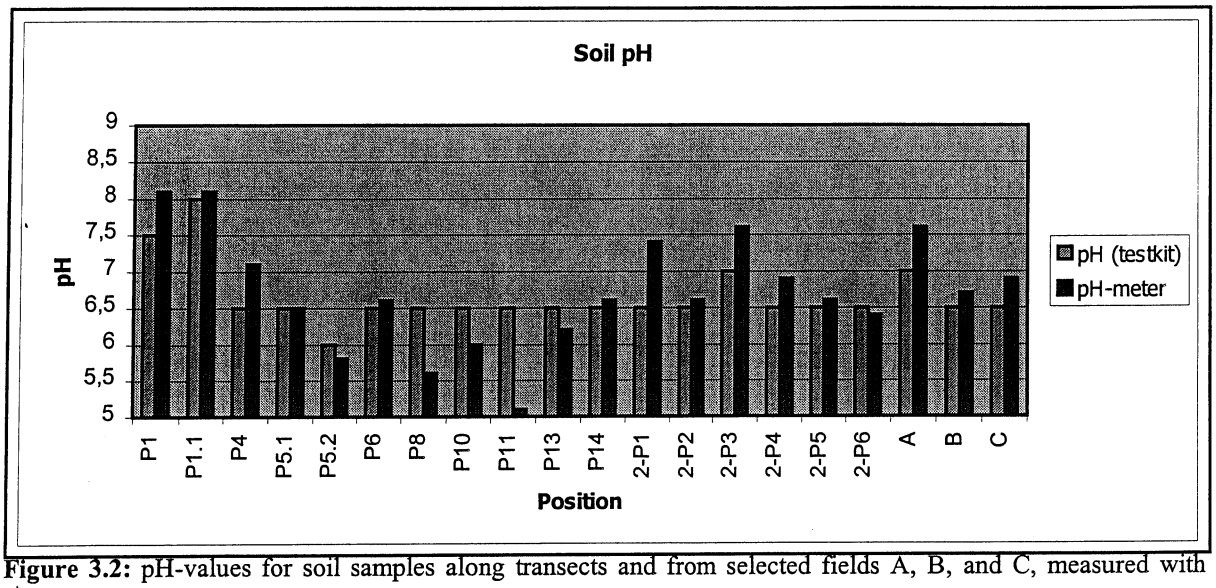

Figure 3.2: pH-values for soil samples along transects and from selected fields A, B, and C, measured with testkit and pH-meter.

As seen in Figure 3.2, all pH-values are in the range of 5.1 to 8.1, which is optimum pH for most nutrients, and therefore most suitable for cultivating most crops (AHN, 1993). Both N, P and K are plant available in this range.

3.5.3 Electric conductivity (EC)

The EC measurements are used as indications of the total quantities of soluble salts in the soils. Results of the measurements are shown in Figure 3.3.

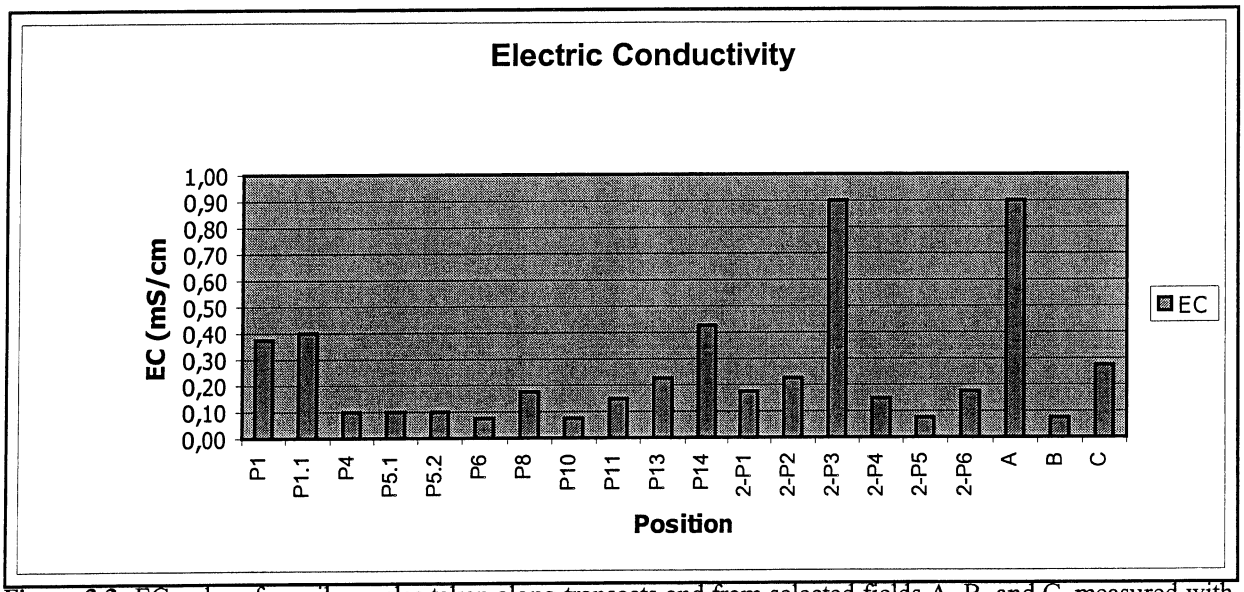

Figure 3.3: EC-values for soil samples taken along transects and from selected fields A, B, and C, measured with an EC-meter.

All the values of EC are in the range 0.08 to 0.90 mS/cm. Values in this range are acceptable, total salt content is less than 0.15%, and salinity effects are mostly negligible (LANDON, 1991). The measured values were from a 2:1 water:soil suspension. According to Landon (1991) the standard method to measure EC is in a 5:1 water:soil suspension. Therefore, to convert measured values to standard values, they have been multiplied by a factor 2.5.

3.5.4 Soil texture

After the soil samples had dried in the shade, they were crushed and the texture was estimated by using the finger method. Results from this is shown in Table 3.9.

Table 3.9: Showing the position, soil texture of the samples, and land use at posotion.

Position	Soil texture	Land use
P1	sandy loam	Teak plantation 0-30 cm
P1.1	sandy clay loam	Teak plantation 30-60 cm
P4	clay	Na don kow doe
P5.1	clay loam	Na don rice
P5.2	sandy clay loam	Poorly looking rice
P6	sandy clay loam	Na don kow pee rice
P8	clay loam	Rice, boundary between Na don/Na loom
P10	clay loam	Rice
P11	sandy clay loam	Rice
P13	sandy clay loam	Rice
P14	sandy clay	Kow Pee Rice
2-P1	silty clay	Rice
2-P2	sandy clay	Rice
2-P3	silty clay loam	Open space
2-P4	silty clay loam	Rice
2-P5	sandy clay loam	Na don kow pee rice
2-P6	sandy clay loam	Maize
A	silty clay loam	Open space
B	silty clay loam	Kow doe rice
C	silty clay	Rice

Soil texture for all samples are done according to USDA Texture Triangle (SOIL SURVEY STAFF, 1994). The results show that all samples have a relatively high clay content. The soil samples taken along the first transect (P1-P14) has a relatively higher content of sand and a relatively lower content of silt than the soil samples from the second transect and the selected fields.

3.5.5 NPK Balance

Table 3.10 shows figures for actual added and recommended amounts of NPK for five crops, and the NPK balance for last year's rice harvest in BKT.

Table 3.10: The average actual amounts of NPK added, and recommended amounts (Landon, 1991) per growing period for five crops, and NPK balance for paddy rice.

Crop	Fertiliser added NPK (kg/rai)	NPK balance (kg/rai)	Recommended amounts NPK (kg/rai)
Paddy rice	5.8 / 2.4 / 0.0	-2.6 / 0.5 / -1.9	20.0 / 4.8 / 16.0
Maize	16.4 / 0.2 / 0.0		24.0 / 10.0 / 12.8
Cabbage	12.9 / 5.6 / 5.2		20.0 / 9.2 / 18.4
Tobacco	4.6 / 0.0 / 0.0		9.6 / 9.6 / 12.8
Soybean	4.0 / 2.2 / 0.0		2.4 / 3.6 / 7.6

The table shows a relatively large difference in the actual added amounts of NPK and the recommended amounts by Landon (1991). Especially K and P seems to be deficient for all five crops. The imbalance for rice supports this, despite a P-surplus.

4 Discussion

4.1 Discussion of Methods

Theoretically, the reason for applying the different methods during the fieldwork was to get the same kind of information from as many sources as possible, and thereby maximise the potential to discover discrepancies and to get a minimum of information gaps. In this way, the reliability of the sample hoped to be maximised.

4.1.1 Social Science

The structured interviews generated the core information of the fieldwork, and generating data in the village by using this method had both advantages and limitations. The closed-ended questions were good for generating material for the quantitative analysis performed, but at the same time might have restricted the response from the respondent. If the respondent feels uncomfortable by not remembering exact values, closed-ended questions might lead to random and unreliable data (CASLEY & KUMAR, 1988). Respondents might also purposively give values, e.g. yield figures or off-farm income, which are higher than in reality to look good in the interview situation.

This was experienced e.g. in the case of estimating the size and components of the household economies. Some components of the economy were added to the interview after the fieldwork had begun because the importance of it was not anticipated on beforehand. Especially the information on on-farm expenses and household saving could have been more accurate. Also, it was seen that some informants gave very accurate figures whereas others could not specify the size of certain

components, and in general the span of the figures given was very large. Yield figures given for rice also are found to be very large, twice the national average.

Open-ended questions were asked in order to get information about the villager's attitude toward the MSR. These questions were good for spontaneous and elaborate answers, but can not be used for quantitative analyses (CASLEY & KUMAR, 1988).

The informants all gave relatively similar answers to these questions, and a concern is how big a role the inexperience of the interviewers and the interpreters affected the information obtained in this part of the interview.

It would have been valuable to do more in-depth interviews with farmers selected on the basis of information given in the structured interviews. These interviews could have been used to obtain more specific information such as labour requirements and input costs for the different crops and farming practices before the construction of the reservoir.

As is the case for the structured survey in the village, time to do repeated interviews with some of the key-informants was not available, but further information would have filled out some information gaps and maybe cleared up discrepancies between their information and data obtained from other sources. Both discrepancies and information gaps can be due to the interviewers way of asking questions, but also there might be different perceptions of things between the sources we were in contact with, either reason making repeated interviews relevant. Also, reliability of the key-informants are to be evaluated by comparison to information from other sources, as no prior knowledge about their functions were known on beforehand.

The optimal case for the participatory scoring and ranking would have been to choose the participants on the basis of information from the structured interviews, and to have the participants fill out the crops and criteria in the schemes themselves. In that way, issues of importance in the agricultural production in BKT would have been characterised by the villagers and not on the basis of our perception of the situation. By choosing the participants randomly, the results have to be interpreted as general information, since we do not have any other information to link to the participants than the fact that they all were farmers. Also, by presenting a predetermined set of

crops and criteria, the participants understanding of their task in the method is very dependent on the message conveyed through the interpreter, and therefore more prone to be influenced by the researcher (OKSEN, 1997).

4.1.2 Natural Science

In order to see any indication of whether different cultivation systems influences soil properties, it is necessary to know the cultivation system on the specific fields for some years. Furthermore, samples from a representative number of fields with similar cultivation systems are needed. Before selecting fields, all structured interviews had to be completed, as fields were selected on the basis of information from these. Completing tests on these samples in addition to the samples from the transects would have been a comprehensive task to overcome, as only two test kits were available, and all groups were using these at more or less the same time.

Being able to conduct NPK tests on water would have been good in order to estimate whether wash out happened from the system, as well as a pesticide test on water also would have been useful due to its use against golden snail.

Consequently, it is only possible to get an indication of whether different cultivation systems are influencing on the soil properties and on the basis of this estimate the sustainability of the soil properties in the area. Many samples were taken in rice fields, and as rice is the major crop in the area, the indications from the soil samples are valuable.

Subsamples were air-dried in the shade, and this might have had an effect on some of the soil properties or constituents. According to Landon (1991), this type of drying can affect the levels of Phosphorous and Potassium. The pH-values were in the range of 5.1-8.1, which is rather high and in such soils the P level tends to decrease if air-dried. The level of Potassium depends on the clay mineral content present in the soil and on the level of exchangeable Potassium.

When walking along the transect it would have been good to use the opportunity to make size measurements on specific fields in order to cross-check the field sizes given by the farmers in the structured interviews.

Overall, the natural science methods applied have problems with validity due to insufficient data, but are less influenced by cultural- and language barriers than the social science methods. The natural science is not based on the memory of informants, another aspect limiting the reliability of the social science methods. In order to be able follow up on the fieldwork, the natural and social science methods applied have to be replicable. In the case of this study, the indicated changes or additions would improve the range and reliability of the data, thus making the approach more worthwhile replicating.

4.2 Discussion of Results

Before the construction of the MSR, the major constraint for the agricultural production in BKT was the water supply. The MSR has increased the water supply to the area and thereby made other factors visible as constraints for the agricultural production. These factors are representing a dynamic system in which aspects of agricultural, economic and social considerations are interconnected and equally important for a holistic perception of the sustainability issue. The increased water supply has enabled the farmers to intensify the agricultural production and increase their yields. Another direct effect of the increased water supply is the appearance of golden snails. The direct effects all bring with them increased labour demands and needs for increased inputs to the natural system. The individual farmer has to weigh up these factors against the potential for higher incomes generated by the increased yields. The choices made by the individual farmer constantly influence the importance of the factors on a long term basis, and reflect the rationale of the farmer's land use- and livelihood strategy. In a situation with increased income possibilities and labour demands, migration away from the village tends to decrease, but the increase in population and the intensification of agriculture both are putting increased stress on the natural resource base. At the same time more of the production is diverted to home consumption, lowering the potential for higher income.

With the extended cultivation period, 75% of the interviewed farmers have been enabled to grow crops in the dry season. The area cultivated in the dry season was almost the same as in the wet season, indicating that the MSR has had a profound effect on the intensification of the agricultural production. Figures on both yields and incomes from sale and also the farmer's statements of being able to grow any crops in the dry season support this. The potential of the MSR might be further increased by expanding the existing irrigation scheme and encouraging the farmers to grow the same varieties of rice and maize at the same time, in order to ease the water distribution from the

reservoir. The new varieties of rice and maize recommended by the government are distributed to the farmers through companies, which appeared in the area after the construction of the MSR, and introduced contract farming. The extend of contract farming in the village is not known, but several of the informants were doing it. Contract farming gives the farmer a security in selling the crop, but since the inputs for production the first year is lended to the farmers and are to be paid back in grain, they are not secured a minimum income as this is dependent on the yield. The farmer therefore holds the risk of production, which in bad years can have severe consequences for small scale farmers. The new varieties of crops all give higher yields and therefore require larger nutrient inputs to the soil in order to maintain its fertility.

The farmers were positive towards the MSR with the exeption of its role in the appearance of golden snail. Golden apple snail (Pomacea canalicula) was mentioned by all interview sources as the major pest affecting the rice production. The snail was introduced intentionally in Asia from South America in the early 1980s as a potential source of protein to supplement the local diet. Cultivation of the snail quickly lost importance as the locals did not find it delicious and no export market was available. The golden snail is a herbivore freshwater snail with very low requirements to water quality and amounts, making it well suited to survive and spread through the vast irrigated agricultural areas present all over Asia. It breeds rapidly and feeds voraciously on crops, features that further increase its survival potential (NAILOR, 1994; WEBSITE I).

The introduction of golden snail has had direct impacts on the security of the farmer, increasing costs of rice production through decreased yields, need to replant seedlings and direct control of the snail. A study conducted in the Philippines showed that over 40% of the farmers reported more than a 25% yield reduction, and over 10% of the farmers had had no harvest at all (NAYLOR, 1996). The younger the seedlings are when planted, the more prone they are to attack (LITSINGER & ESTANO, 1993). Life cycle requirements of the golden snail have been optimised in BKT after construction of MSR, enabling rapid distribution and providing continuous wet conditions. The ways of controlling the pest in the village were by handpicking and by applying pesticides. Studies have been conducted showing that golden snail can be a valuable source of protein in livestock diets, an approach also make by the extension officer, making handpicking a feasible approach (ULEP & SANTOS, 1995). However, golden snails primarily are night-active, burying in the mud during the day, making handpicking less effective. An alternative approach in the village was to leave papaya leaves in the

rice fields, and then remove these as they filled with snails. The manual methods have the disadvantage of being very labour requiring, and walking in the fields can cause damage to the crops. Many farmers acknowledged using pesticides because it was easier, and figures from the status report show no expenditures on pesticides prior to construction of MSR. Both the literature (NAYLOR, 1996) and the information from the extension officer recommend inorganics as pesticides against golden snail, but these informations were not obtained through the interviews. Inorganics are very non-specific in their mode of action and therefore pose a serious risk to humans and other non-target organisms if applied.

Golden snail also poses a direct risk for human health, as it is an intermediate host of a parasitic lungworm, which normally is found in rats, but which also can cause damage to the brain of humans. Furthermore, it is also the intermediate host of various trematodes which can cause skin irritations (NAYLOR, 1996). Rats have been mentioned as a pest by the farmers in the structured interviews, making it possible for the parasite to be in the area.

The ramifications the appearance of golden snail has brought with it are affecting both the economic, ecological and health situation of the village. At the present stage these implications do not seem to be that severe as yields are high and incomes have increased, but in a long term perspective it will be important to consider these effects and sustainable approaches to controlling the golden snail.

Calculation of nutrient balance for rice, based on information from the structured interviews, shows an imbalance for the three macronutrients, Nitrogen (N), Phosphorous (P) and Potassium (K). Even when calculated on the basis of 100% plant uptake for all three nutrients added as fertiliser, an imbalance occurs. Uptake coefficient for N is around 50% and for K 25%, whereas the uptake of the P added as fertiliser is only up to 30% over a period of four to five years (AHN, 1993). This means that the nutrient imbalance is even bigger, if calculated on the basis of actual uptake coefficients. These results are supported by the results from the soil sample analysis, which show a generally low content of plant available N and K. P content tends to be slightly higher. Also, when looking at the actual amounts of nutrients added to the system, the imbalance is further illustrated.

Table 3.10 shows an imbalance in N and K, whereas P has a positive balance. As rice is the major crop removing large amounts of nutrients from the system, the content of plant available nutrients depends to a large extend on the soils capability to replenish these. The soils have pH-values in the range of 5.1-8.1, and within this range N, P and K become more plant available (BORGGAARD, 1996).

The results from both the structured interviews and the soil samples show a nutrient imbalance in the agricultural system. On a long term basis, this is not sustainable in terms of availability of plant nutrients, and without adding further nutrients, the soil will not be able to sustain the production pressure, which has increased since MSR.

Taking the present rice yields into consideration under these soil conditions, there seems to be a discrepancy between the given yields and the amounts of plant available nutrients. Therefore, the average rice yield in BKT of approximately 700 kg/rai seem very high, since the average rice yield on national level is approximately 2,200 kg/ha (350 kg/rai) (NORMAN *et al.*, 1995; FAO, 1999). The high yields given are furthermore a factor that influences the on-farm income.

When evaluating the economic findings, focus was put on the incomes and expenses for the sample and on how the two sectors and the different crops contribute to the income.

Based on two criteria, consumption and savings, it is possible to give an assessment of whether the household economies are on a sustainable path. Meaning that the farmers generate enough income to meet their basic needs in terms of food and basic consumption right now, and at the same time have positive savings in order to generate investment for the future. A situation of no savings make it difficult for the farmers to invest in for example new technologies in order to improve their future yields and profits.

By using the structured interviews as a representative sample of the village, Table 3.3 shows that the population is capable of generating a net surplus that is, generating enough income for subsistence and consumption for the households and at the same time generating a saving for future investments. In order for these future investments to be characterised as sustainable it is necessary that they do not contribute to a worsening of the situation for the future generations.

According to the two criteria, consumption and savings, the economic situation in BKT is on a sustainable path.

Loans are difficult to obtain for farmers who do not own their land. In this context savings are important as it entitles the farmers to borrow money. In some of the nearby villages it has been mentioned as a problem that the farmers could not obtain loans from official banks and had to borrow from idle moneylenders. This has not been mentioned as a problem in BKT and personal savings could be one reason.

The on-farm sector is the main income generator in the sample with Kow Pee Rice, Maize and chili as the major contributors. The off-farm income is for some of the households an important income source and has to be taken into consideration. Since no figures from the past are available it is not possible to say whether the off-farm sector share of the total income has changed after MSR.
However, a normal development pattern shows that this share rises over time, which has also been the case in Thailand (TODARO, 1997). As mentioned in the common introduction Thailand has experienced a rapid migration from the rural sector towards the urban sector in and around Bangkok in the last 30 years (WORLD BANK, 1993). A building of a reservoir can be seen as an attempt from government side to make people stay on the countryside in order to avoid migration.

Many of the farmers expressed that before the MSR they had to do a lot of migration work in order to improve their incomes. It seems that this development has stopped after the Reservoir and that the farmers now stay in the village. This can be interpreted as a sustainability indicator, meaning that the village can now sustain in itself, without needing working in other villagers. However, this is not necessarily true, since a system can be characterised as sustainable, if the villagers receive their incomes from work in other villagers.

Another aspect in the farmer's choice of livelihood strategy is the importance given to non-agricultural activities. In BKT it seemed that non-agricultural activities are divided between incomes from work and income from relatives sending money. Easy market access for farmers in BKT also are important for their choice of crops and the extent of reliability on agriculture as their main income generator. Sustainability in terms of food security can be either subsistence or market based, depending on the security of the existing market. Vicinity of markets and the possibility for farmers to diversify their production speak in favor of the possibility of subsistence being market

based, but the appearance of contract farming and the lack of experience among the farmers in cultivating under the new conditions, still make rice as the staple crop the most important agricultural product in the village. On the other hand, if golden snail is not controlled, the farmers will have to rely on market based subsistence. The participatory scoring and ranking support this. The conclusion of the 1999 status report obtained from the development officer placed BKT among the best developed in the area. For infrastructure, education and health this information did fit well with the general impression obtained from the time spent in the village.

5 Conclusion and Future Aspects

The increased water supply to Ban Klang Thung has increased the agricultural output and diversified the choice of land use strategy, improving the livelihood security for the individual farmer.

The contents of plant available N, P and K was low, and there seems to imbalances in the inputs to and outputs from the system. Measurements of pH and EC were all within acceptable ranges and cannot linked to the low values of N, P and K measured. The actual input of NPK cannot sustain the current production pressure and can not be seen as sustainable.

The appearance of golden snail has direct impact on on-farm income levels, and without implementing a feasible control, the golden snail endangers the sustainability of the system.
Subsistence production in the form of rice is currently secured, but a shift to market based subsistence could be the picture of the future.

The income level in BKT has gone up after the building of MSR. As the income levels are high enough to secure the basic needs of the farmers and at the same time generate a saving, the village economy is on a sustainable path. Sustainability is dependent on whether the savings are used for future investments that does not diminish the possibilities of future generations to secure their needs. The social situation in the village seemed stable in terms of decreased migration, a reasonable level of education and direct observation, all of which can indicate sustainability.

As the main income generating activity in the village is agriculture, the current situation in the village is not sustainable, as the soil conditions not are able to maintain the current production

pressure, and non-agricultural income generating activities in the village not are of major importance. However, all factors examined are interconnected, and if the village is to maintain its focus on agriculture, emphasis has to be put on agricultural practices in the attempt to perceive the system in a holistic way and make it sustainable on a long term basis.

List of References

Ahn, P. M. (1993): Tropical Soils and Fertiliser Use. Longman Scientific & Technical, Essex, England.

Borggard, O. K. (1996): Soil Chemistry in a Pedological Context. DSR Forlag, Den Kgl. Veterinær- og Landbohøjskole, Frederiksberg C.

Food and Agriculture Organization of the United Nations (FAO) (1999): Agricultural Statistical Database. Download from Internet: http://apps.fao.org/cgi-bin/nph-db.pl?subset=agriculture

Landon, J. R. (1991): Booker Tropical Soil Manual. Addison Wesley Longman Limited, Essex, England.

Litsinger, J. A. & Estano, D. B. (1993): Management of the golden apple snail Pomacea canaliculata (Lamarck) in rice. Crop Protection 12 (5): 363-370.

Naylor, R. (1996): Invasions in Agriculture: Assessing the Cost of the Golden Snail in Asia. Ambio 25 (7): 443-448.

Naylor, R. (1994): Socio-Economic Aspects of Biological Invasion, A Case Study: the Golden Apple Snail. Download from Internet: http://www.gcrio.org/ASPEN/science/eoc94/EOC3/EOC3-18.html

Norman, M. J. T., Pearson, C. J. and Searle, P. G. E. (1995): Rice *(Oryza sativa* and *O. glaberrima)*. In: The Ecology of The Tropical Food Crops, 2nd ed. pp 100-125. Cambridge University Press, Cambridge.

SEAMED (1995): The Lowland Ecosystem. In: Working Paper on Sustainable Agriculture Indicators, pp 7-24, Summary from Workshop, May 30th 1995. Regional Center for Graduate Study & Research in Agriculture (SEARCH).

Soil Map (1979): Soil Map of Phrae Province. Soil Survey Division, Bangkok. Department of land development ministry of agriculture and cooperative.

Soil Survey Staff (1994): Keys to Soil Taxonomy, 6th ed. United States Department of Agriculture, Soil Conservation Service. Pocahontas Press, Inc., Blacksburg, Virginia, USA.

The World Bank (1993): The East Asian Miracle, Economic Growth and Public Policy. Oxford University Press, Inc. New York.

Todaro, M. P. (1997): Economic Development, 6th ed. Addison Wesley Longman Limited, Essex, England.

Ulep, L. J. L. & Santos, A. C. (1995): Growth performance of Peking ducks fed with golden snail and fresh banana peelings. Tropicultura 13 (4): 135-138.

Website I (1999): Apple snails (*Ampullariidae*). Download from Internet: http://huizen.dds.nl/~snc/main.htm

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