Land-use Analysis of Highland Agricultural Systems Using Policy Analysis Matrix (PAM): A Case Study from Ban Pha Phueng and Ban Mong Luang in the Mae Chaem Catchment, Northern Thailand

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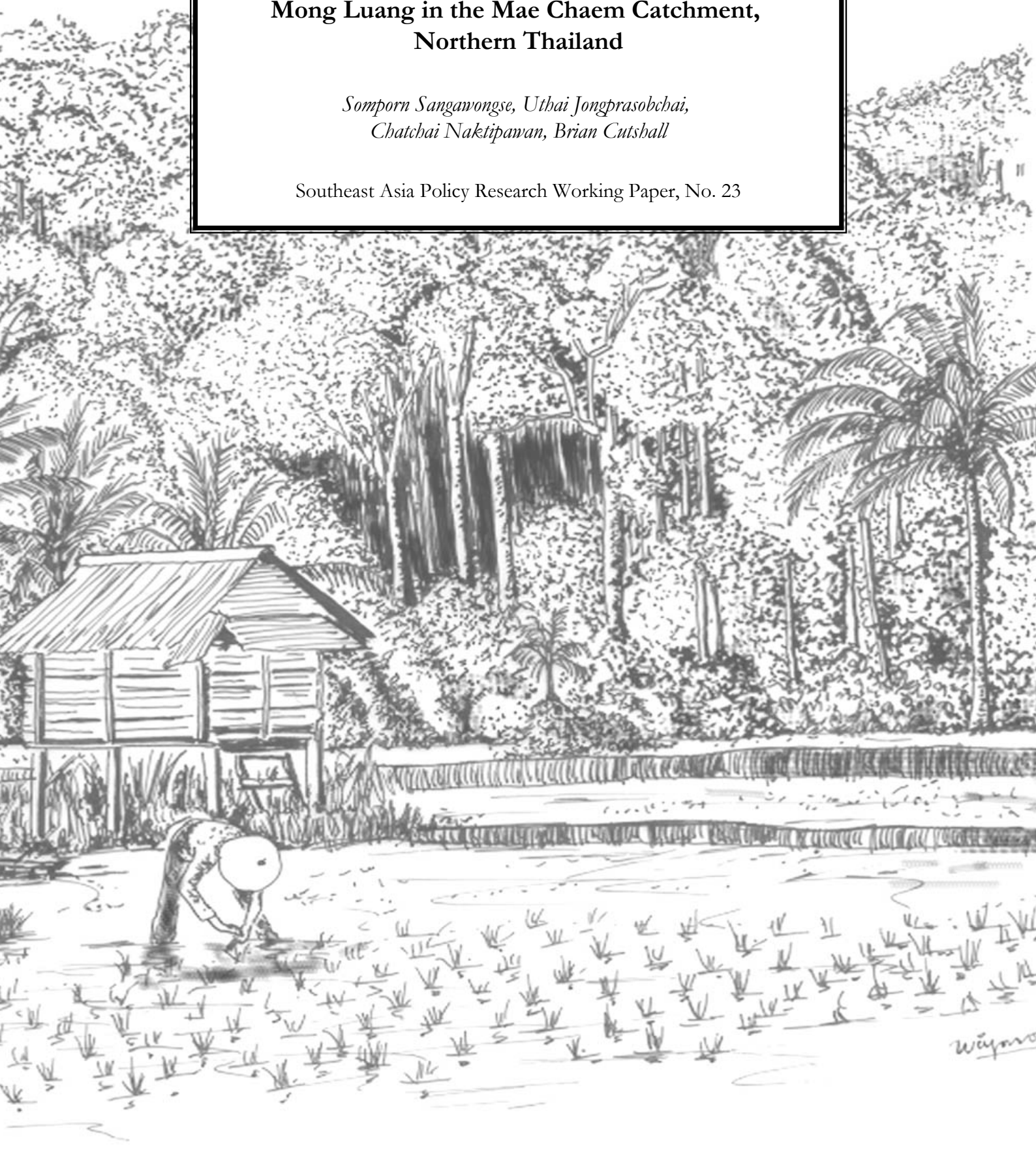

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Land-use Analysis of Highland Agricultural Systems: A Case Study from Ban Pha Phueng and Ban Mong Luang in the Mae Chaem Catchment, Northern Thailand

Abstract

The study of agricultural land use system in the highland areas of the Mae Chaem catchment was conducted by using the Policy Analysis Matrix (PAM). It aims to investigate the private and social profitability from dominant crops grown in the Karen communities (Ban Pha Phueng and Ban Mong Luang), as well as to evaluate the impact of economic and social policies on different land use systems. Extensive economic field survey was conducted in order to derive the necessary data required for creating a number of tables (i.e., Input-Output, private price and social price tables). Four crops chosen for this study are: (1) Paddy rice; (2) Upland rice; (3) Rainfed soy beans and (4) Upland corn. The results of PAM analysis revealed that paddy rice was privately and socially profitable, which should be extensively promoted. Upland rice was privately and socially non-profitable and it should be discouraged to grow on the highlands, except the improvement of yield has been made. Rainfed soy beans and upland corn were not privately profitable, but socially profitable. These two crops were taxed by the government or the society as indicated by a net negative transfer. Sensitivity analysis has been conducted by applying a number of situations on price and productivity on individual crops, so that effects from market imperfections or government policy can be determined. It has been recommended that PAM would be valid if externalities have been taken into account in the analytical process.

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The authors would like to acknowledge the financial support from ASB program for providing the training course in Policy Analysis Matrix (PAM). We also wish to thank Dr. David Thomas and ICRAF staff in Chiang Mai, Thailand for providing useful advice and materials for producing this final report. Special thanks to Miss Pornvilai Saiptong and Ms. Pramuanpit Kunthatham for their friendliness through the period of this research project. Many thanks also go to my PAM colleagues from Chiang Mai University, NESDB Chiang Mai, and from the office of watershed development, Royal Forestry Department for their contribution to the success of this report through the period of PAM analysis. Special thanks to Mr. Sunthorn Saepan, our field research assistant from Ban Pha Phueng, Mae Chaem district who collected the socio-economic data for us. Finally, we hope that you find this report interesting and useful for future research work.

Abbreviations

ASB	**Alternatives Slash and Burn**
ASL	Average Sea Level
CARE	***Integrated National Resource Conservation Project***
C.IF	Cost, freight, and insurance (refers to price at the point of import)
DRC	Domestic Resource Cost Coefficient
EPC	Efficient Protection Coefficient
FOB	Free on Board (refers to price at farm gate or at the point of export)
HH	Household
HM	Her Majesty
ICRAF	***International Center for Research in Agro-Forestry***
IWRAM	Integrated Water Resource Assessment and Management
NESDB	National Economic and Social Development Board
NFR	National Forest Reserve
NGO	Non-governmental organization
NPC	Nominal Protection Coefficient
NPCO	NPC for tradable outputs (i.e., crop output) for each commodity
NPCI	NPC for tradable inputs for each commodity
PAM	Policy Analysis Matrix
RFD	Royal Forestry Department
RTG	Royal Thai Government
RTSD	Royal Thai Survey Department

Units of Measurement

Length	Area	Volume	Weight	proportion
Cm Centimeter	Ha Hectare	Barrel	g- grams	% Percentage
Km kilometers	Rai 1 Rai = 0.16 Ha)	Bushel	Kg- Kilograms	
mm millimeters	Sq.km Square kilometers	cc.	t- ton	
In- inches	Sq.m Square meters	Litres		

Currency

$B Thailand currency
$US American dollar

Classifier
Pcs = pieces

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1. Introduction

The study of highland agricultural systems in the mid-altitude zone of the Mae Chaem catchment in Chiang Mai province was conducted by researchers from Chiang Mai University and from the office of watershed development, the Royal Forest Department during October 1997 to June 1998. The Policy Analysis Matrix (PAM) was chosen as the method for this study, because it provides simple calculation and management of economic and social data. The study has three major objectives as the following:

(1) To classify agricultural land use systems in the study area;
(2) To analyze the economics of the cropping systems; and
(3) To evaluate the social and political policies that affect upon these systems.

2. Research site

2.1 Village characteristics

The villages chosen for this study are Ban[1] Pha Phung and Ban Mong Luang, Gongkag sub-district, Mae Chaem district of Chiang Mai Province. Both sites are geographically located on sheet 4645I 47Q MA of topographic map at 1:50,000 scale (RTSD, 1969). Ban Pha Phung and Ban Mong Luang are located at approximately UTM 437000, 2035000 and UTM 441000, 2030000 respectively. Figure 1 shows the approximate location of these villages in the Mae Chaem catchment. Both villages lie on the middle zone of approximately 500 m ASL.

The Gongkag sub-district has been established legally under the authorization of Ministry of the Interior. The majority of people is Karen. All villagers have been permitted Thai citizenship status, which can be identified by ID cards.

Karen is the largest ethnic minority group that has been settled in northern Thailand for over 200 years (NRCT, 1993). The ages of the villages at their current locations are recorded as ranging from over 50 to over 100 years. There is no accurate record about when these villages have been found. From the overview survey in October 1997, the ages of Ban Pha Phueng are recorded as 110 years (Sunthorn, 1997- personal communication).

[1]Ban is a Thai term for village

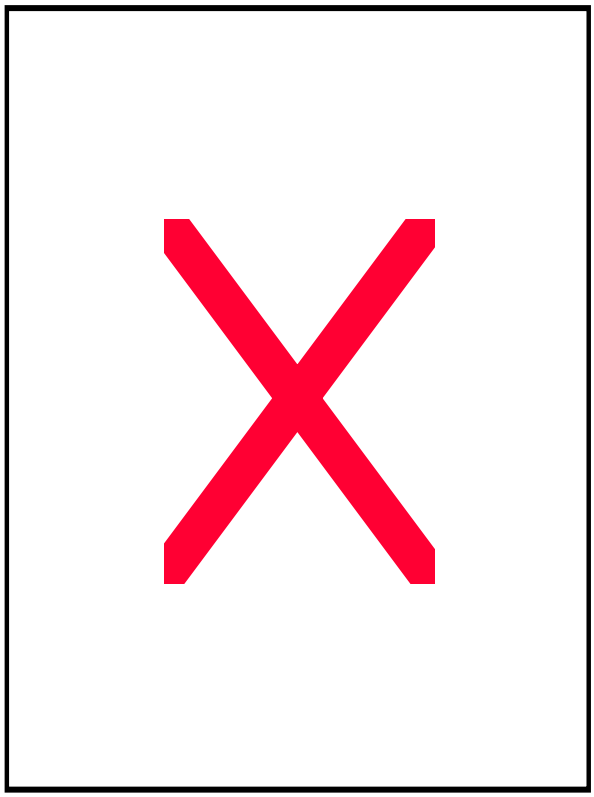

Figure 1: Location map showing the case-study villages in the Mae Chaem catchment (drafted by S. Sangawongse)

Population data consists of the number of households and the composition of population in both villages are listed in Table 1.

Table 1: Population data

Village Name	No. of households	Male Population	Female population	Children	Total population	Religion	
						Buddhist	Christian
Pha Phueng	51	89	70	109	319	78	133
Mong Luang	57	81	97	96	331	62	206

Source: Field survey (October,1998)

2.2. Village access and Interactions

2.2.1. Market access

Accessibility to these villages is possible by all weather roads, with limited access in some places where roads are not paved. The distance from Chiang Mai City to Ban Pha Phueng and Ban Mong Luang is about 135 Km and 147 Km respectively. The distance from Mae Chaem district to Ban Pha Phueng is 11 Km, with 7 Km paved and 4 Km unpaved. Villagers can travel to Mae Chaem district and the City of Chiang Mai using either their own vehicles or the local mini-buses. The travel time from the villages to the market in the district is about one hour, and from the villages to Chiang Mai City via Chom Thong district is about 3 hours. The current bus fare (as of May 1998) from the Mae Chaem district to Chiang Mai

City is about 70 Thai Baht per trip (Soonthorn- personal communication, 1997). The buses operate on a daily basis with 3-4 times a day.

Agricultural produce such as soybeans and corns are traded via the middle- man. Therefore the prices are mainly controlled by the middle man.

2.2.2. Labor

Villagers in the case-study villages maintain the traditional style of working. Most of work is done by exchanging labor among households. For example, during the harvesting period, members in one family can employ laborers from other families in the village to help them without paying. This causes some difficulties in the determination of labor cost. No records of hired labor from outside of the villages were collected. The wage rate is between 100-150 Baht/person/day.

2.2.3. Education

Most of tribe people, including Karen have migrated from neighboring countries, for example, Lao, Mynmar and China over the last one to two hundred years (Keyes, 1979). Most of them have not understood Thai language. Schools were set up in these villages to provide education to Karen people. The distance from Pha Phueng to school at Ban Ommeng is about 2 km and from Pha Phueng to a secondary school in the Mae Chaem district is 14 Km. Ban Mong Luang has one school inside the village vicinity. Details about education levels and number of literates were obtained from Suan Pah Sirikit project (Royal Forestry Department, 1997) and listed in Table 2.

Table 2: Education statistics of the study sites

	Uneducated (person)	Finished Grade 4 (person)	Higher than grade 4 (person)
Ban Pha Phueng	189	17	89
Ban Mong Luang	180	18	70

Source: Royal Forestry Department, 1997

2.2.4. Current projects active in the village

Both villages are under the responsibility of Suan Pah Sirikit project, which is under the HM Queen patronage. It has been recored that villagers are well participated with the project. Major activities include mushroom cultivation (e.g. champion), set up rice banks and promotion of high quality seeds. Mushrooms bring a lot of income to the villages, especially in Mong Luang. There are some local groups set up under the supervision of the local government, such as farmer's group, women's group and youth group.

2.2.5. Land use-related local organizations

At present, the Tambon Administrative Organisation (TAO) has not played much role in land use zoning within the sub-watershed boundary. Land-use relation is viewed as "kinship group". Group committees that have been set-up according to the activity are village committe, housewives committee, rice bank committee, etc.

2.3. Overall village land use status and trends [including tenure & legal status]

2.3.1. Paddy lands

The total paddy areas for Ban Pha Phueng and Ban Mong Luang are 103 rai[2] and 121 rai respectively. Twenty eight households (22.58 %) in Ban Pha Phueng owns paddy fields, whereas nineteen households (12.66 %) of Ban Mong Luang are engaged in paddy cultivation. Some households only require shifting cultivation as an additional contribution. It has been recorded that paddy cultivation ranks second among other agricultural activities in both villages. The average size of paddies is about 0.32 ha per household for both villages. Based on the survey data in 1997, annual yield from paddy rice is about 509 kg per rai.

2.3.2. Rotational shifting cultivation (Swidden)

Traditional agricultural system practiced by Karen people in the middle zone of the Mae Chaem watershed (600 -1200 m-ASL) is influenced by different factors such as demorgraphy, market access and the government policies. These have caused three different types of fallow: (1) composite (short-medium fallow), (2) composite (very short fallow) + expanded protected forest areas and (3) permanent fields (paddy & upland) + expanded protected forest areas.

Like most of villages in the Mae Chaem catchment, slash- and-burn (shifting cultivation) of upland rice and cash crops can be found on the mountain slopes. The total upland area for both villages is 51 rais. Households that own upland fields total 14, with a proportion of 35.7 % in Ban Pha Phueng and 64.3% in Ban Mong Luang. Each household has, on average, 3.62 rai of upland field to work. Some households manage their land by dividing into three or four fields (depending on the extent of their land), maintaining one fallow field, while the others are cropped until the soil fertility is exhausted. The fallow periods reflect the productivity of crops from time to time. Some households cultivate a field for about 1-3 years and leave it fallow for 3 years and greater: this allows some recovery of soil nutrients during the fallow period. The fallow period in both villages ranges between 1 to 3 years (Chatchai, personal communication -1998).

Other cash crops such as cabbages, soybeans, corns, etc. are cultivated on the shifting cultivation plots. Soy beans cultivation ranks first among other crops. Thirty-six households (29%) in Ban Pha Phueng and fifty-two households (34.67 %) in Ban Mong Luang are engaged in soybean cultivation (RFD, 1997).

Owing to land pressures, villagers cannot continue with shifting cultivation. Pressures usually come from increasing market orientation, declining soil fertility, erosion problems and from chemical uses.

2.3.3. Permanent upland fields

Owing to land pressures, some households cannot continue with shifting cultivation. They have to move towards a permanent agricultural pattern, both for subsistence and market production. Upland fields are cultivated only special crops and not being converted into different crops. Figures for upland fields from both villages are yet to estimate.

2.3.4. Home garden

Various types of fruit trees, such as mangoes, tamarind, longan, jackfruit, papaya and banana were grown in Karen's home gardens for a domestic consumption. From the survey conducted by RFD (1997), mangoes and tamarind are mainly grown by the villagers. The percentage of mango growers for Ban Pha Phueng and Ban Mong Luang is 20.75 % and

[2]Rai is a Thai measurement unit (1 rai is equivalent to 0.16 ha)

25.68 % accordingly. Mangoes and tamarind yield a small amount of quantity, so they are not considered as the commercial crops for this study. Some other plants such as nym tree was grown in Ban Mong Luang and mainly used for a domestic consumption. Based on the information from field survey in 1998, seven households in Mong Luang sold mangoes to the middleman at two Baht per Kilogram. Mangoes growing cannot be developed into a large scale cultivation, because Karens have limited knowledge about the use of pesticides and insecticides (personal communication with the village headman in Ban Mong Luang in 1998).

2.3.5. Livestock

Animal raising is a common household activity in most of Karen communities. For example, Pha Phueng villagers are engaged in chicken raising and pig raising at approximately 45 % and 37 % respectively. The produce from chicken and pigs are used solely for a domestic consumption. Some households have raised cattle for use in plowing paddy fields. There are a few households in this village (0.95 %) that do not raise animals. Animal raising in Ban Mong Luang is similar to Ban Pha Phueng. Chicken constitutes a major proportion to other animals, such as cattle, pigs and ducks being raised in this village.

2.3.6. Forest land

The study sites are occupied by mixed deciduous and dipterocarp forests. Mixed deciduous is found in areas of good drainage and on the natural levees where the altitudes do not exceed 1000 m ASL. Mixed deciduous forest is characterized by various species such as teaks.

The livelihood of Karen people is mainly dependent upon the forest. This is not only because of their village locations clinging to/or overlapping the conservation areas, but also the villagers have much relied on the forest products as the supplementary source of food. Subsistence from forest products has long been an important part of the Karen economic system. The main forest products found in both villages include mushrooms, fuel-woods, deciduous leaves (used for making roofs after drying) and bamboo shoots. Villagers from both villages travel about 2-3 Km from home to gather mushrooms. For example, Pha Phueng villagers collect mushrooms in Doi Pong, Nong Chang, Pa Kwai and Huai Rai areas. Mong Luang villagers have special places for mushrooms gathering in Doi Rai and Doi Hed Horm. Distance from home to the fuel-woods locations is within 1 km for both villages. Income from selling mushrooms (40 Baht/kg) contribute significantly among other forest products for both villages. The best collection time of mushrooms is during the rainy season or around June-July each year. Forest products from wild animals (i.e., deers and turtles) are considered as part of forest gathering, but no available record has been made from both villages.

Forest management and protection in both villages are controlled by the watershed management section under the patronage of HM the Queen. Villagers are involved with different conservation activities, such as forest plantation, forest rehabilitation and control of forest fires. It has been reported that 50 rais and 200 rais of land have been allocated to forest plantation in Ban Pha Phung and Ban Mong Luang respectively. With reference to the community forest concept, the villagers have set up the customary law for the protected watershed areas by themselves. They have classified forest into four types: (1) protected area or ceremony forests; (2) headwater forests; (3) forest available for use and (4) fallow forests[3] (Scoccimarrow et.al., 1998). Each type is controlled under community "regulations" incorporated in myths, beliefs, proverbs, and Karen teachings, and sometimes in documents.

[3] Fallow forests referring to land in the regrowth statges of the swidden system

The government regulation of forest lands and protected watersheds and national parks programs has put pressures on to the communities, because villagers fear their land being resumed. At present, the villagers occupy parts of the National Forest Reserves that have been fully or partly deforested (RFD, 1993). The implementation of this regulation will result in the loss of much of the land occupied by villagers. It means that the land owned by villagers should be converted back into forest cover to gain the momentum. National forest policy is to maintain the total forest cover for the country around 40%, with 15 % for conservation and 25 % for economic purposes.

2.3.7. Past or current land use conflicts

Land use activities in the study sites are focused on farming, mostly in the form of shifting cultivation of upland rice and cash crops (e.g. soy beans). At present, the combination of shifting cultivation and the expansion of road networks has increased the problem of soil erosion (Schreider, 1999). There are many environmental issues that have been raised in the Mae Chaem catchment (Scoccimarro et. al, 1998). Issues are mainly concerned with both environmental and socio-cultural problems. Most of the problems have led to land use conflicts between Karen communities themselves as well as between Karen and the lowland residents. According to the study from IWRAM, important issues have been listed by sub-watershed and the information is needed for a case study in integrated catchment modelling. For example, in Mae Lu sub-catchment, issues are concerned with positives and negatives of maintaining shifting cultivation, under trends of land pressures, increasing market orientation, declining soil fertility, and erosion problems. Other issues such as forest degradation, upstream-downstream conflicts and poor rice production were recorded. Conflicts in water use for planting cash crops have slightly occurred between Ban Pha Phueng and Ban Om-meng, but the condition is controlled.

2.4 Major Village Land-Use Systems

Land use in the Mae Chaem catchment has undergone changes over time as a result of physical processes and human activities. Results from the analysis of recent three time slices of satellite data (1985, 1990 and 1995) indicates that forest areas have decreased by about 8%, whereas grassland, agricultural land and bare land have increased by 7%, 0.7 % and 0.6 % respectively (Sangawongse, et.al., 1999). This confirms that agricultural area is one of the major land use categories that has undergone changes. These changes should have more or less impact on agricultural land use in the Pha Phueng and Mong Luang villages.

Land use in Pha Phueng and Mong Luang can be classified, based on the household activity, into four major systems:

(1) Paddy & Upland Rice
(2) Paddy Rice & Soybeans
(3) Upland Rice & Soybeans
(4) Rice & Soybeans & Corn

Paddy & Upland Rice is the composite system of paddy rice and upland rice being grown in the same locations. Based on the example from our field survey data in 1997, the number of households that manage paddy rice and upland rice is 5 and 32 respectively. The total area for upland rice is 51 rais, whereas the area for paddy rice is 54 rais. Therefore, the average area per household for system 1 is 3.62 rai per household

Paddy rice is grown during the rainy season (July) and harvested in November. Upland rice is grown in May each year. Harvesting time for upland rice is around October. During the dry season, most of the lands are used for cultivating cash crops such as soy beans

and cabbages. These cash crops do not require much water compared to paddy rice so that they can be grown during the dry season without intensive investment.

Soy beans are divided into two types according to the growing season: (1) dry soy beans and (2) irrigated soy beans. Dry Soy beans are grown between December and May each year. Normally farmers start to grow soy beans directly after rice harvesting. Irrigated soy beans are grown between June and September each year.

Upland corn is grown between September and January on a very limited land (approximately 2-6 rais). Farmers in Ban Pha Phueng start to grow corn in September (around 26-30 September) and harvest around the end of January.

Figures 2 and 3 represent the crop calendar for representative land use systems and the calendar for individual crop in both villages respectively. The harvesting time for upland rice in Ban Mong Luang starts in December which is two months later than Ban Pha Phueng.

Paddy Rice & Soybeans is the second land use system found in both villages. The total number of households that practice this system is 25, and the total area allocated for this land use type is 69 rais. The average size of area per household was calculated by dividing 69 by 25 to give 2.7 rais. The calculation of the average area per household for another land use system was conducted by the same method. Upland Rice & Soybeans was managed by 22 households in the area of about 66 rais. The average area per household is 3 rais. The final land use system "Rice & Soybeans & Corn" was managed by 42 households in the area of 136 rais to give the average area of 3.24 rais per household.

Table 3: The proportion of cultivation area by households in Pha Phueng and Mong Luang villages

Village name	Cultivation area per household (Unit Rai)							
	Upland rice	Household	Paddy rice	Household	Soya beans	Household	Corn	Household
Pha Phueng	27	5	32	9	5	3	16	3
Mong Luang	24	9	22	7	10	6	0	0
Total	51	14	54	16	15	9	16	5

Source: Field survey (1997)

3. Policy Analysis Matrix (PAM)

3.1. Description of land use systems and components studied

We focus our study on individual crop on the per rai basis rather than on the whole farm basis. Based on this method, Paddy rice, Upland rice, Rain-fed Upland Soybeans and Upland corn were selected for this analysis. Policy Analysis Matrix (Monke and Pearson, 1989) was chosen as the method in this study, because it provides a means to measure profitability and the effects of government policy and market failures. The steps used for PAM analysis follows the diamondback method (Agricultural Policy Analysis Research and Training Program, 1997). Table 4 presents the standard format of PAM used for this study.

Table 4: The format of Policy Analysis Matrix

	Revenue	Tradable Input Cost	Domestic Factor cost	Profit
Private Prices	A	B	C	D
Social Prices	E	F	G	H
Divergences	I	J	K	L

Source: Policy Analysis Matrix Manual (1997)

Private profits: D = A- (B+C) **Input transfers: J = B-F**
Social profits: H = E- (F+G) Factor transfers: K = C-G
Output transfers: I = A- E Net transfers: L = I- J-K

3.2. Data used for PAM analysis

The data collection is necessary for PAM analysis. Field survey has been conducted in order to collect the socio-economic data from the sample households in each village. Households that earn medium income (1,000-10,000 Baht per year) from both villages were used as the sample for this study (see Appendix I). The number of households chosen for PAM analysis totals 31, consisting of 14 from Pha Phueng and 17 from Mong Luang. Data capturing from the sample households was done via the questionnaires with the assistance of the key informant in Pha Phueng. The questionnaire was designed to collect details on capital, labor and factors that are required for the production of each crop. The Input-Output (I-O) table and Prices table (P-Prices) were constructed (see Tables 5 and 6) using variables from the collected data.

Private budget was created by linking I-O table with Private Prices table as shown in Table 7. The private profitability provides information on the competitiveness of community systems at actual market prices.

Social budget was calculated by linking I-O table with social prices table, as shown in Table 8. The social budget provides the information on profitability when commodities and factors are priced at their social opportunity costs.

The PAM was constructed by tabulating variables from private prices and social prices tables using Table 4 as an example. The policy effects and market failures are indicated by divergences between private prices and social prices. Profits obtained from each crop are calculated by subtracting costs from revenues. Results of PAM analysis by individual crop are shown in Tables 10 A-10 D accordingly.

3.3. PAM findings

3.3.1. Private profitability

The overall private profitability for each crop can be primarily assessed from the private budget table. A private profit obtained from trading paddy rice was 247 Baht per rai. Upland rice, rain-fed soybeans and upland corn have a negative benefit of 103, 336 and 880 Baht per rai respectively. Profit per household for paddy rice is about 895 Baht per ria. The negative profits for upland rice, rain-fed soybeans and upland corn have been recorded as 373, 1009 and 2852 Baht per rai respectively.

Farmers have gained a profit from paddy rice production in spite of paying higher tradable inputs, such as depreciation and canal maintenance, than other crops. This has been suggested that paddy rice does not require hormone and sprayer like other crops such as upland soybeans. Only rain-fed soybeans require hormone at a minimal value (approximately 8 cc per rai) during the stage of flowering. Because of the small use of hormone, it does not take into account for calculating the social price for this study.

3.3.2. Social profitability

Social profitability was determined from the social price table. The social prices of tradable inputs and outputs are derived from prices in international markets, whereas the social prices for non-tradable goods and domestic factors require detailed knowledge of individual factor markets (Policy Analysis Matrix Manual, 1997). The prices adjusted for exchange rate and domestic transportation, processing, and marketing costs are called “border price” which is equal to the social price at the wholesale market nearest to the farm gate. Social export parity prices are the adjustment of border price on the basis of export or exportable commodities. Social import parity prices are the adjustment of border price on the basis of import or importable commodities (Ekasingh, *et.al*., 1999).

The social import and export parity prices can be obtained from the country’s trade statistics. In case of import, c.i.f prices at foreign port are used for determining the social import parity price, by dividing the value of the imported commodity by the quantity imported. In case of export, f.o.b prices are used for determining the social export parity price using the same calculation. The social price data utilized in this study was given by ICRAF. The data provides information on type of tradable inputs, trade name, common name, concentration, formulation, unit, processing cost, import price, etc (see Appendix II). For importable commodities, c.i.f. prices were evaluated at social exchange rate to yield c.i.f costs of inputs at domestic currency. Marketing costs, transportation costs and processing costs were added to the c.i.f. domestic prices to yield social import parity prices (Table 12) at the farm level. For exportable commodities, either c.i.f at foreign ports or f.o.b at Bangkok were used, deducted by any freight and insurance costs between countries (evaluated at social

exchange rate). The social export parity price (Table 13) was obtained by deducting transportation costs, marketing costs and processing costs with the necessary unit conversion ratio.

3.3.3. Measurement of government intervention and market imperfection

Results from PAM analysis (Table 10) show that paddy rice is privately and socially profitable at 297 Baht per rai. No private and social profits were obtained from upland rice as indicated by negative divergences of – 75 Baht and – 441 Baht respectively. Soy beans and corn are socially profitable, but privately non-profitable. The negative divergence indicates that the farmers are taxed by either the government intervention or market imperfection or both. These effects can be concluded by making a comparison between PAM summary (Table 10) and PAM ratio (Table 11).

3.3.4. PAM Ratio

A number of different ratios can be made from the PAM. These ratios provided a means to analyse the land use systems in more details for this study.

	Revenue	Tradable Input Cost	Domestic Factor cost	Profit
Private Prices	A	B	C	D
Social Prices	E	F	G	H
Divergences	I	J	K	L

The ratio functions used for this study are:

1. Private Cost Ratio (PCR)

The PCR measures profitability and non-profitability. PCR less than 1 indicates that the farmers have gained privately or socially profit from cultivating different crops. On the contrary, PCR greater than 1 indicates non-profitability.

$$\mathbf{PCR} = \frac{\text{Private Domestic Resources}}{\text{(Private Revenue – Private Tradable Input Costs)}}$$

$$\mathbf{PCR = C/(A\text{-}B)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(1)}$$

2. Domestic Resource Cost Coefficient (DRC) for the single commodities

The DRC measures the efficiency, or comparative advantage of crop production. It serves as a proxy measure for social profits. The DRC is calculated by dividing the cost of labor and capital by value added at social prices. DRCs greater than 1 indicate that the value of domestic resources used to produce the commodity exceeds its value added in social prices. DRCs less than 1 imply that a country has a comparative advantage in producing the commodity (Policy Analysis Manual, 1997).

$$\mathbf{DRC} = \frac{\text{(Labor Costs + Capital Cost) in Social Prices}}{\text{(Social Revenue – Social Tradable Inputs)}}$$

$$\mathbf{DRC = G/(E\text{-}F)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \mathbf{(2)}$$

3. Effective Protection Coefficient (EPC)

EPC is defined as the ratio of value added in the private price to value added in social prices. It indicates the combined effects of policies in the tradable commodities markets. An EPC greater than 1 indicates positive incentive effects of commodity policy, which in this case farmers are subsidized. Farmers are taxed if an EPC less than 1.

$$\textbf{EPC} = \frac{\text{(Private Revenue – Private Tradable Inputs)}}{\text{(Social Revenue – Social Tradable Inputs)}}$$

$$\textbf{EPC} = (A-B)/(E-F) \quad \ldots\ldots (3)$$

4. Ratio of Private and Social Profit = $\frac{\text{Private Profit}}{\text{Social Profit}}$

$$\textbf{RP and SP} = D/H \quad \ldots\ldots (4)$$

5. Subsidy Ratio to Producers (SRP)

The SRP indicates how much net transfer is a ratio of social revenue. A positive ratio indicates subsidy, but a negative ratio indicates tax on individual crop.

$$= \frac{\text{Net Transfer}}{\text{Social Revenue}}$$

$$\textbf{SRP} = L/E \quad \ldots\ldots (5)$$

6. The Nominal Protection Coefficient (NPC)

The Nominal Protection Coefficient for tradable outputs (NPC) is defined by the ratio of private commodity prices and social commodity prices. This ratio compares the impact of government policy or of market failures that are not corrected by efficient policy between different crops. The NPC has been classified into two types: Nominal Protection Coefficient for tradable outputs (NPCO) and Nominal Protection Coefficient for tradable inputs (NPCI).

$$\textbf{NPCO} = \frac{\text{Revenue in Private Prices}}{\text{Revenue in Social Prices}}$$

$$\textbf{NPCO} = A/E \quad \ldots\ldots (6)$$

If NPCO is greater than 1 (the market price of the output exceeds the social price), the farmer receives an implicit output subsidy from policies affecting crop prices such as tariff, trade restrictions, taxes, domestic marketing restrictions, or a distorted exchange rate.

The Nominal Protection Coefficient for tradable inputs (NPCI) is calculated by:

$$\textbf{NPCI} = \frac{\text{Costs of Tradable Inputs in Private Prices}}{\text{Costs of Tradable Inputs in Social Prices}}$$

$$\textbf{NPCI} = B/F \quad \ldots\ldots (7)$$

NPCI less than 1 indicates that market prices of inputs fall below the prices that would result in the absence of policy. This ratio reveals the presence of input subsidies, taxes, trade restrictions or an inappropriate exchange rate (Policy Analysis Manual, 1997).

3.3.5. Sensitivity analysis

Once all the tables have been fully integrated, a sensitivity analysis can be performed. Sensitivity analysis provides a means of assessing the impact of changed assumptions and errors in estimating private and social profitability (Monke and Pearson, 1989). The social estimate of long run world prices for output, labor cost and capital cost receive the most attention in sensitivity analysis because of their uncertainty. A number of different situations concerning change in price and productivity have been investigated, as shown in Table 15.

First, the effect of price changes on every crop was determined. Price for paddy rice increases to 10 Baht/Kg has increased the private profit from 408 Baht/rai to 2, 961 Baht/rai. Upland rice price increases to 10 Baht/Kg has resulted in decreasing of negative private profit from 75 Baht/rai to 1, 496 Baht/rai. Upland Soya bean price increases to 15 Baht/Kg has changed the negative private profit from –336 Baht/rai to 1, 040 Baht/rai. The increase of upland corn price to 5 Baht/Kg has changed the negative private profit from –717 Baht/rai to 753 Baht/rai. The social profitability remains the same for every crop.

Second, the changing of output has been conducted to measure the sensitivity from each crop. The output of rainfed soy beans increases to 30% has resulted in decreasing negative private profit from –336 Baht/rai to – 6 Baht/rai. This means that farmers have no profit from soy beans. The output of upland corn increases to 20% has resulted in a slightly decrease of negative private profit from – 881 Baht/rai to –717 Baht/rai. If the output of paddy rice decreased by 30 %, private profit and social profit became negative. If the output of upland rice increased by 20%, negative private profit and negative social profit decreased, but still negative.

Results obtained from sensitivity analysis confirm that no private profit can be obtained from soy beans and upland corn in the study area, even increasing the price or increasing the output of each crop. No privately and socially profitability can be obtained from upland rice, even increasing price two times or increasing output to 20 %.

4. Implications

Policy implications can be considered from the results of PAM analysis. Among other crops, only paddy rice has proven to be privately and socially profitable as indicated by positive profits. For this reason, paddy rice should be promoted and expanded to a greater extent. There are a number of difficulties which have been encountered by rice-growing farmers, for example seed allocation, inadequate market information, pest and diseases and cost of handling that need to be assisted by the government. It has been suggested that the department of Agricultural Extension should participate with the farmers in all lines of operation and management to improve the paddy rice production (Ekasingh, et. al., 1999). Upland rice was privately and socially non-profitable. Based on the fact that upland rice is grown on a rotational basis (about 5-7 years fallow) which can reduce the profit per year. To solve this problem, alternative upland crops should be promoted to increase income from growing only upland rice. Rainfed soya beans and upland corn were socially profitable, but privately non-profitable.

5. Recommendation for further PAM studies

Only four major crops were used as examples for studying PAM in our study area. Paddy rice, rainfed soy beans and upland corn were socially profitable. Paddy rice was privately and socially profitable, so it should be extensively promoted. Upland rice was socially non-profitable at current level of productivity and prices, which should be subjected to some policy intervention.

Recommendations for further studies:

(1) Whole farm PAM should be conducted if data collection on other crops were made available. Whole farm PAM may aid in a better policy-making.

(2) Forest products such as mushrooms should be taken into account as one crop component in a PAM, but data collection should be done on a regular basis

(3) Include the environmental factors in PAM analysis. These factors could have an impact on the social costs. PAM analysis will be valid if "externalities" (e.g. soil erosion) are taken into consideration.

(4) Link PAM to a Geographical Information Systems (GIS), so that spatial information can be integrated with descriptive information in the PAM. This suggestion will increase the potentiality of PAM, because the wealthy spatial information in GIS (i.e., land use and soil types) can help the policy makers in decision-making.

An approach to link PAM with a GIS can be outlined as the following:

- Conduct the village mapping to obtain the land use boundaries, especially agricultural land use (paddy, upland field crops, etc.) at a fine level of information. Aerial photographs are the best source of information at the village level.
- Prepare GIS layers of information, such as roads, rivers, soil types, vegetation and Digital Elevation Model (DEM) of the study sites;
- Import all the GIS layers into the working environment because they can enhance the information on agricultural land use;
- Adjust all the tables into the format that can be linked with the spatial information in GIS. Normally excel format can be accessed directly by ArcView GIS funtionality.
- Relate spatial data with attribute data by linking or joining
- Spatial analysis
- Create maps

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Table 5: Input-Output table of four major crops in the case study villag

		Paddy Rice	Upland Rice	Rainfed Upland Soybeans	Rain-fed Corn
Tradable	**Fertilizer (Kg/Rai)**				
	16-20-0	37.11	15.31	24.36	28.82
	13-13-21	0.00	1.56	0.00	1.43
	Herbicide (cc/Rai)				
	Gramoxon (cc/Rai)	0.00	56.25	589.74	714.29
	2E (cc/Rai)	0.00	0.00	55.13	0.00
	LD6G (Kg/Rai)	0.86	0.00	0.00	0.00
	Insecticide (cc/rai)				
	Floridon (cc/rai)	0.00	0.00	115.38	0.00
	Hormone (cc/rai)				
	Nothai (cc/rai)	0.00	0.00	7.69	0.00
	Seed (Kg/rai)	12.68	8.10	9.90	2.19
	Fuel (Liters/Rai)	8.98	1.31	0.00	0.00
Factors	**Labor (Days/Rai)**				
	Slash and Burn	0.00	5.82	0.00	0.00
	Canal Maintenance	1.20	0.19	0.00	0.00
	Nursery	3.20	0.76	0.27	0.00
	Seedbed Prep (Site Prep)	2.25	5.09	3.28	3.23
	Planting	6.44	4.23	2.17	1.86
	Crop Care				
	1. Weeding	1.15	3.06	1.09	0.50
	2. Fertilizing	0.20	0.06	0.01	0.00
	3. Watering	1.20	0.19	0.00	0.00
	4. Insecticide Spraying	0.16	0.00	0.00	0.00
	Harvesting	7.92	4.93	2.08	1.89
	Threshing/Winnowing	6.52	3.68	0.00	0.00
	Transportation&Storage	0.31	0.00	0.08	0.00
	Shelling	0	0	0	0
	Drying	0	0	0	0
	Total labour use /Rai	30.55	28.00	8.98	7.47
	Capital				
	Working Capital (Baht/Rai)	667.67	238.47	548.25	891.03
	Tractor Services (Days/Rai)	1.07	0.19	-	-
	Thresher (Day/Rai)	1.00	1.00	1.00	1.00
	Hand Tools (Pcs./rai)				
	Knive (Pcs./rai)	0.11	0.05	0.36	0.23
	Hoe (Pcs./rai)	0.12	0.07	0.36	0.50
	Pick (Pcs./rai)	0.00	0.04	0.05	0.11
	Sparyer (Pcs./rai)	0.00	0.03	0.10	0.11
	Land (Rai)	1.00	1.00	1.00	1.00
Output	(Kg/Rai)	508.59	314.25	165.27	408.29

Table 6. Private Prices of Inputs and Outputs of four major crops

PRICE		Paddy Rice	Upland Rice	Upland Soybean	Rain-fed Corn
Tradables	**Fertilizer (B/Kg)**				
	16-20-0	8.6	8.6	8.6	8.6
	13-13-21	10.2	10.2	10.2	10.2
	Herbicide (B/cc)				
	Gramoxon (B/Rai)	0.12	0.12	0.12	0.12
	2E (B/Rai)	0.72	0.72	0.72	0.72
	LD6G (B/Rai)	20.00	20.00	20.00	20.00
	Insecticide (B/cc)				
	Floridon (B/Rai)	0.60	0.60	0.60	0.60
	Hormone (B/cc)				
	Nothai (B/Rai)	1.75	1.75	1.75	1.75
	Seed (B/Kg)	5.00	5.00	15.00	250.00
	Fuel (B/litre)	12.00	12.00	12.00	12.00
Factors	**Labor (B/Day)**				
	Slash and burn	50.00	50.00	90.00	90.00
	Canal Maintenance	50.00	50.00	90.00	90.00
	Nursery	50.00	50.00	90.00	90.00
	Seedbed Prep.	50.00	50.00	90.00	90.00
	Planting	50.00	50.00	90.00	90.00
	Crop Care				
	1. Weeding	50.00	50.00	90.00	90.00
	2. Fertilizing	50.00	50.00	90.00	90.00
	3. Watering	50.00	50.00	90.00	90.00
	4. Insecticide Spraying	50.00	50.00	90.00	90.00
	Harvesting	50.00	50.00	90.00	90.00
	Threshing/Winnowing	50.00	50.00	90.00	90.00
	Transportation&Storage				
	Shelling	50.00	50.00	50.00	50.00
	Drying	50.00	50.00	50.00	50.00
	Capital				
	Working Capital (Baht/Rai)	15%	15%	15%	15%
	Tractor Services (Days/Rai)	150.00	150.00	150.00	150.00
	Thresher (Day/Rai)	0.00	0.00	0.00	0.00
	Hand Tools (Pcs./rai)				
	Knive (Pcs./rai)	21.25	21.25	21.25	21.25
	Hoe (Pcs./rai)	22.50	22.50	22.50	22.50
	Pick (Pcs./rai)	8.75	8.75	8.75	8.75
	Sparyer (Pcs./rai)	100.00	100.00	100.00	100.00
Output	**Land (Rai)**	0.00	0.00	0.00	0.00
	(Baht/Kg)	5.00	5.00	6.67	5.00

Table 7: Private Budget of costs and returns per rai for four major crops

		Paddy Rice	Upland Rice	Upland Soybeans	Upland Corn
Tradable	**Fertilizer (B/Rai)**				
	16-20-0 (B/Rai)	319.15	131.69	209.49	247.89
	13-13-21 (B/Rai)	0.00	15.94	-	14.57
	Herbicide (B/Rai)				
	Gramoxon (B/Rai)	0.00	6.47	67.82	82.14
	2E (B/Rai)	0.00	0.00	39.69	0.00
	LD6G (B/Rai)	17.18	0.00	0.00	0.00
	Insecticide (B/rai)				
	Floridon (B/Rai)	0.00	0.00	69.23	0.00
	Hormone (B/rai)				
	Nothai (B/Rai)	0.00	0.00	13.46	0.00
	Seed (B/rai)	63.38	40.50	148.56	546.43
	Fuel (B/Rai)	107.74	15.75	0.00	0.00
Factors	**Labor (B/Rai)**				
	Slash and Burn	0.00	291.00	0.00	0.00
	Canal Maintenance	60.22	9.38	0.00	0.00
	Nursery	159.80	37.81	24.23	0.00
	Seedbed Prep (Site Prep)	112.56	254.38	295.38	290.57
	Planting	321.94	211.56	195.00	167.14
	Crop Care				
	1. Weeding	57.45	152.81	98.08	45.00
	2. Fertilizing	9.87	3.13	1.15	0.00
	3. Watering	60.22	9.38	0.00	0.00
	4. Insecticide Spraying	8.08	0.00	0.00	0.00
	Harvesting	396.06	246.56	187.50	169.71
	Threshing/Winnowing	325.90	184.06	0.00	0.00
	Transportation&Storage	15.64	0.00	6.92	0.00
	Shelling	0.00	0.00	0.00	0.00
	Drying	0.00	0.00	0.00	0.00
	Capital				
	Working Capital (Baht/Rai)	100.15	35.77	82.24	133.65
	Tractor Services (Baht/Rai)	160.22	28.13	0.00	0.00
	Thresher (B/Rai)	0.00	0.00	0.00	0.00
	Hand Tools (B/rai)				
	Knive (B/Rai)	2.27	1.13	7.63	4.86
	Hoe (B/Rai)	2.63	1.58	8.08	11.25
	Pick (B/Rai)	0.00	0.34	0.45	1.00
	Sprayer (B/Rai)	0.00	3.13	10.26	11.43
	Land (B/Rai)	0.00	0.00	0.00	0.00
Output	Total Revenue	2,542.97	1,571.25	1,102.35	816.58
(Baht/rai)	Total variable cost	507.45	210.34	548.25	891.03
	Gross margin	2,035.52	1,360.91	554.10	74.45
	Depreciation and interest	260.37	63.90	82.24	133.65
	Return to land and labour	1,775.15	1,297.01	471.86	59.20
	Labour cost	1,527.75	1,400.06	808.27	672.43
	Total cost	2,295.57	1,674.30	1,438.76	1,697.11
	Profit (Return to manageme	247.40	103.05	336.41	717.21
	Implicit Wage Rate (Baht/d	58.10	46.32	52.54	5.59
	Average area (Rai/househol	3.62	3.62	3.00	3.24
	Profit per household	895.59	373.05	1,009.22	2,323.77

Table 8: Social Prices of Inputs and Outputs for Major Crops in the case-study villages

PRICE		Paddy Rice	Upland Rice	Upland Soybean	Rain-fed Corn
Tradables	**Fertilizer (B/Kg)**				
	16-20-0	8.19	8.19	8.19	8.19
	13-13-21	-	-	-	-
	Herbicide (B/cc)				
	Gramoxon (B/Rai)	0.03	0.03	0.03	0.03
	2E (B/Rai)	0.03	0.03	0.03	0.03
	LD6G (B/Rai)	0.03	0.03	0.03	0.03
	Insecticide (B/cc)				
	Floridon (B/Rai)	0.00	0.00	0.03	0.00
	Hormone (B/cc)				
	Nothai (B/Rai)	-	-	-	-
	Seed (B/Kg)	3.84	3.84	10.88	30.47
	Fuel (B/litre)	7.63	7.63	7.63	7.63
Factors	**Labor (B/Day)**				
	Slash and burn	50.00	50.00	90.00	90.00
	Canal Maintenance	50.00	50.00	90.00	90.00
	Nursery	50.00	50.00	90.00	90.00
	Seedbed Prep.	50.00	50.00	90.00	90.00
	Planting	50.00	50.00	90.00	90.00
	Crop Care				
	1. Weeding	50.00	50.00	90.00	90.00
	2. Fertilizing	50.00	50.00	90.00	90.00
	3. Watering	50.00	50.00	90.00	90.00
	4. Insecticide Spraying	50.00	50.00	90.00	90.00
	Harvesting	50.00	50.00	90.00	90.00
	Threshing/Winnowing	50.00	50.00	90.00	90.00
	Transportation&Storage				
	Shelling	50.00	50.00	50.00	50.00
	Drying	50.00	50.00	50.00	50.00
	Capital (Baht)				
	Working Capital (%)	0.05	0.05	0.05	0.05
	Tractor Services (Baht/Day	150.00	150.00	-	-
	Thresher (B/Kg)	-	-	-	-
	Land (Baht/Rai)	-	-	-	-
	Output (Baht/Kg)	3.84	3.84	10.88	4.98

Table 9: Social Budget of costs and returns per rai for four crop components in the case study villages

		Paddy Rice	Upland Rice	Upland Soybeans	Rainfed Corn
Tradables	**Fertilizer (B/Rai)**				
	16-20-0 (B/Rai)	303.93	125.41	199.50	236.07
	13-13-21 (B/Rai)	-	-	-	-
	Herbicide (B/Rai)				
	Gramoxon (B/Rai)	0.00	1.69	17.69	21.43
	2E (B/Rai)	0.00	0.00	1.65	0.00
	LD6G (B/Rai)	0.03	0.00	0.00	0.00
	Insecticide (B/rai)	0.00			
	Floridol (B/Rai)	0.00	0.00	3.46	0.00
	Hormone (B/rai)	0.00	0.00	0.00	0.00
	No-tai (B/Rai)	0.00	0.00	0.00	0.00
	Seed (B/rai)	48.68	31.10	107.75	66.60
	Fuel (B/Rai)	68.51	10.01	-	-
Factors	**Labor (B/Rai)**	-			
	Slash and Burn	-	291.00	-	-
	Canal Maintenance	60.22	9.38	-	-
	Nursery	159.80	37.81	24.23	-
	Seedbed Prep.	112.56	254.38	295.38	290.57
	Planting	321.94	211.56	195.00	167.14
	Crop Care	-	-	-	-
	1. Weeding	57.45	152.81	98.08	45.00
	2. Fertilizing	9.87	3.13	1.15	-
	3. Watering	60.22	9.38	-	-
	4. Insecticide Spraying	8.08	-	-	-
	Harvesting	396.06	246.56	187.50	169.71
	Threshing/Winnowing	325.90	184.06	-	-
	Transportation&Storage	-	-	-	-
	Shelling	-	-	-	-
	Drying	-	-	-	-
	Capital				
	Working Capital (Baht/Rai)	104.67	79.82	56.57	49.83
	Tractor Services (Baht/Rai)	160.22	28.13	-	-
	Thresher (B/Rai)	-	-	0.03	-
	Land (B/Rai)	-	-	-	-
Output	Total Revenue	1,954.78	1,207.82	1,798.14	2,439.95
(Baht/rai)	Total variable costs	421.14	168.22	330.06	324.10
	Gross margin	1,533.64	1,039.60	1,468.08	2,115.85
	Depreciation and interest	264.89	107.95	56.57	49.83
	Return to land and labour	1,268.75	931.66	1,411.50	2,066.03
	Labor costs	1,527.75	1,400.06	808.27	672.43
	Total costs	2,213.78	1,676.22	1,194.90	1,046.35
	Profit (Return to management	259.00	468.40	603.23	1,393.60

Table 10: PAM tables: Private and Social Profitability Per Ra

of four crop components in the case-study villages

A. Policy Analysis Matrix: Paddy rice						
	Tradables		**Domestic Resources**			
	Revenues	**Inputs**	**Labor**	**Capital**	**Land**	**Profits**
Private	2,543	507	1,528	100	-	408
Social	1,955	210	1,528	105	-	112
Divergences	588	297	-	(5)	-	296

B. Policy Analysis Matrix:Rainfed Upland Rice						
	Tradables		**Domestic Resources**			
	Revenues	**Inputs**	**Labor**	**Capital**	**Land**	**Profits**
Private	1,571	210	1,400	36	-	(75)
Social	1,208	168	1,400	80	-	(440)
Divergences	363	42	-	(44)	-	365

C. Policy Analysis Matrix:Rainfed Upland Soybeans						
	Tradables		**Domestic Resources**			
	Revenues	**Inputs**	**Labor**	**Capital**	**Land**	**Profits**
Private	1,102	548	808	82	-	(336)
Social	1,798	330	808	57	-	603
Divergences	(696)	218	-	26	-	(940)

D. Policy Analysis Matrix:Rainfed corn						
	Tradables		**Domestic Resources**			
	Revenues	**Inputs**	**Labor**	**Capital**	**Land**	**Profits**
Private	980	891	672	134	-	(717)
Social	2,440	324	672	50	-	1,394
Divergences	(1,460)	567	-	84	-	(2,111)

Table 11: PAM Ratios

	Paddy rice	Rainfed Upland Rice	Rainfed Upland soybeans	Rainfed corn
Privately profitable	Yes	No	No	No
Socially profitable	Yes	No	Yes	Yes
Output transfer (NPCO)	Subsidy	Subsidy	No protection	tax
Input transfer (NPCI)	Subsidy	Subsidy	Subsidy	Subsidy
Factor transfer	tax	tax	Subsidy	tax
Net transfer	Subsidy	Subsidy	tax	tax
Private Cost Ratio (PCR)	0.70	1.06	1.61	9.06
Domestic resource cost coefficient (DRC)	0.94	-0.08	0.81	1.07
Effective protection coefficient (EPC)	1.17	1.31	-0.37	0.04
Ratio of private and social profits (RP & SP)	3.64	0.17	-0.56	-0.51
Subsidy ratio to producers (SRP)	0.15	0.30	-0.52	-0.87

Table 12: Social import parity prices

		Output		Fuel	Fertilizers		Seed			Chemical		
		Corn	Soybean		16-20-0	13-13-21	Paddy	Corn	Soybean	Gramoxon	Gold 2E	Floridol
Social Import parity prices												
F.o.b ($/tonne)		104	252.67									
Freight/Insurance ($/ton)		32.5	41									
c.i.f ($/unit)		136.5	293.67	20	165.29	236.45		830.00		0.04	0.04	0.00
unit		ton	ton	barrel	ton	ton		ton		kg	litre	
Exhange rate (baht/$)		26.13	26.13	26.13	26.13	26.13		26.13	26.13	26.13	26.13	
Exchange rate premium		0.3395	0.3395	0.3395	0.3395	0.3395		0.3395	0.3395	0.3395	0.3395	
Equilibrium exchange rate		35	35	35	35	35		35	35	35	35	
c.i.f in domestic currency		4777.5	10278.45	700.00	5785.15	8275.75		29,050.00		1.40	1.40	
Weight conversion factor (kg/ton)		1000	1000	158.99	1000	1000		1000		1000	1000	
c.i.f.in domestic currency		4.7775	10.28	4.40	5.79	8.28		29.05		0.00	0.00	
transportation costs (to factory)($/ton)		23										
transportation costs (to factory)		0.805	0.6	0.87	1	1		0.92				
Marketing costs (baht/unit)		0.5	0.5	1.05	1	1				0.00	0.00	
Value before processing (baht/unit)		6.08	11.38	6.32	7.79	10.27575				0.00	0.00	
Processing conversion factor	0.7	0.95	1	0.95	1	1						
Import parity value at wholesale (baht/kg)		5.78	11.38	6.65	7.79	10.27575		29.97				
Processing cost (baht/unit)		0.5	0	0.8731	0	0				0.02	0.02	0.02
Distribution costs to farm (baht/kg)		0.3	0.5	0.1	0.4	0.4		0.5		0.01	0.01	
Import parity at farm gate (baht/unit)		4.98	10.88	7.63	8.19	10.67575		30.47		0.03	0.03	
Adjustment of unit												
Import parity at farm gate (baht/unit)												

Table 13 : Social export parity prices

	Output		
	Paddy	Corn	Soybean
Social export parity values			
c.i.f. ($/ton)			
Freight and Insurance ($/ton)			
f.o.b. ($/ton)	224		
Exhange rate (baht/$)	26.13	26.13	26.13
Exchange rate premium (ERP)	0.3395	0.3395	0.3395
Equilibrium exchange rate	35	35	35
f.o.b in domestic currency	7840		
Weight conversion factor (kg/ton)	1000		
f.o.b in domestic currency	7.84		
transportation costs (from factory)(baht/kg	0.35		
Marketing costs (baht/kg)	0.5		
Value after processing (baht/kg)	6.99		
Processing conversion factor (%)	0.65		
Export parity value at wholesale (baht/kg)	4.54		
Processing cost (baht/kg)	0.2		
Distribution costs to farm (baht/kg)	0.5		
Export parity value at farm gate (baht/kg)	3.84		

Table 14: Assumptions Table

Macro-Economic Assumptions		***Rate***
	Nominal interest rate (%)	15%
	Social interest rate (%)	5%
	Official exchange rate (Bt/$)	26
	Exchange premium (%)	34%
	Percent devaluation (%)	0%

Table 15: Sensitivity Analysis

Crops	**Situations**	**Private profitability**		**Social profitability**	
		Base	Results	Base	Results
Paddy Rice	Price increases to 10 Baht/Kg	408	2,951	110	110
Upland Rice	Price increases to 10 Baht/Kg	-75	1,496	-441	-441
Rainfed Soya beans	Price increases to 15 Baht/Kg	-336	1,040	603	603
Upland Corn	Price increases to 5 baht/Kg	-717	334	1394	987
Paddy Rice	Export price increases 10%	408	408	110	367
Upland Rice	Export price increases 10%	-75	-75	-441	-283
Rainfed Soya beans	Output increases 30%	-336	-6	603	1143
Upland Corn	Output increases 20%	-881	-717	987	1,394
Paddy Rice	Output decreases 30%	408	-355	110	-476
Upland Rice	Output increases 20%	-75	-336	-441	-696

Income Medium

Appendix I

Income distribution in Ban Mong Luang and Ban Pha Pheung

1. Ban Mong Luang

Address	# Familiy Members	Income Rate	Ag.	Em	N.A.
58	5	M	-	1	-
29	5	M	-	1	-
60	3	M	-	1	-
64/2	4	M	-	1	-
87	5	M	-	1	-
18/1	6	M	-	1	-
22	7	M	1	1	-
27	5	M	-	1	-
25/1	5	M	-	1	-
46	6	M	-	1	-
27/1	3	M	-	1	-
52	5	M	-	1	-
44	4	M	-	1	-
46	5	M	-	1	-
61	4	M	-	1	-
18	7	M	-	1	-
40/2	5	M	-	1	-
39	5	M	1	1	-
67/1	2	M	1	1	-
42	3	M	-	1	-
92	4	M	-	1	-
96	4	M	-	1	-
104/1	4	M	1	1	-
110	4	M	-	1	-
34/1	5	M	-	1	-
53	6	M	-	1	-
44	12	M	-	1	-
35/1	4	M	-	1	-
1	5	M	-	1	-
79	9	M	1	1	-
90	5	M	-	1	-
31	5	M	1	1	-
41/1	5	M	1	1	-
73	7	3000	1		0
84	4	5000	1	-90	0
90	4	8000	1	1	0
99	4	7500	1	1	0
71	6	6000	1	1	0
27	3	5600	1	1	0

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64/1	5	9570	1	1	0
20	10	2120	1	1	0
96	3	2000	0	1	0
15	5	8000	1	1	0
2/1	11	7000	1	1	0
91	4	9000	1	1	0
5/1	5	3500	1	0	0
85	4	2080	1	1	0
3/2	4	4300	1	1	0
3/3	2	1500	1	0	0
6/4	4	9000	1	1	0
75	5	3080	1	1	0
64	7	3080	1	1	0
8	6	8500	1	1	0
36	6	6500	1	1	0
42	2	4000	1	1	0
41/1	6	3080	1	1	0
14	7	3000	1	1	0
10	3	8000	1	1	0
4/2	5	9500	1	0	0
9/1	5	5000	1	1	0
10/2	3	5500	1	1	0
6/1	7	3000	0	1	0
6/3	4	5000	1	0	0
61	8	1500	1		0
71	7	6500	1	1	0
100	9	2000	1	1	0
3/1	6	4500	1	1	0

Appendix II: Social Price Data

Type	Trade name	Common name	Concentration	Formulation	Unit	Processing cost	Avg. proc cost	Import Price ($/lt.kg)	Godown cost ($/lt.kg)	Total Proc. cost ($/lt.kg)	Transp Cost (Bkk - CM) (Bht/lt, kg)	Transp Cost (CM-Bkk) (Bht/lt, kg)
Insecticides	Ambush	Permetrine	10%	EC	lt	20-25 Bht/lt	22.50	7.251	0.218	22.718	2.50	1.67
	Folidol	Methyl Pa….	80%	T	kg	20 Bht/lt	20.00	3.073	0.116	20.116	2.50	1.67
Herbicides	Gramozone	Paraqual dichloride	45%	T	kg	5-10 Bht/lt	7.50	4.951	0.149	7.649	2.50	1.67
	Goal 2E	Oxyfluorfen	23.50%	EC	kg	5-10 Bht/lt	7.50	20.897	0.627	8.127	2.50	1.67
	Goal 2E	Oxyfluorfen	23.50%	EC	lt	5-10 Bht/lt	7.50	9.563	0.287	7.787	2.50	1.67
	LD6G	2.4-D+Butachlor	3.8%+3%	T	kg	10-20 Bht/kg	15.00	0.267	0.008	15.008	2.50	1.67
Fungicides	Dithane M45	Mancozeb	80%	WP	kg	10-20 Bht/kg	15.00	2.663	0.080	15.008	1.25	0.40
	Mazale	Mancozeb	80%	WP	kg	10-20 Bht/kg	16.00	2.996	0.090	15.090	1.25	0.40
	Kumulus	Sulfur	80%	WP	kg	0 Bht/kg	0.00	1.118	0.080	0.080	1.25	0.40
	Afugan	Pyrazophos	80%	EC	lt	20 Bht/lt	20.00	7.952	0.090	26.000	2.50	1.67
Hormone	No-tai					10-20 Bht/lt	15.00					

Agricultural chemical has no tax payment
Godown cost is about 3% of import price

Transportation Cost for Chiang Mai
Bangkok to Chiang Mai

12*100 cc/botle	30 Bht/box
12*500 cc/botle	30 Bht/box
6*4 litre/gallon	30 Bht/box
4*5 litre/gallon	30 Bht/box
25 kg/bag	30 Bht/bag

or about 1 baht per kilogram

Chiang Mai to Mae Chaem

In the Box	20 Bht/box
In the Bag	0.40 Bht/bag

EC = Emussion Concentrate (difute in oil)
WP = Wet powder
D = Dust
SL = Soluble Liquid
G = Granule

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