

## **CHAPTER VI MODEL PROJECT AREA**



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### VI-1 LOCATION, AREA AND POPULATION

Four areas are selected as model project areas to implement the overall 5-year development plan on the integrated rural development at the Nower North Thailand, and the feasibility study has been conducted for these four model projects. Locations of the model project area are given below:

#### LOCATION OF MODEL PROJECT AREAS

<u>Name of Areas</u>	<u>Province</u>	<u>Amphoe</u>	<u>Nos. of Villages</u>
Huai Sam Ru	Phitsanulok	Nakhon Thai	3
Huai Nong Kho	Sukhothai	Ban Dan Lan Hoi	4
Khlong Samo Khon	Kamphaeng Phet	Phran Kratai	2
Khlong Sai	Tak	Muang Tak	4

The irrigable lands are selected among the existing farm lands of the backward villages, and the farm lands of other villages than the backward located just downstream of the proposed reservoirs are also included in the project area as far as water resources allow to do so. The project boundaries are determined based on the topographic maps with a scale of 1 : 5,000 prepared for use of the feasibility study and aerophoto-graphs with a scale of 1 : 15,000 prepared by the Royal Thai Survey Department. The gross project areas of four model projects amount to 2,950 ha including villages, forest lands, rivers and others, of which 1,982 ha of lands are under cultivation, as summarized below:

#### GROSS PROJECT AREAS

<u>Model Area</u>	<u>Farm Land</u>	<u>Villages</u>	<u>Forest and Others</u>	<u>Total</u>
Huai Sam Ru	1,130	53	207	1,390
Huai Nong Kho	624	11	75	710
Khlong Samo Khon	200	12	28	240
Khlong Sai	489	57	64	610
Total	2,443	133	374	2,950

- Unit: ha -

The total population of four model project areas in 1988 was 10,145 persons with 2,272 households, or equivalent to an average family members of 4.47 person/household (refer to Table VI-1).

## **VI-2 PHYSICAL CONDITIONS**

### **VI-2-1 Topography and Geology**

#### **① Huai Sam Ru Area**

The area is located along Sam Ru river in the shape of 2.5 km long, 1.5 km wide rectangle. The ground elevation falls within 270 to 300 meters above the mean sea level. The area is consisted of rolling hills and undulating hills; the former occupies about 30 percent of the area and the later about 70 percent. The slope of rolling hills is around 5 to 18 percent, while the slope of undulating hills is around 1 to 8 percent.

The area is geologically composed of Khok Kruat formation, and the bed rocks are brown to reddish brown sandstones formed in the Cretaceous. The tectonic lines are not found by the surface geological survey.

#### **② Huai Nong Kho Area**

The area is consisted of depositional plain, and is divided into two sub-areas of the upstream area and the downstream area. The upstream area is about four km in length and about one km in width with ground elevation of 100 to 120 meters above the mean sea level, being located on the right bank of Nong Kho river. The downstream area is situated in the fan shape on the left bank of Nong Kho river having ground elevation of 70 to 75 meters above the mean sea level. Both the areas are flat with the slope of zero to three percent.

The area is composed of diluvial formations including terrace gravel, sand silt, laterite and lateritic soil. The almost surface soils are laterite and lateritic soils, brown or reddish brown, with the depth of one to three m. The mountainous areas are consisted of sedimentary rocks, phyllite, phyllitic schist, phyllitic tuff, quartzite and shale, being formed in the Devonian-Silurian. Alluvial formation is slightly found along streams.

### ③ Khlong Samo Khon Area

The area is consisted of depositional plain, and the shape is eight km long and one km wide. The ground elevation falls within 120 to 135 meters above the mean sea level with a flat slope of less than three percent.

The area is composed of diluvial formations like Huai Nong Kho area. The surface soils are gray-brown or brown laterite soils with a depth of one to two m. The mountainous lands are consisted of sedimentary rocks. Alluvial formation is slightly found along streams.

### ④ Khlong Sai Area

The area is consisted of depositional plain, and is in the shape of eight km long and one km wide along Sai river. The ground elevation ranges from 140 to 170 meters above the mean sea level with a gentle slope of zero to three percent.

The area is composed of diluvial formations like Huai Nong Kho area. The surface soils are very heterogeneous including reddish to brown lateritic soils, red to brown soils, low humic gley soils and others with a depth of one to two m. Alluvial formation is slightly found along streams.

## VI-2-2 Soils and Land Classification

### (1) Soils

Based on the detailed reconnaissance soil maps prepared by the Department of Land Development, the RTSD topographic maps, and the topographic maps of the model areas, soil investigation was carried out during the period of January to February 1991 through observation of soil profiles and analysis of soil samples. General soil feature are explained as follows:

#### ① Huai Sam Ru Area

Topography of proposed irrigation area is undulating highland with nearly flat lands lying in between. The area tilts eastwards. Soils are derived from sandstone. The highland soils are very deep, medium-texture mainly

sandy loam over sandy clay loam with well drainage. Soil reaction is strongly acid with pH 5.0. Laterite may expose to the surface but in very limited coverage. Cassava is the main crop currently cultivated on these soils. The lowland area normally used for rice growing consists of very deep, silt loam over silty clay loam soils. Drainage is moderately well to somewhat poorly drained with grayish brown to brown matrix and yellowish red mottles. Soil reaction is strongly acid to very strongly acid with pH ranging from 4.5 to 5.5.

#### ② Huai Nong Kho Area

There are two sites namely upper site and lower site. The upper site is situated in the valley of Khao Lan, Ban Wang Takian. Topography is nearly flat valley bottom bounded by foothill. Soils are derived from sandstone and alluvial deposits. The foothill area comprises rather shallow soils with sandstone fragments and gravels. The upper valley bottom consists of well drained, medium to fine texture upland soils which are good for upland crop and orchard. The lower site situated along Khlong Sa Ket is generally flat. Most soils are clayey suitable for paddy and irrigation development. Those along Khlong Sa Ket are well drained medium textured upland soils.

#### ③ Khlong Samo Khong Area

Topography is nearly flat along Samo Khon river which flows from north to south and bounded by highlands in the east and west. Soils in the proposed irrigation area is the recent alluvial deposits. In the northern portion of the stream valley, down stream from the proposed dam site around Ban Nam Dip Ma Praw, the soils are very deep stratified sandy to loamy textures. In the middle part, the topography becomes flat valley bottom consisting of paddy soils having stratified textures of loamy to clayey underlain by sand. Groundwater falls approximately 100 cm. The southernmost around Ban Samo Khon, the flat area become wider. Soils are very deep clayey texture best suited for paddy. Upland soils on the east are sandy to coarse loamy with laterite sheets exposing to the surface.

#### ④ Khlong Sai Area

The area is located in Amphoe Muang Tak, along the rivers of Sai and Pradang, tributaries of the Ping river. Topography of the site is undulating to

rolling on the north and gentle undulating on the south tilting eastwardly. Soils are mainly derived from granitic rock forming the sandy soils poorly suited for crop cultivation. The area along main stream consists of non-calcic brown soils good for orchard, vegetable and also widerange of upland crops. Paddy soils are recognized only in a limited extent in the east close to Ban Takian Duan and Ban Lat Yao.

## (2) Land Classification

For effective land use planning, soil suitability for specific use is essential. In this section, the suitability of soils is identified for paddy (P), non-flooded annual crop (N), fruit tree plantation (F), and for pasture or rangeland livestock farming (L).

Soil Suitability Class: Principally, there are five classes follows:

- |                                 |   |   |
|---------------------------------|---|---|
| Class I (P-I, N-I, F-I)         | : | Soils very well suited having no significant limitations.   |
| Class II (P-II, N-II, F-II)     | : | Soils well suited having slight limitations.  |
| Class III (P-III, N-III, F-III) | : | Soils moderately suited having moderate limitations that require special management.                              |
| Class IV (P-IV, N-IV, F-IV)     | : | Soils poorly suited having severe limitations that require very careful management.                               |
| Class V (P-V, N-V, F-V)         | : | Soils not suited having very severe limitations that preclude their use for crop production with ordinary method. |

Soil suitability for pasture or rangeland livestock farming is classified as Class L-I (well suited), Class L-II (porrly suited) and Class L-III (not suited). Results of land classification of the model area are summarized as follows:

**FARM LAND CLASSIFICATION**

- Unit: ha -

<u>Farm Land</u>	<u>Land Class</u>	<u>Huai Sam Ru</u>	<u>Huai Nong Kho</u>	<u>Khlong Samo Khon</u>	<u>Khlong Sai</u>
Paddy Field	I, II, III	107	336	110	15
	IV, V	-	17	34	42
Upland Crop Field	I, II, III	695	145	17	158
	IV, V	32	57	13	80
Orchard	I, II, III	40	24	3	29
	IV, V	10	15	2	1
Pasture	I, II,	244	21	19	164
	III	2	9	2	-
<b>Total</b>		<b>1,130</b>	<b>624</b>	<b>200</b>	<b>489</b>

**VI-3 HYDROLOGY**

**VI-3-1 Rainfall**

Annual amounts of rainfall at three areas of Huai Sam Ru in Phitsanulok province, Huai Nong Kho in Sukhothai province, and Kholong Samo Khon in Kamphaeng Phet provinces fall within the almost same range as 1,275 mm, 1,126 mm and 1,179 mm, respectively. The annual rainfall in Khlong Sai area in the east Tak is relatively small as 939 mm, while it amounts to 1,567 mm in the west Tak (refer to Table II-2). About 50 percent of annual rainfall concentrates in three months during the rainy season: however, it falls in July to September in Phitsanulok province, July to September or August to October in Sukhothai province, and August to October in Kamphaeng Phet province and the east Tak.

For the introduction of dry season cropping, irrigation is indispensable. Even in the rainy season where about 90 percent of rain fall, problems arise from yearly fluctuation of rainfall, delay in start of rainy season and consecutive dry days.



### VI-3-2 River Runoff

The river runoff at the proposed damsites are estimated basing on the records observed at the existing hydrological gaging stations nearby the proposed damsites. The river runoff rapidly decrease in December, being affected by the rainfall pattern. Runoff was observed at two sites of Huai Sam Ru and Khlong Sai where catchment areas are covered with forest, in the months of February to April while there was no river runoff at the sites of Huai Nong Kho and Khlong Samo Khon. The estimated average annual runoff is given below:

Model Area	Catchment Area (sq.km)	Annual Rainfall (mm)	Annual Runoff (mm)	Runoff Coefficient (%)	Gaging Station	
					Code No.	Observation
Huai Sam Ru	28	1,275	395	31	N-36	1968 - '88
Huai Nong Kho	34	1,126	152	13	Y-26	1979 - '88
Khlong Samo Khon	13	1,179	151	13	Y-26	1979 - '88
Khlong Sai	47	939	403	43	P-26a	1972 - '88

### VI-4 LAND USE AND MAJOR CROPS

The land use survey is based on map analysis of the model areas together with the aerial photographs and field reconnaissance. Out of the total project area of 2,950 ha, 2,443 ha, or equivalent to 83 percent of the total project area, are classified as farm lands. In three model areas except Khlong Samo Khon area in Kamphaeng Phet province, cultivation of upland crops and tree crops are dominant. Present farm land use is given as follows;

Farm Land	PRESENT FARM LAND USE				Total	%
	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai		
Paddy Field	107	353	144	57	661	(27)
Upland Crop Field	727	202	30	238	1,197	(49)
Orchard	50	39	5	30	124	( 5)
Fallow Land	246	30	21	164	461	(19)
Total	1,130	624	200	489	2,443	(100)

Major crops prevailing in the areas are rainy season paddy in paddy fields, but no second cropping, and maize, mungbean, soybean and groundnut

in upland crop fields. Cassava and sugarcane are cropped in Sam Ru area and Khlong Samo Khon area, respectively. Vegetables are grown on a small scale around villages. Mango and banana are main fruits grown in the areas.

Yields and harvested area are yearly fluctuated because of unstable rainfall, floods, disease, lack of soil moisture and so on. Average yields of main crops are estimated for a study purpose by analyzing the recent 3-year records on cropped area, harvested area and production prepared by the Amphoe office of Nakhon Thai and Ban Dan Lan Hoi, the Department of Agricultural Extension. As a result, the following average yields per cropped area are estimated.

**AVERAGE YIELD OF MAJOR CROPS**

- Unit : ton / ha -

Crops	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Rainy Season Paddy	1.49	1.84	1.68	1.98
Maize	1.73	1.64	1.25	1.26
Soybean	0.97	0.85	0.96	1.20
Mungbean	0.71	0.78	1.38	0.35
Groundnut	1.86	0.91	0.91	1.31
Sugarcane	43.5	43.5	43.5	43.5
Mango	3.13	3.13	3.13	3.13
Banana	-	-	-	12.5

## VI-5 BACKWARD VILLAGES

### VI-5-1 List of Backward Villages

Of 13 villages involved in the model projects, eight villages are classified as backward villages. The present development levels of the backward villages are grasped from the NESDB data base in order to clarify the problems villagers confronted and needs for development. The backward villages are listed as follows:

**LIST OF BACKWARD VILLAGES**

<u>Model Area</u>	<u>Tambon</u>	<u>Village</u>	<u>NESDB Code</u>
Huai Sam Ru	Nong Katoa	Kaeng Wa	030708
	-do-	Kaeng Hai	030711
	Bang Yaeng	Sam Ru	030610
Huai Nong Kho	Wang Nam Khaw	Wang Phong	050408
	-do-	Lan Thong	070406
Khlung Samo Khon	Tha Mai	Samo Khon	040501
	-do-	Nam Dip Ma Praw	040506
Khlung Sai	Chung Thong	Wang Tamlung	010509

**VI-5-2 Population and Households**

All villages involved in two model projects of Huai Sam Ru and Khlung Samo Khon are the backward villages, and 73 percent households in Huai Nong Kho area and nine percent households in Khlung Sai area are making livelihood in the backward villages. Total population of 6,376 persons, or 1,357 households would enjoy the benefits to be generated with the implementation of the model projects, as summarized below:

**POPULATION AND HOUSEHOLDS OF BACKWARD VILLAGES**

<u>Model Area</u>	<u>Population</u>	<u>Household</u>	<u>Family Member</u>
Huai Sam Ru	2,182 (100%)	504 (100%)	4.3
Huai Nong Kho	2,622 ( 76%)	552 ( 73%)	4.8
Khlung Samo Khon	1,080 (100%)	231 (100%)	4.7
Khlung Sai	392 ( 11%)	70 ( 9%)	5.6
Total	6,276 ( 62%)	1,357 ( 60%)	4.6

Note: ( ) shows the ratio to the total area.

**VI-5-3 Income Indicator**

The average annual income per capita is calculated as discussed in Chapter III (refer to Table VI-4). Excepting Lan Thong village in Huai Nong Kha area where the average annual income per capita is 11,405 Baht, higher than the provincial average, the average annual income in all the backward

villages ranges from 1,732 to 7,031 Baht being less than the average of provinces concerned. The lowest is 1,732 Baht of Wang Thumlung village in Khlong Sai area.

Table VI-6 gives the income by source and is summarized as under:

- Income in Huai Sam Ru area in Phitsanulok province largely relies on upland crop farming,
- Two areas of Huai Nong Kho in Sukhothai province and Khlong Samo Khon in Khampaeng Phet province have income mainly from paddy cropping,
- The peoples in Khlong Sai area in Tak province earn their income from both paddy and upland crop farming,
- All villages except Sam Ru village in Huai Sam Ru area have income from livestock: however, as low as 21 to 138 Baht, and
- No income from orchard, vegetables and fisheries is reported.

#### **VI-5-4 Quality of Life Indicator**

The quality of life indicator is given in Table VI-5 showing dissatisfaction ratio expressed in percentage at the NESDB 32 items, as discussed in Chapter III. The dissatisfaction ratio exceeds 50 percent at all the backward villages, being higher than the provincial average. At three backward villages in Huai Sam Ru area, the dissatisfaction ratios are as high as 67.6 to 70.6 percent, while the provincial average of Phitsanulok is 44.1 percent.

#### **VI-5-5 Social Infrastructure**

##### **(1) Roads and Transportation**

For the model areas, rural trunkroads function as both the Amphoe road and market road as market centers are located in the village where Amphoe office is seated. All the model areas are linked with the Amphoe office

through the road networks of national highways and ARD roads: however, some roads are impassable in the rainy season. Table VI-7 shows the general information on public transportation. Public bus transportation is available at 2 model areas of Huai Sam Ru and Khlong Sai: however, in the rainy season it is not available for 2 backward villages of Kaeng Wa and Kaeng Hai in Huai Sam Ru area due to impassability of some rural trunkroads.

## (2) Drinking Water Supply

Drinking water supply for the eight backward villages is presented in Table VI-8. Excepting Khlong Sai area where 45 percent households are equipped with pipelines, all households of the backward villages make use of rain and groundwater for their drinking. Only three backward villages have deep wells. The general situation is summarized as follows:

- Huai Sam Ru area has shallow wells and deep wells, and 75 to 82 percent households are satisfied with the minimum water of two  $\ell$ /day per capita,
- In Huai Nong Kho area, no household is satisfied with the present water supply at Wang Pong village,
- There is no deep well in Khlong Samo Khon area in Kamphaeng Phet province: however, it is reported that 100 percent households at Nam Dip Ma village are satisfied with the present water supply and 50 percent households at Samo Khon village, and
- Pipeline systems are equipped in Khlong Sai area in Tak province; however, no household is satisfied with the present water supply.

## (3) Rural Electrification

The present situation of electrification is given on Table VI-9. Out of eight backward villages, at four backward villages 40 to 66 percent households are electrified, at two backward villages rural electrification is being undertaken by the Provincial Electricity Authority, and at two backward villages of Kaeng Hai in Huai Sam Ru area and Nam Dip Ma Praw in Khlong Samo Khon area electrification is not yet started. The distance of 22 KV

transmission line required for electrification is two km for Kaeg Hai village and four km for Nam Dip Ma Praw village. Television has spread throughout the backward areas as much as 0.8 to 1.0 set per households on an average.

#### **VI-5-6 Public Services**

##### **(1) Education**

There is no primary school at six backward villages except Kaneg Hai village in Huai Sam Ru area and Wang Phong village in Huai Nong Kho area. The average hours required for going to school is less than the national standard of 45 minutes. Table VI-10 gives the information on education. 60 to 85 percent of adults have finished their compulsory education. The adult literacy rate exceeds 90 percent at all the backward villages and two mode areas of Huai Nong Kho in Sukhothai province and Khlong Sai area in Tak province have attained 100 percent of the adult literacy rate. The average frequency of training per person is less than one time a year at all the backward villages: 0.3 times at three backward villages and no training in Tak province.

##### **(2) Public Health**

No hospital is established at the backward villages. The general situation on public health is presented in Table VI-11. The implementation rate of survey on nutritive condition of one to five years old children is as low as two percent at Wang Tamlung village and 10 to 15 percent at six backward villages, excepting Nam Rip Ma Praw village with the rate of 40 percent, which reflect on the malnutrition rates of the backward villages except Lan Thong village. The rates of family planning and vaccination are as low as less than 20 percent. The NESDB standards of the progressive village are more than 70 percent for family planning and more than 90 percent for vaccination.

#### **V-5-7 Rice Mills and Storage Facilities**

There is no rice mill nor storage facilities operated by agricultural cooperatives or merchants. Small scale rice mills with a capacity of one to four ton/day are in operation: 11 rice mills in Huai Sam Ru area, five rice mills in Huai Nong Kho area, eight rice mills in Khlong Sarno Khon area and only one rice mill in Khlong Sai area, totaling 25 rice mills.

Price makers of paddy in the model areas are generally local merchants since farmers have poor access to markets. Surveys of paddy prices at the model areas reveal that the difference between farm gate price and market price is 540 to 620 Baht per ton as given below:

<b>PRICE OF PADDY</b>			
- Unit: Baht/ton -			
<u>Model Area</u>	<u>Market</u>	<u>Market Price</u>	<u>Farm Gate Price</u>
Huai Sam Ru	Nakhon Thai	4,190	3,650
Huai Nong Kho	Ban Dan Lon Hoi	4,150	3,550
Khlong Samo Khon	Phran Krathai	4,150	3,530
Khlong Sai	Muang Tak	4,000	3,450

## **VI-6 AGRO-SOCIO-ECONOMIC CONDITION**

In order to grasp a general situation of the model project areas, a sample survey for farmers in the related villages to the areas was conducted. While selection of villages to be surveyed was made on the basis of the topographic maps with a scale of 1/50,000 at the last part of the field works in Phase (1), interview works were carried out by mainly ARD's counterpart staff during the transition period between Phase (1) and Phase (2). Farmers to be surveyed were sampled by ARD's counterpart, putting more emphasis on the backward villages and taking into consideration total number of household in the selected villages, the work schedule, an accessibility to sampled farmer, and so on. The result of the survey is briefly described in the following, of which details are given in Appendix I-2.

### **VI-6-1 General Information on Household**

Table VI-12 summarizes general information on household in each model project areas. The specific remarks on this item are as follows:

- An average household size in Khlong Sai areas is 6.2, which exceeds considerably approximate 5.0 in the other three areas.
- Concerning average age of household head, Huai Nong Kho area shows the highest of 48.9 years old and Khlong Sai area does the

lowest of 42.4 years old, averaging about 46 years old in the four areas.

In connection with age composition, the young generation aged below 20 years old occupies about 54 percent in Khlong Sai area which is bigger than approximate 40 percent in the other three areas. On the contrary, the youth to manhood generation aged between 21 to 60 years old does 44 percent in Khlong Sai area, which is lower than approximate 55 percent in the other areas.

As for a percentage of employment on farm labor, Khlong Sai area shows around 60 percent which is lower than about 70 percent in the other three areas. This is explainable by the limited employment opportunity for farming in Changwat Tak, which is revealed by the result of hearing to farmers representatives. The rate of full time worker is brought by Huai Nong Kho area with the highest of 62 percent.

An average literacy rate including read ability only is around 80 percent in the four areas, showing the highest of 92 percent in Khlong Samo Khon area, followed by Huai Nong Kho area with 85 percent, Huai Sam Ru area with 82 percent and Khlong Sai area with 65 percent.

While only 14 percent belong to a category of Christian in Khlong Sai area, the others are all budhist.

About 70 percent of total household in the four areas have transmigrated to the present residence, indicating the highest of 90 percent in Huai Nong Kho area and the lowest of 50 percent in Khlong Samo Khon area. An average of year living in the present villages is around 20 in Khlong Samo Khon area, 14 in Huai Nong Kho area and 17 in whole four areas.

#### **VI-6-2 Diffusion Rate of Farm Machinery and Equipment**

Figure VI-1 illustrates diffusion rate of hand tractors, irrigation pumps, sprayers and carts as an agricultural machinery, and bicycles,



motorcycles, pick-up trucks, radios, radios with cassette recorder, T.V. (black and white, and color) and refrigerators as durable goods.

### VI-6-3 General Condition on Agriculture

Table VI-13 summarizes general information on agricultural condition in each areas, based on which some specific remarks are given below.

- An average farm management size in Khlong Samo Khon area is relatively small as about 1.75 ha (11 rais), on the other hand, those of other three areas are ranging from 3.04 ha (19 rais) to 3.62 ha (23 rais).
- A cropping intensity in Khlong Sai area is as high as 137 percent, followed by Huai Sam Ru area with 123 percent, Huai Nong Kho area with 108 percent and Khlong Samo Khon area with lowest 96 percent.
- Average yield of paddy, mungbean, maize, cassava, etc., under harvested area basis in the four areas are a little lower than the national averages. Paddy yield in Khlong Samo Khon area shows the highest of 2.3 tons/ha, and the lowest of 1.4 tons/ha in Huai Nong Kho area.
- In connection with cash income per farm arising from crop cultivation, while Huai Sam Ru area shows the highest of about 9,000 Baht, followed by about 7,700 Baht in Khlong Sai area, Huai Nong Kho area shows only 408 Baht and Khlong Samo Khon area does a deficit of 440 Baht. This is the reason why the crop yields are relatively low in the former area, and the farm management area is rather small and also cropping intensity is low in the latter area.
- Regarding cash income arising from livestock breeding, Huai Nong Kho area gains the highest of around 5,000 Baht per farm, followed by about 2,500 Baht in both Khlong Samo Khon and Khlong Sai areas, and only 350 Baht in Huai Sam Ru area. The reason is that while average number of cattle and buffalo to be fed

in Huai Sam Ru area is below one, that is over 2.3 in the other three area.

- While a household cash expenditure in the other three areas is ranging from about 11,000 to 12,500 Baht, that of Khlong Sai area indicates rather high value of about 17,000 Baht. This is understandable by the reason that the average size of household in Khlong Sai area is the highest of 6.2 among the four areas, in comparison with about 5.0 in the four areas, on the average.

**TABLE VI-1 POPULATION AND HOUSEHOLD**

<u>Village</u>	<u>Population</u>	<u>Household</u>	<u>Family Size</u>
<b>Huai Sam Ru Area</b>			
- Kaeng Wa	1,037	245	4.23
- Kaeng Hai	399	95	4.20
- Sam Ru	746	164	4.55
Sub-total	2,182	504	4.33
<b>Huai Nong Kho Area</b>			
- Wang Phong	1,468	281	5.22
- Lan Thong	1,154	271	4.26
- Huai Khrai	288	61	4.72
- Phu Thong	548	139	3.94
Sub-tota	3,458	752	4.60
<b>Khlong Samo Khon Area</b>			
- Samo Khon	490	86	5.70
- Nam Dip Ma Praw	590	145	4.07
Sub-total	1,080	231	4.68
<b>Khlong Sai Area</b>			
- Wang Tamlung	392	70	5.60
- Na Bot	1,690	411	4.11
- Lat Yao	1,025	229	4.48
- Takhian Ngam	318	75	4.24
Sub-total	3,425	785	4.36
<b>Total</b>	<b>10,145</b>	<b>2,272</b>	<b>4.47</b>

**TABLE VI-2 CROPPED AREA AND YIELD (Amphoe Nakhon Thia)**

Crop Year	① Cropped Area (rai)	Harvested Area (rai)	② Production (ton)	②/① : Average Yield (kg/rai)
<b>[Rainy Season Paddy]</b>				
1987/'88	32,101	26,028	8,849	276
1988/'89	20,458	12,837	4,493	220
1989/'90	34,626	24,301	7,533	218
<u>Average</u>	<u>29,062</u>	<u>21,055</u>	<u>6,958</u>	<u>239</u>
<b>[ Maize ]</b>				
1987/'88	124,327	66,368	21,238	171
1988/'89	88,190	74,132	26,465	300
1989/'90	126,117	126,117	45,654	362
<u>Average</u>	<u>112,878</u>	<u>88,872</u>	<u>31,119</u>	<u>276</u>

**TABLE VI-3 CROPPED AREA AND YIELD (Amphoe Ban Dan Lan Hoi)**

Crop Year	① Cropped Area (rai)	Harvested Area (rai)	② Production (ton)	②/① : Average Yield (kg/rai)
<b>[Rainy Season Paddy]</b>				
1987/'88	53,535	19,318	6,955	130
1988/'89	67,116	67,116	23,491	350
1989/'90	81,774	81,774	29,112	356
<u>Average</u>	<u>67,475</u>	<u>56,069</u>	<u>19,853</u>	<u>294</u>
<b>[ Maize ]</b>				
1987/'88	15,735	620	198	13
1988/'89	19,243	18,922	6,623	344
1989/'90	20,755	20,755	7,762	374
<u>Average</u>	<u>18,578</u>	<u>13,432</u>	<u>4,861</u>	<u>262</u>
<b>[Soybean : Rainy Season]</b>				
1987/'88	8,882	1,266	203	23
1988/'89	8,865	8,865	1,773	200
1989/'90	6,050	6,050	1,271	210
<u>Average</u>	<u>7,932</u>	<u>5,394</u>	<u>1,082</u>	<u>136</u>
<b>[Mungbean : Rainy Season]</b>				
1987/'88	2,720	2,720	462	170
1988/'89	10,842	4,565	708	65
1989/'90	13,415	13,415	2,173	162
<u>Average</u>	<u>8,992</u>	<u>6,900</u>	<u>1,114</u>	<u>124</u>
<b>[Sesame]</b>				
1987/'88	9,281	1,008	111	12
1988/'89	9,295	9,295	837	90
1989/'90	9,582	9,582	805	84
<u>Average</u>	<u>9,386</u>	<u>6,628</u>	<u>584</u>	<u>62</u>
<b>[Groundnut]</b>				
1987/'88	421	215	39	93
1988/'89	107	107	24	224
1989/'90	90	90	28	311
<u>Average</u>	<u>206</u>	<u>137</u>	<u>30</u>	<u>146</u>
<b>[Cotton]</b>				
1987/'88	12,884	12,884	2,319	180
1988/'89	21,096	15,024	3,005	142
1989/'90	24,354	24,354	5,212	214
<u>Average</u>	<u>19,445</u>	<u>17,421</u>	<u>3,512</u>	<u>181</u>

**TABLE VI-4 INCOME INDICATOR OF BACKWARD VILLAGES**

<u>Model Area</u>	<u>Backward Village</u>	<u>Income Indicator</u> <u>(฿/year/person)</u>	<u>Income Level</u> <u>(Provincial Ave. = 100)</u>
Huai Sam Ru	Kaeng Wa	3,970	49
	Kaeng Hai	7,031	88
	Sam Ru	4,030	50
Huai Nong Kho	Wang Phong	6,651	84
	Lan Thong	11,405	144
Khlung Samo Khon	Samo Khon	4,100	42
	Nam Dip Ma Praw	5,869	61
Khlung Sai	Wang Tamlung	1,732	64

**TABLE VI-5 QUALITY OF LIFE INDICATOR OF BACKWARD VILLAGE**

<u>Model Area</u>	<u>Backward Villages</u>	<u>Quality of Life Indicator (%)</u>
Huai Sam Ru	Kaeng Wa	70.6
	Kaeng Hai	79.4
	Sam Ru	67.6
Huai Nong Kho	Wang Phong	55.9
	Lan Thong	55.9
Khlung Samo Khon	Samo Khon	64.7
	Nam Dip Ma Praw	52.9
Khlung Sai	Wang Tamlung	58.8

TABLE VI-6 INCOME BY SOURCE OF BACKWARD VILLAGE

- Unit: Baht -

Backward Village	Paddy	Upland Crop	Livestock	Sub-total	Hand Craft	Wage	Sub-total	Total
Huai Sam Ru Area								
- Kaeng Wa	371	3,531	25	3,927	-	43	43	3,970
- Kaeng Hai	130	6,495	21	6,646	-	385	385	7,031
- Sam Ru	95	3,912	-	4,007	-	23	23	4,030
Huai Nong Kho Area								
- Wang Phong	6,623	-	28	6,651	-	-	-	6,651
- Lan Thong	10,125	453	827	11,405	-	-	-	11,405
Khlong Samo Khon Area								
- Samo Khon	3,173	387	353	3,913	99	88	187	4,100
- Nam Dip Ma Praw	4,541	964	280	5,785	8	76	84	5,869
Khlong Sai Area								
- Wang Tamlung	953	641	138	1,732	-	-	-	1,732

**TABLE VI-7 PUBLIC TRANSPORTATION**

<u>Backward Village</u>	<u>Frequency of Bus Service</u> (per day)	<u>Frequency of Pick-up Service</u> (per day)	<u>Availability of Rainy Season Services</u>
<b>Huai Sam Ru Area</b>			
- Kaeng Wa	-	-	No
- Kaeng Hai	-	-	No
- Sam Ru	10 time	10 time	Yes
<b>Huai Nong Kho Area</b>			
- Wang Phong	-	1 time	Yes
- Lan Thong	-	1 time	Yes
<b>Khlong Samo Khon Area</b>			
- Samo Khon	-	2 time	Yes
- Nam Dip Ma Praw	-	2 time	Yes
<b>Khlong Sai Area</b>			
- Wang Tamlung	10 time	10 time	Yes

**TABLE VI-8 DRINKING WATER SUPPLY**

<u>Backward Village</u>	<u>Nos. of Shallow Wells per 1,000 Persons</u>	<u>Nos. of Deep Wells per 1,000 Persons</u>	<u>Rate of Households with Pipeline (%)</u>	<u>Rate of Satisfied Households (%)</u>
<b>Huai Sam Ru Area</b>				
- Kaeng Wa	6.8	-	-	82.1
- Kaeng Hai	4.7	-	-	88.0
- Sam Ru	-	2.8	-	75.0
<b>Huai Nong Kho Area</b>				
- Wang Phong	13.9	3.5	-	-
- Lan Thong	11.8	-	-	39.6
<b>Khlong Samo Khon Area</b>				
- Samo Khon	11.0	-	-	50.0
- Nam Dip Ma Praw	5.7	-	-	100.0
<b>Khlong Sai Area</b>				
- Wang Tamlung	7.7	5.1	45.0	-

**TABLE VI-9 RURAL ELECTRIFICATION**

<u>Model Area</u>	<u>Backward Village</u>	<u>Availability of Electricity</u>	<u>Electrification(%)</u>
Huai Sam Ru	Kaeng Wa	Yes	66.0
	Kaeng Hai	No	
	Sam Ru	Yes	39.9
Huai Nong Kho	Wang Phong	No 1/	
	Lan Thong	No 1/	
Khlung Samo Khon	Samo Khon	Yes	63.2
	Nam Dip Ma Praw	No	
Khlung Sai	Wang Tamlung	Yes	57.5

Note: 1/ : Under construction as of 1991

**TABLE VI-10 EDUCATION AND TRAINING**

<u>Backward Village</u>	<u>Rate of Finishing</u>		<u>Annual Frequency of Training per Person</u>
	<u>Compulsory Education (%)</u>	<u>Adult Literacy (%)</u>	
<b>Huai Sam Ru Area</b>			
- Kaeng Wa	57.4	96.6	0.1
- Kaeng Hai	61.5	92.1	0.5
- Sam Ru	59.9	93.4	0.1
<b>Huai Nong Kho Area</b>			
- Wang Phong	86.8	100	0.3
- Lan Thong	81.9	100	0.1
<b>Khlung Samo Khon Area</b>			
- Samo Khon	77.3	97.6	0.6
- Nam Dip Ma Praw	61.1	99.1	0.5
<b>Khlung Sai Area</b>			
- Wang Tamlung	78.3	100	



TABLE VI-11 PUBLIC HEALTH

Backward Villages	Survey of Nutrition 1-5 Years Old Children (%)		Malnutrition 1-5 Year Old Children (%)	Family Planning (%)	Vaccination (%)		
	Years Old Children	Old Children			Pregnant Woman	0-1 Years Old Children	5-14 Years Old Children
<b>Huai Sam Ru Area</b>							
- Kaeng Wa	20	33.3	5	5	15	-	-
- Kaeng Hai	25	46.6	10	10	20	-	-
- Sam Ru	10	26.0	15	25	10	10	10
<b>Huai Nong Kho Area</b>							
- Wang Phong	10	10.5	10	10	10	-	-
- Lan Thong	20	0.0	20	20	10	-	-
<b>Khlong Samo Khon Ara</b>							
- Samo Khon	20	100.0	-	15	10	10	10
- Nam Dip Ma Praw	40	11.1	14	10	24	2	2
<b>Khlong Sai Area</b>							
- Wang Tamtung	2	15.5	3	13	-	-	-

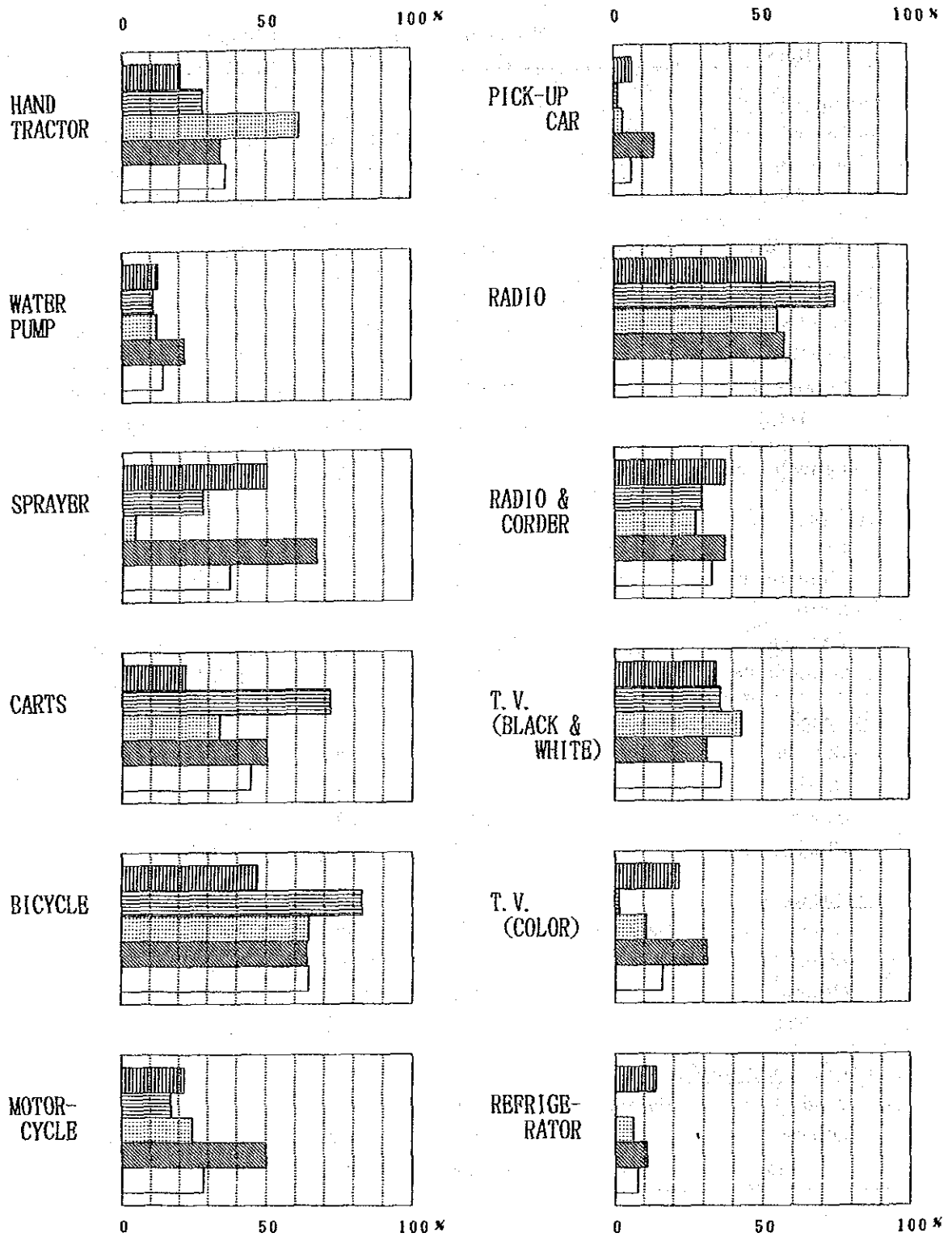
TABLE VI-12 FARM HOUSEHOLD INFORMATION

Group Composition	Model Project Areas				Grand Total
	Huai Sam Ru (PSN)	Huai Nong Kho (SKT)	Khlong Samo Khon (KPP)	Khlong Sai (TAK)	
No. of Farms	64.0	64.0	65.0	64.0	257.0
No. of Members	301.0	321.0	306.0	399.0	1,327.0
Household Size	4.7	5.0	4.7	6.2	5.2
Ave. Age of Head of Household (Yrs.)	45.3	48.9	46.3	42.4	45.7
AGE COMPOSITION (%)					
1 to 10 Years	20.9	17.1	13.1	29.3	20.7
11 to 15 Years	8.3	10.6	10.8	13.0	10.9
16 to 20 Years	10.0	13.4	16.0	11.3	12.6
21 to 60 Years	57.1	53.0	55.9	43.6	51.8
61 to 66 Years	2.0	1.9	2.0	1.0	1.7
Above 66 Years	1.7	4.0	2.3	1.8	2.4
Total	100.0	100.0	100.0	100.0	100.0
FARM LABOUR STATUS(%)					
Total Available	71.8	70.4	75.2	58.4	68.2
- Full Time	57.5	62.0	58.8	50.1	56.7
- Part Time	14.3	8.4	16.3	8.3	11.5
Not Active	28.2	29.6	24.8	41.6	31.8
Total	100.0	100.0	100.0	100.0	100.0
STATUS OF LITERACY(%)					
Read Only	4.7	3.7	.3	1.8	2.6
Literacy	77.1	81.3	91.2	62.9	77.1
Illiteracy	18.3	15.0	8.5	35.3	20.3
Total	100.0	100.0	100.0	100.0	100.0
STATUS OF RELIGION(%)					
Buddhism	100.0	100.0	100.0	86.0	95.8
Islam	.0	.0	.0	.0	.0
Christian	.0	.0	.0	14.0	4.2
Others	.0	.0	.0	.0	.0
Total	100.0	100.0	100.0	100.0	100.0
No. of Farms Migrate	46.0	57.0	33.0	46.0	182.0
% of Farms Migrate	71.9	89.1	50.8	71.9	70.8
Av. Year lived in the Village	15.7	14.4	19.4	18.2	16.6

TABLE VI-13 AGRICULTURAL INFORMATION

Item	Unit	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
<u>Farming Land</u>						
- Owned	rai	1,335.25	1,287.50	649.50	1,136.00	4,408.25
- Rented	"	111.00	110.00	62.00	81.00	364.00
Total	"	1,446.25	1,397.50	711.50	1,217.00	4,772.25
<hr/>						
Av. Farm Size	rai	22.60	21.84	10.95	19.02	18.57
<hr/>						
<u>Cropped Area</u>						
- Wet Season	rai	1,142.50	1,345.50	641.00	1,145.00	4,274.00
- Dry Season	"	412.50	164.75	18.00	433.50	1,028.75
- Perennial	"	227.75	-	21.50	48.00	297.25
Total	"	1,782.75	1,510.25	680.50	1,626.50	5,600.00
<hr/>						
Cropping Intensity	%	123	108	96	137	117
<hr/>						
<u>Av. Crop Yield</u>						
- Rice	kg/rai	342.9	219.3	371.5	335.5	288.8
- Mung Bean	"	123.7	98.5	68.9	88.6	99.7
- Maize	"	338.8	-	267.5	469.1	378.3
- Cassava	"	1,693.3	-	2,367.3	3,200.0	1,717.1
- Groundnuts	"	214.6	-	145.2	186.6	205.0
<hr/>						
<u>Livestock</u>						
- Buffalo	head/farm	0.03	1.27	1.78	0.78	0.97
- Cattle	"	0.80	2.08	0.58	1.97	1.35
- Swine	"	0.30	0.91	0.26	2.25	0.93
- Chicken	"	6.27	5.67	7.08	8.89	6.98
<hr/>						
<u>Income (cash)</u>						
- Crop	Baht/farm	8,958	408	- 437	7,722	4,145
- Livestock	"	348	5,006	2,603	2,530	2,622
- Others	"	5,281	12,832	13,537	11,871	10,891
Total	"	14,587	18,246	15,703	22,123	17,658
<hr/>						
<u>H.H. Expenditure (Cash)</u>						
- Food	Baht/farm	5,506	5,682	5,332	7,790	6,075
- Others	"	7,018	6,689	5,634	9,063	7,095
Total	"	12,524	12,371	10,966	16,853	13,170

FIGURE VI-1 DIFFUSION RATE OF FARM IMPLEMENT AND EQUIPMENT



Legend

- |                      |                          |                            |
|----------------------|--------------------------|----------------------------|
| Huai Sam Ru (PSN)    | ≡≡≡ Huai Nong Kho (SKT)  | ⋯⋯⋯ Khlong Samo Khon (KPP) |
| ▨▨▨ Khlong Sai (TAK) | □ Total of 4 Model Areas |                            |

## **CHAPTER VII PLAN OF MODEL PROJECT**



## CHAPTER VII PLAN OF MODEL PROJECT

### VII-1 MODEL AREA AND PROJECT COMPONENT

As is discussed in Chapter V, four model areas are selected to demonstrate the implementation of the integrated rural development project at the Lower North Thailand, in due consideration of the present development levels, development possibility and so on. General information on the selected model areas are summarized as under:

#### GENERAL INFORMATION ON MODEL AREAS

Item	Huai Sam Ru	Huai Nong Kho	Khlung Samo Khon	Khlung Sai
1) Administrative Unit				
- Province	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak
- Amphoe	Nakhon Thai	Ban Dan Lan Hoi	Phran Kratai	Muang Tak
- Nos. of Villages	3	4	2	4
2) Population and Household				
- Population	2,182	3,458	1,080	3,425
- Household	504	752	231	785
3) Area (ha)				
- Gross Area	1,390	710	240	610
- Farm Land	1,130	624	200	489

The topographic maps (1 : 5,000 scale and 1.0 m contour intervals) of the model areas including the proposed dam and reservoir sites were prepared for the use of the feasibility study of model projects. The feasibility study is based on the results of various field survey and investigation such as water quality analysis, soil tests of embankment materials, soil analysis of farm land, test pits at damsites and sample survey of farmers.

The model project will be composed of ① irrigated agriculture development, ② rural road development, ③ rural water supply development, and ④ establishment of rural youth and agricultural technology training center, and promotion of cottage industries, all of which are implemented under the responsibility of the Office of Accelerated Rural development, as presented in Chapter V.

## VII-2 IRRIGATED AGRICULTURE DEVELOPMENT

### VII-2-1 Land Use Plan

The share of upland crop fields in the present farm land use is relatively high as 82 percent in Huai Sam Ru area, 73 percent in Khlong Sai area and 34 percent in Huai Nong Kha area, with the exception of Khlong Samo Khon area. According to the sample farmers survey, 22 to 36 percent of sample farmers have no paddy field, and in two areas of Huai Sam Ru and Khlong Sai, only eight percent of sample farmers have surplus paddy for sale as given under :

#### PADDY CROPPING OF SAMPLE FARM HOUSEHOLDS

- Unit: Nos. of Farm Households (%) -

<u>Model Area</u>	<u>No Paddy Cropping</u>	<u>Self-sufficiency</u>	<u>Surplus</u>	<u>Total</u>
Huai Sam Ru	23 (36)	36 (56)	5 ( 8)	64 (100)
Huai Nong Kho	14 (22)	19 (30)	31 (48)	64 (100)
Khlong Samo Khon	20 (31)	17 (26)	28 (43)	65 (100)
Khlong Sai	21 (33)	38 (59)	5 ( 8)	64 (100)

At the meetings with officials and villagers concerned, called during the study period, several representatives of villagers expressed their views that farmers would expand paddy cropping when irrigation water is secured with the implementation of the project. In consideration of the above-mentioned situation, this project has proposed to convert such farm lands as have suitability for paddy cultivation into paddy fields. In accordance with the land classification study, 180 ha of upland crop fields will be converted into paddy fields: 98 ha in Huai Sam Ru area, 31 ha in Huai Nong Kho area and 51 ha in Khlong Sai area.

Fallow lands will be turned to practical use by introducing irrigation as orchard or upland crop fields depending on their suitability of cropping. The proposed land use of the model areas is given as follows:



### PROPOSED LAND USE

- Unit: ha -

Land	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Paddy Field	187	355	131	103	776
Upland Crop Field	647	119	26	143	935
Orchard	188	100	22	144	454
Sub-total	1,022	574	179	390	2,165
Villages	53	11	12	57	133
Forest and Others	315	125	49	163	607
Sub-total	368	136	61	220	785
Total	1,390	710	240	610	2,950

## VII-2-2 Agricultural Development

### (1) Selection of Crops and Cropping Pattern

The proposed storage water is firstly used to stabilize rainy season paddy cropping, and in the dry season, water is supplied for irrigation of upland crops and vegetables as cash crop which will be introduced to about 40 percent of the project area. Leguminous crops are fundamentally recommendable for increasing soil fertility. The selection of crops is based on the policy of provincial DAE offices, marketability and farming practice in and around the model areas, as presented hereafter.

#### ① Huai Sam Ru Area

As the second crop to rainy season paddy, cultivation of groundnut and redbean are proposed to an area equivalent to 40 percent of paddy fields. Redbean is selected as Amphoe Nakhon Thai, the regional center, is known for its production of profitable redbean. Farmers in the project area have good access to the market and learning farm technique. In addition to the currently cropped maize, groundnut, soybean and mungbean, cultivation of redbean, vegetables and pasture for cattle raising is planned as well as mulberry and bamboo shoots for orchard development.

## ② Huai Nong Kho Area

To a 20 percent area of paddy fields, soybean, mungbean and groundnut are proposed as the second crop during the dry season. Maize, soybean and mungbean are being grown at upland crop fields, and additionally cultivation of sugarcane, groundnuts, vegetables and pasture is proposed. Major proposed tree crops are mango, tamarind and bamboo shoots.

## ③ Khlong Samo Khon Area

Soybean and mungbean are planned to be cropped to a 28 percent area of paddy fields during the dry season, after examination of water availability. In addition to the present upland crops of soybean and mungbean, this cropping plan proposes to grow sugarcane, vegetables and asparagus. An asparagus canning factory is in full operation in Kamphaeng Phet province where the model project is located and the factory has a plan to increase production of asparagus to meet the increasing demand by expanding cultivation area on a contract farming base with farmers.

## ④ Khlong Sai Area

Dry season cropping to paddy fields is not planned because of limited water availability. In the dry season water will be used for irrigation of sugarcane, vegetables and asparagus, in addition to the present cropped maize, soybean and mungbean, in the upland crop fields. The development plan includes cultivation of mulberry for sericulture promotion and pasture for cattle raising.

The proposed cropping patterns are illustrated on Figure VII-1 ~ 4.

## (2) Farming Technique

Paddy of high yielding variety will be transplanted, for which emphasis is placed on shallow planting with a density of 16 hills/sq.m and use of young vigorous seedlings of 25 - 30 days of age. For rich harvesting and substantial grains, appropriate fertilization, pest and insect control are practiced to prevent lodging with short stem and diseases, and timely drainage of residual water are enforced to grade up substantial grain and quality.

Plowing, harrowing and leveling for upland crop cultivation will be practiced by mechanized farming with a farm tractor (10 PS), cultivator, 2-row sowing machine with desk, knapsack sprayer, bean harvester and so on.

### (3) Yield Projection

Target yields are estimated in consideration of agricultural statistics available in and around the project areas, actual yields attained in irrigation areas and results of survey of sample farmers. The scale of the model projects is as small as 179 to 1,022 ha and the rural youth and agricultural technology training center is established with the implementation of the project, which may produce relatively high efficiency of agricultural extension services. Under the situations, the following target yields are projected to be attained five years after the completion of the model projects.

#### TARGET YIELDS

- Unit: kg/ha -

Crop	Yield	Crop	Yield
Paddy	4,000	Sugarcane	62,500
Maize	2,500	Vegetable	15,160
Soybean	1,875	Asparagus	6,000
Mungbean	1,125	Mango	15,625
Redbean	1,500	Bamboo Shoots	8,200
Groundnut	1,875	Cocoon	300

### (4) Sericulture

Among fallow lands, 128 ha of lands will be converted into mulberry fields according to the results of land classification. For promotion of sericulture, farmers' groups will be organized to work together in production of cocoon. One member has 0.8 ha of mulberry fields, and a sericulture farmers' group jointly manages 16 ha of mulberry fields, in case of a standard group organized by 20 members, and a cooperative rearing house for silkworms.

#### SERICULTURE PROMOTION PROGRAM

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Nos. of Groups	2	1	1	3	7
Nos. of Members	40	30	20	70	160
Mulberry Field (ha)	32	24	16	56	128
Nos. of Working House	2	1	1	3	7

#### (5) Cattle Raising

130 ha of pasture lands will be developed from the fallow lands with land leveling works and provision of water places and fences in three model areas of Huai Sam Ru, Huai Nong Kho, and Khlong Sai. Farmers' groups jointly manage pasture lands and grazing. The promotion plan of cattle raising is summarized as follows:

#### CATTLE RAISING PROMOTION PROGRAM

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Nos. of Groups	2	1	-	1	4
Nos. of Members	76	36	-	16	128
Pasture Land (ha)	77	37	-	16	130
Nos. of Cattle	190	90	-	40	320

#### (6) Inland Fisheries

Site selection of small swamps with moderate catchment area and water depth of two to three m is based on the topographic maps (1 : 5,000 scale and 1.0 m contour intervals) of the project areas, and as a result four small swamps are proposed to be rehabilitated for inland fisheries development purpose with the construction of dikes and water control facilities, as outlined as below:

#### INLAND FISHERIES PROMOTION PROGRAM

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Water Surface (ha)	3.70	1.88	3.13	5.30	14.01
length of Dikes (m)	80	15	65	180	-

### VII-2-3 Irrigation Development

#### (1) Water Resources

River flows into the proposed reservoirs are estimated based on the records observed at hydrological gaging stations located nearby the model project areas as stated in Chapter V. The followings present the estimated river flows into the proposed reservoirs in the average year, the dry year with a return period of 10 years and the wet year with a return period of 10 years respectively.

#### PROBABLE ANNUAL INFLOW

- Unit: MCM -

Item	Huai	Huai	Khlong	Khlong
	Sam Ru	Nong Kho	Samo Khon	Sai
Catchment (sq.m)	28	34	13	47
Average Year	11.07	5.16	1.96	18.96
Dry Year	6.85	2.33	0.88	8.34
Wet Yea	16.27	9.82	3.72	33.57

#### (2) Irrigation Water Requirements

##### (a) Crop Consumptive Use

Crop consumptive use is induced from reference evapotranspiration (ET<sub>o</sub>) and crop coefficient (K<sub>c</sub>). ET<sub>o</sub> is calculated by the modified Penman method, presented in FAO irrigation and drainage paper No.24, based on the meteorological data at the Phitsanulok station.

##### (b) Other Water Requirement

In addition to the above crop consumptive use, the following water is needed for successful irrigation of crops, as discussed in Chapter IV.

- Paddy Fields : Percolation : 2 mm/day
- Nursery water : 400 mm
- Land preparation : 200 mm
- Upland Field : Pre-irrigation : 60 mm

(c) Effective Rainfall

Some parts of rainfall is effective for irrigation. For paddy cropping the method developed by the United State Bureau of Reclamation is applied to estimate of effective rainfall, while for dry season field crops and fruit trees, estimates are based on FAO irrigation and drainage paper No.25. The meteorological data observed at stations located in Amphoe Muang of each province where the model projects are situated, are used as the basis of calculating effective rainfall.

(d) Irrigation Efficiency

For the proposed projects after full development with well designed system, built and operated for some years, the following irrigation efficiencies will be applicable:

Field Application Efficiency (Ea)	:	85 %
Field Canal Efficiency (Eb)	:	85 %
Conveyance Efficiency (Ec)	:	80 %
Overall Efficiency (Ea × Eb × Ec)	:	58 %

(e) Irrigation Water Requirements by Crops

Field irrigation water requirements are calculated by subtracting effective rainfall from the amount of field water requirements. Irrigation water requirements to be released from the proposed reservoirs are determined by adding water losses to the field irrigation water requirements. The proposed irrigation water requirements in the designed dry year with a return period of 10 years are presented as follows:

**IRRIGATION WATER REQUIREMENTS BY CROPS**

Item	- Unit : mm -			
	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Rainy Season Paddy	690	788	800	809
Soybean	457	579	576	578
Groundnuts	269	-	-	-
Maize	69	171	-	228
Vegetable - Rainy Season	66	134	160	183
- Dry Season	479	486	481	484
Pasture	976	1,166	1,193	1,147
Orchard	1,202	1,416	1,357	1,400

**(3) Reservoir Operations**

In order to determine a reasonable irrigation area with the proposed calendars and the given reservoir storage capacities, reservoir operations are examined for a two year period on a monthly basis on the condition that the first year is the dry year and the second year is the wet year, both with a return period of 10 years. The reservoir operation simulation are run by substituting variable irrigation area into the balance equation to obtain the maximum irrigation area that reservoir water contents recover to full contents in the end of October in the second year.

In the simulation, water losses of evaporation from the reservoir surface and percolation through the reservoirs are accounted. As a result, with a combined storage of 15 - 31 MCM, 2,165 ha and 1,140 ha of farm lands will be irrigated in the rainy season and dry season respectively as shown as follows:

**PROPOSED IRRIGATION AREA**

- Unit: ha -

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Effect. Storage (MCM)	3.98	6.79	2.40	2.14	15.31
<b>Irrigation in Rainy Season</b>					
- Paddy Fields	187	355	131	103	776
- Upland Crop Fields	647	119	26	143	935
- Orchards	188	100	22	144	454
Total	1,022	574	179	390	2,165
<b>Irrigation in Dry Season</b>					
- Paddy Fields	75	71	37	-	183
- Upland Crop Fields	255	119	26	103	503
- Orchards	188	100	22	144	454
Total	518	290	85	247	1,140
<b>Grand Total</b>	<b>1,540</b>	<b>864</b>	<b>264</b>	<b>637</b>	<b>3,305</b>

The average annual water supply for 2 years of operation was used as follows:

**ANNUAL AVERAGE WATER USE**

- Unit: MCM -

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Effective Storage	3.98	6.79	2.40	2.04
Inflow	11.56	6.08	3.25	20.96
<b>Irrigation Diversion</b>				
Reservoir Losses	0.61	1.30	0.79	1.22
Reservoir Spills	5.36	-	-	16.27
Total	11.56	6.17	2.31	20.96



## VII-2-4 Irrigation Facilities

### (1) Dam and Reservoir

#### (a) Geology of Damsite

The bedrock of Huai Sam Ru damsite consists of reddish brown sandstone and belongs to Khok Kruat formations in the Cretaceous. At the left bank abutment, topsoils are fairly thick and weathering bedrocks are not found at a depth of about one m. Cone penetrometer indexes are 90 at a depth of 1.0 m and 150 at a depth of 1.1 m. Generally the cone penetrometer index of the dam body ranges from 130 to 150. Riverbed consist of reddish fine sand with a thickness of about 1.5 m. The topsoils at the right bank abutment is not so thick, and bedrocks may be found at a depth of about one m.

The basement complex of Huai Nong Kho damsite is composed mainly of diluvial formations and phyllite. Both abutments, left and right, of the proposed dam consist of phyllite, outcrops of which are weathered. At the flatland section of diluvial formations, clayey soils with sand, with a thickness of about five m, the cone penetrometer indexes are 130 at a depth of 0.8 m and 170 at a depth of 1.0 m. Riverbed consists of coarse sand, gravel and pebble, and its thickness is supposed to be around 2 m.

The basement complex of Khlong Samo Khon damsite consists of diluvial formations and phyllite. Both abutments of the dam are supposed to consist of weathered phyllite. Riverbed is covered with consolidated sand and cobble gravel, and fragments of phyllite are found at several places. Dry excavation at the riverbed reveals weathered phyllite at a depth of 1.3 m. Depositional terraces are composed of silty loam, sand and fragments of rocks, and its thickness is supposed to range from two m to four m.

The Khlong Sai damsite is located between two depositional terraces formed in the Pleistocene. The depositional terraces are composed of gravel, sand, silt and fragments of sedimentary rocks. At the left terrace with brown sandy silt soils, the cone penetrometer index is observed to be 190 at a depth of 1.1 m, and at the right terrace, the cone penetrometer index shows same value as the right terrace.

## (b) Reservoir

The proposed dam and reservoir sites are selected upstream of the objective backward villages. In the Phase I study period, possible sites were identified based on the analysis of the RTSD topographic maps (1 : 50,000 scale and 20 m contour interval) and the field reconnaissance surveys, and one potential site for each area was proposed for 3 model areas of Huai Sam Ru, Huai Nong Kho and Khlong Sai. In Khlong Samo Khon area, two alternative sites were identified based on the said topographic maps: upstream site with a catchment area of 13 sq.km and possible storage of 2.6 MCM, and downstream site with a catchment area of 24 sq.km and possible storage of 6.3 MCM.

In the Phase II Study, detail site surveys were done to alternative damsites with the topographic maps (1 : 5,000 scale and 1 m contour intervals) prepared for the study purpose, and the following problems on the downstream site, which was hardly found on the RTSD maps, have been revealed: ① about 80 ha of paddy fields are to be submerged, ② about two km length of ARD road is to be relocated, and ③ several farmhouses are to be moved. The upstream site has no such problems; however, topography of the dam and reservoir site is inferior to the downstream site from the view point of water resources engineering. Careful consideration was given to two alternative sites, thus leading to the selection of the upstream site. Rejection of the downstream site is due to negative impact on the existing farm lands.

The reservoir capacities of two projects of Huai Sam Ru and Khlong Sai have been determined with a practical maximum dam height, and for two projects of Huai Nong Kho and Khlong Samo Khon the reservoir capacities have been determined with water availability. Major features of the proposed reservoirs are presented as follows:

**MAJOR FEATURES OF PROPOSED RESERVOIRS**

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Gross Storage (MCM)	4.30	7.30	2.60	2.85
Dead Storage (MCM)	0.32	0.51	0.20	0.71
Live Storage (MCM)	3.98	6.79	2.40	2.14
Flood Level (EL.m)	310.40	139.50	141.00	171.10
Retention Level(EL.m)	308.80	138.30	140.20	169.80
Reservoir Area (ha)	79	203	143	145
Catchment Area (ha)	2,800	3,400	1,300	4,700

(c) Dam

The earth fill type dam is recommendable, judging from the topographical and geological conditions of damsites as well as the quality and quantity of construction materials available at the sites. Dam design is based on the following criteria:

- Width of dam crest : 6.00 m
- Free-board : 1.50 m above surcharge flood level
- Slope, upstream : 1 : 30
- Slope, downstream : 1 : 2.5

A cut-off trench should be provided at the center of dam body in order to attend the pass length of seepage line through the dam foundation. Three dams of Huai Nong Kho, Khlong Samo Khon and Khlong Sai, the dam height of which are less than 20 m, will not require foundation treatment by grouting. However, Huai Sam Ru dam with a dam height of 23.9 m will be provided with grouting works to improve the permeability of the foundation. Curtain grouting is planned of 1 row at an interval of three m.

The design discharge of spillways are determined based on the probable maximum daily rainfall with a return period of 50 years, taking into account the flood storage above the retention water level, as summarized below:

### DESIGNED FLOOD DISCHARGE

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Catchment Area (sq.km)	28	34	13	47
Design Rainfall (mm)	246.7	142.1	187.3	167.3
Peak Inflow (cu.m/sec)	178	127	82	222
Designed Discharge (cu.m/sec)	170	55	45	187

The intake facilities are composed of the inlet, the conduit pipe protected with steel liner, and the outlet. The design capacity of intake facilities is based on the peak diversion water requirements.

### MAJOR FEATURES OF PROPOSED DAMS

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
Dam Length (m)	260	935	1,380	1,345
Dam Height (m)	23.9	19.4	11.0	12.1
Embankment (1,000 cu.m)	122	398	138	181
Design Flood (cu.m/sec)	170	55	45	187
Intake Capacity (cu.m/sec)	1.66	0.94	0.29	0.63

## (2) Irrigation Facilities

The proposed irrigation areas are selected among the existing farm lands located just downstream of the proposed dam for three projects of Huai Sam Ru, Khlong Samo Khon and Khlong Sai. The irrigation area of Huai Nong Kho project is composed of two isolated areas of the upstream area with an irrigation area of 259 ha and the downstream area with an irrigation area of 320 ha where the objective backward villages are located. The diversion weir will be constructed about 10 km downstream of the proposed dam for the downstream area.

The layout of the canal systems is based on the topographic maps with a scale of 1 : 5,000. The canal alignment is planned to enable the farm lands to be irrigated by gravity. Main and lateral canals are designed to be trapezoid channels with concrete lining having a conveyance capacity of 1.62  $\ell$ /sec/ha. Canals will be constructed to command an irrigation area down to a terminal

irrigation block of 16 ha (or, 100 rai). Regulators with measuring devices, check structures, drops and so on will be provided for better water control. Tails of irrigation canals are connected with existing rivers to drain excess water in the canals. Major features of the canal systems are summarized below:

**MAJOR FEATURES OF PROPOSED IRRIGATION SYSTEMS**

Item	Huai Sam Ru	Huai Nong Kho	Khlung Samo Khon	Khlung Sai
① Main Canals				
- Irrigation Area (ha)	1,022	574	179	390
- Canal Length (km)	13.50	7.20	8.95	9.90
- Max. Discharge(cu.m/sec)	1.66	0.52	0.29	0.53
② Lateral Canals				
- Nos. of Canals	15	2	2	6
- Canal Length (km)	23.40	1.80	3.10	9.63

### VII-3 RURAL ROAD DEVELOPMENT

#### ① Huai Sam Ru Area

An existing road with a total length of 13.5 km, which is branched off from the national highway (No. 2013) to run through 2 villages of Kaeng Hai and Kaeng Wa, will be improved as the ARD standard road, and 1.0 km of village sections will be paved with the concrete I blocks. An existing road with a length of 1.5 km to connect the the proposed dams site with the above ARD standard road will be improved as the service road of the ARD type I-5 m wide road, and another existing road to connect with the above ARD standard road at Kaeng Wa village will also be improved for a reach of 0.5 km as the ARD type II-4 m wide road.

#### ② Huai Nong Kho Area

There are three roads of ST 11012, ST 11017 and ST 11014 under consideration of ARD, of which the ongoing ST 11012 road is given top priority to be completed in the 5-year development plan. The model project includes the completion of the construction works for the distance of 22.0 km between Huai

Khrai (2) village and a two km point from the No.12 national highway with the involvement of three km long road pavement with the concrete one block. In connection with this road, two service roads will be improved: one is the existing road to connect Huai Khrai (2) village with Wang Pong village through the villages of Khao Khwang, Nong Krathum and Khok Kwai Yai Lang totaling 10.0 km in length, the other is a three km long existing road to link Huai Khrai (2) village to Huai Khrai (1) village.

③ Khlong Samo Khon Area

There is an ARD standard road completed in 1990, functioning as a rural trunkroad for the project area. The model project will provide a service road of ARD type II with a length of 1.0 km to connect the right bank area with the above ARD standard road.

④ Khlong Sai Area

Since all four villages involved in the model project face the national highway route 1110, only the construction of a service road with a length of 900 m is proposed to connect Lat Yao village with the national highway. The outline of the proposed rural roads is given below:

**OUTLINE OF PROPOSED RURAL ROAD DEVELOPMENT**

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
<b>ARD Standard Road</b>					
- Nos. of Routes	1	1	-	-	2
- Length (km)	13.5	22.0	-	-	35.5
<b>Service Road</b>					
- Nos. of Routes	2	2	1	1	6
- Length (km)	2.0	13.0	1.0	0.9	16.9
<b>Total Length (km)</b>	<b>15.5</b>	<b>35.0</b>	<b>1.0</b>	<b>0.9</b>	<b>52.4</b>
<b>of which, Pavement (km)</b>	<b>1.0</b>	<b>5.0</b>	<b>1.0</b>	<b>-</b>	<b>7.0</b>

#### VII-4 RURAL WATER SUPPLY DEVELOPMENT

The model projects will provide deep wells of a 4-inch bore with a hand pump for water supply of drinking and daily use. The minimum space between deep wells shall be 1,000 m as deep wells are assumed to have a 500 m radius of the circle of influence. Yields of a deep well is estimated to be at least 20 gpm (or, 75.7  $\ell$ /minute). The average depth of wells is assumed to be 50 m from the experience of ARD projects.

The number of proposed deep wells is based on the standard water demand of 60  $\ell$ /day per capita. Populations and distribution of houses in connection with the circle of influence of wells. The satisfaction rate of the present water supply is over 70 percent at three villages in Huai Sam Ru area and Nam Dip Ma village in Khlong Samo Khon area; however, the rural water supply development projects include these villages since the present water supply relies on unstable rain and shallow wells having problems of quality and quantity. As mentioned in Chapter IV, no distribution system is proposed for this project. Outline of the rural water supply is given below:

##### OUTLINE OF RURAL WATER SUPPLY DEVELOPMENT

Item	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Nos. of Villages	3	4	2	4	13
Nos. of Deep Wells	3	7	4	6	20

#### VII-5 RURAL INFRASTRUCTURE DEVELOPMENT

##### (1) Rural Youth and Agricultural Technology Training Center

The model projects will provide four rural youth and agricultural technology training centers: 1 center for each project. The centers will be established in the seat of Amphoe office namely, Nakhon Thai, Ban Dan Lan Hoi, Phran Kratai, and Muang Tak. The center with a floor space of 144 sq.m have a administration office, meeting rooms and training rooms for the use of rural youth and villagers for training of vocational skills and improved agricultural technology. Furthermore, the center will be utilized for

exhibitions of agricultural products and cottage industry product, thus functioning as the center of the integrated rural development project. The center will be equipped with equipment for office and extension service uses. The Office of Accelerated Rural Development will be responsible for the management of the centers.

## (2) Cottage Industry Promotion

The model projects will provide the group working houses for the promotion of silk weaving and bamboo art crafting in the model areas where materials are available. The group working houses will be managed by farmers' groups concerned: five farmers for a silk weaving group and 20 farmers for a bamboo art craft group. Jewelry polishing, one of the most flourishing cottage industries in Thailand, will be promoted in Khlong Sai area in Tak province, as a pilot project. A farmers' group composed of 20 members will be organized in order to manage the group working house for jewelry polishing on the contract basis with jewelers. The number of group working houses for the cottage industries are given as under:

### NOS. OF GROUP WORKING HOUSES FOR COTTAGE INDUSTRY

Type of Work	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Total
Silk Weaving	1	1	1	1	4
Bamboo Art Craft	1	1	-	-	2
Jewelry Polishing	-	-	-	1	1
Total	2	2	1	2	7

## VII-6 AGRIBUSINESS

In association with the implementation of model projects by the Office of Accelerated Rural Development, the establishment of such agribusiness related facilities as rice mills, grain storage facilities, collecting houses of fruit and vegetable and village shops are recommendable. For this purpose, the participation of private sector in the model projects is anticipated for the improvement of the value added of agricultural products. The agribusiness related facilities are outlined hereafter for reference.



- Rice Mill : One rice mill with a capacity of 5 ton/day for each project areas, amounting to 4 rice mills.
- Grain Storage Facilities : One grain storage facilities for each project area with a capacity of 300 ton for Huai Nong Kho area, 500 ton for Huai San Ru area and 150 ton for both areas of Khlong Samo Khon and Khlong Sai.
- Fruit and Vegetable Collecting House : One collecting house for each project area.
- Village Shop : One village shop for each of 9 villages that have no shop at present, totaling 9 village shops.

## VII-7 MAE RAMAT PRIORITY AREA

Mae Ramat area in the western Tak is warranted for early implementation, as the model project, of the integrated rural development project for its unique physical and socio-economic situation when compared with the general situation of Tak province. The general description of the area is briefly given hereafter.

### VII-7-1 Present Development Levels of Amphoe Mae Ramat

Out of eight Amphoe in Tak province, being located along the Thai-Myanmar border, Amphoe Mae Ramat, together with Amphoe Tha Song Yang, is given top priority for development because of its low present development level as given below:

Amphoe	<u>HIGH PRIORITY AMPHOE IN TAK PROVINCE</u>					
	Income Indicator		Quality of Life Indicator		Average Rank	Priority
	B/person	Rank	%	Rank		
Tha Song Yang	1,817	3	71.8	1	2	1
Mae Ramat	1,384	1	56.2	3	2	1
Umphang	2,561	4	65.9	2	3	3

### VII-7-2 Possibility of Irrigation Development

Annual rainfall over the western Tak where Mae Ramat area is located is relatively high as 1,567 mm when compared to 939 mm over the eastern Tak. In the western Tak, annual average runoff of a river is estimated at 302 mm, which is equivalent to two times of average runoff of 156 mm in the eastern Tak. The rainfall pattern, however, is same to other areas that about 90 percent of annual rainfall concentrate in the rainy season. Accordingly, the construction of a storage dam is an effective counter measure for irrigation development to store water during high flow periods and release during low flow periods for crop growing. Owing to high rainfall and river runoff, the area has high potentialities for the development of irrigation in the dry season.

According to the topographic maps (1 : 50,000 scale) and field reconnaissance, a potential dam site is identified across the river of Lae four km east of Tambon Mae Ramat. The estimated gross storage capacity is about four million cubic meters and catchment area at damsite is nine sq.km. The proposed water storage will be firstly used for rainy season paddy cropping; however, considerable amount of storage may be used for dry season irrigation of soybean, mungbean and vegetables because of abundant rainfall and river runoff in the rainy season.

### VII-7-3 Backward Villages

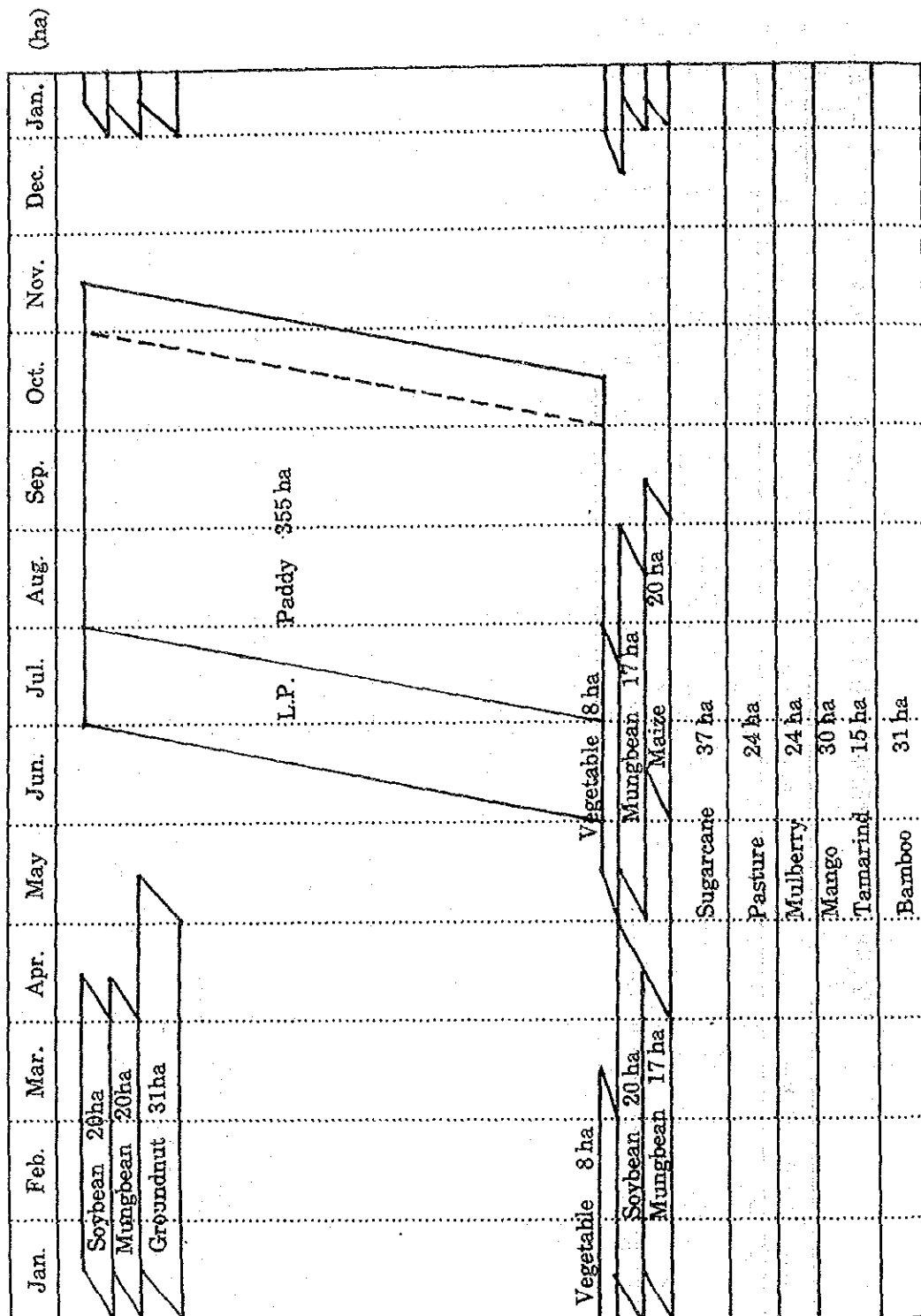
Mae Ramat area may covers three backward villages, present development levels of which are summarized, showing that the quality of life indicator of Mae Ramat village is very low, in other word: many villagers are satisfied with present public services in terms of the NESDB's 32 items on the quality of life.

#### PRESENT DEVELOPMENT LEVELS

	Nok Lae Nua	Nok Lae	Mae Ramat
NESDB Code No.	040313	040102	040105
Population	564	121	414
No. of Household	82	38	101
.....			
Income Indicator (฿/person)	2,776	2,445	3,409
Quality of Life Indicator (%)	67.6	11.8	2.9



FIGURE VII - 1 PROPOSED CROPPING CALENDAR HUAI NONG KHO AREA







**CHAPTER VIII IMPLEMENTATION AND OPERATION  
AND MAINTENANCE OF PROJECT**





## **CHAPTER VIII IMPLEMENTATION AND OPERATION AND MAINTENANCE OF PROJECT**

### **VIII-1 Implementation of Project**

#### **VIII-1-1 Project Coordination**

The implementation of the integrated rural development project at the Lower North Thailand involves many ministries, government agencies and private sectors such as the five principal ministries of Interior, Agriculture and Cooperatives, Public Health, Education and Industry, which are responsible for rural development activities, local governments, provincial electricity authority, and private sectors on cottage industries and agribusinesses. In order to implement the rural development project in time in an integrated manner, at the national level, the National Rural Development Coordination Center will be responsible for coordinating the plans and project implementation of various agencies concerned. The office of Accelerated Rural Development will play an important role in formulation of the integrated development plan.

The rural development program should be prepared on a village, or Tambon basis with participation of rural people to solve the actual problems faced by the rural people in each area. In this context, the establishment of a project coordinating committee on an Amphoe basis is proposed with the emphasis to give localities of areas careful consideration. The representative of provincial government concerned will preside over the committee and the committee member will be composed of the representatives of the provincial offices of government agencies, Amphoe offices, Tambon and villages.

The Office of Accelerated Rural Development will prepare guidelines regarding the development of land resources, water resources, irrigation and agriculture and the improvement of the quality of life, for solution of problems confronted by rural peoples. The guidelines will be presented to the committee for discussion of the promotion of the rural development project. The chief of Amphoe, who will be the secretary of the committee, will perform the duties to promote better communication between provincial office, local governments and rural people, and to give advice to the committee. The director of ARD provincial office will be the deputy secretary of the committee.

## **VIII-1-2 Project Implementation**

### **(1) Executive Agency**

The Office of Accelerated Rural Development will be the executive agency responsible for implementing the integrated rural development project at the Lower North Thailand. Out of several project components, four project components of irrigated agriculture development, rural road development, rural water supply development, and rural infrastructure development including rural youth and agricultural technology training program and cottage industry development, will be implemented under the direct responsibility of the Office of Accelerated Rural Development with the assistance and cooperation by other government agencies concerned in their respective fields. Three project components of rural electrification, public health and education will be planned and implemented under the responsibility of the Provincial Electricity Authorities, the Ministry of Public Health and the Ministry of Education respectively. The establishment of rice mills, grain storage facilities, and fruit and vegetable collecting houses will be invested by the private sector related to agribusiness.

### **(2) Project Construction Offices**

The integrated rural development project at the Lower North Thailand will be implemented as the package project on the provincial basis. For the successful implementation of the project, ARD will appoint a project director to be responsible for the promotion and coordination of projects under the supervision of the Deputy Secretary-General. The assignments of the project director are preparation of detail design of engineering works of the model projects, detail planning of other development projects than the model project, and bidding and constructing of engineering works. The construction works of the model projects will be supervised by four project construction offices to be established in the sites.

### **(3) Kamphaeng Phet Field Operation Center**

The Kamphaeng Phet field operation center established in 1990 is composed of five sections of administration and development, survey and design, construction and maintenance, and mechanical engineering, under the

control of the director. 158 officials are assigned to service as of 1991. According to the operation plan of the center to meet the increasing demand of implementation of rural development projects, the staff and office spaces area being increased. The center has a plan to procure by 1992 a fleet of construction equipment such as reservoir construction equipment, rotary type drilling rigs, road construction equipment, asphalt road construction equipment, concrete road construction equipment, road maintenance equipment and so on.

The construction equipment mentioned above would be used for the early completion of on-going projects in seven provinces to be covered by the Kamphaeng Phet field operation center. Therefore, the integrated rural development project has proposed additionally to provide the following construction equipment in order to cope with the implementation of the model project, namely, one set of reservoir construction equipment composed of bulldozers, scrapers, graders, hydraulic excavators, draglines, compactors, dump trucks and so on; three sets of large size percussion drilling equipment, and one set of road maintenance equipment.

#### (4) Consulting Services

For successful implementation of the model projects, the Office of Accelerated Rural Development would employ consultants in the fields of dam, civil engineering, irrigation, engineering geology, agriculture, sericulture, cattle raising, fisheries and bidding. The consultants shall assist ARD in the review of planning, detail design of engineering works, cost estimate, preparation of bid documents, tendering and contracting, quality control of construction work, and general supervision of the project implementation.

#### VIII-1-3 Implementation Schedule

The project will be implemented over five years from 1992 to 1996. ARD will commence the detailed topographic surveys of dams and canals in the later half of the year of 1992. The detailed design of model projects will be completed in two years 1992 to 1993 by employing consultants. The construction of four model project is scheduled to start in the dry season of 1994 with the construction period of three years. Dam construction will be completed in two years. The construction of canals and on-farm facilities will commence one year before the completion of dams for a two year period in two

projects of Huai Sam Ru and Khlong Sai, and on completion of dam construction, the construction of canals and on-farm facilities will commence with a construction period of one year in two project of Huai Nong Kho and Khlong Samo Khon.

Rural roads and deep wells will be constructed with an implementation schedule of three year period from 1994 to 1996. Project facilities planned for the promotion of sericulture, livestock and inland fisheries will be constructed in 1996 as well as the construction of group working houses for the promotion of cottage industries. In accordance with the above-mentioned implementation schedule, construction works of model projects will be completed in the late half of the year of 1996, and farm lands will be irrigable in 1997.

For other projects than the above-stated model projects incorporated into the overall 5-year development project, feasibility studies and detail design will be completed in the second half of the year of 1993, and the construction works are scheduled to be completed in 1996 with a construction period of three years from 1994 to 1996.

Table VIII-1 gives the implementation schedule of the overall 5-year development plan.

## **VIII-2 Operation and Maintenance of Project**

After the integrated rural development projects are completed, their potential benefits will be realized only if operation and maintenance are satisfactory. Among many project facilities, operation and maintenance of major facilities and public facilities will be responsible of the government agencies concerned since they require skilled professionals, adequate guidelines and standards, specialized machinery and equipment, and comprehensive system management. Beneficiaries, whose income typically rise substantially, shall reasonably share on the grounds of equity the work on operation and maintenance of the project.

The Office of Accelerated Rural Development is responsible for the operation and maintenance of the main irrigation systems including dams, reservoirs, main canals and secondary canals, while the operation and

organized under the direction of ARD. The ARD will undertake the task of maintaining the rural trunkroads, and Tambon or villages will maintain the service roads and deep wells. The project facilities for sericulture, livestock, inland fisheries and cottage industries will be operated and maintained by farmers' groups concerned.

**TABLE VIII - 1 PROPOSED IMPLEMENTATION SCHEDULE OF OVERALL 5-YEAR DEVELOPMENT PROJECT**

Work items	1991	1992	1993	1994	1995	1996
<b>① Model Project</b>						
1. Feasibility Study	██████████					
2. Survey and Investigation		██████████				
3. Detail Design and Tendering		██████████	██████████			
4. Construction						
(1) Huai Sam Ru Project						
- Dam			██████████	██████████	██████████	
- Canal and On-farm Works				██████████	██████████	██████████
- Agricultural Development					██████████	██████████
- Rural Road					██████████	██████████
- Rural Water Supply			██████████	██████████		
- Cottage Industry					██████████	██████████
(2) Huai Nong Kho Project						
- Dam			██████████	██████████	██████████	
- Canal and On-farm Works					██████████	██████████
- Agricultural Development					██████████	██████████
- Rural Road					██████████	██████████
- Rural Water Supply			██████████	██████████		
- Cottage Industry					██████████	██████████
(3) Khlong Samo Khon Project						
- Dam			██████████	██████████	██████████	
- Canal and On-farm Works					██████████	██████████
- Agricultural Development					██████████	██████████
- Rural Road					██████████	██████████
- Rural Water Supply			██████████	██████████		
- Cottage Industry					██████████	██████████
(4) Khlong Sai Project						
- Dam			██████████	██████████	██████████	
- Canal and On-farm Works				██████████	██████████	██████████
- Agricultural Development					██████████	██████████
- Rural Road					██████████	██████████
- Rural Water Supply			██████████	██████████		
- Cottage Industry					██████████	██████████
5. Procurement of Equipment				██████████	██████████	██████████
<b>② Other Projects than Model Project</b>						
1. Feasibility Study		██████████				
2. Detail Design		██████████	██████████			
3. Construction				██████████	██████████	██████████

## **CHAPTER IX PROJECT COST**





## CHAPTER IX PROJECT COST

The construction cost is estimated based on the work quantity and current unit rates employed in ARD projects and the proposed implementation schedule. In addition to the construction costs for irrigated agriculture development, rural road development, rural water supply development, rural youth and agricultural technology training center and cottage industry promotion, the costs of the overall 5-year development project include the costs for procurement of equipment, land acquisition, survey and investigation, administration and consulting services. 10 percent of physical contingencies are added to the costs of the model projects as well as 20 percent to the costs of other projects than model projects. Price escalation contingencies are calculated at a rate of 4.5 percent per year for local currency component and for foreign currency component, escalation rates are based on World Bank's data. The project costs are estimated at a price level of March, 1991, and the foreign exchange rate of US\$1.00 = Baht 25.5 is applied.

The total project cost of the overall 5-year development project, inclusive of the model projects, amounts to 2,942.9 million Baht, of which 1,465.7 million Baht (or, equivalent to 50 percent of the total) are foreign currency component. The costs for model projects are estimated at 655.6 million Baht, corresponding to 22 percent of the total costs for the overall 5-year development project.

The summary of the project costs for the overall 5-year development project and the model projects are given below:

## PROJECT COSTS FOR OVERALL 5-YEAR DEVELOPMENT PROJECT

- Unit: Baht Million -

<u>Sub Project</u>	<u>Local Currency</u>	<u>Foreign Currency</u>	<u>Total</u>	<u>Foreign (%)</u>
Phitsanulok Province	468.9	409.7	878.6	47
Sukhothai Province	332.8	325.0	657.8	49
Kamphaeng Phet Province	382.2	355.7	737.9	48
Tak Province	241.9	233.8	475.7	49
Filed Operation Center	51.4	141.5	192.9	73
<u>Total</u>	<u>1,477.2</u>	<u>1,465.7</u>	<u>2,942.9</u>	<u>50</u>

## BREAKDOWN OF PROJECT COSTS

- Unit : Baht Million -

<u>Sub Project</u>	<u>Local Currency</u>	<u>Foreign Currency</u>	<u>Total</u>	<u>Foreign (%)</u>
Phitsanulok Province				
- Model Project	92.4	106.5	198.9	54
- Other Projects	376.5	303.2	679.7	45
<u>Total</u>	<u>468.9</u>	<u>409.7</u>	<u>878.6</u>	<u>47</u>
Sukhothai Province				
- Model Project	104.3	111.7	216.0	52
- Other Projects	228.5	213.3	441.8	48
<u>Total</u>	<u>332.8</u>	<u>325.0</u>	<u>657.8</u>	<u>49</u>
Kamphaeng Phet Province				
- Model Project	46.3	49.7	96.0	52
- Other Projects	335.9	306.0	641.9	48
<u>Total</u>	<u>382.2</u>	<u>355.7</u>	<u>737.9</u>	<u>48</u>
Tak Province				
- Model Project	71.8	72.9	144.7	50
- Other Projects	170.1	160.9	331.0	49
<u>Total</u>	<u>241.9</u>	<u>233.8</u>	<u>475.7</u>	<u>49</u>
Field Operation Center	51.4	141.5	192.9	73
<u>Grand Total</u>	<u>1,477.2</u>	<u>1,465.7</u>	<u>2,942.9</u>	<u>50</u>

## ANNUAL DISBURSEMENT SCHEDULE

### (1) Overall 5-Year Development Project

- Unit: Baht 1,000 -

<u>Year</u>	<u>Phitsanulok</u>	<u>Sukhothai</u>	<u>Kamphaeng</u>		<u>Field Operation</u>	
			<u>Phet</u>	<u>Tak</u>	<u>Center</u>	<u>Total</u>
1992	10,979	11,585	10,822	9,686	-	43,072
1993	187,139	137,920	143,354	81,792	-	550,205
1994	206,847	159,283	193,699	138,036	60,375	758,240
1995	255,951	172,147	216,219	153,936	115,549	913,802
1996	217,706	176,878	173,830	92,256	16,965	677,635
<b>Total</b>	<b>878,622</b>	<b>657,813</b>	<b>737,924</b>	<b>475,706</b>	<b>192,889</b>	<b>2,942,954</b>

### (2) Model Projects

<u>Year</u>	<u>Huai Sam Ru</u>	<u>Huai</u>		<u>Khlong</u>		<u>Total</u>
		<u>Nong Kho</u>	<u>Samo Khon</u>	<u>Khlong Sai</u>		
1992	6,263	7,957	6,319	7,549	28,088	
1993	6,677	9,024	4,534	7,022	27,257	
1994	36,427	47,800	26,072	41,083	151,382	
1995	72,140	79,766	39,210	64,829	255,945	
1996	77,432	71,486	19,861	24,209	192,988	
<b>Total</b>	<b>198,939</b>	<b>216,033</b>	<b>95,996</b>	<b>144,692</b>	<b>655,660</b>	

TABLE IX - 1 MODEL PROJECT COST : HUAI SAM RU PROJECT

- Unit : Baht 1,000 -

Cost Item	1992	1993	1994	1995	1996	Total
1. Irrigation						
- Dam	-	-	20,394	31,655	-	52,049
- Canal	-	-	-	10,506	28,467	38,973
- On-farm Works	-	-	-	-	2,783	2,783
- Overhead Cost	-	-	3,701	7,652	5,672	17,025
<u>Total (1)</u>	-	-	<u>24,095</u>	<u>49,813</u>	<u>36,922</u>	<u>110,830</u>
2. Agricultural Development						
- Sericulture	-	-	-	-	604	604
- Livestock	-	-	-	-	1,442	1,442
- Inland Fisheries	-	-	-	-	433	433
<u>Total (2)</u>	-	-	-	-	<u>2,479</u>	<u>2,479</u>
3. Rural Road	-	-	-	-	13,119	13,119
4. Rural Water Supply	-	-	194	-	-	194
5. Cottage Industry						
- Silk Weaving	-	-	-	-	270	270
- Bamboo Hand Craft	-	-	-	-	245	245
<u>Total (5)</u>	-	-	-	-	<u>515</u>	<u>515</u>
6. Building						
- Project Office	-	-	600	-	-	600
- Training Center	-	-	-	-	680	680
<u>Total (6)</u>	-	-	<u>600</u>	-	<u>680</u>	<u>1,280</u>
7. Equipment for Training	-	-	500	-	-	500
<u>Total (1 ~ 7)</u>	-	-	<u>25,389</u>	<u>49,813</u>	<u>53,715</u>	<u>128,917</u>
8. Land Acquisition	-	-	25	1,325	-	1,350
9. Survey and Investigation	2,708	-	-	-	-	2,708
10. Administration	645	645	1,031	2,011	2,114	6,446
11. Consulting Service	1,928	4,837	2,930	2,512	1,674	13,881
<u>Base Cost (1 ~ 11)</u>	<u>5,281</u>	<u>5,482</u>	<u>29,375</u>	<u>55,661</u>	<u>57,503</u>	<u>153,302</u>
12. Physical Contingencies	528	548	2,938	5,566	5,749	15,329
13. Price Escalation	454	647	4,114	10,913	14,180	30,308
<u>Total Cost (1 ~ 13)</u>	<u>6,263</u>	<u>6,677</u>	<u>36,427</u>	<u>72,140</u>	<u>77,432</u>	<u>198,939</u>

**TABLE IX-2 MODEL PROJECT COST : HUAI NONG KHO PROJECT**

- Unit : Baht 1,000 -

Cost Item	1992	1993	1994	1995	1996	Total
<b>1. Irrigation</b>						
- Dam	-	-	26,219	46,308	-	72,527
- Canal	-	-	-	-	12,441	12,441
- On-farm Works	-	-	-	-	1,564	1,564
- Overhead Cost	-	-	4,759	8,405	2,542	15,706
<u>Total (1)</u>	-	-	<u>30,978</u>	<u>54,713</u>	<u>16,547</u>	<u>102,238</u>
<b>2. Agricultural Development</b>						
- Sericulture	-	-	-	-	464	464
- Livestock	-	-	-	-	721	721
- Inland Fisheries	-	-	-	-	234	234
<u>Total (2)</u>	-	-	-	-	<u>1,419</u>	<u>1,419</u>
<b>3. Rural Road</b>	-	-	-	-	30,530	30,530
<b>4. Rural Water Supply</b>	-	-	453	-	-	453
<b>5. Cottage Industry</b>						
- Silk Weaving	-	-	-	-	270	270
- Bamboo Hand Craft	-	-	-	-	245	245
<u>Total (5)</u>	-	-	-	-	<u>515</u>	<u>515</u>
<b>6. Building</b>						
- Project Office	-	-	600	-	-	600
- Training Center	-	-	-	-	680	680
<u>Total (6)</u>	-	-	<u>600</u>	-	<u>680</u>	<u>1,280</u>
<b>7. Equipment for Training</b>	-	-	500	-	-	500
<u>Total (1 ~ 7)</u>	-	-	<u>32,531</u>	<u>54,713</u>	<u>49,691</u>	<u>136,935</u>
<b>8. Land Acquisition</b>	-	-	100	500	-	600
<b>9. Survey and Investigation</b>	3,337	-	-	-	-	3,337
<b>10. Administration</b>	685	685	1,698	2,793	986	6,847
<b>11. Consulting Service</b>	2,682	6,726	4,075	3,493	2,328	19,304
<u>Base Cost (1 ~ 11)</u>	<u>6,704</u>	<u>7,411</u>	<u>38,404</u>	<u>61,499</u>	<u>53,005</u>	<u>167,023</u>
<b>12. Physical Contingencies</b>	670	741	3,841	6,150	5,301	16,703
<b>13. Price Escalation</b>	583	872	5,555	12,117	13,180	32,307
<u>Total Cost (1 ~ 13)</u>	<u>7,957</u>	<u>9,024</u>	<u>47,800</u>	<u>79,766</u>	<u>71,486</u>	<u>216,033</u>

TABLE IX - 3 MODEL PROJECT COST : KHLONG SAMO KHON PROJECT

- Unit : Baht 1,000 -

Cost Item	1992	1993	1994	1995	1996	Total
<b>1. Irrigation</b>						
- Dam	-	-	14,081	22,892	-	36,973
- Canal	-	-	-	-	7,293	7,293
- On-farm Works	-	-	-	-	488	488
- Overhead Cost	-	-	2,556	4,155	1,412	8,123
<u>Total (1)</u>	-	-	<u>16,637</u>	<u>27,047</u>	<u>9,193</u>	<u>52,877</u>
<b>2. Agricultural Development</b>						
- Sericulture	-	-	-	-	302	302
- Inland Fisheries	-	-	-	-	376	376
<u>Total (2)</u>	-	-	-	-	<u>678</u>	<u>678</u>
<b>3. Rural Road</b>	-	-	-	-	2,220	2,220
<b>4. Rural Water Supply</b>	-	-	259	-	-	259
<b>5. Cottage Industry</b>						
- Silk Weaving	-	-	-	-	270	270
<u>Total (5)</u>	-	-	-	-	<u>270</u>	<u>270</u>
<b>6. Building</b>						
- Project Office	-	-	600	-	-	600
- Training Center	-	-	-	-	680	680
<u>Total (6)</u>	-	-	<u>600</u>	-	<u>680</u>	<u>1,280</u>
<b>7. Equipment for Training</b>	-	-	500	-	-	500
<u>Total (1 ~ 7)</u>	-	-	<u>17,996</u>	<u>27,047</u>	<u>13,041</u>	<u>58,084</u>
<b>8. Land Acquisition</b>	-	-	175	300	-	475
<b>9. Survey and Investigation</b>	3,684	-	-	-	-	3,684
<b>10. Administration</b>	290	290	720	1,092	511	2,903
<b>11. Consulting Service</b>	1,368	3,434	2,080	1,784	1,189	9,855
<u>Base Cost (1 ~ 11)</u>	<u>5,342</u>	<u>3,724</u>	<u>20,971</u>	<u>30,223</u>	<u>14,741</u>	<u>75,001</u>
<b>12. Physical Contingencies</b>	534	372	2,098	3,023	1,474	7,501
<b>13. Price Escalation</b>	443	438	3,003	5,964	3,646	13,494
<u>Total Cost (1 ~ 13)</u>	<u>6,319</u>	<u>4,534</u>	<u>26,072</u>	<u>39,210</u>	<u>19,861</u>	<u>95,996</u>

TABLE IX - 4 MODEL PROJECT COST : KHLONG SAI PROJECT

- Unit : Baht 1,000 -

Cost Item	1992	1993	1994	1995	1996	Total
1. Irrigation						
- Dam	-	-	23,752	33,717	-	57,469
- Canal	-	-	-	3,140	8,685	11,825
- On-farm Works	-	-	-	-	1,062	1,062
- Overhead Cost	-	-	3,431	7,570	1,769	12,770
<u>Total (1)</u>	-	-	<u>27,183</u>	<u>44,427</u>	<u>11,516</u>	<u>83,126</u>
2. Agricultural Development						
- Sericulture	-	-	-	-	906	906
- Livestock	-	-	-	-	721	721
- Inland Fisheries	-	-	-	-	654	654
<u>Total (2)</u>	-	-	-	-	<u>2,281</u>	<u>2,281</u>
3. Rural Road	-	-	-	-	308	308
4. Rural Water Supply	-	-	388	-	-	388
5. Cottage Industry						
- Silk Weaving	-	-	-	-	270	270
- Jewel Polishing	-	-	-	-	450	450
<u>Total (5)</u>	-	-	-	-	<u>720</u>	<u>720</u>
6. Building						
- Project Office	-	-	600	-	-	600
- Training Center	-	-	-	-	680	680
<u>Total (6)</u>	-	-	<u>600</u>	-	<u>680</u>	<u>1,280</u>
7. Equipment for Training	-	-	500	-	-	500
<u>Total (1 ~ 7)</u>	-	-	<u>28,671</u>	<u>44,427</u>	<u>15,505</u>	<u>88,603</u>
8. Land Acquisition	-	-	75	750	-	825
9. Survey and Investigation	3,805	-	-	-	-	3,805
10. Administration	443	443	1,134	1,772	638	4,430
11. Consulting Service	2,122	5,324	3,225	2,766	1,843	15,280
<u>Base Cost (1 ~ 11)</u>	<u>6,370</u>	<u>5,767</u>	<u>33,105</u>	<u>49,715</u>	<u>17,986</u>	<u>112,943</u>
12. Physical Contingencies	637	577	3,310	4,971	1,799	11,294
13. Price Escalation	542	678	4,668	10,143	4,424	20,455
<u>Total Cost (1 ~ 13)</u>	<u>7,549</u>	<u>7,022</u>	<u>41,083</u>	<u>64,829</u>	<u>24,209</u>	<u>144,692</u>

TABLE IX-5 PROJECT COST OTHER THAN MODEL PROJECT

- Unit : Baht 1,000 -

Cost Item	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Field Operation		Total
					Center	Center	
Construction	462,526	299,229	433,901	224,892	840	1,421,388	
Equipment	-	-	-	-	151,570	151,570	
Land Acquisition	500	594	1,668	868	-	3,630	
Survey and Investigation	5,107	3,792	5,929	2,344	-	17,172	
Administration	20,501	14,962	18,897	10,153	-	64,513	
<u>Total (1)</u>	<u>488,634</u>	<u>318,577</u>	<u>460,395</u>	<u>238,257</u>	<u>152,410</u>	<u>1,658,273</u>	
Physical Contingencies	97,727	63,715	92,079	47,652	15,241	316,414	
Price Escalation	93,322	59,488	89,454	45,105	25,238	312,607	
<u>Total (2)</u>	<u>191,049</u>	<u>123,203</u>	<u>181,533</u>	<u>92,757</u>	<u>40,479</u>	<u>629,021</u>	
<b>Total Cost</b>	<b>679,683</b>	<b>441,780</b>	<b>641,928</b>	<b>331,014</b>	<b>192,889</b>	<b>2,287,294</b>	



## **CHAPTER X PROJECT EVALUATION**



## **CHAPTER X PROJECT EVALUATION**

### **X-1 GENERAL DESCRIPTION**

#### **X-1-1 Project Component**

The major objective of the study is to formulate an integrated rural development in the 4 provinces of Phitsanulok, Sukhothai, Kamphaeng Phet and Tak, of which major components are (a) irrigated agriculture development, (b) rural road development, (c) rural water supply, (d) rural infrastructure and (e) others. Although those components indicated as above are basic for an integrated rural development, some components are not suitable for ARD's current activities. And item (e) others include a reinforcement plan for ARD Kamphaeng Phet Field Operation Center (KPFOC).

In this study, in order to quickly implement an integrated rural development project in the Lower North Thailand, the following items are considered main theme;

- to formulate an overall plan which shall be involved in ARD's 7th 5-year Plan; and
- to conduct a feasibility study for the model projects which have been selected one for each province during the Phase (1) field survey.

#### **X-1-2 Method of Evaluation**

Method of project evaluation consists of (a) economic evaluation which focuses on efficient utilization of limited resources from national economic point of view, (b) financial analysis on the basis of balance in revenue and expenditure of beneficial farmers and implementing body, (c) social evaluation putting more emphasis on income equity, and (d) environmental impact study by project implementation. The project evaluation for this study shall be carried out by combining the above methods, taking into consideration availability of the required data for the respective analysis.

Generally, an economic evaluation shall be based on an economic internal rate of return (EIRR) with its sensitivity analysis. The EIRR is a discount rate which makes present worth values of cost and benefit over the analysis period equal, and it can be worked out by applying several discount rates for streams of economic cost and benefit. For calculation of tangible cost and benefit, economic prices (accounting prices) shall be applied. A sensitivity analysis is one of effective way to examine and judge project risks during its implementation and operation, and is measured by computing EIRR with change of key factors which are composed of the proposed project.

A financial analysis is one of methods to judge sustainability of a project. In this study, it shall be based on incremental farm economic surplus of typical size of beneficial farmers with its farm budget analysis. All prices to be applied in the farm budget analysis are derived on the basis of their market prices which include taxes and subsidies. Based on the incremental farm economic surplus, repayment capacity (operation and maintenance cost as well as initial investment cost) of beneficial farmers shall be analyzed.

## X-2 PRICES

All prices to be applied have been estimated on the basis of the recent available information and data so far obtained as of the beginning of 1991. Out of input and output, the internationally traded goods and services have been estimated on the basis of their border prices, by quoting "Price Forecast for Major Primary Commodities" published by the World Bank. In addition, in order to calculate their economic prices of internally traded goods and services, the following conversion factors have been quoted from the recent information provided by the Word Bank:

Standard conversion factor .....	0.92
Conversion factor for consumption .....	0.95
Conversion factor for margin of middleman etc. ....	0.64
Conversion factor for construction .....	0.88
Conversion factor for transportation .....	0.80
Conversion factor for farm labour .....	0.92

Table X-1 summarizes both economic and financial farmgate prices of agricultural input and output at 1991 constant prices.

### **X-3 ECONOMIC PROJECT BENEFIT**

#### **X-3-1 General**

In general, the project benefit for each project component shall be computed by an incremental tangible one in monetary terms between "with project" case and "without project" case. Table X-2 summarizes the estimated economic benefit by project component, of which calculation basis is given hereinafter.

#### **X-3-2 Irrigated Agriculture**

A benefit of irrigated agriculture is basically computed as an incremental net production value of crop cultivation between without and with project cases. The net production value of crop can be obtained by deducting production cost from gross production value of respective crop which is result of multiplying yield and price of each crop. In the case of this study, an incremental crop production shall be brought by an irrigation water through either a storage dam or a diversion weir in the existing streams.

##### **(1) Storage Project**

There are 4 dam projects, one each for 4 model project areas covering total irrigable area of 2,165 ha, consisting of 1,022 ha in the Huai Sam Ru area in Phitsanulok province, 574 ha in the Huai Nong Kho area in Sukhothai province, 179 ha in the Khlong Samo Khon area in Kamphaeng Phet province and 390 ha in the Khlong Sai area in Tak province. Through implementation of the dam projects, the anticipated agricultural benefit is estimated at about 39.36 million Bahts at full production stage (See Table X-2). The dam projects are also included in the overall plan.

## (2) Diversion Project

In the model project, none of diversion project is planned, but total of 26 projects are planned under the overall plan, covering total irrigable area of 7,140 ha, consisting of 1,080 ha with 5 projects in Phitsanulok province, 1,210 ha with 4 projects in Sukhothai province, 2,580 ha with 9 projects in Kamphaeng Phet province and 2,270 ha with 8 projects in Tak province. The projects would produce about 30.39 million bahts as agricultural benefit (See Table X-2).

### X-3-3 Rural Road

On the basis of the proposed plan for the rural road development with its alignment under the overall plan, road beneficiaries, especially those for backward villages were identified in the following.

<u>Province</u>	<u>Road Length</u> (km)	<u>Village</u>	<u>Household</u>	<u>Population</u>	<u>Farming Area</u> (rai)
Phitsanulok	391.4	149	19,572	93,834	587,732
Sukhothai	251.6	112	14,251	67,484	323,648
Kamphaeng Phet	367.0	184	26,357	134,920	736,899
Tak	119.5	122	12,749	67,453	210,216
Total	1,129.5	567	72,929	363,691	1,858,495

On the other hand, estimation of saving of vehicle operation cost (VOC) is worked out below, of which details are compiled in Appendix I-3-2.

<u>Province</u>	<u>Without Project</u>	<u>With Project Case</u>		
		<u>ARD STD</u>	<u>S.R.-1</u>	<u>S.R.-2</u>
- Average Speed (km/hr)	10	45	35	30
<u>Economic Base (B/km/unit)</u>				
- Fixed Cost	2.60	0.43	0.55	0.63
- Variable Cost	4.79	1.83	2.35	2.73
- <u>Total VOC</u>	<u>7.39</u>	<u>2.26</u>	<u>2.90</u>	<u>3.36</u>
- Saving of VOC	-	5.13	4.49	4.03

Assuming an average daily traffic (ADT) in whole study area would be 100 vehicles after completion of the road projects, the project benefit could be estimated at 139.63 million Bahts and 5.7 million Bahts for the overall plan

and for the model projects, respectively, taking into consideration the expected traffic volume by each planned road alignment (See Table X-2 and Appendix I-3-2).

#### **X-3-4 Rural Water Supply**

The component of rural water supply is considered one of the basic minimum needs. It is one of responsibilities laying on an administrative authority concerned to stably secure drinking water with good quality for all inhabitant throughout a year. For this purpose, it is necessary to invest a certain amount for securing water sources and constructing treatment and distribution facilities, and thus a beneficiary should bear a full and/or part of these investment. Usually, a benefit of the component is calculated as a "willingness to pay" by beneficiaries. In this connection, the prevailing water charge collected by PWA in the study area is based for estimation of the willingness to pay. The expected benefit arising from the component could be estimated at 21.6 million Baht for 411 villages under the overall plan, and 0.8 million Bahts for 13 villages under the model projects (See Table X-2 and Appendix I-3-3).

#### **X-3-5 Inland Fishery**

In the 4 reservoirs under the model projects as well as the planned fish ponds under overall plan, fish catch could be expected. In every reservoir and fish pond, about 30,000 fingerlings per hectare of water surface area be released once a year, and a half of them could be caught after 10 to 12 months with expected production of 1.5 tons per ha. Eventually, 18.5 million Bahts and 0.4 million Bahts would be expected as fishery benefit under the overall plan and the model projects, respectively (See Table X-2 and Appendix I-3-4).

#### **X-3-6 Rural Infrastructure**

Users of some facilities in this component are unspecified and it is considered adequate to define as a part of public services in the regional administration. However, it is expected that positive participation of women and youth to the project in connection with provision of meeting hall and vocational training facilities.

## X-4 ECONOMIC EVALUATION

### X-4-1 Economic Cost

After deducting the price contingency from the estimated financial initial investment, the economic costs (initial investment cost and operation and maintenance cost) have been computed by applying the conversion factor of construction works (0.88) as summarized below;

	<u>SUMMARY OF PROJECT COST</u>			
	<u>Financial Cost</u>		<u>Economic Cost</u>	
	<u>Initial Cost</u>	<u>O &amp; M Cost</u>	<u>Initial Cost</u>	<u>O &amp; M Cost</u>
(1) <u>Model Project</u>				
- Huai Sam Ru	198,939	2,529	148,396	2,226
- Huai Nong Kho	216,033	2,756	161,679	2,425
- Khlong Samo Khon	95,996	1,085	63,653	955
- Khlong Sai	144,692	1,864	109,329	1,640
<hr/>				
(2) <u>Overall Plan</u>				
- Phitsanulok	878,622	11,325	664,392	9,966
- Sukhothai	657,813	8,490	498,096	7,471
- Kamphaeng Phet	737,924	9,525	558,779	8,382
- Tak	475,706	6,152	360,929	5,414
- KPFOC	189,563	2,474	145,122	2,177
Total	2,939,828	37,966	2,227,318	33,410

### X-4-2 Economic Internal Rate of Return and Sensitivity Analysis

A period of analysis for calculating an economic internal rate of return is fixed at 50 years, on the basis of synthetic durable life of various major project facilities with premise that they will be properly operated and maintained. In considering 4 year of gestation period until attaining full benefit in the component of irrigated agriculture, economic rates of return have been computed by discounting both streams of economic cost and benefit over the period of analysis with several discount rates as well as by applying linear interpolation method. On the other hand, for the purpose of judging project risks during the implementation and operation, changes of the EIRR have been



worked out in connection with movement of various key factors of the projects. The results of the said analyses are summarized in the following;

**ECONOMIC INTERNAL RATE OF RETURN AND SENSITIVITY**

- Unit: %

(1) Model Projects

<u>Case</u>	<u>Huai Sam Ru</u>	<u>Huai Nong Kho</u>	<u>Khlong Samo Khon</u>	<u>Khlong Sai</u>
- Original Case	7.0	4.9	3.1	5.5
- Project Benefit 10% Down	6.2	4.1	2.4	4.9
- Project Cost 10% Up	6.3	4.2	2.5	5.0
- Crop Yield 10% Down	5.7	3.8	1.9	4.5
- Construction 1 Year Delay	6.5	4.6	2.9	5.3

(2) Overall Plan

<u>Case</u>	<u>Phitsanulok</u>	<u>Sukhothai</u>	<u>Kamp. Phet</u>	<u>Tak</u>	<u>Total</u>
- Original Case	8.0	7.5	9.5	8.2	7.8
- Project Benefit 10% Down	7.3	6.7	8.6	7.4	7.0
- Project Cost 10% Up	7.4	6.8	8.7	7.5	7.1
- Crop Yield 10% Down	7.4	6.9	9.1	7.2	7.1
- Construction 1 Year Delay	7.7	7.2	9.1	7.9	7.5

In the above analyses, while any case of EIRR in both the model projects and the overall plan, is lower than the marginal productivity (opportunity cost) of capital in Thailand, which is ranging from 10 to 12 percent, it is considered not reasonable to judge appropriateness of implementation of the proposed projects/plan by the reason of only low economic feasibility. Because the proposed integrated rural development plan put more emphasis on backward villages so as to make contribution to such primary objectives in the 7th National Plan "to smooth out regional income differential" and "to eradicate poverty", for which due attention be usually not paid from efficient allocation of limited resources.

**X-5 FINANCIAL ANALYSIS FOR MODEL PROJECT**

**X-5-1 Farm Budget Analysis**

In order to evaluate a financial impact on beneficiary farmers through implementation of the proposed model projects, farm budget analysis for typical farms has been made in cases of "without" and "with" project. The size of the

typical farms has been derived from the result of the farm economic survey for 257 farms in the 4 model project areas, namely, 3.62 ha in Huai Sam Ru, 3.49 ha in Huai Nong Kho, 1.75 ha in Khlong Samo Khon and 3.04 ha in Khlong Sai. In addition, the result has been referred for off-farm income, household expenditure and so forth. Table X-3 gives such basic information to be used in this analysis as farming pattern by area, etc.

No off-farm income is considered for the 3 model project areas of Huai Sam Ru, Huai Nong Kho and Khlong Sai, in which the typical farm size exceeds 3 ha and farmers shall be concentrating on their farming only. On the other hand, farmers in Khlong Samo Khon area will be able to earn a half of the present off-farm income, taking into consideration workable capacity as off-farm labor, because the typical farm size is as smaller 1.75 ha than the other areas.

On the basis of the information given in Table X-3, the farm budget analysis has been carried out by area and farming type. Incremental farm economic surpluses between without and with project cases, have been worked out 8,357 Bahts with farming type of "upland crops + mulberry" in Khlong Sai area as the lowest, and 58,577 Bahts with "upland crops + orchard" in Huai Nong Kho area as the highest, summarized in the following (See Appendix I-4);

#### INCREMENTAL FARM ECONOMIC SURPLUS

- Unit: Baht/farm -

<u>Farming Type *1</u>	<u>Huai Sam Ru</u>	<u>Huai Nong Kho</u>	<u>Khlong Samo Khon</u>	<u>Khlong Sai</u>
Type-0	26,073	22,371	11,525	25,422
Type-1	28,848	14,608	-	-
Type-2	-	-	10,201	18,182
Type-3	-	-	10,837	-
Type-4	46,643	22,533	-	35,995
Type-5	28,788	14,856	10,168	-
Type-6	17,664	30,978	-	-
Type-7	25,760	58,577	-	41,068
Type-8	-	-	-	8,357

Note : \*1 Refer to Table X-3

## **X-5-2 Repayment Capacity of Beneficiary Farmers**

As basic data on farmers' repayment capacity, the farm budget analysis as mentioned above provides one of indicators, in which a part of incremental farm economic surplus arising from the implementation of the projects, becomes a basis for calculating the capacity. In this case, it is a general rule that a beneficiary who enjoys higher profit from the project should bear heavier burden of its cost. Supposing the repayment capacity of farmers is 50 percent of the incremental farm economic surplus, after allocating another 50 percent for improving their living standard, it would be ranging widely from 4,178 Bahts to 29,288 Bahts per farm.

On the other hand, preliminary computation on farmers' burden for the operation and maintenance cost of the irrigation facilities, works out 3,924 Bahts in Huai Sam Ru area, 6,216 Bahts in Huai Nong Kho area, 4,263 Bahts in Khlong Samo Khon area and 6,475 Bahts in Khlong Sai area. According to the result, only farmers who belong to the farming type-8 in Khlong Sai area could bear 65 percent of the burden, and the other farmers can bear the full burden of the operation and maintenance cost.

## X-6 DEDUCTIVE CONCLUSION

The ARD, an implementing agency of the project, faces the following specific features and limitations;

- ARD is, mainly, carrying out its development activities in the backward villages and the frontier, in which developmental attention is usually not paid because of lower efficiency of the national economy.
- ARD projects do not include the construction of a large-scale storage dam which is essential for providing water source needed by an irrigated agriculture, thus most of all ARD' projects could not enjoy so-called scale-merit.
- Because of location of beneficial farmers in this project, they are difficult to easily access to public services like an agricultural extension, and obliged to remain quite low level in their farming technology. When the proposed project is, therefore, formulated, it cannot be ignored that they should rely on the traditional farming method on the basis of cultivating paddy under rainfed condition. In other words, it is considered unrealistic to introduce an advanced farming since the beginning of the project implementation.

Under the said circumstances, the economic feasibility of the overall plan as well as the model projects for the four provinces in terms of an economic internal rate of return does not satisfy the opportunity cost of capital in Thailand, which is one of standard to judge a justification of an investment project. However, the financial analysis on the model project forecasts considerable increase in farm income of beneficiaries, through which it is obvious that the proposed project would contribute to eradicate poverty in the region as well as correct regional income differential. Furthermore, the following secondary and other benefits could be expected through the implementation of the proposed project;

- Introduction of dry season farming as well as cottage industries would create new employment opportunity in the region.

Especially, mobilization of the women and the youths would give great impact to the region.

- By securing the new employment opportunity, transmigration from rural areas to urban areas could be controlled.
- Rural environment would be satisfactorily maintained through preservation of forest resources and farmland.
- It is expected to stabilize civil administration in the region through increase in income and improvement of living standard of rural people.

Through comprehensive judgment on the primary benefit used in the economic evaluation as well as the secondary and other benefits stated above, it can be deductively concluded that the overall plan and the model projects are economically and financially feasible for their further implementation.

**TABLE X-1 ECONOMIC AND FINANCIAL FARMGATE PRICES  
(1991 Constant Price)**

	Unit	Year 2000	
		Financial	Economic
<u>Crop</u>			
Paddy	Baht/ton	3,696	4,291
Maize	"	2,212	2,545
Soybean	"	6,525	6,458
Groundnuts	"	8,200	8,940
Sugarcane	"	330	360
Cassava	"	650	710
Vegetables (Tomato)	"	2,000	1,840
Orchard (Mango)	"	7,380	8,040
Bamboo Shoot	"	5,980	5,500
Upland Rice	"	2,900	3,160
Sesame	"	20,500	18,860
Mulberry (Cocoon)	"	70,000	73,290
Feedgrass	"	350	320
<u>Fertilizer</u>			
Urea	Baht/ton	7,454	6,831
T.S.P.	"	7,247	6,609
Potassium Chloride	"	5,127	4,669
Nutrient Basis - N	Baht/Kg	16.2	14.9
- P	"	16.1	14.7
- K	"	8.5	7.8
<u>Farm Labor</u>			
Average	Baht/man-day	45	41.4
<u>Agr. Machinery</u>			
Hand Tractor	Baht/hour	19.2	15.2
Medium-size Tractor	"	318.1	213.4
Thresher (4 ton/hr)	"	161.5	108.1
Pump (Low-lift)	"	16.1	13.3

TABLE X-2 SUMMARY OF ECONOMIC BENEFIT

- Unit : B 1,000 -

	Model Project						Overall Plan				
	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai	Phitsanulok	Sukhothai	Kamphaeng Phet	Tak	Total		
<u>Irrigated Agriculture</u>											
(1) Dam Project											
- Irrigable Area (ha)	(1,022)	(574)	(179)	(390)	(1,022)	(574)	(179)	(390)	(2,165)		
- Crops N.P.V.	5,365	4,129	1,730	2,264	5,365	4,129	1,730	2,264	13,488		
- Bamboo N.P.V. *1	2,161	930	-	-	2,161	930	-	-	3,091		
- Orchard N.P.V. *1	8,579	4,596	613	8,988	8,579	4,596	613	8,988	22,776		
- Sub-total	16,105	9,655	2,343	11,252	16,105	9,655	2,343	11,252	39,355		
(b) Weir Project											
- Irrigable Area (ha)	-	-	-	-	(1,080)	(1,210)	(2,580)	(2,70)	(7,140)		
- Crops N.P.V.	-	-	-	-	5,963	4,803	12,064	7,557	30,387		
(c) Total N.P.V.	<u>12,122</u>	<u>13,638</u>	<u>3,466</u>	<u>11,252</u>	<u>22,068</u>	<u>14,458</u>	<u>14,407</u>	<u>18,809</u>	<u>69,742</u>		
Rural Road											
- Road Length (km)	15.5	35.0	1.0	0.9	391.4	251.6	367.0	119.5	1,129.5		
- Total Saving of VOC	1,744	3,635	123	162	44,048	26,130	45,253	21,501	136,932		
<u>Village Water Supply</u>											
- Beneficial Village (No.)	2	4	2	4	126	85	150	50	411		
- Total Water Charge	164	266	77	264	6,885	5,658	5,791	3,295	21,629		
- Pond Area (ha)	3.70	1.88	3.13	5.30	149.3	272.8	241.0	41.9	704.5		
- Total N.P.V.	97	49	82	139	3,915	7,153	6,319	1,099	18,486		

Note: \*1 At full production stage

TABLE X-3 BASIC INFORMATION ON FARM BUDGET

	Unit	Huai Sam Ru	Huai Nong Kho	Khlong Samo Khon	Khlong Sai
1. Farm Size *1	ha	3.62	3.49	1.75	3.04
2. Family Size *1	person	4.7	5.0	4.7	6.2
3. Cropped Area					
- Without	ha	3.45	3.41	1.64	3.02
- With *2	ha	4.37 ~ 5.07	4.37 ~ 5.07	2.11 ~ 2.19	3.04 ~ 3.89
4. Cropping Intensity					
- Without	%	95	98	94	99
- With	%	121 ~ 140	125 ~ 145	121 ~ 125	100 ~ 128
5. Off Farm Income *1					
- Without	Baht	5,281	12,832	13,537	11,871
- With	Baht	-	-	6,768*3	-
6. Household Expenditure *1					
- Without	Baht	12,524	12,371	10,966	16,853
- With	Baht	12,524	12,371	10,966	16,853
7. Farming Type					
Type-0 (Proposed Crop Pattern)		○	○	○	○
Type-1 (Paddy + Upland Crop)		○	○	-	-
Type-2 (Paddy + Vegetables)		-	-	○	○
Type-3 (Paddy + Sugarcane)		-	-	○	-
Type-4 (Paddy + Orchard)		○	○	-	○
Type-5 (Paddy + Mulberry)		○	○	○	-
Type-6 (Upland Crops + Bamboo)		○	○	-	-
Type-7 (Upland Crops + Orchard)		○	○	-	○
Type-8 (Upland Crops + Mulberry)		-	-	-	○

Note: \*1 Based on the farm economic survey

\*2 Depending upon farming type

\*3 Because of smaller farm size than other areas, a half of the present off-farm income is taken into account.