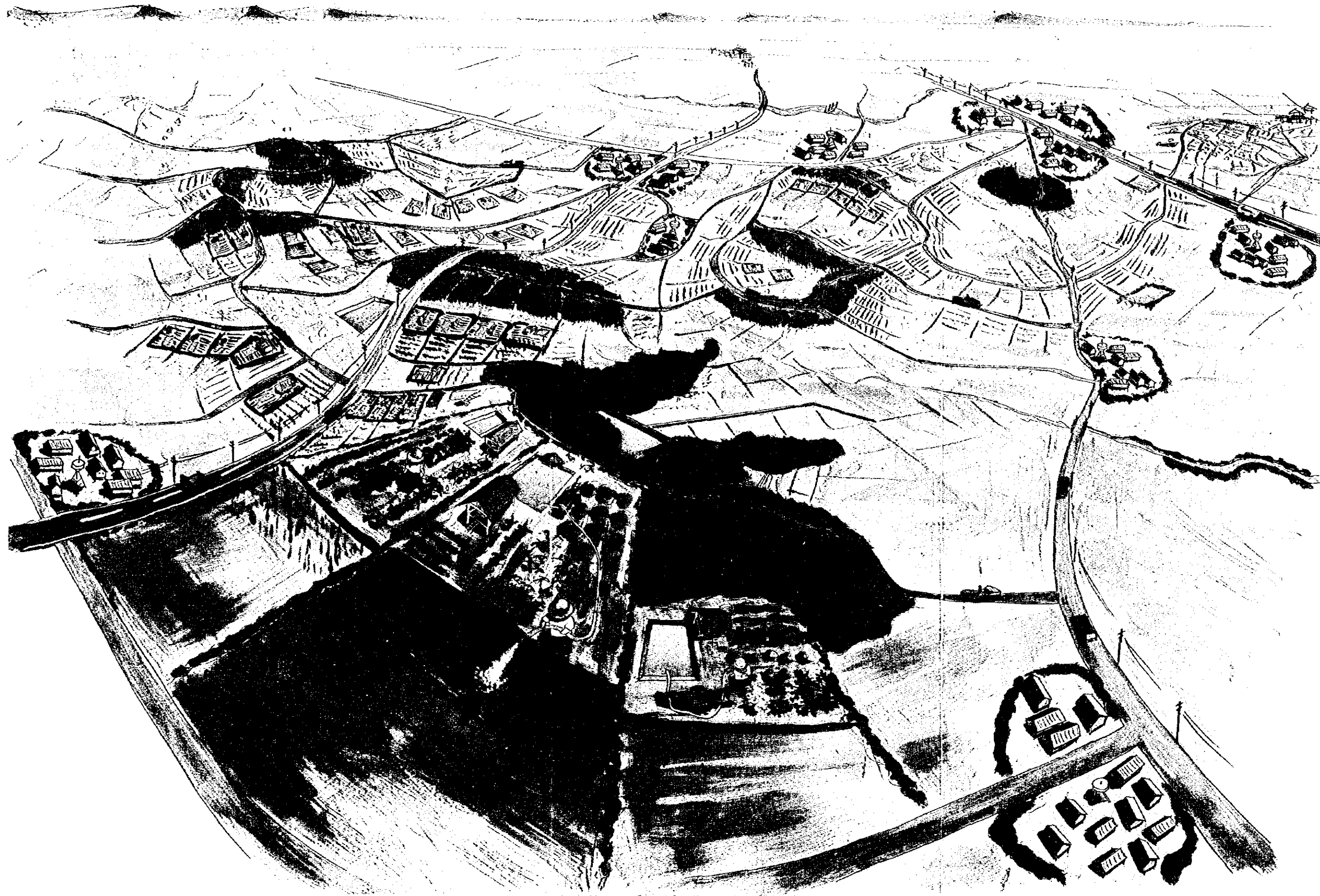


CHAPTER 8 MAHA SARA KHAM PRIORITY AREA (No. 5 LRA)

INTEGRATED AGRICULTURE DEVELOPMENT IN MAHASARAKHAM PRIORITY AREA (MHS-5 LRA)

The Feasibility Study on The Integrated Agriculture Development in The Agricultural Land Reform Areas in The Upper Northeastern Region, The Kingdom of Thailand
AIRO (MOAC), JICA, March 1998 (SANYU Consultants INC.)



CHAPTER 8 MAHA SARAKHAM PRIORITY AREA (No. 5 LRA)

8.1 Present Condition of the Area

8.1.1 Location, Area and Population

The Maha Sarakham Priority Area is completely covered the LRA, MHS-5, Khok Phuk Kut and Pong Kaeng Forest. The Priority Area is located about 50 km. southwest of Maha Sarakham province, which is administratively composed of Tambon Non Daeng and Don Nqua, Amphoe Borabu and Tambon Nong Rua, Amphoe Na Chuk. The area is located mostly in Tambon Non Daeng of Amphoe Borabu and Tambon Nong Rua, Amphoe Na Chuk. Highway No. 219 runs from north to south through the west of the area and the road from Borabu to Na Dun runs from north to south through the eastern sector.

The Maha Sarakham Priority Area consists of all of LRA MHS-5 with a total land area of 18,200 rai and a farmland of 14,600 rai. The average size of farm land in LRA, MHS-5 is estimated at about 12 rai per household. The area is in non-municipal areas and outside sanitary districts which is considered rural. The Priority Area covers four villages in Amphoe Borabu and three villages in Amphoe Na Chuk. Most villages are adjacent to the Priority Area. There are 3,694 people living in 746 households in seven villages in the area with the average family size of five persons per household. The people in the area work in the agriculture sector. The results of the Study Team Survey in 1997 indicated that about 95 per cent of the population in the area have primary education and the remaining 5 per cent have secondary education.

The names of villages, population, households, average family size per household, and village land of some selected villages in the priority area can be summarized as follows:

Table 8.1-1 Administrative Summary of MHS-5 Priority Area

Province Amphoe	Tambon	Village	Muban	Household	Population	Ave. Family Size (person/H.H)	Villageland " (rai)
Maha Sarakham							
Borabu	Non Daeng	Sala	8	171	864	5.05	3,981
		Non Thong	9	124	662	5.34	2,613
		Non Sa-at	13	67	313	4.67	1,300
	Don Nqua	Nong Kham	13	77	414	5.38	*2,500
Na Chuk	Nong Rua	Ta-Lai Muang	1	142	717	5.05	3,433
		Nong Po	2	92	465	5.05	1,627
		Hua Kao Taek	3	73	259	3.55	1,328
Total				746	3,694	4.95	6,782

Source: Interviewing local leaders by Study Team November, 1997

" Kor Chor Chor 2 Khor 1996

* Kor Chor Chor 2 Khor 1994

Total households are about 750 in the concerned 7 villages, while the land holding farmers in the priority area are 1,220. From this fact, about 470 farmers are supposed living in other villages than the 7 villages.

8.1.2 Topography and Geology

Mahasarakham Priority Area has an area of 18,200 rai (2,900 ha), which is a whole part of MHS-5 LRA. Land reform area shares 13,246 rai (2,100ha) that is equivalent to 73% of the area. It locates on an isolated hilly mound in the flat land. Its elevation ranges from EL.160m to EL.205m, and slope from 0.5% to 4.7%. Silty soils are washed away, and sandy soils are dominant at the top layer in the area as similar as KK-6 Priority Area. Most areas are cultivated with upland crops in higher elevation so that soils are suffered from erosion at the steeper slope when heavy rain hits the area. The steep sloping land over 5% gradient shares only 0.5% or 70 rai in the area, where soils are suffered from erosion. Silty soils are deposited in the depressed area at the valley so that paddy fields are extent in such valley. Small individual farm ponds are also extent in such valley, which are used for supplemental irrigation for paddy.

Silt or silty clay soils lies at the depth of 1.5 m to 2.0 m from ground surface even at the hilly mound. Farm ponds can retain water in such topography if enough depth is provided.

8.1.3 Meteorology and Hydrology

1) Meteorology

At the city of Kosum Phisai in Maha Sarakham province, monthly mean temperature changes from 23.0°C in December to 30.7°C in April and mean of monthly maximum is 36.5°C in April from the data of 30 year from 1965 to 1994. The maximum temperature of this period recorded 42.4°C in April and minimum 5.5°C during November to January with fairly large difference.

Mean relative humidity changes 61% in March to 79% in August and annual comes to 72%.

Mean rainfall at Kosum Phisai city is 1,194 mm and rainy day counted more than 10 during May and September with 16 and 17 days in August and September. Annual rainy day is 100. Rainfall station (code 21292) is applied as representative for this priority area, it rains annually 1,002 mm as average of 1985 to 1995 changing from 600mm in 1985 to 1,538 mm in 1995. It rains 92% of annual rainfall during the period from April to October.

2) Hydrology

50% of this priority area are calculated to belong the range of less than 2 cu.m/hr as expected well yield, 40% to range of 2-10 cu.m/hr and 10% to range of 10-20 cu.m/hr respectively by means of the Groundwater Map by GREP, Department of Mineral Resources.

Table 8.1-2 Expected Well Yield in MHS-5 Priority Area

Area (ha)	Area Ratio by Well Yield			
	< 2 m ³ /hr	2 - 10 m ³ /hr	10 - 20 m ³ /hr	> 20 m ³ /hr
2085	50%	40%	10%	0%

High chloride density zone is extended in northern and southern part of the province in complicated condition. MHS-5 is located in middle-south part of the province with chloride density less than 200 mg/lit (Cl.) concentration.

Table 8.1-3 Groundwater quality in MHS-5 Priority Area

Study Area No.	Acreage		Water quality mg/lit(Cl)			
	A (rai)	A (ha)	< 200	200 - 600	600 - 1,000	> 1,000
MHS - 5	13,030	2,085	100%			

8.1.4 Soil and Land Use

1) Soil

Soil in Maha Sarakham Priority Area consists of different groups namely 20 & 18, 22 & 24, 35B & 41B, 36/18, 36B/41B, 40/41, 41/35, and 41B/24B as shown in Appendix E, Figure E-6 : Soil Map of Maha Sarakham Priority Area. From these soil groups No 41B/24B occupy about 62% or 11,250 rai of the total land area, and about 16% or 2,820 rai belongs to group No 36B/41B. The rest occupy only a small area as shown in Table 8.1-4 : Soil Groups in Priority Area (No.5 LRA).

Most of the soils are Loamy Paleustults and Sandy Quartzipsamments as shown in Appendix E, Table E-6.

The characteristic of the soil are loamy sand and sandy loam in texture, low in organic matter. Soil pH is 4.5 - 5.5 for Loamy Paleustults and 5.0 - 7.0 for Sandy Quartzipsamments. Most of the soil is moderately suited to tree crops and grass as shown in Appendix E, Table E-7 and E-8.

Table 8.1-4 Soil Groups in MHS-5 Priority Area

Soil Group	Land Area (rai)	Percentage (%)
20 & 18	150	0.9
22 & 24	360	2.0
35B & 41B	1,050	5.7
36/18	530	2.9
36B/41B	2,820	15.5
40/41	1,710	9.4
41/35	330	1.8
41B/24B	11,250	61.8
Total	18,200	100.0

2) Land Use

Land use in Maha Sarakham Priority Area comprise of three Tambons, in two Amphoes with total farm land of 14,600 rai. Rice is the main crop about 46% in the area of 6,690 rai follow by upland crop mainly cassava which is about 33% or 4,824 rai and about 13% (1,880 rai) is under sugarcane. Mulberry is cultivated in almost every household at the small area ranging from 0.25 rai to one rai with the total area of about 500 rai or about 3.4%. Fruit tree occupy 4% or 600 rai and vegetables occupy only 0.7% or 106 rai which is smallest area as shown in table below.

Table 8.1-5 Present Land Use in MHS-5 Priority Area

Priority Area (rai)	Agricultural Land (rai)	Paddy Land (rai)	Cassava (rai)	Sugarcane (rai)	Fruit Tree Area (rai)	Vegetables Area (rai)	Mulberry Area (rai)	Maize (rai)	Fallow (rai)
Maha Sarakham	14,600	6,690 (45.8%)	4,824 (33.1%)	1,880 (12.9%)	600 (4.1%)	106 (0.7%)	500 (3.4%)	-	-

Source : Department of Agricultural Extension, 1996

8.1.5 Agricultural Infrastructure

1) Water Resources

Water resources in MHS-5 priority area are also limited as same as KK-6 priority area that is similar in topographical conditions. Surrounding lower flat area of this priority area is recently developed with dredging type projects. However, these projects are located in outside of the priority area. Although water resources of this priority area had been developed since many years by means of small reservoirs and community ponds, these reservoirs and ponds are irrigating 105 rai of paddy but in the titled lands in the priority area.

a) Community Pond

All villages in MHS-5 Priority Area have community pond in the village, and total number of ponds are 17 ponds. Main purposes of utilization are irrigation for the surrounding area by bucket or house and for the livestock water. Only one community pond in Ta-lat Muang. is utilized for fisheries. Most community ponds are utilized efficiently except one pond in Ban Sala due to pollution of water. Water collectivity is high in four villages while poor in three villages mainly due to insufficient catchment area. Retention capacity is generally high except in Hua Kao Tack due to high seepage. Those community ponds are excavated type so that increase of capacity can not be largely expected by excavation. Since most lands are cultivated, there is no land for new community ponds..

Table 8.1-6 Community Ponds and Utilization in MHS-5 Priority Area

Village	General Information of Community Pond		Reasons of none effective utilization				Purpose of Utilization				Collecting Capacity of Runoff				Retention Capacity														
	Number of Ponds	constructed by	efficiently utilized?	water pollution	distraction of dike	seepage	sediment	weeds	Irrigation	Livestock water	Drinking water	Domestic water	Fisheries	Swimming	Environment	Collecting of runoff	Enough catchment	Enough collecting canal	Poor catchment Area	Poor collecting canal	Water retention Capacity	Blanket pavement	Good maintenance of dike	Good impermeable soil	High seepage	High evaporation	High leakage through dike	sediment	
41) Sala	1	RID	no	1					1	1					good					good									
42) Non Theeg	1	ARD	yes												good					good									
43) Non Sa-at	2	Tambon	yes						1	1					good					good									
44) Nong Khan	2	RID	yes						1	1					poor				1	good									
45) Sa Baeng	1	ARD							1											good									
46) Ta-lat Muang	4	PWD, Tambon	yes										1		good		1			good				1					
47) Nong Bo	2	community	yes						1	1					poor					good									
48) Hua Kao Tack	4	ARD	yes						1	1					poor				1	poor									

(Note) based on Interview to the village leaders

b) Wells

Wells are not commonly utilized except for village water source in this area.

2) Farm Pond

Individual small farm ponds are well developed and counted totally at 260 ponds in this area. It equivalent to 23% of farmers having a farm pond. Average size of farm pond is about 0.7 rai. They are utilized mainly for supplemental irrigation of paddy rice. Most farm ponds are too small to support integrated farming together with paddy supplemental irrigation.

Common problems of individual small farm pond are as follows;

- Too small both for paddy supplemental irrigation and integrated farming.

Table 8.1-7 Present Problems of Individual Small Farm Pond in MHS-5 Priority Area

Village	Problems on Farm Pond									
	No sufficient inflow (%)	Sediment (%)	Heavy seepage (%)	Heavy weeds (%)	Too small for integ. farming	No sufficient labour force	Much labour for irrigation	No budget for integ. farming	No sufficient benefit	No market
41 Sala					yes			yes		
42 Non Thong					yes			yes		
43 Non Sa-at					yes			yes		
44 Nong Kham					yes			yes		
46 Ta-lai Muang					yes			yes		
47 Nong Bo					yes			yes		
48 Hua Kao Tack	yes							yes		

(Note) based on interview to village leaders.

3) Farm Road

Farm roads are also well developed in this area, and 66% of farm lands are accessible directly from road. Farm roads are generally passing on a ridge of mound as same as in KK-6 Priority Area, and generally running along a shorter side of farm plots. However, sandy soils are deeply deposited on surface of farm road, and trafficability is very low in the area.

Farm plots are generally rectangular, and extending from a ridge to another ridge as same as in KK-6 Priority Area. General features of farm road and farm plots are as shown in Figure 7.1-1.

4) Farm Plot Size and Farming Categories

Farming plot size and farming categories are analyzed based on the Land Reform Cadastral Map and land categories in 1/4,000 map. Average farm size in Land Reform Area is estimated at 12 rai for a farmer. Farming categories are analyzed based on ratio of upland field and paddy field in each cadastral block.

Table 8.1-8 Present Farming Type and Farm Size in MHS-5 Priority Area

Type of Land	Area (rai)	Paddy	Upland	Plots having Farm Road	Plots having Farm Pond	Plots Blocks & Block
Lowland Type	22.4 % 2,966 rai Average 10.1 rai	76 % 2,261 rai	24 % 705 rai	53 % 156 plots Distance to village 1.4 km	24 % 69 plots Average 0.6 rai	293 plots 15 blocks 666, 668, 670, 676, 681, 683, 684, 690, 699, 701, 702, 704, 706, 910, 911
Mixed Type	54.3 % 7,194 rai Average 13.4 rai	46 % 3,340 rai	54 % 3,854 rai	71 % 381 plots Distance to village 1.4 km	26 % 138 plots Average 0.7 rai	538 plots 33 blocks 663, 664, 667, 669, 673, 675, 677, 678, 679, 680, 682, 685, 687, 688, 692, 693, 694, 696, 697, 698, 700, 703, 705, 708, 709, 710, 901, 902, 903, 904, 905, 906, 908
Upland Type	23.3 % 3,087 rai Average 10.9 rai	15 % 468 rai	85 % 2,619 rai	71 % 203 plots Distance to village 2.4 km	19 % 53 plots Average 0.6 rai	284 plots 17 blocks 661, 662, 665, 671, 672, 674, 686, 689, 691, 695, 707, 907, 909, 912, 913, 914, 915
Total	100 % 13,246 rai Average 11.9 rai	46 % 6,070 rai	54 % 7,176 rai	66 % 740 plots Distance to village 1.6 km	23 % 260 plots Average 0.7 rai	1,115 plots 65 blocks

(Note) Study was given only to ALRO 4-01 area in above Table.

Farming categories are classified into three groups as shown in Figure 8.1-1, namely Lowland Type, Mixed Type, and Upland Type based on upland field ratio.

- Lowland Type : upland field less than 30%
- Mixed Type : upland field from 30% - 70%
- Upland Type : upland field more than 70%

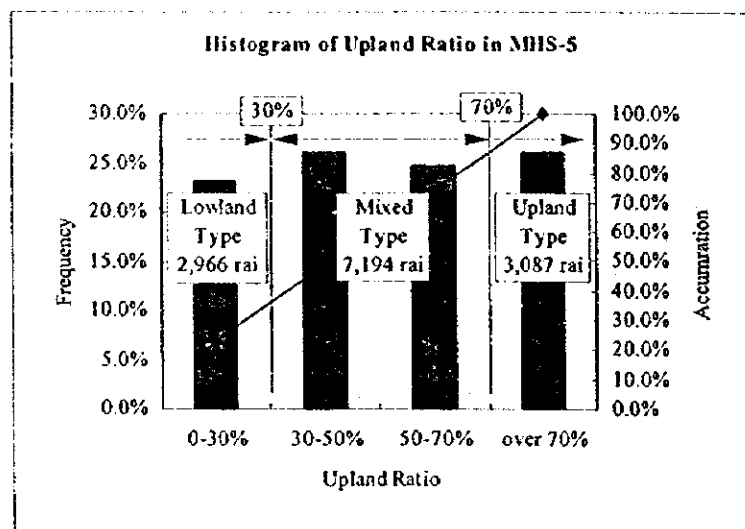


Figure 8.1-1 Upland Ratio in MHS-5 Priority Area

Distribution of land holding size is analyzed as shown in Table 8.1-9, and average land holding is estimated at 11.9 rai. As shown in Figure 8.1-2, land holdings are concentrated at 5 rai to 10 rai.

Table 8.1-9 Distribution of Land Holding Size in MHS-5 Priority Area

Section (rai)		Frequency	Accumulation
0 - 5	0 < <= 5	361	32.4%
5 - 10	5 < <= 10	320	28.7%
10 - 15	10 < <= 15	171	15.3%
15 - 20	15 < <= 20	99	8.9%
20 - 25	20 < <= 25	51	4.6%
25 - 30	25 < <= 30	26	2.3%
30 - 35	30 < <= 35	26	2.3%
35 - 40	35 < <= 40	17	1.5%
40 - 50	40 < <= 50	18	1.6%
50 - 60	50 < <= 60	10	0.9%
60 -	60 <	16	1.4%
Total		Ave= 11.9 rai	1,115

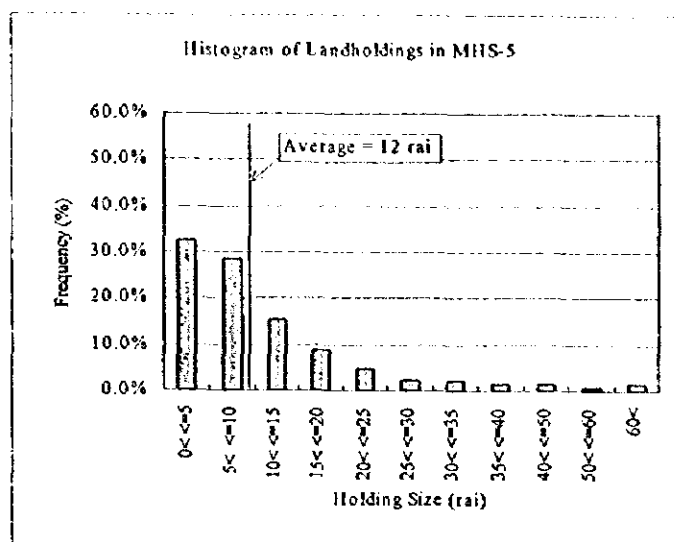


Figure 8.1-2 Histogram of Land Holdings in MHS-5 Priority Area

8.1.6 Rural Infrastructure

1) Rural Road

Rural roads runs at 33.4km length in MHS-5 Priority Area. Roads are mostly 4 m width and paved by laterite. Some of rural roads are recently improved with asphalt and enlarged to 6 m width partly. However, improvement of rural road particularly among villages is still limited, and its improvement is highly requested by villagers. Out of 33.4 km, asphalt pavement is requested for 22.8 km by the concerned village leaders..

Table 8.1-10 Rural Road in MHS-5 Priority Area and Necessary Improvement

Road No.	Route		Length (km)	Present		Improvement		
	from	to		Width (m)	Pavement	Length (km)	Width (m)	Pavement
1	Ta-lat Muang (46)	Outside	5.4	6	Asphalt			Completed
2	Nong Kham (44)	Outside	5.2	6	Asphalt			Completed
3	Sala (41)	Outside	1.4	4	Laterite	1.4		4 Asphalt
4	Non Thong (42)	Outside	1.6	4	Laterite	1.6		4 Asphalt
5	Non Thong (42)	Sala (41)	1.8	4	Laterite	1.8		4 Asphalt
6	Sala (41)	Nong Kham (44)	3.2	2	Laterite	3.2		4 Asphalt
7	Nong Kham (44)	Nong Bo (47)	4.4	4	Laterite	4.4		4 Asphalt
8	Nong Bo (47)	Hua Kao Tack (48)	4.1	4	Laterite	4.1		4 Asphalt
9	Hua Kao Tack (48)	Ta-lat Muang (46)	3.8	4	Laterite	3.8		4 Asphalt
10	Non Thong (42)	Non Sa-at (43)	0.9	4	Laterite	0.9		4 Asphalt
11	Sala (41)	Non Sa-at (43)	1.6	4	Laterite	1.6		4 Asphalt
Total			33.4			22.8		4 Asphalt

(Note) Location of roads is shown in Figure 8.3-1.

2) Village Water

All villages have own village water supply system in the area. Coverage ratio of services is almost 100%. Most villages are depending on shallow well as a source of village water system. However, two villages, Non Sa-at and Ta-lat Muang, are facing water shortage of groundwater. Water shortage of Ta-lat Muang will be solved by a new community pond constructed by RID in 1977 as shown in Table 8.1-6. Non Sa-at can also use this pond, but rainjar water will be main source for the time being.

3) Electricity and Communications

Electrification has been completed since 22 years before in first electrification, and 10 years before in latest village. Telephone system is now rapidly expanding, and covering 6 villages among 8 at the end of 1997.

4) Health Center

Health centers are located in 4 villages among 8 villages in the area. Average distance to the center is 1 km distance from village.

8.1.7 Rural Organization

At present there are many kinds of peoples' organization such as BAAC, agricultural cooperative, productive saving groups, housewives' groups, etc. According to the results of interviews with farmers in the Priority Area, membership of major local organizations may be summarized as follows.

Table 8.1-11 Membership Ratio of Organizations in MHS-5 Priority Area

Type of Organization	Membership % of total respondents (77)
BAAC	37.70
Agricultural Coop.	35.10
Housewives' Group	2.60
Productive Saving Group	1.30
Others	6.50

The majority (38%) stated they belonged to the BAAC, with 35 per cent belonging to agricultural cooperatives. Only a few are members of Productive Saving Groups, Farmer's Housewives' Groups, and local organization membership varies from one village to another.

The results of the Study Team survey indicate that farm households which do not belong to a local organization, are interested in applying for membership to BAAC, Agricultural Cooperatives and Housewives' Groups respectively.

At present, all villages in the Priority Area belong to the BAAC membership. Among existing local organizations in the area, household members can obtain good benefits from BAAC and Agricultural Cooperatives. The remaining local organizations are not strong enough. Generally speaking, the operation performance of most existing local organizations is inactive and there is low membership.

8.1.8 Environmental Conditions

The area surrounding MHS-5 is an agricultural zone with titled farmland. However, there is a community forest of 1,270 rai that belongs to the surrounding villages, where mushroom and vegetable collection is possible. The main tree in the community forest is *Dipterocarpus* and there are not many young trees. The boundary between forest and farmland is not clear and there is the possibility of gradual encroachment within the forest .

Generally, villagers are active in these villages. The cooperation of villagers, ALRO and RFD is good because of frequent visit by ALRO and RFD officers as well as a German volunteer who belongs to ALRO and supports sericulture. There is a "sports center" with a ball game net in Muban Non Thong, and a woman in Ban Non Sa-at is making rice cakes for sale in villages and towns.

Reforestation and Extension (REX) Project has been carried out by RFD Maha Sarakham nursery center with JICA experts. REX provides the extension service for forestry and seedlings. In 1996, 5,000,000 of seedlings were produced in which 46 % is *Pterocarpus macrocarpus*, one of the indigenous species. As for the seedling provision, 92 % is for farmers and the next, government agencies, schools and temples.

8.2 Present Agriculture

8.2.1 Agricultural Production

Agriculture in all priority areas of Maha Sarakham is also rainfed and all farmers are more or less subsistent. In Borabu major crops are rice and cassava, and minor crops are sugarcane, mulberry, fruit trees, and vegetables. In Na Chuk major crops are similar to those crops in Borabu, except that there is no acreage for fruit trees. However, crops in the whole province of Mahasarakham are so diversified. Crops that are grown elsewhere and can be introduced into the priority areas are Turkish tobacco and yam bean. These two crops are drought tolerant and require less water.

Acreage and yield of crops in the Priority Area of Maha Sarakham are presented in

Table 8.2-1.

Table 8.2-1 Acreage and Yield of Crops in MHS-5 Priority Area¹⁾

Locations	Crops	Areas (rai)	Production (ton)	Yield (rai)
Borabu	Rice	8,200	2,050	250
	Cassava	1,550	2,867	1,850
	Sugarcane	330	2,310	7,000
	Mulberry	57	103	1,800
	Fruit Trees	212	233	1,100
	Vegetables	35	87	2,500
Na Chuk	Rice	2,560	640	250
	Cassava	550	1,017	1,850
	Sugarcane	950	6,650	7,000
	Mulberry	120	216	1,800 ²⁾
	Vegetables	36	90	2,500 ²⁾
	Total	Rice	10,720	2,690
Cassava		2,100	3,884	1,850
Sugarcane		1,280	8,960	7,000
Mulberry		177	*n.a.	*1,800 ²⁾
Fruit Trees		212	*n.a.	*1,100 ²⁾
Vegetables		71	*n.a.	*2,500 ²⁾
Total of Planted Land		14,600 rai		

Source :¹⁾ Amphoe Borabu and Na Chuk Agricultural Extension Offices, 1996.

²⁾ Estimated figures

8.2.2 Farming Practice

Agriculture in the priority areas is rainfed and it depends entirely on rainfall. Farming practice is still traditional. Mechanization can be seen only in land preparation that farmers use walking tractors along with water buffalo labor for paddy land preparation. In cassava and sugarcane land preparation the farmers use big tractors on a lease basis.

8.2.3 Livestock and Fishery

Livestock in Maha Sarakham consist of beef cattle, water buffalo, pig, chickens and ducks. Water buffaloes are raised for farm labor. For cattle and pigs they are raised for household income. In poultry category, chickens are local breed and ducks are all muscovy.

For fishery, the people in the area culture their fish in natural ponds or reservoirs for public consumption. Only in Na Chuk, fishponds are reported. Unfortunately, number of fish cultured is not available. However, in all areas fish cultured are tilapia and fish of carp family.

Number of beef cattle, buffaloes, ducks, chickens and pigs in the priority area in priority area is shown in Table 8.2-2.

Table 8.2-2 Livestock in MHS-5 Priority Area

Location	Cattle	Water Buffalo	Pigs	Ducks	Chickens
Borabu	297	266	141	185	3,097
Na Chuk	687	260	339	391	2,780
Total	984	526	480	576	5,877

Source : Amphoes Borabu and Na Chuk Livestock Offices, 1997.

8.2.4 Post-Harvest Handling and Marketing

Major crops in the study area are rice, cassava and sugarcane. Rice is usually harvested manually by farmers and dried in the same field for two to three days. Threshing is done by the family and relatives or sometimes-hired labor. Estimated paddy production in this priority area is approximately 1.6 million kg provided 250 kg/rai yield, and its surplus is 0.95 million kg after deducting home consumption and seeds for next planting (refer to Appendix F : Table 8.2.5-1 Estimated Paddy Production and Surplus).

Marketing of rice is conducted by dried paddy being sent from farm to rice miller by local traders, middlemen and representatives of large-scale rice millers immediately after threshing because they don't have enough warehouses for late selling (refer to Appendix F: Table 7.2.5-2. Inventory of Post-Harvest/Marketing Facilities in the Priority Area). Farmers can select a buyer, but as small-scale farmers have not enough capital to transport their products, they sometimes cannot help selling from the field or the farm gate at unreasonable prices. As loans from the agricultural cooperatives or BAAC are of high interest and the loan regulations are severe on small-scale farmers, they sometimes hesitate to take out loans.

Marketing routes of cassava and sugarcane are fixed as same as Khon Kaen Priority Area. There is, therefore, less merit for farmers to enter into the market.

Cattle graze in the area, and they are sold to Nong Khun market nearby or to a far larger market in Chiang Yun through traders. Farmers, however, can select how they prefer to sell in the area for convenience and small price differences.

Other agricultural crops such as vegetables and fruit are rarely planted in the area and they are generally cultivated for domestic consumption. No typical post-harvest handling and marketing scheme is found because only surplus products are sometimes sold at acceptable prices to traders or middlemen who come to do business for other purposes.

The marketing points in this area are Amphoe Borabu and Amphoe Na Chuak. It may also be possible to use Changwat Mahasarakham or even Amphoe Payakkaphum Pisai or Amphoe Wapi Pathum (refer to Figure 8.2-1 Marketing Points near the Priority Area). There may be enough marketing points in this area. Unfortunately, roads are narrow and roughs as well as farmers have insufficient marketing information systems and lack of knowledge. They only get the information from relatives or traders.

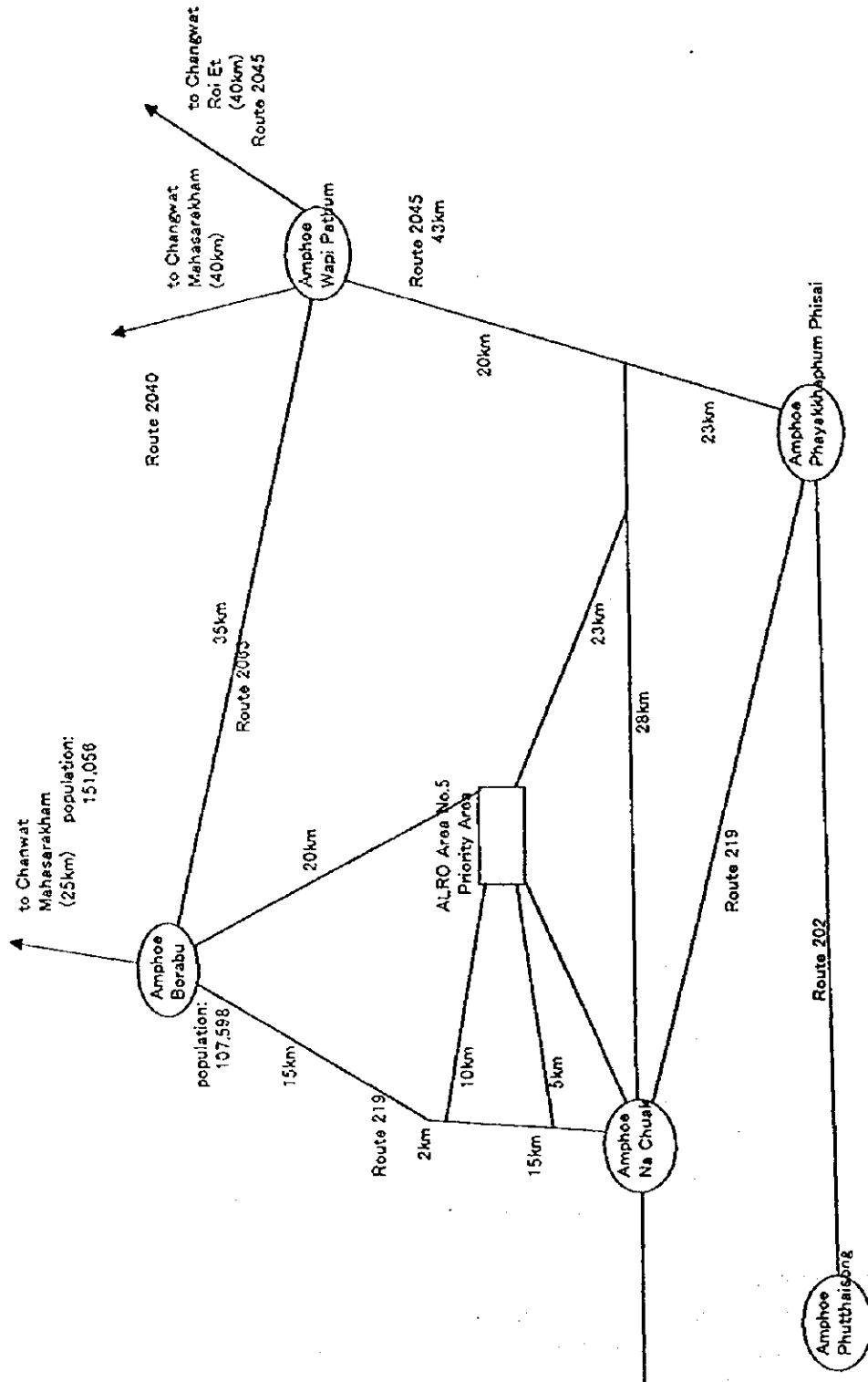


Figure 8.2-1 Marketing Points near the Priority Area (Maha Sarakham) Changwat Mahasarakham total population: 931,000

8.2.5 Farm Household Economy

The income of farmers living in Maha Sarakam Priority Area ranks in the middle of the four Priority Areas. According to the survey by the Study team, the average annual income in the area is 31,600 baht, of which 10,100 baht or 32% is agricultural income. Major source of non-agricultural income is employment. Categorized level of agricultural income is as below;

Estimated net agricultural income	
Less than 15,000 baht	76.6 %
15,000 baht	10.4%
More than 15,000 baht	10.4%
Others	2.6%
Mean	10,100 baht/year

8.3 Development Plan

8.3.1 Objectives of the Development

The main objectives of the development have been established in Chapter 3.4.1 and are as follows :

- a) To increase farmers' income,
- b) To satisfy basic human needs, and
- c) To conserve the forest reserve areas adjacent to LRAs. (This is not concerned due to no conservation forest in the area.)

8.3.2 Farming Plan

The development strategy of the Priority Area is to introduce integrated farming (including vegetable production, fruit tree cultivation, poultry, fish breeding) based on a farm pond; or integrated farming together with beef cattle breeding in the farmland where rice and cassava are cultivated. Mahasarakham Local Government has a policy to increase livestock production as one of the strategies to realize the 8th National Economic and Social Development Plan. Under this policy, the local government is proceeding the improvement and expansion of livestock market and the extension of knowledge related to livestock. In the area, it is proposed to breed 5 cattle per household composed of American Braman hybrid cattle and local cattle by shifting cassava to pasture.

Present farming type can be classified into 3 categories in the area, namely, lowland type (rice cultivation), upland type, and mixed type. Farming plan of each type is proposed as shown below:

Table 8.3-1 Farming Plan for a Typical Household (12rai)

Land Use	Low land Type	Upland Type	Mixed Type
	(23%)	(23%)	(54%)
Rice	5rai	-	5rai
Cassava	-	5rai	-
Grassland	4rai	4rai	4rai
Vegetable	1rai	1rai	1rai
Beef cattle breeding	(5head)	(5head)	(5head)
Poultry	(75head)	(75head)	(75head)
Fish breeding	(0.2rai)	(0.2rai)	(0.2rai)
Farm Pond	1rai	1rai	1rai
House, etc.	1rai	1rai	1rai

By implementation of the farm pond and farm road project, farmland with a farm pond will be increased to 9,240 rai or 63% of the whole, together with the present farmland with a pond. Three fourth of present cassava field will be shifted to pasture and vegetable by the project. Cropping pattern of the area will be changed as shown in Table 8.3-2.

Table 8.3-2 Present and Planned Cropped Area in MHS-5 Priority Area

Land Use	Present	Plan	Difference
Rice	6,690rai	5,421rai	(-) 1,269rai
Cassava	4,824rai	1,130rai	(-) 3,694rai
Sugarcone	1,880rai	1,520rai	360rai
Mulberry	500rai	500rai	0rai
Fruit tree	600rai	600rai	0rai
Grassland	-	3,080rai	3,080rai
Vegetable	106rai	809rai	703rai
Farm Pond	-	770rai	770rai
House, etc.	-	770rai	770rai
Total	14,600rai	14,600rai	0rai

8.3.3 Agricultural Infrastructure Development Plan

1) General Direction of Agricultural Infrastructure Development

Due to limitation of water resources, individual farm pond development will be major direction in this area for expanding integrated farming. Furthermore, farm road system should be improved and expanded for increasing accessibility to conduct the integrated farming. Since farmers are facing difficulties in access due to narrow width and poor surface condition of farm road, they are acceptable to pay land for farm road improvement. It was confirmed in the meeting of the concerned village leaders.

Therefore, farm pond and farm road development is the major project in this area.

2) Farm Pond Development

At present, 23% of farmers have a 1,200m³ class farm pond in this area. Among three types of lands, high farm pond holding is in the mixed land at 26%, and low in upland at 19%. Possible development of farm pond in this area has been analyzed based on following factors;

Table 8.3-3 Factors on Farm Pond Development in MHS-5 Priority Area

Average size of land holding	12 rai/farmer
Irrigable farming size (1/5 dry year)	
1,200m ³ Farm pond	1 rai vegetables through the year (3 cropping/year)
6,000m ³ Farm pond	1 rai vegetables through the year (ditto) and, 3 rai of wet season rice and dry season crop like water melon.
Necessary Catchment	
1,200m ³ Farm pond	3 rai
6,000m ³ Farm pond	30 rai
Farm road accessibility	Lowland = 93%, Mixed land = 93%, Upland = 92%
Topographical suitability	Lowland = 100%, Mixed land = 90%, Upland = 80%
Soil suitability	Lowland = 100%, Mixed land = 90%, Upland = 80%

Based on above factors, it is estimated that farm ponds will be expanded to the farmers as shown in Table 8.3-4. In case developed only by 1,200m³ farm ponds, 46% to 51% of farmers will able to have 1,200m³ farm pond newly. In case introducing 6,000m³ farm pond, 18% of farmers will able to have 6,000m³ farm pond.

Table 8.3-4 Physically Possible Farm Pond Development in MHS-5 Priority Area

Development of Farm Pond	Lowland	Mixed Land	Upland	Total
Present				
1,200m ³ Farm Pond	24%	26%	19%	23%
Future Possible Expansion				
<In case developed only by 1,200m ³ Farm Pond>				
In case accessibility considered	58%	46%	33%	46%
In case accessibility not considered	65%	51%	37%	51%
<in case developed mixed with 6,000m ³ Farm Pond>				
6,000m ³ Farm Pond	17%	22%	10%	18%
1,200m ³ Farm Pond (accessibility counted)	41%	24%	24%	29%
1,200m ³ Farm Pond (accessibility not counted)	47%	29%	27%	34%

(Note) Detail procedure of estimation and computation are shown in Table 8.3-5.

Table 8.3-5 Farm Pond Availability in MHS-5 Priority Area

Elements	Land Type Classification				Remarks
	Lowland	Mixed Land	Upland	Total	
Vegetable = 1rai					
1-1) Necessary Farm Pond (m3)	1,200	1,200	1,200		
1-2) Farm Pond Size (rai)	1	1	1		
1-3) Necessary Catchment (rai)	3	3	3		
1-4) Necessary Min. Farm (rai)	2	2	2		Veg + F Pond
1-5) Necessary Total Area (rai)	4	4	4		C A + F Pond
Vegetable = 1rai, Fruit Tree = 3rai (Total 4 rai)					
2-1) Necessary Farm Pond (m3)	6,000	6,000	6,000		
2-2) Farm Pond Size (rai)	2	2	2		
2-3) Necessary Catchment (rai)	30	30	30		
2-4) Necessary Min. Farm (rai)	6	6	6		Veg + F Tree + F Pond
2-5) Necessary Total Area (rai)	32	32	32		C A + F Pond
Number of Farmers and Land Holdings					
3-1) Total 04-1 Area (rai)	2,966	7,194	3,087	13,247	
3-2) Total 04-1 Farmers	293	538	284	1,115	
3-3) Average Holdings (rai/farmer)	10.1	13.4	10.9	11.9	3-1) / 3-2)
3-4) Total Farmers >= 2 rai	258	511	245	1,018	
3-5) Ratio	88.1%	95.0%	87.7%	91.3%	3-4) / 3-2)
3-6) Total Farmers >= 6 rai	165	378	138	681	
3-7) Ratio	56.3%	70.3%	48.6%	61.1%	3-6) / 3-2)
Farm Road Accessibility					
4-1) Present Accessibility	53%	71%	71%	66%	
4-2) Assumed Future Accessibility	93%	93%	92%	93%	
Suitability of Farm Pond Construction					
5-1) Topographical Suitability	100%	90%	80%		lower in upland because some area locating at top of hill
5-2) Soil Suitability	100%	96%	80%		assumed from a viewpoint of sandy texture.
5-3) Area for 1,200m3 pond	100%	100%	100%		3-3) / 1-5)
5-4) Area for 6,000m3 pond	32%	42%	34%		3-3) / 2-5)
Possibility of Farm Pond to Farmers					
<In case only 1,200m3 Farm Pond>					
6-1) in case accessibility counted	82%	72%	52%	70%	3-5)* 4-2)* 5-1)* 5-2)* 5-3)
(1) Farmers able to have 1,200m3 pond	240	317	143	775	3-2)* 6-1)
6-2) in case accessibility not counted	88%	77%	56%	75%	3-5)* 5-1)* 5-2)* 5-3)
(2) Farmers able to have 1,200m3 pond	258	414	159	831	3-2)* 6-2)
<In case 6,000m3 Farm Pond introduced>					
6-3) 6,000 m3 Farm Pond	17%	22%	10%	18%	3-7)* 4-2)* 5-1)* 5-2)* 5-4)
(3) Farmers able to have 6,000m3 pond	50	118	28	196	3-2)* 6-2)
(4) 1,200m3 ponds when access counted	190	269	120	579	(1)(3) <> 3-5)* 4-2)* 5-1)* 5-2)* 5-3)* (3-1)-
(5) 1,200m3 ponds when access not counted	208	296	131	635	(3)* 32rai/4rai
Existence of Present Farm Pond					
7-1) 1,200 m3 Farm Pond	24%	26%	19%	23%	(4) / 3-2)
(6) Farmers having 1,200m3 pond	69	138	53	260	by 1:4,000 map
7-2) 6,000 m3 Farm Pond	0%	0%	0%	0%	by 1:4,000 map
(7) Farmers having 6,000m3 pond	0	0	0	0	3-2)* 7-2)
Future Expansion					
<Farmers able to have 1,200m3 pond>					
8-1) in case accessibility counted	171	249	95	515	(1) - (6)
(8) Ratio of Expansion of 1,200m3 pond	58%	46%	33%	46%	8-1) / 3-2)
8-2) in case accessibility not counted	189	276	106	571	(2) - (5)
(9) Ratio of Expansion of 1,200m3 pond	65%	51%	37%	51%	8-2) / 3-2)
<Farmers able to have 6,000m3 pond>					
8-3) Farmers able to have 6,000m3 pond	50	118	28	196	(3) - (7)
(10) Ratio of Expansion of 6,000m3 pond	17%	22%	10%	18%	8-3) / 3-2)
<In case accessibility is counted>					
(11) Farmers with 1,200m3 pond	121	131	67	319	(4) - (6)
(12) Ratio of Expansion of 1,200m3 pond	41%	24%	24%	29%	(11) / 3-2)
<In case accessibility is not counted>					
(13) Farmers with 1,200m3 pond	139	158	78	375	(5) - (6)
(14) Ratio of Expansion of 1,200m3 pond	47%	29%	27%	34%	(13) / 3-2)

3) Farm Road Development

There exists 69 km of farm road in the area, and covering 66% of accessibility of farm plots. Farm road density is reaching 4.7 m/rai or 29 m/ha at present. Farm road will be extent to 101 km and density will be 6.9 m/rai or 43 m/ha. Accessibility will be improved 93% in future. Farm road density will be higher than KK-6 Priority area (5.4m/rai), because of smaller plot size in the MHS-5 Priority Area.

Table 8.3-6 Farm Road Development in MHS-5 Priority Area

Farm Road	Total 14,600 (rai)	Number of Roads	Total Length (km)			Density (m/rai)		Width (m)	Pavement (km)		Cross-structures	
			Existing Improvement	New Provision	Total	Existing	Future		Asphalt	Laterite	Culverts	Bridge
Main Farm Road (MFR)		10	30.01	2.52	32.53	2.06	2.23	4	32.53	0.00	20	0
Lateral Farm Road (LFR)		7	8.38	3.83	12.21	0.57	0.84	4	1.50	10.71	15	0
On-Farm Road (OFR)		94	30.60	25.70	56.30	2.10	3.86	2	2.65	53.65	53	0
Total		111	68.99	32.05	101.04	4.73	6.92		36.68	64.36	88	0

(Note) 1) Above farm roads are converted for the whole farm area of 14,600 rai.

2) Lateral and on-farm roads have been increased in proportion with following area ratio.

$$14,600 \text{ rai} / 13,246 \text{ rai} = 1.102$$

3) Width of existing road is assumed at 2 m.

4) A concrete pipe of diameter 500 mm is assumed be installed for culvert.

(Each culvert to be reviewed by its drainage area at implementation stage)

5) Asphalt pavement of Main, Lateral and On-farm roads is considered for subject to flood.

Main and Lateral farm roads: 100m per culvert or bridge.

On-farm road: 50m per culvert or bridge.

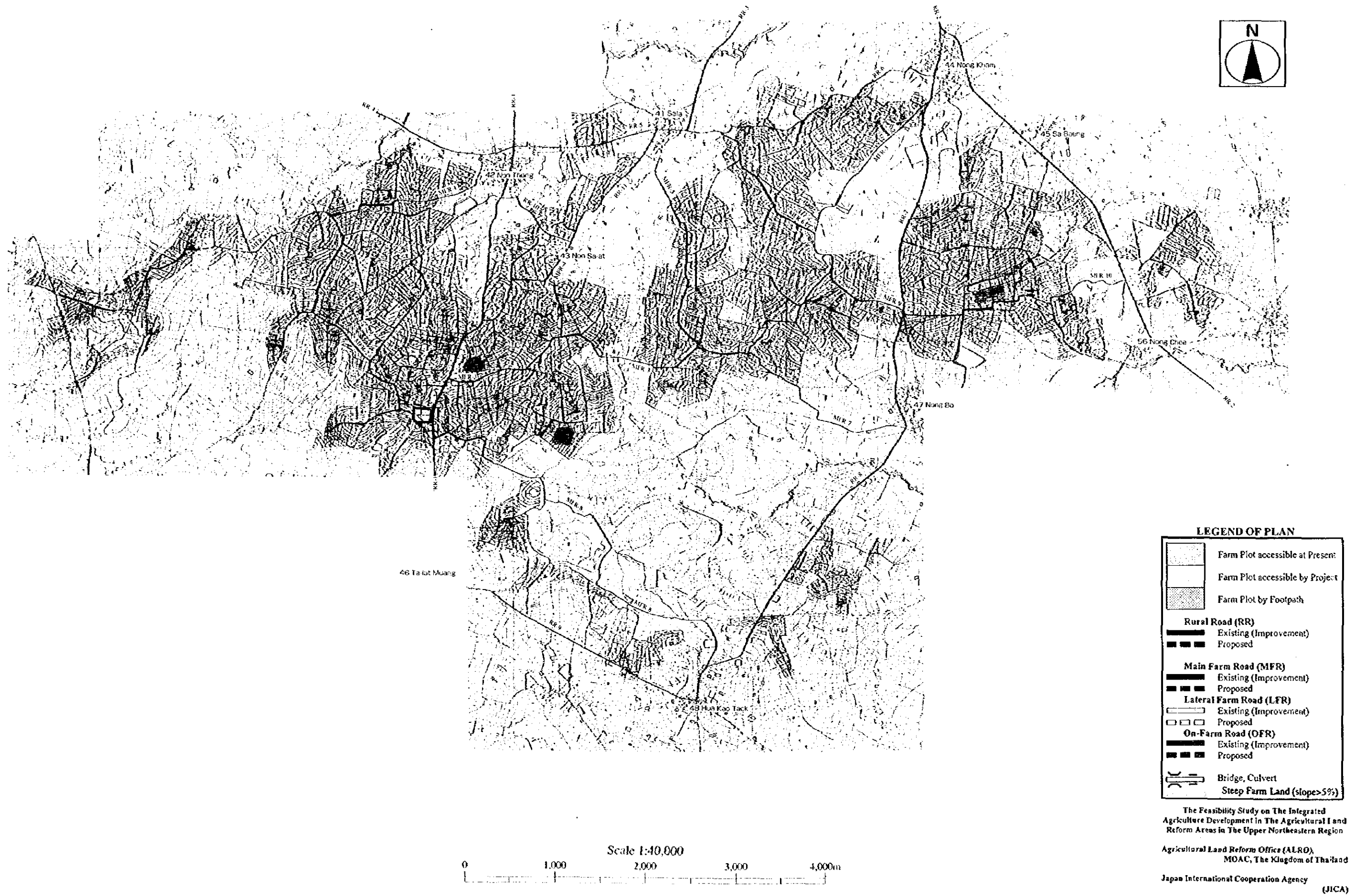
6) Main farm road is assumed not to increase because Length is sufficient even for the whole farm land.

4) Soil Protection Measures

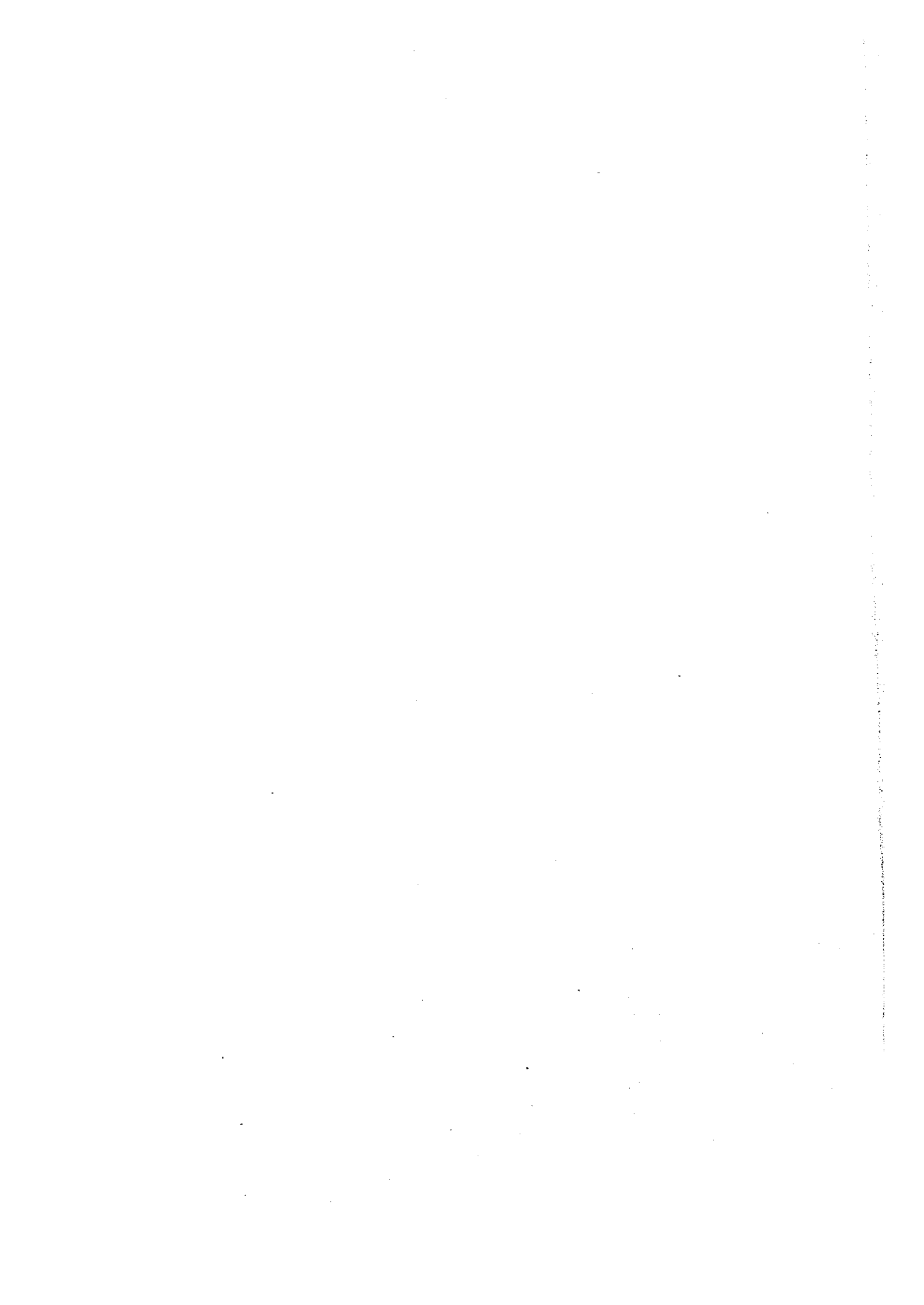
Steep lands over 5% slope are only 0.5% or 70 rai in this area as shown in Figure 8.3-

1. It is recommended is to utilize those lands with fruit trees or pasture, which are effective for soil protection.

Figure 8.3-1 On-Farm Development Plan of Mahasarakham Priority Area (MHS-5)



The Feasibility Study on The Integrated
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Reform Areas in The Upper Northeastern Region
Agricultural Land Reform Office (ALRO),
MOAC, The Kingdom of Thailand
Japan International Cooperation Agency
(JICA)



8.3.4 Forest Conservation Plan

The forest conservation plan would be based on environmental education, leadership training and regular meetings with villagers by ALRO, RFD and NGOs. It includes support for community forest development and the afforestation plan.

The village leader of Ban Non Thong is thinking of establishing a community forest and practicing agroforestry. For community forest development, the village will be able to prepare 20 rai of public land, that is mulberry fields but that is no use because villagers grow mulberry on their farmland, and 30 rai of Pa Cha¹⁾ that belongs to four villages.

The main obstructions to community forest development are lack of leadership and no public land for reforestation. These problems have already been solved in Ban Non Thong and this village will be able to take the role of leading village.

¹⁾ Pa Cha means crematory forest. That forest was used as crematory ten years ago by the villagers of Non Thong, Non Sa-at, Non Thum and Safa. Now the crematory is in the temple.

Support by ALRO, RFD and NGOs

- a) Meeting with villagers to enlighten them about the importance of forest conservation
- b) Leadership training
- c) Environmental education for both adults and children
- d) Meeting with villagers for the planning of community forest and afforestation
- e) Provision of seeds and seedlings
- f) Regular meetings and technical advice

Note: Training will be carried out by ALRO for a) and d) in the same way as Khon Kaen. (see Chapter 11.4.1)

1) Community Forest Development Plan

Purpose:

Improvement of communal forest by the community for soil and water conservation and improvement of diet.

Operation by villagers:

- Comprehensive regulations to prohibit private logging and farming
- Seeding and planting seedlings
- Protection of seedlings from livestock
- Collection of vegetables, mushrooms, firewood, etc.

8.3.5 Strengthening People's Organizations

ALRO should endeavor to strengthen the peoples' organization under collaboration among relevant agencies such as DOAE, CPD, and the Department of Industrial Promotion, etc. For successful implementation of agricultural development, ALRO should proceed the

project under participation of people. For strengthening peoples' organization, ALRO should select progressive farmers and provide them with "Training of Leadership", mentioned in Chapter 11.4.1. In strengthening of peoples' organization in this area, following matters are to be taken into consideration as same as for Khon Kaen Priority Area.

- a) Provide peoples' organization members with appropriate information and understanding of all aspects of the formation and management of groups or local organizations such as the rights, duties and roles of local organizations.
- b) Promote training and disseminate know-how for production, marketing, accounting, finance and general administration.
- c) Provide and transfer knowledge and technology to farmers' housewives' groups, farmers' groups and youth groups being able to play a greater role in integrated farming development as well as handicrafts, cottage industries and home processing of agricultural products.
- d) Strengthening the existing farmers' groups or local organizations and campaign for establishment of professional farmers' groups, particularly, vegetable farmers' groups, fruit farmers' groups, livestock breeding farmers' groups, and marketing farmers' groups.
- e) Provide community funds and low interest rate credit to support the formation and operation of all types of peoples' organizations, particularly business initiatives launched and run by groups or local organizations.
- f) Promote networking among peoples' organizations for the exchange of information, experience and local wisdom and for improving administrative skills.
- g) Formulate strong back-up bodies at provincial and/or Amphoe levels in all activities related to strengthening peoples' organizations, not only at the initial stage of establishment but also during the subsequent operation period.

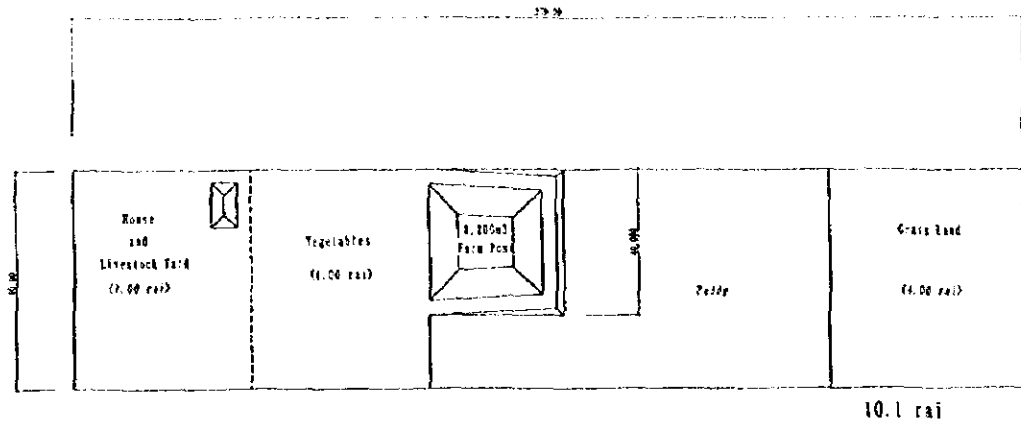
8.4 Preliminary Design

1) Farm Pond

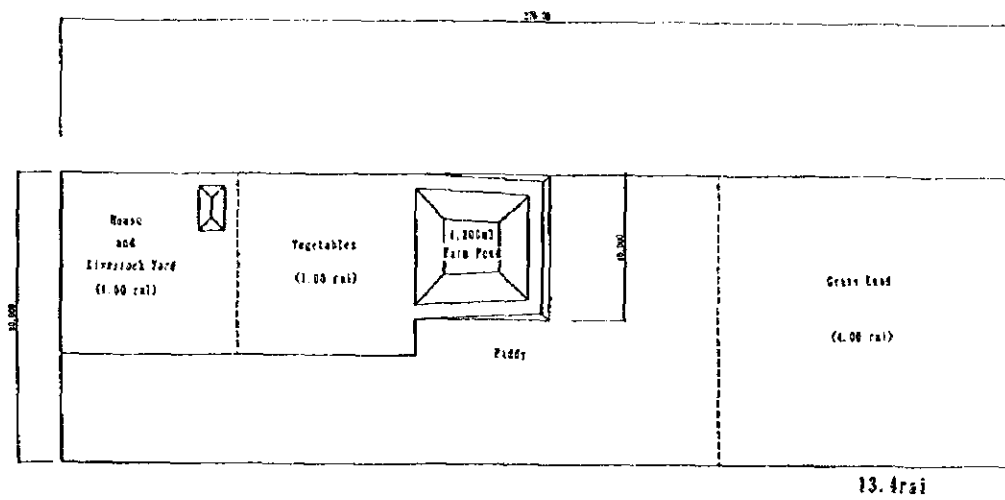
The location of 1,200m³ farm pond and land use plan for each type of land is shown in Figure 8.4-1. Structural dimensions of farm pond are same as that shown in Chapter 7.4.1.

2) Farm Road

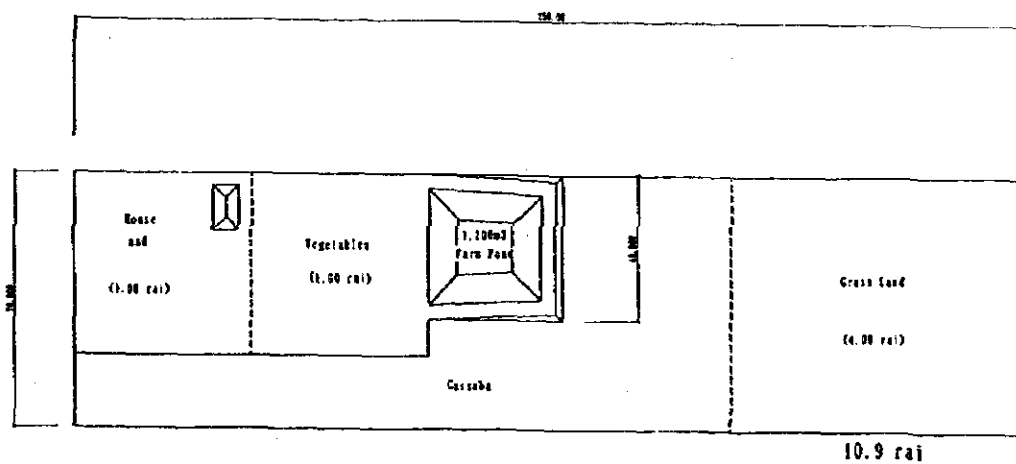
The design of farm road is same as that shown in Chapter 7.4.2.



Typical Layout of Farm at Mahasarakham Lowland Type



Typical Layout of Farm at Mahasarakham Mixedland Type



Typical Layout of Farm at Mahasarakham Upland Type

Figure 8.4-1 Type Layout of Farm with 1,200m³ Farm Pond in MHS-5 Priority Area

8.5 Cost Estimation

1) Farm Ponds and Farm Roads Construction Project

a) Project Cost

The cost of farm ponds and farm roads construction project in Maha Sarakham Priority Area is estimated at 66,708 thousand baht as shown below.

Table 8.5-1 Cost of Farm Ponds and Farm Roads in MHS-5 Priority Area

Item	Q'ty	Unit	Total Cost ('000Baht)
1. Civil Works			
1) 1,200m ³ Farm Pond	490	Ponds	18,375
2) Farm	101,040	m	26,315
2. Engineering Survey and Design	1	L.S	6,701
3. Administration	1	L.S	4,469
4. Physical Contingencies	1	L.S	5,586
Sub-Total			61,445
5. Price Escalation	1	L.S	5,263
Total			66,708

b) Annual Disbursement Schedule

The annual disbursement schedule is prepared as shown below.

Table 8.5-2 Annual Disbursement Schedule of Farm Ponds and Farm Roads in MHS-5 Priority Area

Item	Total Cost ('000Baht)	Year			
		1999	2000	2001	2001
1. Civil Works	44,690	0	0	22,345	22,345
2. Engineering Survey and Design	6,701	3,350	3,350	0	0
3. Administration	4,469	251	251	1,983	1,983
4. Physical Contingencies	5,586	296	296	2,497	2,497
Sub-Total	61,445	3,898	3,898	26,825	26,825
5. Price Escalation	5,263	131	265	2,070	2,797
Total	66,708	4,028	4,163	28,895	29,622

c) Annual Operation and Maintenance (O/M) Cost of Farm Pond on Farm Road

The annual O/M cost is estimated at 2,132,000 baht/year according to the same conditions set for Khon Kaen Priority Area.

Table 8.5-3 Annual O/M Cost of Farm Pond and Farm Road in NHS-5 Priority Area

Item	Q'ty	Unit	Total Cost ('000Baht)
1. 1,200m ³ Farm Pond	770	Place	290
2. Farm Road			
1) Main Farm Road	32.53	km	856
2) Lateral Road	12.21	km	356
3) On-Farm Road	56.3	km	629
Total			2,132

8.6 Project Evaluation

Agricultural development project of the Mahasarakham Priority Area is the Farm Pond and Farm Road Development.

This project composed of farm road development and construction of 1,200m³ capacity farm ponds of about 490. By implementation of this project, farmland with a farm pond will be 9,240 rai or 63 % of the whole, together with present farmland with a pond. In the farmland of 9,240 rai, integrated farming (including vegetable production, fruit tree cultivation, poultry, fish breeding, etc.) and integrated farming together with beef cattle breeding will be introduced. This project includes the training of farmers and the in-sit farming support by ALRO.

Economic internal rate of return (EIRR) of the project is as shown in table below by the results of project evaluation mentioned in Chapter 11.6.

Project	EIRR	B/C Ratio
① Farm Pond and Farm Road Development Project	10.6	0.9

(Note) B/C ratio is based on the discount rate of 12%.

EIRR of the project is little lower than the rate 12% of the opportunity cost of capital set up in the Kingdom. However, in considering the characteristic of the project, it is due to carry out in Northeastern Region where is most populated and poor area. As the development of this area is one of the most important policies under promoting spatially balanced economic development of Kingdom of Thailand, the figure 10% mark would be highly enough because trickle-down effects can be expected by the project.

Annual agricultural income of the typical farmers holding 12 rai farmland, an average in the area, will be increased as follows by the implementation of the planned farming in Table 8.3-1;

Annual Agricultural Income of Typical Farmers (Baht/Year/Farmer)			
	Lowland Type	Upland Type	Mixed Type
Present	10,654	10,952	10,654
Future	36,454	38,865	36,439

(Note) Details are in Chapter 11.6.5.

Average annual total income of farmers in the area is about 31,600 Baht. As shown in the above table, agricultural income of a typical farmer will be little higher than the average total income. However, agricultural income itself is not high enough. It will be depending on the opportunity of non-agricultural income whether farmers will earn income only on agriculture or not.

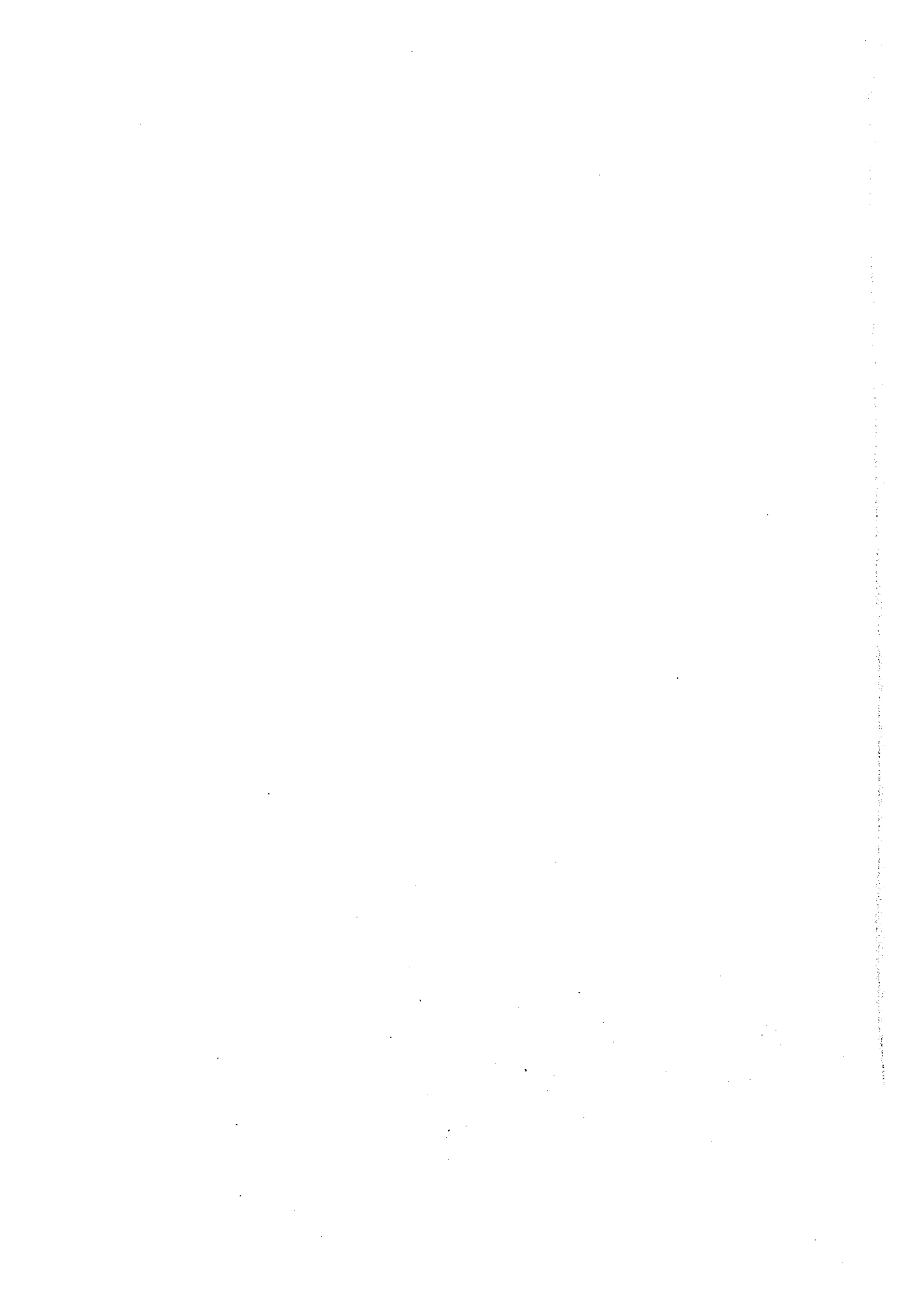
CHAPTER 9 SAKHON NAKHON PRIORITY AREA

(No. 3-1 LRA)

INTEGRATED AGRICULTURE DEVELOPMENT IN SAKON NAKHON PRIORITY AREA (SKN-3.1 LRA)

The Feasibility Study on The Integrated Agriculture Development in The Agricultural Land Reform Areas in The Upper Northeastern Region, The Kingdom of Thailand
ALRO (MOAC), JICA, March 1998 (SANYU Consultants INC.)





CHAPTER 9 SAKHON NAKHON PRIORITY AREA (No. 3-1 LRA)

9.1 Present Condition of the Area

9.1.1 Location, Area and Population

The Sakhon Nakhon Priority Area is sub-LRA SKN3-1 situated in the southwest of LRA SKN 3, Kut Hai, Na Noi, Non Udom Forest, Amphoe Kut Bak of Sakhon Nakhon province. The area is located about 55 km. west of Sakhon Nakhon, which is close to the border of the province. The east end of the area is adjacent to Kut Bak and the road No. 2218. The Priority Area is composed of seven villages in Tambon Kut Buk and five villages in Tambon Kut Huai of Amphoe Kut Bak. Three villages named Kut Bak No.1 and No. 2, and Nong Song Hong are in the Kut Bak Sanitary District area.

The total population within the 12 villages amounts to 15,426 in 3,006 households, out of which 4,734 are in the sanitary area. Accordingly, the average family size per household is estimated at five persons. The majority of villages in the area has a population of more than 1,000 and the number of households is between 150 to 300.

The Sakhon Nakhon Priority Area has a total area of 33,900 rai of which 25,100 rai is farm- holding land. The average farm size per farm household is estimated at 10 rai.

Farmers in Bang Bua village are actively engaged in ecological farming, where rattan and nursery trees are briskly produced for marketing. They are organizing a rural organization, so called as "In-Paeng Network". In-Paeng Network in Sakhon Nakhon Priority Area, which is a networks of several tens of communities surrounding the Phu Phan Range, is a local environmental organization aiming at native plant conservation and alternative agriculture. "Forest is life, love the forests as you love yourself." is the slogan of the Network. The lofty goals of the Network are to enhance the capacity-building potential of the communities by assigning members to over 100 local species in the nursery for "ecological farming" totalling 500,000 trees per year. Nursery of fruit trees, vegetables, timber trees, and herbs are included in their plan.

88 % of villagers have primary education, 4 % have secondary education at junior high school and high school and 6 % have more than secondary education.

The names of villages, population, households, average family size per household, and village land area in Sakhon Nakhon Priority Area can be summarized in Table 9.1-1.

Landholding farmers in the priority area is estimated at 2,510 while total howseholds are about 3,000 in the concerned 12 villages. From this fact, almost landholding farmers in the priority area live in the 12 villages.

Table 9.1-1 Administrative Summary of SKN-3.1 Priority Area

Province Amphoe	Tambon	Village	Muban	H.H	Population	Ave. Family Size (person/H.H)	Villageland ¹⁾ (rai)		
Sakhon Nak. Kut Bak	Kut Bak	Kut Bak	1	428	1,695	3.96	5,280		
		Kut Bak	2	325	2,212	6.81	6,214		
		Nong Song Hong	3	190	827	4.35	2,355		
		Kut Had	4	275	1,291	4.69	} 8,920		
		Kut Had	7	153	780	5.10			
		Sai Kaeo	6	277	1,208	4.36	4,000		
		Bang Bua	5	270	1,450	5.37	3,825		
	Kut Hai	Kut Hai	1	286	1,570	5.49	} 3,600		
		Kut Hai	6	171	1,019	5.96			
		Kho Yai	4	168	1,250	7.44	3,940		
		Kho Noi	5	376	1,666	4.43	4,300		
		Ngui	2	87	458	5.26	2,732		
		Total				3,006	15,426	5.13	45,166

Source: Interviewing local leaders by Study Team November, 1997

¹⁾ Kor Chor Chor 2 Khor 1996

9.1.2 Topography and Geology

Sakon Nakhon Priority Area has an area of 33,900 rai (5,420 ha), which is a part of SKN-3.1 LRA. The priority area is located at the southern part of SKN-3.1 LRA, and drained to the Nam Un Reservoir with a gentle slope of about 0.1%. The area is a gently rolling plain with some 5m to 20m undulations and connecting to the hilly range of Phu Phan Range in south. Its elevation ranges from EL190m to EL.240m, and slope ranges from 0.1% to 7.5%. In this area, alluvial flood plain extends widely so that paddy rice is planted extensively. The steep sloping land over 5% gradient shares 8.6% or 2,160 rai in the area, where soils are suffered from erosion. The steep land extends at the piedmont of the Phu Phan Range in the southwestern part of the area. Huai Kra Choe and Huai I Don rivers flow into the area from the Phu Phan Range, and drains to the Nam Un Reservoir. These rivers sometime cause floods in the northern part of the area. Flood duration is one or two days in southern flood plain, but inundation continues 7 to 10 days in the northern lower flood plain. Floods are serious in the northern part of this priority area. Some of flood water will be mitigated by construction of the Huai Kra Choe Dam, but it is necessary to provide the drainage system in the whole flood plain including the outside area of the Priority Area for complete improvement. This drainage work will need considerable amount of right-of-way, so that the study should be given farm an economical viewpoint. Serious inundation is concentrated in only 10% or 1,500 rai in the priority area, so that flood problems will not be major subject in the Priority Area.

Soil is silty clay in flood plain, but sandy at top layer in undulated mounds. Loose sand stone lies at 3 to 4 m depth from surface with a thickness about 6m, and no farm for agriculture.

9.1.3 Meteorology and Hydrology

1) Meteorology

At the city of Sakon Nakhon, monthly mean temperature changes from 21.8°C in December to 29.1°C in April and mean of monthly maximum is 34.9°C in April from the data of 30 year from 1965 to 1994. The maximum temperature of this period recorded 41.8°C in April and minimum 2.1°C during in January with fairly large difference. Mean relative humidity changes 61% in March to 83% in August and annual comes to 72%.

Mean rainfall at Sakon Nakhon city is 1,578 mm and rainy day counted more than 10 during May and September with maximum 23 days in August. Annual rainy day is 127. Rainfall station (code 50180) is applied for representative for this priority area, it rains annually 1,425 mm as average of 1958 to 1994 changing from 989mm in 1985 to 1,965 mm in 1961. It rains 97% of annual rainfall during the period from April to October.

2) Hydrology

a) General Feature of Groundwater

20% of this priority area are calculated to belong the range of less than 2 cu.m/hr as expected well yield, 50% to range of 2-10 cu.m/hr and 30% to range of 10-20 cu.m/hr respectively by means of the Groundwater Map by GREP, Department of Mineral Resources. These yields are rather high than other priority areas, because this area is formed by alluvial plane and flat lowland.

Table 9.1-2 Expected Well Yield in SKN-3.1 Priority Area

Area (ha)	Area Ratio by Well Yield			
	< 2 m ³ /hr	2 - 10 m ³ /hr	10 - 20 m ³ /hr	> 20 m ³ /hr
2,970	20%	50%	30%	0%

High chloride density zone are scattered and some of them extend from north-east to south-west direction in the center of the province. SKN-3.1 locates in the southern part of the province with less than 200 mg/lit (Cl) concentration. There is no harm for utilization of groundwater for irrigation and drinking purposes from an aspect of chloride concentration.

Table 9.1-3 Groundwater quality in SKN-3.1 Priority Area

Study Area No.	Acreage		Water quality mg/lit(Cl)			
	A (rai)	A (ha)	< 200	200 - 600	600 - 1,000	> 1,000
SKN - 3-1	80,920	12,946	100%			

b) Available Aquifer and Quantity

From preliminary observation in the field, there are two aquifers in the area. First aquifer lies at about 9 m depth with a thickness of 20 to 80 cm, and second at about 35 m depth. Both aquifers are formed by gravel layer. First aquifer connects to free surface groundwater, and its groundwater surface fluctuates from 1.5 m to 6 m depth from ground surface. Under the first aquifer, hard conglomerate lies until about 35m depth from surface, and second aquifer lies under the conglomerate.

First aquifer is commonly utilized by villagers for domestic and drinking purposes by shallow wells, while second layer for village water supply by deep wells. However, it is reported that the yield of second aquifer is decreasing and causing difficulty of water supply in Kut Hai, Ngiu and Kho Yai villages. It is considered that the second aquifer seems lower in recharge because it is recharged through a thick conglomerate. On the other hand, first aquifer is recharged directly through loose sandstone. It seems the first aquifer more stable and reliable for irrigation purpose than the second aquifer. Shallow well can be easily dug to the first aquifer by villagers themselves with a cost about 3,000 Baht.

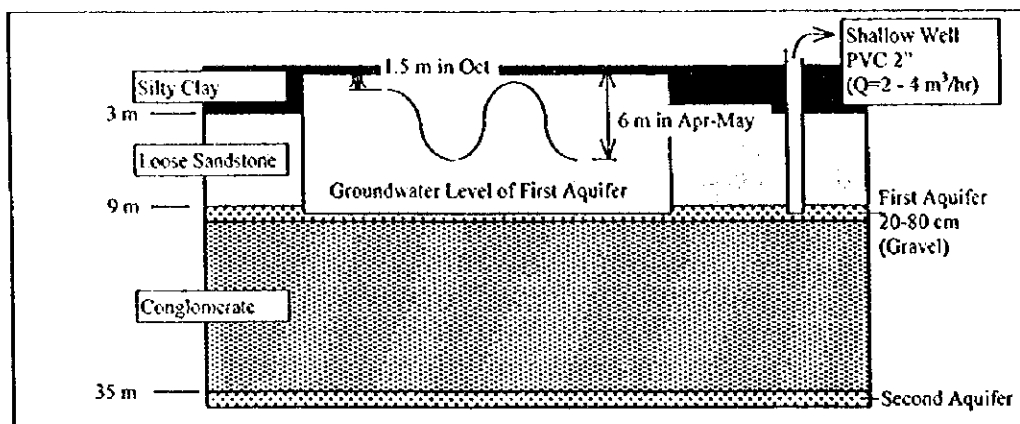


Figure 9.1-1 Approximate Profile of Geological Layer and Shallow Well in SKN-3.1 Priority Area

Allowable well density may be one well in 26 rai for 4 rai integrated farming and one in 3.2 rai for 1 rai vegetable farming by the preliminary investigation as discussed in Chapter 9.3.3.

9.1.4 Soil and Land Use

1) Soil

The soil in Sakon Nakhon Priority Area is classified into 7 groups namely Nos. 6, 17, 35, 35B, 35B/40B, 49, 49C as shown in Appendix E, Figure E-7 : Soil Map of Sakon Nakhon Priority Area. Out of a total area of 33,900 rai, soil group No 35 occupies about 40% or 13,730 rai, soil Nos. 35B/40B and 17 cover about 23% and 20% or an area of 7,900 and 6,920 rai, whereas the other groups occupy only a small area as shown in Table 9.1-4: Soil Groups in Priority Area (No.3-1 LRA).

Most of the soil is Clayey Paleaquults and Loamy Paleaquults which are found in paddy fields. Soils in paddy fields are loamy sand, sandy and sandy loam which are low in organic matter. Soil pH is 4.5 - 6.5.

Upland soils are Loamy Paleustults, Loamy Dystropepts and Skeletal Plinthustults as shown in Appendix E, Table E-6. Soils in the upland fields are loamy sand, sandy, sandy loam and sandy clay loam. The soil are low in organic matter. Soil pH is 4.5 - 6.5.

The Department of Land Development has classified the lowland area as suitable for rice is suitable, and on upland area many crops can be cultivated except rice as shown in Appendix E, Table E-7 : Land Classification System and Appendix E, Table E-8 : Soil Groups and Crop Suitability in Different Priority Areas.

Table 9.1-4 Soil Groups in SKN-3.1 Priority Area

Soil Group	Land Area (rai)	Percentage (%)
6	3,200	9.4
17	6,920	20.4
35	13,730	40.5
35b	1,020	3.0
35B/40B	7,900	23.3
49	340	1.0
49C	790	2.4
Total	33,900	100.0

2) Land Use

Agricultural land use in Sakon Nakhon Priority Area is shown in the table below. From a total agricultural land area of 25,100 rai, about 51.2% or 12,850 rai is paddy field, whereas the area for upland is less at about 43.6% comprise of 31.7% is cassava and 11.9% is under sugarcane and only 5.2% is under fruit trees as shown below :

Table 9.1-5 Present Land Use in SKN-3.1 Priority Area

Priority Area (rai)	Agricultural Land (rai)	Paddy Land (rai)	Cassava (rai)	Sugarcane (rai)	Fruit Tree (rai)
Sakon Nakhon	25,100	12,850 (51.2%)	7,956 (31.7%)	2,990 (11.9%)	1,304 (5.2%)

Source : Department of Agricultural Extension, 1996.

9.1.5 Agricultural Infrastructure

1) Water Resources

a) Dredging and Excavation Projects

Water resources of this area has been developed mainly by means of dredging swampy areas mainly by RID since 1980s. However, those works were not for irrigation but for drainage to prevent floods from the area. Other than public water resources development, two small reservoirs had been developed by farmers themselves in the southern foothill of the Phu Phan Range in old time. Those reservoirs are utilized for supplemental irrigation of paddy rice by farmers themselves. It is difficult to evaluate the efficiency quantitatively because reservoirs are utilized for a large extent of paddy field together with the runoff water from the mountains.

b) Community Pond

All villages have one to three community ponds for the village, and there exist 15 community ponds in the area. Out of 15 community ponds, 4 ponds are not effectively used due to pollution, seepage and sediment. They are utilized mainly for livestock and fisheries, and partly for irrigation. Community ponds in this area are excavated type, so that irrigation

is limited at the surrounding lands. Collectivity and retention capacity are generally good in the area.

Table 9.1-6 Community Ponds and Utilization in SKN-3.1 Priority Area

Village	General Information of Community Pond			Reasons of none effective utilization					Purpose of Utilization					Collecting Capacity of Runoff					Retention Capacity											
	Number of Ponds in Village	Constructed by	Efficiently utilized?	Water pollution	Distraction of dike	Seepage	Sediment	Woods	Irrigation	Livestock water	Drinking water	Domestic water	Fisheries	Swimming	Environment	Collecting of runoff	Enough catchment	Enough collecting canal	Enough rainfall	Poor catchment Area	Poor collecting canal	Water retention Capacity	Blanket pavement	Good maintenance of dike	Good impermeable soil	High seepage	High evaporation	High leakage through dike	Bediment	
15 Kut Bak	1	PWD	no	1					1	1					good						good									
16 Kut Bak	1	Gov. Ror. Por.	yes												good	1					good	1								
17 Nong Song Meng	2	Tambon	no						1	1					poor						poor									
18 Kut Haet	2	RID	yes						1	1					good						good									
19 Bua	1	community	no												good						good									
20 Sai Kao	1	PWD	yes												good	1					good									
21 Kut Hai	1	ARD	yes												good	1					good	1								
22 Neiu	1	Changwat	yes												good	1					good	1								
24 Kho Yai	2	Tambon	yes												good	1					good									
25 Kho Noi	3	ARD	yes												poor						good									

(Note) based on Interview to the village leaders

c) Wells

Wells are commonly utilized in this area for various purposes for village water supply and domestic water in individual households. Yield of well is estimated 2 to 10 m³/hr by DMR in most area of this priority area. Total number of wells are estimated more than 700 wells in the area. Most of private wells are shallow well and utilizing first aquifer at the depth of about 9 m from surface. Although wells had been utilized for watering vegetables in house yard since many years before, wells have been recently utilized for conducting integrated farming by means of pipe and sprinkler system in the area. Such farmers are increasing in number rapidly. It is, therefore, important to investigate groundwater potential in this area.

Table 9.1-7 Wells in SKN-3.1 Priority Area

Village	Public Wells		Private Wells	Purposes of Wells					Water Quality					Operation Condition of Public Wells (%)				Operation Condition of Private Wells (%)							
	Number of wells	Agency	Number of Wells	Drinking	Domestic	Livestock	Garden water	Irrigation	Good	Fair	Poor	Saline	Polluted	Well working	Broken	Drying	Polluted	Saline	Well working	Broken	Drying	Polluted	Saline		
15 Kut Bak	1	ARD			1								1				100								
16 Kut Bak	0		10	1	1	1	1			1									70	20	10	0	0		
17 Nong Sibe Han	5	ALRO,ARD,DMR,DOH	70	1	1			1	1					95	5	0	0	0	80	20	0	0	0		
18 Kut Haet	5	ALRO,DMR	100	1	1					1				25	10	1	10	0	80	50	5	50	0		
19 Bua	4	ALRO,DMR,DOH	80		1	1				1				95	5	30	50	0	50	50	50	10	0		
20 Sai Kao	4	ALRO,ARD,DMR,DOH	50					1	1					98	2	0	20	0	70	30	20	0	0		
21 Kut Hai	4	ARD,DMR	350	1	1			1	1					80	10	0	20	0	70	30	0	0	0		
22 Neiu	4	ALRO,DMR,PWD	20		1								1	95	5	0	50	0	80	20	0	0	0		
24 Kho Yai	6	ARD,DMR,DOH	12		1				1					90	10	0	0	0	80	20	0	0	0		
25 Kho Noi	5	ARD,DMR	10		1				1					90	10				50	50					
Total	38		702																						

(Note) interviewed to Village Leaders

2) Farm Pond

Individual small farm ponds are not well developed like as in KK-6 and MHS-5, but counted at about 7% of farmers having a farm pond. Those farm ponds are utilized for paddy supplemental irrigation and partly for integrated farming. Although wells have been recently

utilized for integrated farming, farm ponds are still important for individual water resources for farmers in the higher lands where wells are not suited for development .

Common problems of individual small farm pond are as follows;

- Seepage problems in Kut Bak, Bua and Sai Kaco. (Depth to be kept in enough depth to contact into impermeable layer)
- Too small for integrated farming .

Table 9.1-8 Present Problems of Individual Small Farm Pond in SKN-3.1 Priority Area

Village No.	Village	Problems on Farm Pond									
		No sufficient inflow (%)	Sediment (%)	Heavy seepage (%)	Heavy weeds (%)	Too small for integ. farming	No sufficient labour force	Much labour for irrigation	No budget for integ. farming	No sufficient benefit	No market
15	Kut Bak										
16	Kut Bak	60		70							
17	Nong Sibg Hang					yes			yes	yes	
18	Kut Hact					yes			yes	yes	
19	Bua			100							
20	Sai Kaco			100					yes	yes	
21	Kut Htai	40							yes	yes	
22	Ngip					yes					
24	Kho Yai								yes	yes	
25	Kho Noi										

(Note) based on interview to village leaders.

3) Farm Road

Farm road development is remained at lower level in this area. Total length of farm roads is about 24 km or 0.95 m/rai in density. (Table 9.3-8) Land holdings of paddy area is so small that it is difficult to construct farm roads. Consequently, only 11 % of paddy plots has a access farm road in the lowland while 38% in the upland. In whole area, accessibility is counted at 27%.

4) Farm Plot Size and Farming Categories

Farming plot size and farming categories are analyzed based on the Land Reform Cadastral Map of 1/4,000 scale. Average farm size in the Priority Area is estimated at about 10 rai for a farmer, that is the smallest land holdings among the priority areas.

Table 9.1-9 Landholding Distribution in SKN-3.1 Priority Area

Section (rai)		Frequency Plots	Accumulation	
0 - 5	0 < <= 5	862	51.0%	51.0%
5 - 10	5 < <= 10	406	24.0%	75.0%
10 - 15	10 < <= 15	160	9.5%	84.5%
15 - 20	15 < <= 20	79	4.7%	89.2%
20 - 25	20 < <= 25	47	2.8%	92.0%
25 - 30	25 < <= 30	32	1.9%	93.9%
30 - 35	30 < <= 35	24	1.4%	95.3%
35 - 40	35 < <= 40	17	1.0%	96.3%
40 - 50	40 < <= 50	22	1.3%	97.6%
50 - 60	50 < <= 60	9	0.5%	98.1%
60 -	60 <	32	1.9%	100.0%
Total		1690		

Average = 9.42rai

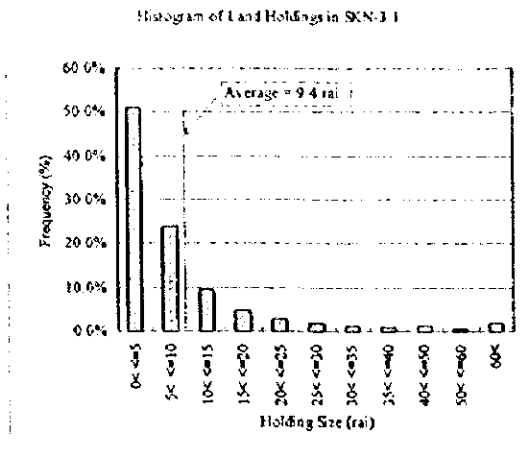


Figure 9.1-2 Landholdings in SKN-3.1 Priority Area

Farming categories are classified into three groups as shown in Table 9.1-10, namely Lowland Type, Mixed Type, and Upland Type based on upland field ratio.

- Lowland Type : upland field less than 30%
- Mixed Type : upland field from 30% - 70%
- Upland Type : upland field more than 70%

Among three farming groups, average land holdings are smaller in lowland as at 6.8 rai and larger in upland as at 11.4 rai.

Table 9.1-10 Present Farming Type and Farm Size in SKN-3.1 Priority Area

Type of Land	Area (rai)	Paddy	Upland	Plots having Farm Road	Plots having Farm Pond	Plots Blocks & Block
Lowland Type	18.9 % 3,012 rai Average 6.8 rai	87 % 2,623 rai	13 % 389 rai	11 % 48plots Distance to village 1.3 km	8 % 35plots Average 0.5 rai	444 plots 21 blocks 178, 179, 180, 189, 280, 338, 351, 352, 359, 374, 431, 443, 444, 446, 495, 502, 661, 855, 921, 922, 923
Mixed Type	28.5 % 4,863 rai Average 9.0 rai	45 % 2,189 rai	55 % 2,674 rai	25 % 132plots Distance to village 1.4 km	10 % 55plots Average 0.3 rai	538 plots 22 Blocks 172, 186, 190, 198, 199, 332, 334, 339, 340, 342, 346, 347, 350, 445, 510, 513, 630, 646, 821, 822, 840, 924
Upland Type	52.6 % 8,041 rai Average 11.4rai	10 % 795 rai	90 % 7,246 rai	38 % 272plots Distance to village 1.3 km	5 % 34plots Average 0.5 rai	708 plots 47 blocks 171, 173, 174, 175, 176, 177, 181, 182, 183, 184, 185, 187, 191, 192, 193, 194, 195, 196, 197, 200, 331, 333, 335, 336, 337, 341, 343, 344, 345, 348, 349, 432, 434, 440, 442, 647, 671, 672, 674, 675, 818, 828, 852, 853, 854, 912, 925
Total	100 % 15,916 rai Average 9.4 rai	35 % 5,607 rai	65 % 10,309 rai	27 % 452plots Distance to village 1.3 km	7 % 124plots Average 0.4 rai	1,690 plots 90 blocks

Histogram of Upland Distribution in SKN-3.1

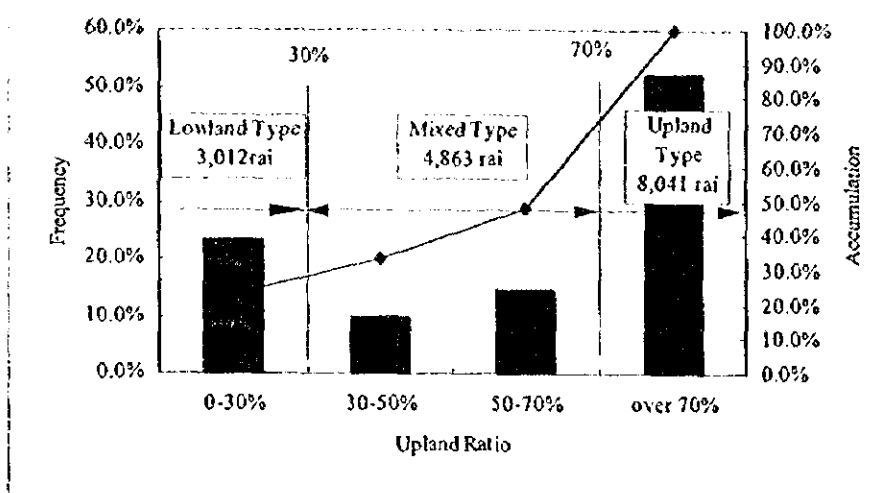


Figure 9.1-3 Upland Ratio in SKN-3.1 Priority Area

9.1.6 Rural Infrastructure

1) Rural Road

Rural roads are mostly 4 m width and paved by laterite. Some of rural roads are recently improved with asphalt and enlarged to 6 m width partly. However, improvement of rural road is still limited in particular location, and its improvement is highly requested by villagers. Pavement of rural road will be 25 km with asphalt in this area. Location of rural roads is shown in Figure 9.3-1.

Table 9.1-11 Rural Road in SKN-3.1 Priority Area and Necessary Improvement

Road No.	Name	Route		Length (km)	Present		Improvement		
		from	to		Width (m)	Pavement	Length (km)	Width (m)	Pavement
1	2218	Kut Bak	Outside	10.3	6	Asphalt			Completed
2		Kut Bak	Outside	0.5	6	Asphalt			Completed
3		Kut Bak	Outside	0.8	4	Asphalt			Completed
4		Kut Heat (18)	Bua (19)	3.7	4	Laterite	3.7	4	Asphalt
5		Bua (19)	Ngiu (22)	5.0	4	Laterite	5.0	4	Asphalt
6		Bua (19)	Kho Noi (25)	3.9	4	Laterite	3.9	4	Asphalt
7		Kho Noi (25)	Ngiu (22)	2.9	4	Laterite	2.9	4	Asphalt
8		Kho Noi (25)	Kho Yai (24)	4.0	4	Laterite	4.0	4	Asphalt
9		Kho Yai (24)	Ngiu (22)	2.7	4	Laterite			under pavement
10		Kho Yai (24)	Outside	2.4	4	Laterite	2.4	4	Asphalt
11		Kut Hai (21)	2218	1.2	4	Laterite	1.2	4	Asphalt
12		Kut Hai (21)	2218	0.5	4	Laterite	0.5	4	Asphalt
13		Kut Hai (21)	2218	0.7	4	Laterite	0.7	4	Asphalt
14		Ngiu (22)	2218	1.1	4	Laterite	1.1	4	Asphalt
Total				39.7			25.4		

(Note) Location of roads is shown in Figure 9.3-1.

2) Village Water

Most villages have own village water supply system except two villages, Nong Song Hang and Bua, in the area. In two villages, private wells are utilized for domestic purposes. Coverage ratio of water supply services is very low due to deterioration of well yield in many villages. In those villages, existing private shallow wells are utilized again as well as rainjars.

3) Electricity and Communications

Electrification has been completed since 30 years before in first electrification, and 3 years before in latest village. Telephone system is now rapidly expanding, and covering 9 villages among 10 at the end of 1997.

4) Health Center

Health centers are located in four villages among 10 villages in the area. However, nearest centers are available within 3 km distance from every villages.

9.1.7 Rural Organization

Many kinds of peoples' organizations have been organized within the Priority Area, such as, BAAC, Agricultural Cooperatives, Housewives' Groups, Young Farmers' Groups and Productive Saving Groups. Membership of the organizations at Tambon level in the Priority Area may be summarized as follows:

Table 9.1-12 Organization and Membership in SKN-3.1 Priority Area

Tambon	BAAC		Ag. Coop.		Housewives		Youth Groups		Same Activity Farmers' Groups		Production Saving	
	No	Member	No	Member	No	Member	No	Member	No	Member	No	Member
Kut Bak	17	416	6	300	4	113	3	51	4	65	3	150
Kut Hai	8	296	2	100	4	67	5	109	4	72	4	270

Source: Amphoe Kut Bak Agricultural Extension Office, 1995

According to the results of interviews in the area, membership of major existing groups or local organizations is as follows. Most organizations are not so active.

Table 9.1-13 Membership Ratio of Organizations in SKN-3.1 Priority Area

Type of Organization	Membership % of total respondents (317)
BAAC	17.4
Agricultural Coop.	23.7
Housewife Group	13.6
Youth Group	7.6
Production Saving Group	14.5
Others	1.6

Within the Priority Area, the people have lived in this area for centuries. Most of the villages in the area are communities of strong solidarity, especially Ban Bua Mu 5 in Tambon Kut Bak. They have organized a local group, with an active leader, which is called as the In-Paeng Network under technical and financial support from the government agencies and NGOs. The main objectives of the In-Paeng Network are the following.

- Providing a youth training program aimed at sustainable agricultural practices and village life.
- Native plants and indigenous trees conservation and their sustainable use.
- Expanding ecological farming.
- Production of traditional Thai medicines made from native plants, indigenous

trees, etc.

- Forming an In-Paeng Network covering 60 villages in eight Amphoe in these three provinces, Kalasin, Udon Thani and Sakon Nakhon.

At present, twenty two villages in five Amphoe belong to the In-Paeng Network. Among these, ten villages are in Amphoe Kut Bak and the group leader is in Ban Bua within the Priority Area. The In-Paeng Network is a local organization set up and administered by farmers. It is well preformed in operation due to the existence of a strong leader and the close operation to the farmers.

9.1.8 Environmental Conditions

The priority area is adjacent to Nam Un Reservoir, an agricultural zone, an economic zone and a conservation zone. The forest condition is comparatively good because of forest conservation activity by monks.

A group of monks planned three forest temples in Sakon Nakhon, including the forest in the priority area. In Kho Noi, 779 rai of Pa Cha ¹⁾ is managed by monks and is maintained in good natural condition. Villagers respect the monks and a fence was constructed by using the donations from villagers around the forest.

In Sakon Nakhon, since 1994 plantation of *Acacia mangium* is promoted in a reforestation campaign by the Agricultural Extension Office in association with a private company. 2,800 rai in the priority area and a total of 27,000 rai in Sakon Nakhon were planted with *Acacia mangium* for pulp production. The pulp factory that was to be constructed in Nong Khai Province by that company had no prospect of construction until now. Also the planting density of *Acacia mangium* looks too high to get the expected yield of 15 ton/rai/three years.

1) Pa Chumchon means the forest that belongs to the temple. Sometimes, it is used like a Community Forest by villagers though they do not call it "Community Forest".

9.2 Present Agriculture

9.2.1 Agricultural Production

Like most areas in the Northeastern Region, the Priority Area in Sakon Nakhon are in a rainfed area. Approximately 90 per cent of agriculture depends on rainfall. However, average precipitation of 1,400 mm is among the high ranges in the Region.

The major crops are rice, cassava and sugarcane. Agricultural land is also devoted to some fruit tree varieties such as tamarind, mango, jackfruit and logan. Acreage and production of those crops are presented in the table below.

Table 9.2-1 Acreage and Yield of Crops in SKN-3.1 Priority Area ¹⁾

Location	Crops	Area (rai)	Production (ton)	Yield (kg/rai)
Kut Bak	Rice	12,850	5,012	390
	Cassava	7,956	17,503	2,200
	Sugarcane	2,990	35,880	12,000
	Tamarind	400	240	600 ²⁾
	Mango	686	755	1,100 ²⁾
	Jackfruit	142	320	2,250 ²⁾
	Logan	76	60	790 ²⁾
Total Planted Land		25,100 rai		

Source : ¹⁾ Amphoe Kut Bak Agricultural Extension Office, 1996

; ²⁾ Estimated figures

Some farmers in the Priority Area also practice sericulture for additional household income. Both silkworm and mulberry are of local varieties. Silkworm rearing houses are modest. Farmers who produce silk usually sell their products in both silk cloth and thread form.

9.2.2 Farming Practice

The farming practice in the areas is still traditional. Even though extension agents try their best to transfer innovative agricultural technology to the farmers, adoption by the recipients is not satisfactory. The obstacles of technology transfer attempted by extension officers are from two angles or approaches - the farmers themselves and the natural environment. The farmers are largely uneducated and poor, and are not ready to follow advice when it requires investment. Rainfall for rainfed cultivation in the Northeastern Region is unreliable. Drought and dry spells can occur at any time during the rainy season. So, sometimes water is scarce and sometimes there is too much. However, the farmers readily adopt the use of recommended varieties. Chemical fertilizers and pesticides are used but not much.

9.2.3 Livestock and Fishery

As in other priority areas, livestock in Sakon Nakhon Priority Area consists of cattle, water buffalo, pigs, ducks, and chickens. Most cattle and chickens are of local breeds. Only pigs, which the majority of the animals belong to, are of improved lines. Ducks are Muscovy.

There are no fishery statistics as to variety of fish and number of ponds available. Most farmers who breed fish usually acquire fingerlings from natural sources and raise them in natural ponds in the rainy season. Only a few farmers can afford to fish ponds because they require high investment. All species cultured in the excavated ponds are herbivorous.

The number of cattle, water buffalo, ducks, chickens and pigs are presented in Table 9.2-2.

Table 9.2-2 Number of Livestocks in SKN-3.1 Priority Area ¹⁾

Location	Cattle	Water Buffalo	Pigs	Ducks	Chickens
Tambon Kut Bak	1,807	1,740	827	1,207	9,860
Tambon Kut Hai	2,596	1,849	439	1,771	12,273
Total	4,403	3,589	1,266	2,978	22,133

Source : ¹⁾ Amphoe Kut Bak Agricultural Extension Office, 1996

9.2.4 Post-Harvest Handling and Marketing

Major crops in the study area are rice, cassava and sugarcane. Rice is usually harvested manually by farmers and dried in the same field for two to three days. Threshing is done by the family and relatives or sometimes hired labor. Estimated paddy production in this priority area is approximately 5.0 million kg provided 390 kg/rai yield, and its surplus is 2.29 million kg after deducting home consumption and seeds for next planting (refer to Appendix F : Table 7.2.5-1 Estimated Paddy Production and Surplus).

Rice selling is conducted through traders, middlemen, etc. at farm gate after threshed. Farmers don't have enough warehouses for storing dried paddy for late selling (refer to Appendix F : Table 7.2.5-2 Inventory of Post-Harvest/Marketing Facilities in Priority Area).

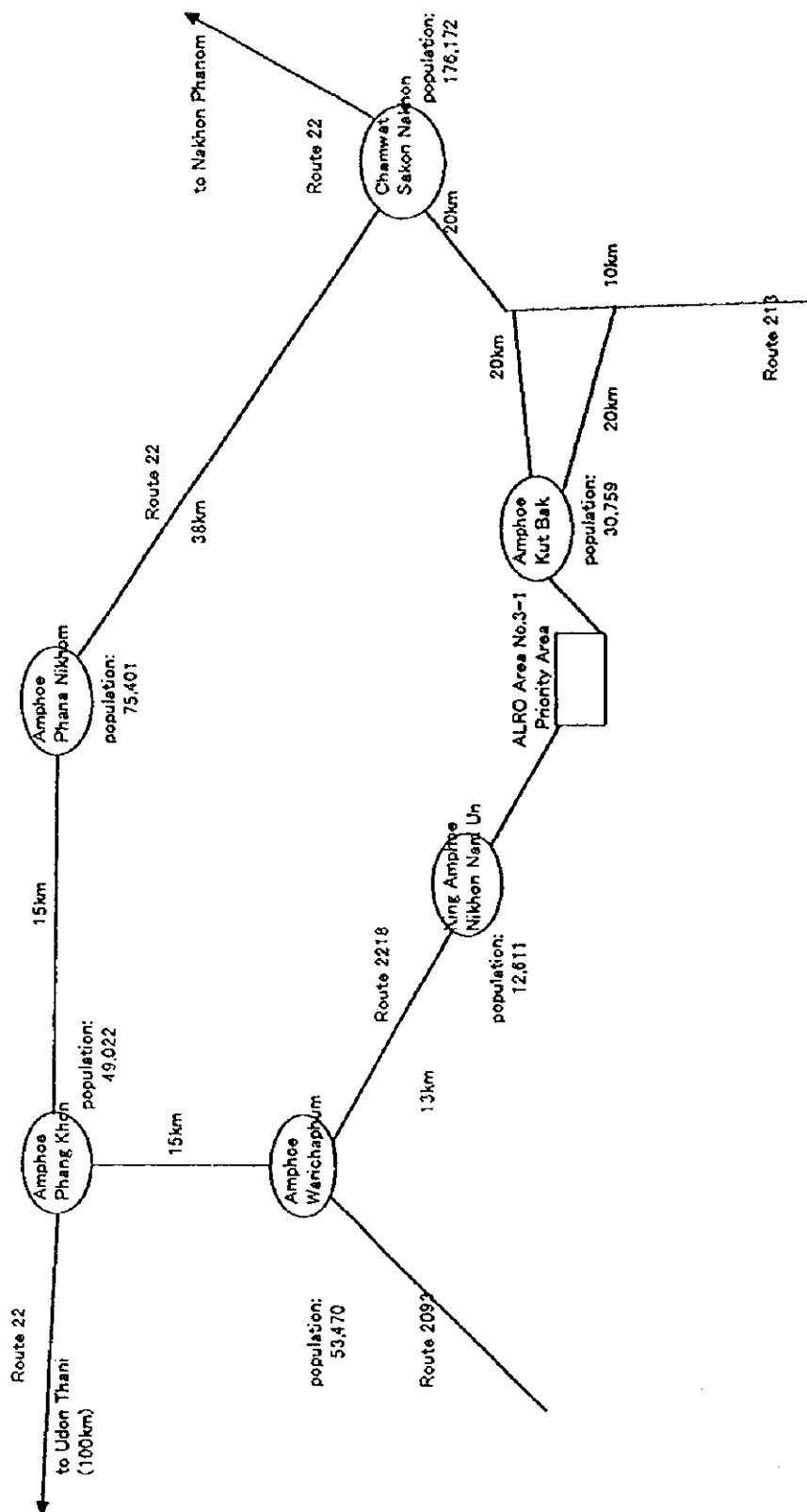
Marketing routes of cassava and sugarcane are fixed as same as in Khon Kaen and Mahasarakham. There is, therefore, less merit for farmers to enter into the market.

Livestock raising like as chickens, ducks and pigs is conducted in the area and animals are fed around farmers' houses and in fields. These animals are raised for domestic consumption. They are sometimes sold to traders who come to do business for other purposes.

Specialized agricultural products such as herbs, wood or roots for medicine as well as traditional cloth woven by women farmers are produced supported by agencies under the government and sold through the cooperatives or associations to distant markets such as Changwat Sakhon Nakhon or even Bangkok.

Other agricultural crops such as vegetables and fruit are rarely planted in the area and they are generally cultivated for domestic consumption. No typical post-harvest handling and marketing scheme is found.

The marketing point for this area is Amphoe Kut Bak. It may also be possible to use Changwat Sakhon Nakhon, King Amphoe Nihon Nam Un, Amphoe Warichaphum or even Amphoe Phang Khon (refer to Figure 9.2-1 Marketing Points near the Priority Area). However, their market points are a little far from the area. Unfortunately, roads are not adequate and farmers have insufficient marketing information systems and lack of knowledge. They only get information from relatives or traders.



Changwat Sakon Nakhon total population: 1,058,000
Figure 9.2-1 Marketing Points near the Priority Area (Sakon Nakhon)

9.2.5 Farm Household Economy

The income of farmers living in Sakhon Nakhon Priority Area ranks in the middle of the four Priority Areas. According to the survey by the Study Team, the average annual income in the area is 22,200 baht, of which 12,600 baht or 57% is agricultural income. Major sources of non-agricultural income is employment. Categorized agricultural income is as below;

Estimated net agricultural income	
Less than 15,000 baht	74.1 %
15,000 baht	5.0%
More than 15,000 baht	20.5%
Others	0.3 %
Mean	12,600 baht/year

9.3 Development Plan

9.3.1 Objectives of the Development

The main objectives of the development have been established in Chapter 3.4.1 and are as follows :

- a) To increase farmers' income,
- b) To satisfy basic human needs, and
- c) To conserve the forest reserve areas adjacent to LRAs.

Basic development strategy of this area is introduction of integrated farming (including vegetable production, fruit tree cultivation, poultry, fish breeding) and fast-growing trees based on farm pond or well development. The integration of integrated farming is expected to contribute considerably in accomplishing the development objectives listed above. However, it should be understood that providing increased access to education is the most effective way for reducing pressure on forests and for increasing the effectiveness of development.

9.3.2 Farming Plan

The development strategy of the Priority Area is to introduce integrated farming (including vegetable production, fruit tree cultivation, poultry, fish breeding) based on a farm pond, and fast-growing trees in the farmland presently cropped with rice and cassava.

Present farming type can be classified into 2 categories in the area, namely, lowland type (rice cultivation) and upland type. Farming plan of each type is proposed as shown below:

Table 9.3-1 Farming Plan for a Typical Household (10rai)

Land Use	Lowland Type	Upland Type
	(51%)	(49%)
Rice	5 rai	3 rai
Cassava	-	-
Sugarcane	-	-
Fruit tree	2.5 rai	2.5 rai
Fast-growing tree	-	2 rai
Vegetable	0.5 rai	0.5 rai
Pig breeding	(2 heads)	(2 heads)
Poultry	(100 heads)	(100 heads)
Fish breeding	-	-
Farm pond	1 rai	1 rai
House, etc.	1 rai	1 rai

By implementation of the farm pond and farm road project, farmland with a farm pond will be increased to 11,800 rai or 47% of the whole, together with the present farmland with a pond. Present cassava field will be changed to fruit tree and fast-growing tree by 55% by the project. Cropping pattern of the area will be changed as shown in Table 9.3-2.

Table 9.3-2 Present and Planned Cropped Area in SKN-3.1 Priority Area

Land Use	Present	Plan	Difference
Rice	12,850 rai	12,350 rai	(-) 500 rai
Cassava	7,956 rai	3,644 rai	(-) 4,312 rai
Sugarcane	2,990 rai	2,110 rai	(-) 880 rai
Fruit tree	1,304 rai	3,640 rai	2,336 rai
Fast-growing tree	-	1,156 rai	1,156 rai
Vegetable	-	590 rai	590 rai
Farm pond	-	430 rai	430 rai
House, etc.	-	1,180 rai	1,180 rai
Total	25,100 rai	25,100 rai	0 rai

a) Fruit trees

Fruit trees recommended in Chapter 4.2 will be also recommended for Sakon Nakhon Priority Area. Furthermore, longan, which is already grown in the area will be encouraged to be grown in an extended area with high quality varieties. However, longan is suitable only in a farming system where the trees can receive supplementary irrigation water.

In addition a few species of native fruit trees necessary for ecological farming will be included in the fruit tree list. Examples of the native fruit trees are Ma Huad (*Lepisanthes rubigenosa* Leenh.), Wah (*Eugenia cumini* Druca), and Ma Kok (*Spondias pinnata* Kurz).

b) Fast growing trees

Fast growing trees recommended in Chapter 4.2 are also recommended for Sakon Nakhon Priority Area. In addition, since Sakon Nakhon is more humid and its precipitation is high, it is suggested that two more kinds be added to the list for farmers to choose from. These are:

i) Para rubber

This tree covers huge areas in the south and is of dual purpose - for latex and wood. It has been introduced to provinces located near the Mekong river and has proved successful. For latex production, the planted area must be at least 7 rai to return investment. Maturity for first tapping is 5-6 years, and for wood is 12 - 15 years. However, one or two rai of para rubber trees for wood are adequate. This tree can grow well in poor soils as long as precipitation is sufficient.

ii) Rattan

Rattan needs shade from other trees and can be grown as part of an ecological farming and agroforestry system since it needs shade from other trees. Young shoots are popular vegetables and the cane is unique for making furniture. Rattan for vegetable can be grown in open sunlight. The Production cost of rattan is low.

c) Vegetables

No information about vegetable production in Sakon Nakhon Priority Area is available. It is highly recommended that vegetables be grown both in integrated farms and rainfed farms for household consumption and additional income. The farmers choice vegetables is the same as recommended in Chapter 4.2. However, choice of kinds of vegetables in Sakon Nakhon Priority Area will include native species as Rattan (*Calamus* spp.), Sour Star Fruit (*Averrhoa carambola* Linn.), and Phak Wahn Pah (*Melientha suavis* Pierre).

In Sakon Nakhon, marketing channels are small when compared to Khon Kaen and Maha Sarakham. A vegetable surplus may occur from the vegetable production in the priority area. Since vegetables are perishable crops, the farmers may be discouraged when they encounter with left over and rotten products. So an alternative is recommended. The products should be divided into two halves, first half is sent to the market fresh, the second preserved as dried and/or pickle vegetables. The preserved products can be kept and sold to the market in other places. This recommendation can be carried out with assistance from provincial agricultural extension office and other government agencies concerned.

9.3.3 Agricultural Infrastructure Development Plan

1) General Direction of Agricultural Infrastructure Development

Since SKN-3.1 priority area is located on gently rolling flood plain, most land of this area is fully cultivated with rice in lowland and with upland crops in mound land. It is very difficult to find out the suitable development sites for additional water resources in the area. Any new reservoir development is not accepted by villagers due to no space for reservoirs. Land holding size is quite small as 9 rai per farmer in this area, so that farmer does not accept even dredging type of water resources development lake in KK-6 priority area. Existing dredging projects of creeks are not aiming storage of water. These projects are aiming drainage of flood water from this area. Excavated width is much smaller than in KK-6

priority area, because its width and depth are planed only for draining flood water within allowable inundation time. Past major water resources developments were by means of community ponds and dredging of natural swamps. Therefore, for large scale of water resources development for this area, it is necessary to develop in surrounding outside area like in Phu Phan Range. However as mentioned in Chapter 2.6.1, 2), water resources development in Phu Phan Range causes the decrease of water resources of Nam Un Dam. It is, therefore, necessary to remain development only at Huai Krachoe Dam which under construction by RID.

As the direction of individual water resources development, groundwater development should be considered other than farm pond. However, availability of groundwater may be limited in certain level, it will be necessary to develop in combination with farm pond.

Consequently, farm pond development including wells, and farm road development will be major development in this Priority Area .

2) Water Resources Development

Huai Krachoe Reservoir and Nam Un Pump Irrigation Projects have been proposed by RID. These projects will irrigate north-western part of this area. Irrigation area of these projects in this area is estimated at about 3,000 rai. However, these irrigation projects are mainly aiming to irrigate wet season rice.

Table 9.3-3 Proposed RID Irrigation Projects in SKN-3.1 Priority Area

Water Resources Development	Estimated Irrigation Area	Major Villages to be served
Huai Krachoe Reservoir Irrigation Project	2,500 rai	Kho Yai Kho Noi
Nam Un Pump Irrigation	500 rai	Kho Yai
Total	3,000 rai	2 villages

Regarding above two projects, Huai Krachoe Reservoir is under construction by RID, while Num Un Pump Irrigation just under preliminary plan. Therefore, Huai Krachoe Reservoir shall be considered as a firm project to irrigate 2,500 rai for this Priority Area. This project will be proceeded by RID including construction of irrigation canal and road. The location of irrigation area of this project is shown in Figure 9.3-1.

3) Well and Farm Pond Development

Due to limitation of available water resources only for certain part of area, individual well and farm pond development will be major direction in this area for expanding integrated farming. Furthermore, farm road system should be improved and expanded for increasing accessibility to conduct the integrated farming.

In lowland paddy area, land holding size is quite small as 7 rai in average and shape of land is quite irregular. It is, therefore, very difficult to provide farm roads in this lowland. Furthermore, lowland is subject to flood which causes serious damage to integrated farming.

Development priority of such lowland will be, therefore, low from an aspect of

integrated farming development. In lowland, development plan will be considered only for the land which has a certain area of upland and locates nearby the mixed land.

At present, only 7% of farmers have a 1,200m³ class farm pond in this area. Among three types of lands, farm pond holding is high in the mixed land at 11%, and low in upland at 5%. In lowland, 8% of farmers has a farm pond, but these farm ponds are only for nursery of paddy and supplemental water supply in dry spell.

a) Possible Well Development

Possible well development will be analyzed from both factors of water recharge and water consumption.

i) Estimation of Available Groundwater

Annual Rainfall: 1,219 mm (1/5 drought year)

Runoff coefficient: 30%

Infiltration = $(1 - 0.3) * 0.5 = 35\%$

Evapotranspiration = $(1 - 0.3) * 0.5 = 35\%$

Infiltration = $1,219 \text{ mm} * 35\% = 427 \text{ mm/yr}$

Available depth of groundwater is assumed at 20% of infiltration = $427 \text{ mm} * 0.2 = 85 \text{ mm/yr}$

ii) Water Requirement

Annual Water Consumption = 7,086 m³/yr (Vegetables = 1 rai, Fruit tree = 3 rai)

Available density of well = $\text{Water Consumption} / \text{Available groundwater depth}$
= $7,086 \text{ m}^3/\text{yr}/\text{well} / 0.085 \text{ m/yr} = 83,365 \text{ m}^2/\text{well} = 52 \text{ rai}/\text{well}$
(assumed to be 26 rai/well taking outside groundwater basin in surrounding conservation forests.)

Annual Water Consumption = 851 m³/yr (Vegetables = 1 rai)

Available density of well = $\text{Water Consumption} / \text{Available groundwater depth}$
= $851 \text{ m}^3/\text{yr}/\text{well} / 0.085 \text{ m/yr} = 10,012 \text{ m}^2/\text{well} = 6.3 \text{ rai}/\text{well}$
(assumed to be 3.2 rai/well taking outside groundwater basin in surrounding conservation forests.)

From above investigation, one well can be developed approximately in each 26 rai for 4rai integrated farming, and 3.2 rai for 1 rai vegetable farming. It is equivalent to about 36% of farmers for 4 rai farming, and 100% for 1 rai vegetables taking average land holding of 9.4 rai in the area.

b) Farm Pond and Well Development

Farm pond development will be provisionally analyzed only by the factors in Table 9.3-4, without taking groundwater development into consideration.

Table 9.3-4 Factors on Farm Pond Development in SKN-3.1 Priority Area

Factors	Dimensions
Average size of land holding	9 rai/farmer
Irrigable farming size (1/5 dry year) 1,200m ³ Farm pond 6,000m ³ Farm pond	1 rai vegetables through the year (3 cropping/year) 1 rai vegetables through the year (ditto) and, 3 rai of fruit trees
Necessary Catchment 1,200m ³ Farm pond (Well) 6,000m ³ Farm pond (Well)	1.5 rai (1 rai vegetables = 3.2 rai) 15 rai (4 rai integrated farming = 26 rai)
Farm road accessibility	Lowland = 64%, Mixed land = 81%, Upland = 93%
Topographical suitability for Farm Pond for Well Development	Lowland = 100%, Mixed land = 90%, Upland = 80% Lowland = 100%, Mixed land = 80%, Upland = 70%
Soil suitability for Farm Pond for Well Development	Lowland = 100%, Mixed land = 90%, Upland = 80% Lowland = 100%, Mixed land = 100%, Upland = 100%

Based on above factors, it is preliminarily estimated that potential of well development is higher than farm pond development. Priority of development should be given to the well not only from potential but also from economical viewpoint.

Table 9.3-5 Physically Possible Farm Pond and Well Development in SKN-3.1 Priority Area

Development of Farm Pond	Lowland	Mixed Land	Upland	Total
Present				
1,200m ³ Farm Pond	8%	11%	5%	7%
Future Possible Expansion				
<In case developed only by 1,200m ³ Farm Pond>				
In case accessibility considered	44%	43%	45%	44%
In case accessibility not considered	74%	56%	49%	58%
<in case developed mixed with 6,000m ³ Farm Pond>				
6,000m ³ Farm Pond	9%	15%	18%	15%
1,200m ³ Farm Pond (accessibility counted)	35%	28%	27%	29%
1,200m ³ Farm Pond (accessibility not counted)	65%	41%	31%	43%
Present				
Wells (assumption)	0%	17%	13%	11%
Future Possible Expansion of Wells				
<In case developed only by 1 rai Vegetable Wells>				
In case accessibility considered	60%	43%	49%	50%
In case accessibility not considered	94%	57%	54%	66%
<in case developed mixed with 4 rai Wells>				
4 rai Wells	9%	13%	17%	14%
1 rai Wells (accessibility counted)	51%	29%	32%	36%
1 rai Wells (accessibility not counted)	85%	43%	37%	52%

(Note) Details are shown in Table 9.3-6 and 9.3-7.

c) Combination Development of Well and Farm pond

From above analysis, it is found that the priority is to be given to the well development. However, well development is difficult at the mound hills and the piedmont area higher than EL. 205m in southern part of the Priority Area. These high elevation area shares about 1/4 of the area. In such high land, farm pond development is recommendable.

Taking a number of the farmers willing to have a farm pond into consideration as well as physical possibility, it is estimated to construct 1,000 farm ponds newly, of which 750 or 3/4 are to be developed by wells.

Table 9.3-6 Farm Pond Availability in SKN-3.1 Priority Area

Elements	Land Type Classification			Total	Remarks
	Lowland	Fixed Land	Upland		
Vegetable = 1rai					
1-1) Necessary Farm Pond (m3)	1,200	1,200	1,200		
1-2) Farm Pond Size (rai)	1	1	1		
1-3) Necessary Catchment (rai)	1.5	1.5	1.5		
1-4) Necessary Min. Farm (rai)	2	2	2		Veg. + F.Pond
1-5) Necessary Total Area (rai)	2.5	2.5	2.5		C.A + F.Pond
Vegetable = 1rai, Fruit Tree= 3rai (Total 4 rai)					
2-1) Necessary Farm Pond (m3)	6,000	6,000	6,000		
2-2) Farm Pond Size (rai)	2	2	2		
2-3) Necessary Catchment (rai)	15	15	15		
2-4) Necessary Min. Farm (rai)	6	6	6		Veg. + F.Tree + F.Pond
2-5) Necessary Total Area (rai)	17	17	17		C.A + F.Pond
Number of Farmers and Land Holdings					
3-1) Total 04-1 Area (rai)	3,012	4,663	8,011	15,916	
3-2) Total 04-1 Farmers	444	538	708	1,690	
3-3) Average Holdings (rai/farmer)	6.8	9.0	11.4	9.4	(3-1) / (3-2)
3-4) Total Farmers >= 2 rai	364	445	594	1,403	
3-5) Ratio	82.0%	82.3%	83.9%	83.0%	(3-4) / (3-2)
3-6) Total Farmers >= 6 rai	158	232	319	709	
3-7) Ratio	35.6%	43.1%	45.1%	42.0%	(3-6) / (3-2)
Farm Road Accessibility					
4-1) Present Accessibility	11%	25%	38%	27%	
4-2) Assumed Future Accessibility	64%	81%	93%	82%	
Suitability of Farm Pond Construction					
5-1) Topographical Suitability	100%	90%	80%		lower in upland because some area locating at top of hill.
5-2) Soil Suitability	100%	90%	80%		assumed from a viewpoint of sandy texture.
5-3) Area for 1,200m3 pond	100%	100%	100%		(3-3) / (1-5)
5-4) Area for 6,000m3 pond	40%	53%	67%		(3-3) / (2-5)
Possibility of Farm Pond to Farmers					
<In case only 1,200m3 Farm Pond>					
6-1) in case accessibility counted	52%	54%	50%	52%	(3-5)* (4-2)* (5-1)* (5-2)* (5-3)
(1) Farmers able to have 1,200m3 pond	231	291	354	876	(3-2)* (6-1)
6-2) in case accessibility not counted	82%	67%	54%	65%	(3-5)* (5-1)* (5-2)* (5-3)
(2) Farmers able to have 1,200m3 pond	364	360	382	1,106	(3-2)* (6-2)
<In case 6,000m3 Farm Pond introduced>					
6-3) 6,000 m3 Farm Pond	9%	15%	18%	15%	(3-7)* (4-2)* (5-1)* (5-2)* (5-4)
(3) Farmers able to have 6,000m3 pond	40	81	127	248	(3-2)* (6-2)
(4) 1,200m3 ponds when access counted	191	210	227	628	(1)-(3) <= (3-5)* (4-2)* (5-1)* (5-2)* (5-3)* (3-1)- (3)* (17rai) / 2.5rai
(5) 1,200m3 ponds when access not count	324	279	255	858	(1)-(3) <= (3-5)* (5-1)* (5-2)* (5-3)* (3-1)- (3)* (17rai) / 2.5rai
Existence of Present Farm Pond					
7-1) 1,200 m3 Farm Pond	8%	11%	5%	7%	by 1:4,000 map
(6) Farmers having 1,200m3 pond	36	59	35	130	(3-2)* (7-1)
7-2) 6,000 m3 Farm Pond	0%	0%	0%	0%	by 1:4,000 map
(7) Farmers having 6,000m3 pond	0	0	0	0	(3-2)* (7-2)
Future Expansion					
<Farmers able to have 1,200m3 pond>					
8-1) in case accessibility counted	195	232	319	746	(4) - (6)
(8) Ratio of Expansion of 1,200m3 pond	44%	43%	45%	44%	(8-1) / (3-2)
8-2) in case accessibility not counted	328	301	347	976	(2) - (6)
(9) Ratio of Expansion of 1,200m3 pond	74%	56%	49%	58%	(8-2) / (3-2)
<Farmers able to have 6,000m3 pond>					
8-3) Farmers able to have 6,000m3 pond	40	81	127	248	(3) - (7)
(10) Ratio of Expansion of 6,000m3 pond	9%	15%	18%	15%	(8-3) / (3-2)
<In case accessibility is counted>					
(11) Farmers with 1,200m3 pond	155	151	192	498	(4) - (6)
(12) Ratio of Expansion of 1,200m3 pond	35%	28%	27%	29%	(11) / (3-2)
<In case accessibility is not counted>					
(13) Farmers with 1,200m3 pond	288	220	220	728	(5) - (6)
(14) Ratio of Expansion of 1,200m3 pond	65%	41%	31%	43%	(13) / (3-2)

Table 9.3-7 Well Development Availability in SKN-3.1 Priority Area

Elements	Priority Area				Total	Remarks
	Lowland	Mixed Land	Upland			
Vegetable = 1rai						
1-1) Well	1 well/1 rai	1 well/1 rai	1 well/1 rai			
1-2) Necessary Occupation of Well (rai)	0	0	0			
1-3) Necessary Catchment (rai)	3.2	3.2	3.2			
1-4) Necessary Min. Farm (rai)	1	1	1			Veg + Well Area
1-5) Necessary Total Area (rai)	3.2	3.2	3.2			C A + Well Area
Vegetable = 1rai, Fruit Tree= 3rai (Total 4rai)						
2-1) Well	1 well/4 rai	1 well/4 rai	1 well/4 rai			
2-2) Necessary Occupation of Well (rai)	0	0	0			
2-3) Necessary Catchment (rai)	26	26	26			
2-4) Necessary Min. Farm (rai)	4	4	4			Veg + F.Tree + well
2-5) Necessary Total Area (rai)	26	26	26			C A + well
Number of Farmers and Land Holdings						
3-1) Total 04-1 Area (rai)	3,012	4,863	8,041	15,916		
3-2) Total 04-1 Farmers	441	538	708	1,690		
3-3) Average Holdings (rai/farmer)	6.8	9	11.4	9.4		(3-1) / (3-2)
3-4) Total Farmers >= 1 rai	417	498	677	1,592		
3-5) Ratio	93.9%	92.6%	95.6%	94.2%		(3-4) / (3-2)
3-6) Total Farmers >= 4 rai	234	329	429	992		
3-7) Ratio	52.7%	61.2%	60.6%	58.7%		(3-6) / (3-2)
Farm Road Accessibility						
4-1) Present Accessibility	11%	25%	38%	27%		
4-2) Assumed Future Accessibility	64%	81%	93%	82%		assumed at (100% - [4-1]*2 + [4-1]*1)
Suitability of Farm Pond Construction						
5-1) Topographical Suitability	100%	80%	70%			area less than EL205m.
5-2) Soil Suitability	100%	100%	100%			not relating to soil condition.
5-3) Area for 1rai well	100%	100%	100%			(3-3) / (1-5)
5-4) Area for 4rai well	26%	35%	44%			(3-3) / (2-5)
Possibility of Well to Farmers						
<In case only 1rai well>						
6-1) in case accessibility counted	66%	60%	62%	61%		(3-5)* 4-2)* 5-1)* 5-2)* 5-3)
(1) Farmers able to have 1rai well	266	323	439	1,028		(3-2) * 6-1)
6-2) in case accessibility not counted	94%	74%	67%	76%		(3-5)* 5-1)* 5-2)* 5-3)
(2) Farmers able to have 1rai well	417	398	474	1,289		(3-2) * 6-2)
<In case 4rai well fully introduced>						
6-3) Ratio able to introduce 4rai well	9%	14%	17%	14%		(3-7)* 4-2)* 5-1)* 5-2)* 5-4)
(3) Farmers able to have 4rai well	40	75	120	235		(3-2) * 6-2)
(4) 1rai wells when access counted	226	248	319	793		(1)-(3) < (3-1)-(3)*26rai)/3.2rai
(5) 1rai wells when access not counted	377	323	354	1,054		(2)-(3) < (3-1)-(3)*26rai)/3.2rai
Existence of Present wells for Integrated Farming						
7-1) Ratio of 1rai wells	0%	17%	13%	11%		(6) / (3-2)
(6) Farmers having 1rai well	0	90	90	180		25% of existing private wells are assumed for integrated farming. (702*25%=180wells)
7-2) Ratio of 4rai wells	0.0%	0.6%	0.4%	0.4%		(6) / (3-2)
(7) Farmers having 4rai well	0	3	3	6		interview to farmers conducting Integrated farming
Future Expansion						
<Farmers able to have 1rai well>						
8-1) in case accessibility counted	266	233	349	848		(1) - (6)
(8) Ratio of Expansion of 1rai well	60%	43%	49%	50%		(8-1) / (3-2)
8-2) in case accessibility not counted	417	308	384	1,109		(2) - (6)
(9) Ratio of Expansion of 1rai well	94%	57%	54%	66%		(8-2) / (3-2)
<Farmers able to have 4rai well>						
8-3) Farmers able to have 4rai well	40	72	117	229		(3) - (7)
(10) Ratio of Expansion of 4rai wells	9%	13%	17%	14%		(8-3) / (3-2)
<In case accessibility is counted>						
(11) Farmers with 1rai well	226	158	229	613		(4) - (6)
(12) Ratio of Expansion of 1rai wells	51%	29%	32%	36%		(11) / (3-2)
<In case accessibility is not counted>						
(13) Farmers with 1rai well	377	233	264	874		(5) - (6)
(14) Ratio of Expansion of 1rai wells	85%	43%	37%	52%		(13) / (3-2)

4) Farm Road Development

There exist 24 km of farm road in the area, and covering 27% of accessibility of farm plot. Farm road density is remained at 0.95 m/rai or 5.9 m/ha at present. Farm road should be extent drastically to 171 km and density to 6.8 m/rai or 43 m/ha. Accessibility will be improved to 82% in future so that integrated farming will be extended in the upland and the mixed land. Farm road development will be difficult due to smaller and irregular farm plots in the lowland. It will be delayed until land consolidation becomes possible.

Table 9.3-8 Farm Road Development in SKN-3.1 Priority Area

Farm Road	Total (rai)	Number of Roads	Total Length (km)			Density (m/rai)		Width (m)	Pavement (km)		Cross-structures	
			Existing Improvement	New Provision	Total	Existing	Future		Asphalt	Laterite	Culverts	Bridge
Main Farm Road (MFR)	25,100	10	10.82	15.63	26.45	0.43	1.05	4	4.00	22.45	28	12
Lateral Farm Road (LFR)		31	9.16	54.58	63.74	0.36	2.54	4	11.70	52.04	107	10
On-Farm Road (OFR)		175	3.90	76.98	80.88	0.16	3.22	2	6.85	74.03	137	0
Total		216	23.88	147.19	171.07	0.95	6.82		22.55	148.52	272	22

(Note) 1) Above farm roads are converted for the whole farm area of 25,100 rai excluding Huai Kra Choe Command Area.

2) Lateral and on-farm roads have been increased in proportion with following area ratio.

$$25,00 \text{ rai} / 15,240 \text{ rai} = 1.647$$

3) Length of Bridge is assumed at 10 meters.

4) Width of existing road is assumed at 2 m.

5) A concrete pipe of diameter 500 mm is assumed be installed for culvert.

(Each culvert to be reviewed by its drainage area at implementation stage)

6) Asphalt pavement of Main, Lateral and On-farm roads is considered for subject to flood.

Main and Lateral farm roads: 100m per culvert or bridge.

On-farm road: 50m per culvert or bridge.

7) Main farm road is assumed not to increase because Length is sufficient even for the whole farm land.

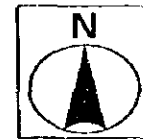
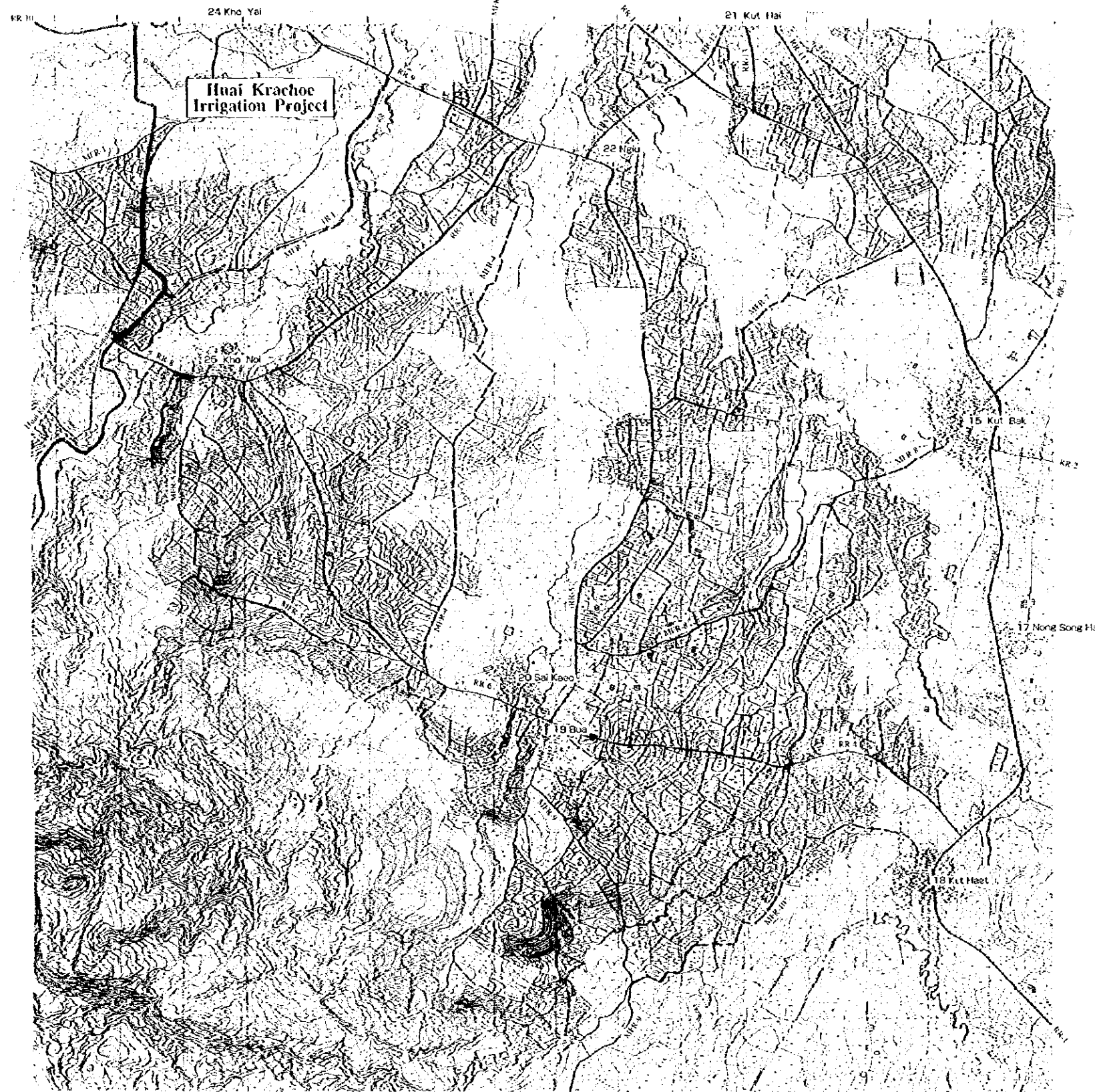
5) Rehabilitation of Existing Facilities

Most community ponds are utilized efficiently due to recent excavation by various agencies. Sedimentation is reported in one community pond in Bua village. Sediment removal should be carried out urgently in such community pond. Community ponds such as subject to seepage problem are to be considered after more detail investigation.

6) Soil Protection Measures

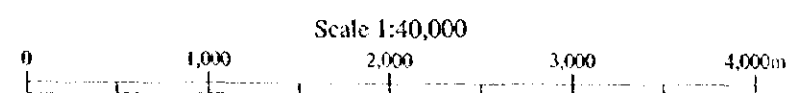
Steep lands over 5% slope are 8.6% or 2,160 rai in the area as shown in Figure 9.3-1. It is recommended to utilize those lands with fruit trees and fast-growing trees. It is necessary to request farmers to provide contour ditches in their fields and protect ditches with vertiver grass. Its nursery should be provided to the farmers. Location of steep lands is shown in Figure 9.3-1.

Figure 9.3-1 On-Farm Development Plan of Sakon Nakhon Priority Area (SKN-3.1)



LEGEND OF PLAN

	Farm Plot accessible at Present
	Farm Plot accessible by Project
	Farm Plot by Footpath
Rural Road (RR)	
	Existing (Improvement)
	Proposed
Main Farm Road (MFR)	
	Existing (Improvement)
	Proposed
Lateral Farm Road (LFR)	
	Existing (Improvement)
	Proposed
On-Farm Road (OFR)	
	Existing (Improvement)
	Proposed
	Bridge, Culvert
	Steep Farm Land (slope > 5%)



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 Agricultural Land Reform Office (ALRO),
 MOAC, The Kingdom of Thailand
 Japan International Cooperation Agency (JICA)

9.3.4 Forest Conservation Plan

The forest conservation plan should be based on environmental education, leadership training and regular meetings with villagers by ALRO, RFD and NGOs. It includes support for community forest development and the afforestation plan.

Villagers in Ban Bua have grasped the idea of sustainable agriculture through the support of NERDA ¹⁾ and the leader of the nursery center in Ban Bua is recognized as one of the most valuable people in Thailand. It is a successful example of NGO support.

¹⁾ NERDA (North East Rural Development Association), an NGO, was supported by New Zealand from 1991 to 1997. Details can be found in Appendix II-26.

Support by ALRO, RFD and NGO

- a) Meeting with villagers to enlighten them about the importance of forest conservation
- b) Leadership training
- c) Environmental education for both adults and children
- d) Meeting with villagers for the planning of community forest and afforestation
- e) Provision of seeds and seedling
- f) Regular meetings and technical advice

Note: Training will be carried out by ALRO for a) and d) in the same way as Khon Kaen (see Chapter 11.4.1).

1) Community Forest Development Plan

Purpose:

Improvement of communal forest by the community for soil and water conservation and improvement of diet.

Operation by villagers:

- Comprehensive regulations to prohibit private logging and farming
- Seeding and planting seedlings
- Protection of seedlings from livestock
- Collection of vegetables, mushrooms, firewood, etc.

2) Afforestation Plan

Purpose:

- To reduce pressure on the conservation forest
- Improvement of soil fertility by fallen leaves
- Increase in income from forestry

For the purpose of reduction in pressure on the conservation forest, it is important to select appropriate species as construction materials and superior seedlings. RFD's Udonthani Nursery Center will support the provision of these seedlings and In-paeng Network sells seedlings.

Operation by villagers:

- Plantation of seedlings around/in the farm plot.
- Protection of seedlings from livestock
- Logging and replanting trees at the proper time

9.3.5 Strengthening People's Organizations

ALRO should endeavor to strengthen the peoples' organization under collaboration among relevant agencies such as DOAE, CPD, and the Department of Industrial Promotion, etc. For successful implementation of agricultural development, ALRO should proceed the project under participation of people. For strengthening peoples' organization, ALRO should select progressive farmers and provide them with "Training of Leadership", mentioned in Chapter 11.4.1. In strengthening of peoples' organization in this area, seven (7) items mentioned in Chapter 7.3.5 are to be taken into consideration as well as to support expansion of activities of the In Paeng Network, which is contributing to the preservation and rehabilitation of natural resources and environment, and the expansion of sustainable agriculture.

9.4 Preliminary Design

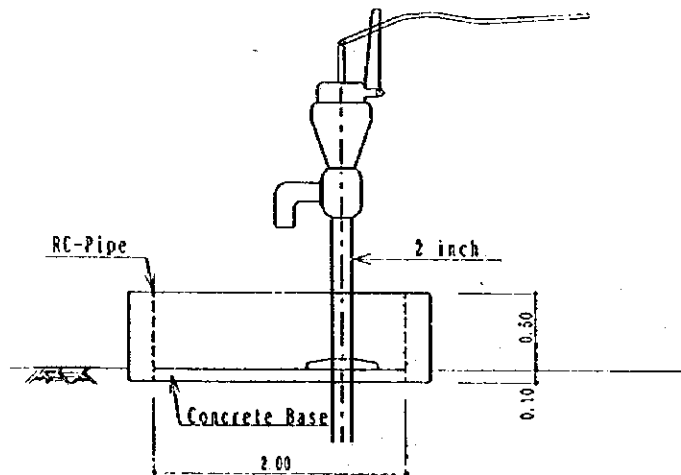
9.4.1 Farm Pond and Well Development

1) Farm Pond

The design of farm pond is same as that shown in Chapter 7.4.1.

2) Well

The well is 2 inch bore-hole of 9 m deep with a hand pump.



Typical Section of Hand Pump

9.4.2 Farm Road

The design of farm road is same as that shown in Chapter 7.4.2.

9.4.3 Mini Sprinkler Irrigation System

The mini sprinkler irrigation systems are already introduced in some places in Sakon Nakhon Priority Area. This irrigation system shall be introduced in case that a 6,000m³ farm pond or an electrical pump for groundwater withdrawal is provided.

Necessary equipment of this system is summarized as shown in Table 9.4-1.

Table 9.4-1 Equipment of Mini Sprinkler System

Equipment / Water Resource	6,000m ³ Farm Pond	Well (Bore Size 2 inch)
Electric Motor Pump	2 inch 1.5 kwh	1 inch 0.37 kwh
Discharge of Sprinkler Head for Vegetable (/ Head)	10.0 l/min	10.0 l/min
Discharge of Sprinkler Head for Fruit Tree (/ Head)	8.00 l/min	8.00 l/min
Spread Area of Sprinkler Head for Vegetable	10.00m	10.00m
Spread Area of Sprinkler Head for Fruit Tree	5.00m	5.00m
Number of Sprinkler Head for Vegetable (1 rai)	25	25
Number of Sprinkler Head for fruit Tree (4 rai)	70	70

(Note) Details are described in Appendix D, 4.2.4.

9.5 Cost Estimation

1) Farm Ponds and Farm Roads Construction Project

a) Project Cost

The cost of farm ponds and farm roads construction project in Sakon Nakhon Priority Area is estimated at 131,061 thousand baht as shown below.

Table 9.5-1 Project Cost of Farm Ponds and Farm Roads in SKN-3.1 Priority Area

Item	Q'ty	Unit	Total Cost ('000Baht)
1.Civil Works			
1) Farm Pond and Well	1,000	Places	23,592
2) Farm Road	171,000	m	63,149
2.Enginerring Survey and Design	1	L.S	14,245
3.Physical Contingencies	1	L.S	8,674
4.Physical Contingencies	1	L.S	10,966
Sub - Total			120,626
5.Price Escalation	1	L.S	10,436
Total			131,061

(Note) Cost of mini-sprinkler system is not included, because about system is only for 1 rai irrigation system.

b) Annual Disbursement Schedule

The annual disbursement schedule is prepared as shown below.

Table 9.5-2 Annual Disbursement Schedule of Farm Ponds and Farm Roads in SKN-3.1 Priority Area

Item	Total Cost ('000Baht)	Year			
		1999	2000	2001	2001
1.Civil Works	86,741	0	0	43,370	43,370
2.Enginerring Survey and Design	14,245	7,122	7,122	0	0
3.Administration	8,674	540	540	3,797	3,797
4.Physical Contingencies	10,966	581	581	4,902	4,902
Sub - Total	120,626	8,244	8,244	52,069	52,069
5.Price Escalation	10,436	277	563	4,081	5,515
Total	131,061	8,520	8,806	56,150	57,584

c) Annual Operation and Maintenance (O/M) Cost

The annual O/M cost is estimated at 4,725,000 baht/year as shown below.

Table 9.5-3 Annual O/M Cost of Farm Ponds and Farm Roads in SKN-3.1 Priority Area

Item	Q'ty	Unit	Total Cost ('000Baht)
1.1,200m ³ Farm Pond and Well	1	L.S	304
1.Main Farm Road	26.45	km	1,150
3.Lateral Road	63.74	km	2,318
3.On - Farm Road	80.88	km	952
Total			4,725

9.6 Project Evaluation

Agricultural development project of the Mahasarakham Priority Area is the Farm Pond (including wells) and Farm Road Development.

This project composed of farm road development and construction of 1,200m³ capacity farm ponds of about 1,000, of which 750 are wells. By implementation of this project, farmland with a farm pond or a well will be 11,800 rai or 47 % of the whole, together with the present farmland with a pond. In the farmland of 11,800 rai, integrated farming (including vegetable production, fruit tree cultivation, poultry, fish breeding, etc.) and fast-growing trees will be introduced. This project includes the training of farmers and the in-sit farming support by ALRO.

Economic internal rate of return (EIRR) of the project is as shown in table below by the results of project evaluation mentioned in Chapter 11.6.

Project	EIRR	B/C Ratio
① Farm Pond and Farm Road Development Project	11.4	0.9

(Note) B/C ratio is based on the discount rate of 12%.

EIRR of the project is little lower than the rate 12% of the opportunity cost of capital set up in the Kingdom. However, in considering the characteristic of the project, it is due to carry out in Northeastern Region where is most populated and poor area. As the development of this area is one of the most important policies under promoting spatially

balanced economic development of Kingdom of Thailand, the figure 11% mark would be highly enough because trickle-down effects can be expected by the project.

Annual agricultural income of the typical farmers holding 10 rai farmland, an average in the area, will be increased as follows by the implementation of the planned farming in Table 9.3-1;

Annual Agricultural Income of Typical Farmers (Baht/Year/Farmer)		
	Lowland Type	Upland Type
Present	13,900	13,159
Future	40,241	38,742

(Note) Details are in Chapter 11.6.5.

Average annual total income of farmers in the area is about 22,200 Baht. As shown in the above table, agricultural income of a typical farmer will be higher than the average total income. If a farmer is satisfied with his present income, he may concentrate on agriculture. However, agricultural income itself is not high enough. It will be depending on the opportunity of non-agricultural income whether farmers will earn income only on agriculture or not.