CHAPTER 4 BASIC DEVELPMENT PLAN

CHAPTER 4 BASIC DEVELOPMENT PLAN

4.1 General Description

The basic development plan of this Study is formulated herewith to pay due attention to improvement of land productivity and restructuring of agricultural production for the allotted farmland to hitherto land-less farmers in the Study Area through the Agricultural Land Reform Act, with a view to provide agricultural infrastructure and necessary support for them and thus trying to stabilize their living standard. To this end, current status of farming and development constraints should be made clear, and these should be due reflected in the plan so as to make it sustainable. The basic development plan consists of the followings :

- Land use and agricultural development plan
- Promotion of livestock, inland fisheries and sericulture
- Agricultural infrastructure development plan
- Agricultural extension services
- Employment promotion
- Strengthening of people's organization
- Rural infrastructure development plan
- Supporting services for marketing and farmers' supporting fund
- Plan justification
- Project implementation program

4.2 Land Use and Agricultural Development Plan

4.2.1 Basic Approach

The development strategies are to promote introduction of integrated farming, ecological farming, agroforestry, fruit tree cultivation, plantation of fast growing trees, livestock breeding for increasing farmers' income and capacity of self-sufficiency in agriculture and for stabilizing agricultural production. It is expected to reduce planting areas of cassava as a result of the development. For irrigated areas, introduction of upland crops such as soybean, maize, etc. for more diversification of crop cultivation and supplementary irrigation for paddy rice cultivation during the rainy season will be carried out.

4.2.2 Land Use Plan

The land use plan is proposed as follows taking account of current land use pattern, pedological conditions, farm production and demand for farm products and for home-consumption etc.:

- Land use in paddy fields is proposed to concentrate on major paddy cultivation, sustaining current land use pattern but with improved productivity in order to

meet demand for home consumption.

- Land use in sugarcane fields is proposed to rotate with three-year term followed by other upland crops such as leguminous ones in order to prevent land degradation and to sustain crop productivity. The planned area under cane is projected to maintain the current acreage taking on-going contract system into consideration.
- Land use in the tracts of cassava should be diversified into upland crop production with vegetable, fruit trees, grass pasture (or feed crops) and area for afforestation.

4.2.3 Recommended Crops

1) Vegetable

In areas with farm ponds it is highly recommended that the farmers grow vegetables. The products are for household consumption and the local market. If the project is highly progressive, the vegetables production scheme can be extended to produce food industry raw materials. Families without farm ponds, are also recommended to grow vegetables for home consumption. A few hills of such vegetables as chili, eggplant, stringbean, lemongrass, and a few more others can be planted near the house using waste water the from kitchen and laundry to retain soil moisture.

In an integrated farming system a large number of vegetables can be grown. Sweet corn, baby corn, watermelon, tomato, cucumber, chili, Chinese kale, stringbean, eggplant and Chinese morning glory can be grown all year round, but, sweet corn, baby corn and watermelon are usually cultivated in winter.

2) Fruit Trees

In rainfed areas, a certain amount of the cassava cultivated area will be transformed into fruit tree, pasture, and fast growing tree areas. There are many kinds of fruit tree that are suitable for the Study Area as follow:

a) Mango

Mango can grow in many types of soils especially the "Kaew" variety which is widely adaptable to growing conditions. Kaew mangos can be sold fresh and preserved. However, main use of this variety is for preservation and market demand is still wide open. Some other popular varieties such as Kaew Sawey, Nam Dawkmai and Okrong can also be introduced to the areas.

b) Jackfruit

Jackfruit is a drought tolerant tree and prefers a dry environment. This fruit tree is recommended on high land and on farm pond ridges.

c) Tamarind

There are two types of tamarind, sweet tamarind and sour tamarind. This fruit tree

can grow in poor soils, especially sour tamarind. Fruit can be sold fresh and preserved, and preserved sour tamarind has export value.

d) Guava

This species can be recommended as a cash crop fruit tree because after planting, if well managed, the fruit can be harvested within a year. It can be intercropped with other fruit trees.

e) Banana

The monocotelydonous fruit tree is marvelous. Its leaves are good for wrapping materials like foodstuffs and vegetables and inner part of the trunk can be consumed as a vegetables. Its fruit, especially the popular variety "Kluay Namwa", is nutritious, and mothers in the villages feed this banana to their babies along with their milk. In the field banana leaves can shade other young fruit trees if planted close enough, and its roots retain soil moisture for its neighbors. It is ideal for farm pond ridges and intercropped with other fruit trees.

f) Papaya

This may be the most popular fruit of the Northeastern people. In general, they consume this fruit daily as papaya hot salad or "Som Tam". Papaya can be grown intercropped with other fruit trees, or on farm pond ridges.

3) Trees

There are some kinds of tree crops are suitable to grow under poor soil condition. Kapok is suited to grow in the study area. Bamboo is recommend as a fast growing trees. Bamboo shoot, either fresh or canned, are popular food and can be sold in every market. Canned and dry bamboo shoots are exported to many countries including Japan, USA, Hongkong, Singapore and EC. The stalk of bamboo can be processed to make paper pulp or making furniture, house hold utensils, scaffold for construction works and raft. Other marketable part of bamboo are twig for supporting rod for use of yard long bean growing, branch with node for propagation, leaf for wrapping some kind of desert and bud and root for medicine.

Eucalyptus, acacia and neem can grow under poor soil and drought condition. They are a fast growing tree and many part of trees are utilized, e.g. wood can be used for paper pulp and construction, leaves, flowers, bark, sap and fruits may use for food, medicine, and fuel.

Rattan can be grown in Agroforestry system. It needs shade from other forest trees. Young shoots are popular as a food like asparagus shoot. It is also can process for canning. At present the production is not yet sufficient. The cane of ratten is also used for making furniture.

4) Agroforestry

It is imperative to plan practical agroforestry and to put it into practice through repeated technical transfer and instruction to the farmers so as to realize sustainable land use over steep slope at hill-side. It is advised to deploy an effective extension activity based on

field experiences of trainees, for instance, showing successful cases in Chiang-Mai (e.g. Chom Thon Project) in the Northern Region. Contour terraces should be provided for planting orchard trees over slope, with such preventive devices as planting bamboo or terraced mulberry trees over the steeply sloped patches so that their root zone can hold soil against erosive soil loss. If farmers select fruit species with sparse canopy like tamarind and guava, they can use inter-row space for alley cropping for a couple of years after their plantation. As inter-cultivated crops, green gram and cassava can be employed depending on soil fertility and manuring ability, and such shade plants as pine-apple and lemon grass can be grown even they are shaded by developed canopy. For the land use of surrounding areas of orchard plantation or artificial forests, another type of agroforestry, i.e., mulch-story planting can be applied. In this case, trees can be planted over natural slope without terracing, where areca-nut, neem and other tall species reaching average height of over 10 m are planted to occupy higher forest space, in combination with fast-growing species with lower height such as ipyl-ipyl, *Leucaena leucocephala* etc. are planted, and alley cropping is followed for a year or two with fast growing fodder species (*Chlotalaria sp., Sesbania sp. and Centrocema sp.* etc.) to serve for feeds in the combined farming.

4.2.4 Livestock

Since demand for beef cattle increasingly arises in the Northeastern Region, it is also recommended to introduce beef cattle for increasing income and buffaloes for draught purpose in the Study Area. As species for beef cattle, it is advised to employ American Brahman because it can tolerate hot and humid climate, producing high quality meat.

It is planned to make full use of cassava fields as grassland or forage field for providing high quality feed to beef cattle and buffaloes. As for leguminous forages to be incorporated into upland rotation, centro, stylo, desmodium, Egyptian clover, siratro, calopo etc., while with regard to gramineae species rhodes grass, Guinea grass, ruzi grass, Sudan grass, signal grass, para grass and other perennial grass of tropical origin, can be grown by seed sowing or by propagating through scion at the onset of monsoon. Usually, these are raised as annual crops with four cutting during rainy season, and the yield per rai reaches about 5 ton if they are properly manured.

For other livestock components, i.e., pig breeding and poultry, it is suggested to expand these head/fowls by proper husbandry management. Each farm household is planned to feed a pig and a number of chicken and/or ducks. Those who are engaged in integrated farming can afford to feed by-products obtained in their own farm yard. It is advised to locate pig breeding stables on the dike of farm ponds so that pig droppings can be fed to fish. As regards poultry, there is a room for further expansion both in broiler and egg production.

4.2.5 Afforestation, Sericulture and Inland Fishery

1) Afforestation

To promote the afforestation in the Study Area, the following activiteis will be necessary.

a) ALRO should cooperate with RFD to encourage private sector and farmers to plant economic trees.
b) Promoting in changing from economic forest to community forest for better forest conservation .
c) Promoting farmers' participation in management of conserved forest and community forest.
d) Promoting farmers to practice agroforestry, especially ecological farming in the buffer zone or other suitable areas.

2) Sericulture

For sericulture development, following guidelines should be done:

a) Organize training courses on sericulture for farmers.
b) Soil improvement for growing mulberry by using manure or compost.
c) Growing high yielding variety of mulberry recommended by DOA and DOAE namely BR.60 and NM.60.
d) Encourage farmers to rear Polyvoltine or Poly-Bivoltine type of silk worm eggs.
e) Organizing the sericulture group to produce the product to meet market demand.
f) Growing mulberry on upland area.

3) Inland Fishery

To develop the inland fisheries in the Study Area, the followings should be achieved.:

a) Swamps will be rehabilitated as fish ponds with the construction of dykes, spillways and outlet works so as to maintain water surface area with a moderate water depth for fisheries.
b) Encourage farmers to construct the pond in the area where can get water supply through the year from reservoir.
c) Promoting farmers in rainfed area to practice integrated farming by having farm ponds within the farm. In the Study Area, farm ponds are provided by ALRO and other agencies. Size of farm pond is rather small with a standard of 1,200 m^3 of each pond. It is recommended that the size of farm pond should be expanded into 1-2 rai of water surface area. Herbivorous fish including tilapia, carps should be raised in farm ponds.
d) Assist farmers to secure the fingerlings.

4.2.6 Farming Plan

The land found in the Study Area can be classified into three topographic categories, i.e., area predominated by paddy field , upland area and area with steep slope. In all these areas, integrated farming should be introduced, comprising vegetables, orchard fruit trees, poultry and fish farming. In particular, livestock, fruit trees planting and plantation of fast growing trees constitutes the skeleton of this integrated farming, while another component, agroforestry should be introduced in the area with steep slope. Even in the irrigated areas, integrated farming should play a key role, accompanying with the plan of supplemental irrigation during the rainy season for paddy, vegetables and orchard trees. Besides, in the LRAs where more water can be secured than to meet this water demand during the rainy season, not only vegetables and fruit trees but soybeans and maize are planned for more drastic reduction of acreage under cassava. When the integrated farming is employed, the more farm income can be expected from a farm with the more irrigated acreage under vegetables that enables more intensive farming. However, a standard area 1 rai is taken as the unit of vegetable field that can be covered with a farm pond capable of storing 1,200 m^3 of water and that can be constructed within the amount of government subsidy. In this context, 60 ~ 70% of the entire households in the Study Area, including those in the existing irrigation schemes, will be able to practice integrated farming. From the self supplied farm labor point of view, the size of irrigated field per farm household can be expanded up to about 4 rai (equivalent to the capacity of a farm pond of 6,000 m^3).

Twelve farming types, shown as A - L in the following table, are planned according to three types of topographic categories classified above.

Table 4.2-1 Recommended Farming Types

Type	Main	Secondary		
A	Paddy(12 rai)	I/F(V:1rai, F:5 rai)		
B	Paddy(12 rai)	I/F(V:1rai, F:2 rai)	Livestock(3 rai)	
C	Paddy(7 rai)	I/F(V:1rai, F:2 rai)	Upland Crop(5 rai)	Livestock(3 rai)
D	Upland Crop(15 rai)	I/F(V:1rai, F:2 rai)		
E	Upland Crop(12 rai)	I/F(V:1rai, F:2 rai)	Livestock(3 rai)	
F	Upland Crop(10 rai)	I/F(V:1rai, F:2 rai)	Livestock(3 rai)	Fast Growing tree(2 rai)
G	Upland Crop(13 rai)	I/F(V:1rai, F:2 rai)		Fast Growing tree(2 rsi)
H	Rubber Tree(10 rai)	I/F(V:1rai, F:2 rai)	Upland Crop(5 rai)	
I	Agroforestry(10 rai)	Rice(5 rai)	Upland Crop(5 rai)	
J	Agroforestry(15 rai)	Livestock(5 rai)		
K	Fast Growing Tree(15)	Fruit Tree(5 rai)		
L	Ecological Farming(15)	I/F(V:1rai, F:2 rai)		

Note: For integrated farming, 1 rai for farm pond and 1rai for house, etc. are necessary.
I/F : integrated farming, V : vegetable, F : fruit tree

Table 4.2-2 Application Criteria for Farming Types (A - L)

I) Paddy Prevailing Area

a) Khon Kaen & Maha Sarakham

Farming Type	Standard (Type I-1)		Promoted Area of Livestock (Type I-2)		
A	A_1	40%	A_2	32%	$(A_1+B_1)\times 0.4$
B	B_1	40%	B_2	48%	$(A_1+B_1)\times 0.6$
C	C_1	20%	C_2	20%	
Total		100%		100%	

b) Sakhon Nakhon & Mukdahan

Farming Type	Standard (Type I-3)		Promoted Area of Livestock (Type I-4)	
A	A_1	50%	A_2	40%
B	B_1	50%	B_2	60%
Total		100%		100%

II) Uplan Crop Prevailing Area

a) Area W/O Buffer Zone

Farming Type	Standard (Type II-1)		Promoted Area of Livestock (Type II-2)		
D	D_1	45%	D_2	36%	$(D_1+E_1)\times 0.4$
E	E_1	45%	E_2	54%	$(D_1+E_1)\times 0.6$
F	F_1	5%	F_2	5%	
G	G_1	5%	G_2	5%	
Total		100%		100%	

b) Area W/ Buffer Zone

Farming Type	Standard (Type II-3)		Promoted Area of Livestock (Type II-4)		
D	D_1	40%	D_2	32%	$(D_1+E_1)\times 0.4$
E	E_1	40%	E_2	48%	$(D_1+E_1)\times 0.6$
F	F_1	5%	F_2	5%	
G	G_1	5%	G_2	5%	
H	H_1	5%	H_2	5%	
I	I_1	5%	I_2	5%	
Total		100%		100%	

III) Steeply Sloped Area

a) W/O Paddy Area

Farming Type	Standard (Type III-1)		Promoted Area of Livestock (Type III-2)	
I	I_1	10%	I_2	5% (I_1-5)
J	J_1	30%	J_2	25% (J_1-5)
K	K_1	30%	K_2	25% (K_1-5)
L	L_1	30%	L_2	45% (L_1+15)
Total		100%		100%

b) W/ Paddy Area

Farming Type	Standard (Type III-3)	Promoted Area of Livestock (Type III-4)
I	-	-
J	33%	26%
K	33%	26%
L	34%	48%
Total	100%	100%

The farming types as defined above are applied to the LRAs distributed in three topographic categories, based on an application criterion as shown in table 4.2-2 that was prepared regarding such factors as presence or absence of buffer zone and paddy field. Areas with higher priority put on livestock are confined to all those belonging to Khon Kaen where a large scale livestock market is located and to Maha Sarakham where the provincial development policy has been set to enhance livestock, as well to those where number of cattle head kept per farm household exceeds the average level of cattle holding within the Study Area (refer to Chapter 2.8.2). The basic application criterion of the farming types is summarized as follows:

- Types A and B are applied to the LRAs where paddy predominates, but Type C is also applied in Khon Kaen and Maha Sarakham where paddy and upland fields are co-existing owing to topographic reason,
- Types D, E, F and G are applied to upland areas without any buffer zone, while Types H and I are added to those accompanying with buffer zone,
- more Types B and E, including livestock component, are applied to those where higher priority is attached to livestock than those without priority on livestock,
- Higher application of Type L, including ecological farming, is made to LRAs with steep slope accompanying with buffer zone.

The tables 4.2-3 - 4.2-6 show the result of farming type application to all LRAs. Types more frequently applied are Types D and E in upland areas, and Types A and B in those predominated with paddy field. Given that 60% of the land within LRAs is available to projected development plan, the proposed project will be able to reducet cassava field to about two-thirds of the current level refer to table 4.2-4).

Table 4.2-3 Results of Farming Types Application

Model	Paddy Prevailing Area	Upland Crop Prevailing Area	Steeply Sloped Area	Total
A	11.3%	-	-	11.3%(6.8%)
B	13.5%	-	-	13.5%(8.1%)
C	1.5%		-	1.5%(0.9%)
D	-	25.4%	-	25.4%(15.2%)
E	-	31.1%	-	31.1%(18.6%)
F	-	3.3%		3.3%(2.0%)
G	-	3.3%		3.3%(2.0%)
H	-	1.80%		1.8%(1.1%)
I	-	1.8%	0.4%	2.2%(1.3%)
J	-	-	1.8%	1.8%(1.1%)
K	-	-	1.8%	1.8%(1.1%)
L	-	-	3.0%	3.0%(1.8%)
Total	26.3%	66.7%	7.0%	100.0%(60%)

Note: Figures in parentheses are application rate in case that 60 % of the Study Area are developed.

Table 4.2-4 Present and Planned Cropped Area

Land Use	Present	Planned	Difference
Paddy	274,760 rai	271,800 rai	(-)2,960 rai
Cassava	788,610 rai	524,820 rai	(-)263,790 rai
Sugarcane	225,520 rai	225,520 rai	0 rai
Vegetable		38,380 rai	
Fruit Tree		94,230 rai	
Grassland		64,040 rai	
Fast Growing Tree	68,720 rai	5,450 rai	226, 750 rai
Rubber Tree		7,410 rai	
Agro-Forestry	-	30,810 rai	
Ecological Farming	-	18,380 rai	
Farm Pond, etc.		76,770 rai	
Total	1,357,610 rai	1,357,610 rai	0 rai

Note: Planned areas in this table are area in case that 60 % of the Study Area are developed.

4.2.7 Improvement of Rainfed Agriculture

In the rainfed areas, it is necessary to improve methods of crop production. The farmers need training, advice encouragement from extension agents; site visits by extension officers are also important for the good progress of the farmers . General recommendations to improve rainfed agriculture are drawn up as shown below :

i) Convert the crop to a more drought tolerant one, e.g. form upland crop to fruit tree or fast growing trees, or switch from paddy to upland crops.

In some specific rainfed areas, soil and rainfall pattern may be suitable for growing the crops that are generally preferred by the farmers. In most cases, the farmers prefer growing paddy for family security even though environmental factors do not render. In some cases under this circumstances, it may be more profitable to recommend the farmers to grow upland crops such as peanut, soybean etc. which are more drought tolerant than rice and require less water.

In some areas which fall in rain shadow even upland crops can not be grown successfully because of low soil moisture especially in top layer which is the root zone of most upland crops. In this case it is better to recommend the farmers to cover the soil with tree crops such as fruit trees or fast growing trees have deeper root system.

However, the farmers will need assistance form extension officers and/or subject matter specialist in decision making as to what crop should be most suitable for shire farms.

Table 4.2-5 Application of Farming Types (A - L)

Province	LRA	Buffer Zone	Promote Livestock	I. Paddy Prevailing Area				II. Upland Crop Prevailing Area						III. Steeply Sloped Area					Total
				Type	A (rai)	B (rai)	C (rai)	Type	D (rai)	E (rai)	F (rai)	G (rai)	H (rai)	I (rai)	Type	J (rai)	K (rai)	L (rai)		
Khon Kaen	KK 1		◎	I-2	2,901	4,352	1,813	II-2	10,645	15,969	1,479	1,479	0	0	III-1	71	209	209	209	39,336
	KK 2		◎	I-2	439	660	275	II-2	2,515	3,775	350	350	0	0	III-1	0	0	0	0	8,364
	KK 3		◎	I-2	1,171	1,757	732	II-2	2,552	3,826	354	354	0	0	III-1	0	0	0	0	10,746
	KK 4		◎	I-2	194	291	121	II-2	2,136	3,205	297	297	0	0	III-1	35	106	106	106	6,894
	KK 5		◎	I-2	244	366	152	II-2	1,061	1,591	147	147	0	0	III-1	0	0	0	0	3,708
	KK 6		◎	I-2	5,693	8,539	3,558	II-2	25,547	38,319	3,548	3,548	0	0	III-1	0	0	0	0	88,752
Total					10,642	15,965	6,651		44,456	66,685	6,175	6,175	0	0		106	315	315	315	157,800
Maha Sarakham	MHS 1		◎	I-2	0	0	0	II-2	571	855	79	79	0	0	III-3	0	0	0	0	1,584
	MHS 2		◎	I-2	0	0	0	II-2	12,026	18,038	1,670	1,670	0	0	III-3	1	793	793	817	35,808
	MHS 3		◎	I-2	0	0	0	II-2	666	998	92	92	0	0	III-3	0	0	0	0	1,848
	MHS 4		◎	I-2	0	0	0	II-2	2,055	3,081	285	285	0	0	III-3	0	0	0	0	5,706
	MHS 5		◎	I-2	1,742	2,612	1,088	II-2	1,194	1,792	166	166	0	0	III-1	0	0	0	0	8,760
	MHS 6		◎	I-2	2,114	3,171	1,321	II-2	3,835	5,753	533	533	0	0	III-1	53	161	161	161	17,796
	MHS 7		◎	I-2	2,033	3,050	1,271	II-2	75	113	11	11	0	0	III-1	0	0	0	0	6,564
	MHS 8		◎	I-2	2,619	3,928	1,637	II-2	12,723	19,084	1,767	1,767	0	0	III-1	425	1,272	1,272	1,272	47,766
	MHS 9		◎	I-2	0	0	0	II-2	68	100	9	9	0	0	III-3	0	0	0	0	186
	MHS 10		◎	I-2	163	245	102	II-2	860	1,290	119	119	0	0	III-1	0	0	0	0	2,898
Total					8,671	13,006	5,419		34,073	51,104	4,731	4,731	0	0		479	2,226	2,226	2,250	128,916
Sakhon Nakhon	SKN 1			I-3	1,098	1,098	0	II-1	5,103	5,103	567	567	0	0	III-1	0	0	0	0	13,536
	SKN 2			I-3	6,078	6,078	0	II-1	6,210	6,210	690	690	0	0	III-1	0	0	0	0	25,956
	SKN 3	◎		I-3	10,551	10,551	0	II-3	18,526	18,526	2,316	2,316	2,316	2,316	III-2	183	916	916	1,649	71,082
	SKN 4	◎		I-3	8,364	8,364	0	II-3	13,836	13,836	1,730	1,730	1,730	1,730	III-2	0	0	0	0	51,318
	SKN 5	◎		I-3	993	993	0	II-3	12,562	12,562	1,570	1,570	1,570	1,570	III-2	785	3,923	3,923	7,061	49,080
	SKN 6	◎	◎	I-4	7,015	10,523	0	II-4	1,713	1,712	214	214	214	214	III-2	246	1,226	1,226	2,207	26,724
	SKN 7			I-3	1,218	1,218	0	II-1	2,468	2,468	274	274	0	0	III-1	0	0	0	0	7,920
Total					35,317	38,825	0		60,416	60,417	7,361	7,361	5,830	5,830		1,212	6,065	6,065	10,917	245,616
Mukdahan	MKD 1	◎		I-3	9,048	9,048	0	II-3	14,803	14,802	1,850	1,850	1,850	1,850	III-2	327	1,639	1,639	2,950	61,656
	MKD 2	◎	◎	I-4	2,376	3,564	0	II-4	11,933	17,901	1,865	1,865	1,865	1,865	III-2	84	427	427	768	44,940
	MKD 3	◎		I-3	12,447	12,447	0	II-3	14,226	14,225	1,778	1,778	1,778	1,778	III-2	102	513	513	923	62,508
	MKD 4	◎	◎	I-4	74	112	0	II-4	148	221	23	23	23	23	III-2	21	102	102	184	1,056
	MKD 5	◎	◎	I-4	377	565	0	II-4	520	780	81	81	81	81	III-2	51	262	262	471	3,612
	MKD 6	◎	◎	I-4	14	22	0	II-4	67	103	11	11	11	11	III-2	9	44	44	79	426
	MKD 7	◎	◎	I-4	6,290	9,436	0	II-4	2,029	3,043	317	317	317	317	III-2	243	1,217	1,217	2,191	26,934
	MKD 8	◎		I-3	2,577	2,577	0	II-3	10,390	10,390	1,299	1,299	1,299	1,299	III-2	154	774	774	1,392	34,224
	MKD 9	◎		I-3	3,087	3,087	0	II-3	8,834	8,834	1,104	1,104	1,104	1,104	III-2	147	742	742	1,335	31,224
	MKD 10	◎		I-3	243	243	0	II-3	89	89	11	11	11	11	III-2	0	0	0	0	708
	MKD 11	◎		I-3	696	696	0	II-3	2,351	2,351	294	294	294	294	III-2	39	197	197	355	8,058
	MKD 12	◎		I-3	0	0	0	II-3'	2,505	2,506	367	367	367	0	III-4	0	202	202	372	6,888
Total					37,229	41,797	0		67,895	75,245	9,000	9,000	9,000	8,633		1,177	6,119	6,119	11,020	282,234
Grand Total					91,859	109,593	12,070		206,840	253,451	27,267	27,267	14,830	14,463		2,974	14,725	14,725	24,502	814,566
Grand Total (%)					11.3%	13.5%	1.5%		25.4%	31.1%	3.3%	3.3%	1.8%	1.8%		0.4%	1.8%	1.8%	3.0%	100.0%
Grand Total (%)		For all Farm land			6.8%	8.1%	0.9%		15.2%	18.7%	2.0%	2.0%	1.1%	1.1%		0.2%	1.1%	1.1%	1.8%	60.0%

(Note) 1) Farming Types (A-L) are shown in Table 4.2-1.

2) "Type" such as I-2, II-3, etc. mentioned in this table means application type of the farming types that is shown in Table 4.2-2.

Table 4.2-6 Cropped Area after Development (Developed Area = 60 %)

Province	LRA	Farm Land	Paddy Prevailing Area	Upland Crop Prevailing Area	Strongly Sloped Area	Cropped Area after Development (rai)									
		(rai)	(rai)	(rai)	(rai)	Paddy	Upland Crop	Vegetable	Fruit Tree	Grassland	Fast Grow.Tree	Rubber Tree	Agroforestry	Ecological Farming	Farm Pond, etc.
Khon Kaen	KK 1	65,560	15,110	49,287	1,163	11,048	39,917	1,942	4,372	3,594	296	0	349	157	3,885
	KK 2	13,940	2,290	11,650	0	1,672	9,283	418	902	759	70	0	0	0	836
	KK 3	17,910	6,100	11,810	0	4,453	9,524	537	1,250	1,000	71	0	0	0	1,075
	KK 4	11,490	1,010	9,892	588	746	8,098	332	720	614	59	0	177	80	665
	KK 5	6,180	1,270	4,910	0	927	3,921	185	407	338	29	0	0	0	371
	KK 6	147,920	29,650	118,270	0	21,645	94,429	4,438	9,729	8,095	710	0	0	0	8,875
Total		263,000	55,430	205,819	1,751	40,491	165,172	7,853	17,381	14,400	1,235	0	526	236	15,706
Maha Sarakham	MHS 1	2,640	0	2,640	0	0	2,088	79	158	140	16	0	0	0	158
	MHS 2	59,680	0	55,674	4,006	0	45,635	1,711	3,620	3,154	334	0	1,190	613	3,422
	MHS 3	3,080	0	3,080	0	0	2,436	92	185	164	18	0	0	0	185
	MHS 4	9,510	0	9,510	0	0	7,522	285	571	505	57	0	0	0	571
	MHS 5	14,600	9,070	5,530	0	6,621	4,646	438	1,137	849	33	0	0	0	876
	MHS 6	29,660	11,010	17,756	894	8,051	14,745	871	2,099	1,657	107	0	268	121	1,742
	MHS 7	10,940	10,590	350	0	7,731	594	328	961	667	2	0	0	0	656
	MHS 8	79,610	13,640	58,901	7,069	10,063	49,928	2,240	5,191	4,280	353	0	2,121	954	4,480
	MHS 9	310	0	310	0	0	245	9	19	16	2	0	0	0	19
	MHS 10	4,830	850	3,980	0	621	3,173	145	314	263	24	0	0	0	290
Total		214,860	45,160	157,731	11,969	33,087	131,012	6,199	14,256	11,696	946	0	3,579	1,688	12,399
Sakhon Nakhon	SKN 1	22,560	3,660	18,900	0	2,782	15,101	677	1,518	1,015	113	0	0	0	1,354
	SKN 2	43,260	20,260	23,000	0	15,398	18,377	1,298	3,507	1,947	138	0	0	0	2,596
	SKN 3	118,470	35,170	77,194	6,106	27,354	62,197	3,338	8,487	4,938	463	1,158	2,624	1,237	6,675
	SKN 4	85,530	27,880	57,650	0	21,621	44,592	2,479	6,213	3,590	346	865	865	0	4,959
	SKN 5	81,800	3,310	52,340	26,150	3,104	51,141	1,944	5,018	3,250	314	785	7,061	5,296	3,888
	SKN 6	44,540	29,230	7,135	8,175	22,330	8,851	1,191	3,740	2,174	43	107	2,069	1,655	2,381
	SKN 7	13,200	4,060	9,140	0	3,086	7,303	396	975	594	55	0	0	0	792
Total		409,360	123,570	245,359	40,431	95,674	207,561	11,322	29,458	17,507	1,472	2,915	12,619	8,188	22,644
Mukdahan	MKD 1	102,760	30,160	61,675	10,925	23,466	52,158	2,810	7,387	4,265	370	925	3,547	2,213	5,620
	MKD 2	74,900	9,900	62,156	2,844	8,011	48,789	2,107	4,677	3,606	373	933	1,615	576	4,214
	MKD 3	104,180	41,490	59,271	3,419	32,002	47,240	2,980	7,956	4,396	356	889	1,710	692	5,960
	MKD 4	1,760	310	769	681	247	867	40	117	79	5	12	175	138	81
	MKD 5	6,020	1,570	2,706	1,744	1,226	2,784	148	418	279	16	41	459	353	296
	MKD 6	710	60	356	294	51	392	16	45	31	2	6	76	59	32
	MKD 7	44,890	26,210	10,567	8,113	20,060	11,403	1,197	3,642	2,224	63	159	2,106	1,643	2,394
	MKD 8	57,040	8,590	43,294	5,156	6,892	35,588	1,561	3,702	2,333	260	650	1,888	1,044	3,122
	MKD 9	52,040	10,290	36,806	4,944	8,133	30,484	1,424	3,497	2,139	221	552	1,739	1,001	2,849
	MKD 10	1,180	810	370	0	618	236	35	106	51	2	6	6	0	70
	MKD 11	13,430	2,320	9,797	1,313	1,846	8,113	367	887	550	59	147	462	266	733
	MKD 12	11,480	0	10,186	1,294	0	8,488	324	699	481	73	184	303	279	648
Total		470,390	131,710	297,953	40,727	102,552	246,593	13,009	33,133	20,436	1,800	4,500	14,084	8,265	26,019
Grand Total		1,357,610	355,870	906,862	94,878	271,803	750,338	38,384	94,228	64,038	5,453	7,415	30,806	18,377	76,768
Grand Total (%)		100%	26%	67%	7%	20%	55%	3%	7%	5%	0%	1%	2%	1%	6%

ii) To prevent risk, grow diversified crops

It has been established that in rainfed areas mono-crops is more risky than diversified crops in term of water availability the pest outbreak because different crops have different ability to tolerate to drought and pests. Therefore, to prevent entire crop loss it is recommended to grow several kinds of crops, such as paddy, peanut, soybean, etc. if possible.

iii) Improve physical soil properties by compost, green manure or animal manure to increase soil moisture retention capacity.

iv) Use mulching to slow down evapotranspiration form soil and plants.

v) Use the direct seeding method for paddy to avoid delayed transplanting,

4.3 Agricultural Infrastructure Development Plan

4.3.1 Water Resources Development

1) Water Resources Development Concepts

Water resources development is one of the most important factors for the development of agriculture. Water resources development has, therefore, proceeded centering on development by small-scale reservoirs and weirs in the region. In the basins, where perennial river flows in the area, pump irrigation has also been developed in such large river basins as the Chi river in Khon Kaen and Maha Sarakham or in the medium basins like the Huai Ban Sai and the Huai Bang I rivers in Mukudahan , of which basins are covered by the healthy forests.

However, since most study LRAs are generally located in higher locations in the region, water resources are scarce both for surface and groundwater, and most areas have been left from water resources development.

Water resources facilities are to be developed taking upland crop irrigation into consideration, because upland is a major land use in the LRAs due to higher location than nearby areas. It is, therefore, such facility like a weir which has no storage function will not be effective for dry season irrigation. Consequently, weirs will not be proposed in the LRAs except for stabilizing water level for pump irrigation in perennial rivers or storing water in dredging .

On the other hand, reservoir development is rather difficult from environmental and social points of view. Most LRA land has already been reclaimed by farmers so that it is difficult to get the agreement of farmers to use the land for reservoir development. Conservation forests are protected from development activity in the forest as well as from

illegal wood collection and cutting. Suitable sites for water resources development are found rather in the conservation forests than in the LRAs. Consequently, water resources are to be developed both in the LRAs and the conservation forests. The selection criteria for water resources development for the LRAs are as follows;

<Priority of Site Selection for Reservoir Development>

(1st selection) Community lands in the LRAs used such as wetland, fallow land and deteriorated community forests.

(2nd selection) Conservation forests.

(3rd selection) Farm land in the LRAs.

As well as selection of development sites, new development sites have to be assessed from the effects on existing downstream reservoirs. As discussed in Section 2.6.1, almost no spillage has occurred from the Nam Un and the Nam Phung reservoirs in the last 10 years, and almost all of the water has been effectively utilized in those reservoirs. In case spill seldom occurs from the existing downstream reservoir, upstream water resources development will certainly affect and reduce water utilization of the reservoir. Upstream areas of these reservoirs, that is SKN 3, 4 and 5 LRAs, are to be evaluated from this viewpoint. There are several attractive sites for medium-scale water resources development in the basin of SKN 3 which is located upstream of the Nam Un reservoir. However, Huai Kra Choe dam, one of the attractive sites, has been already implemented by RID in spite of the effective use of Nam Un dam. Other attractive sites are scheduled for studying more water resources development in upstream. Consequently, only Huai Kra Choe reservoir will be considered for development of SKN 3, but care should be taken to avoid duplication of investment in the development.

On the other hand, groundwater is not adequate for extensive use in the LRAs as discussed in Section 2.6.2. Groundwater is presently utilized exclusively for domestic and household water supply in the study areas by shallow wells especially in Sakhon Nakhon and Mukdahan. In the study area of those two provinces, there is no water quality problem for irrigation while quantity is limited. Groundwater shall be utilized at the micro scale by such means as micro irrigation system by shallow wells within their safety yield.

Although developed by the above resources, available water is still limited and most LRA land will remain as rainfed as before. Therefore, small farm pond development is the key development factor for the LRAs.

Based on above the concepts, water resources development will be studied to find out the optimum and acceptable level of development for the LRAs in the area.

2) Surface Water Resources Development in Each LRA

a) Reservoirs

The area is not only scarce in water resources, but there are also difficulties in storing water from the viewpoint of topography. Based on a 1:50,000 map, potential development sites have been studied, and 110 sites have been selected for reservoir development and 14

sites for pump irrigation development. Table 4.3-1 shows the results of the investigation. Besides the new development sites, existing 39 reservoirs have been selected for rehabilitation by dredging sediment and installing outlets. As the results of the investigation, potential irrigation areas are estimated at 98,380 rai or 15,740 ha. Present irrigation ratio is estimated at 2.7%, that is a lot lower than the present average irrigation ratio of 9% in the Northeastern Region. Although the area is fully developed, the irrigation ratio remains 7.2% that is still lower than the present average ratio of the region.

Table 4.3-1 Potential Development of Surface Water Resources

Development Stage	Reservoirs			Rehabilitation	Pump Irrigation	Total	Irrigation Area	Irrigation Ratio
	MSIPs	SSIPs	Total					
Present Irrigation Projects	5	39	44	-	2	46	36,730 rai 5,876 ha	2.7 %
Potential Development	15	95	110	39	14	163	61,650 rai 9,864 ha	4.5 %
- Conservation Forest	(7)	(18)	(25)					
- Economic Forest	(4)	(38)	(42)					
- LRAs	(4)	(39)	(43)					
Total	20	134	154	39	16	209	98,380 rai 15,740 ha	7.2 %

(Note) Detail descriptions are reported in Table 4.3-3.

Figure 4.3-1 shows the irrigation ratio of each sub-LRA. The irrigable area has been estimated at each development site by the following equation, that is studied from the relation between irrigation area and storage capacity of the existing reservoirs in Section 2.6.1.

$$Ia = 829\ Sr^{0.751} \quad (r^2 = 0.80)$$

Where, Ia: irrigation area (rai)
Sr: Storage capacity of reservoir (MCM)
r^2: Correlation Coefficient

In Khon Kaen and Maha Sarakham Provinces, potential development sites are very limited due to limitation of catchment and storage pockets. Therefore, it is very difficult to increase irrigation in those two provinces. However, in Mukdahan and Sakhon Nakhon, irrigation can be expanded to a certain level as shown in the Figure. Details of irrigation areas are shown in Table 4.3-3.

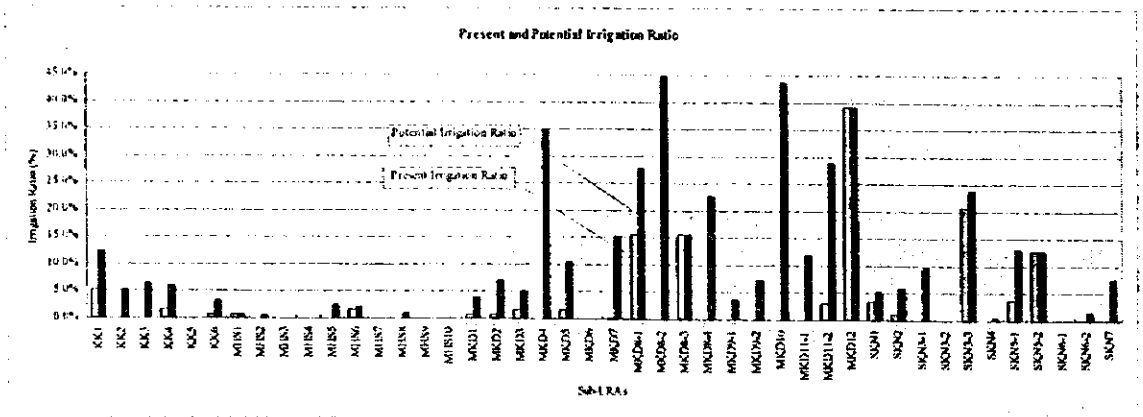


Figure 4.3-1 Present and Potential Irrigation Ratio by the LRAs

b) Weirs

No weirs will be proposed for irrigation purposes in the LRAs, but 14 weirs for pump irrigation will be an exception. These weirs are as follows:

Table 4.3-2 Weirs for Pump Irrigation

Rivers for installation	Number of Weirs(Pump Stations)	Served LRAs
Nam Phung River	3	SKN 5-1
Huai Ban Sai	4	MKD 8-2, MKD 9-1, MKD 11-2
Huai Bang I	7	MKD 1, MKD 2, MKD 3
Total	14	7 LRAs

c) Pump Irrigation

As shown in Table 4.3-2, 14 pump irrigation projects have been proposed for three perennial rivers in the LRAs. Other than these three rivers, the Chi river in Khon Kaen is considered as a possible river for KK 1 by pump irrigation. KK 1 is already served by two pump irrigation projects for 3,000 rai by DEDP. However, there are so many pump irrigation systems that have already been provided in the Chi River that it is difficult to estimate the remaining availability of water for KK 1. Three rivers other than the Chi have, therefore, been selected for pump irrigation.

d) Rehabilitation of Existing Water Resources Facilities

As mentioned in water resources development concepts, many existing reservoirs are not utilized effectively due to no outlets or heavy sedimentation. Among such reservoirs, 39 have been selected for rehabilitation of existing reservoirs as shown in Table 4.3-1. Out of 39 rehabilitation works, 23 are for installation of outlets and 16 both for outlets and sediment dredging.

e) Farm Ponds

Farm pond development should be essential for the development of the LRAs because water resources development by reservoirs will cover only 7% of the area while 93% will remain as rainfed land. For development of the remaining 93% land, farm pond will be only one water source for farming. The details are given in Section 4.3.2 because farm ponds are developed at the on-farm level in direct connection with farming activities.

f) Groundwater Development in Each LRA

There is not adequate data other than the Groundwater Resource Evaluation Pilot Project (GREP) by DMR for investigating groundwater in the LRAs. According to the groundwater map, most LRA areas belong to low potential areas of less than 2 m^3/hour. It is, therefore, difficult to introduce large extensive utilization for irrigation. It is recommended that a micro-irrigation system be introduced utilizing shallow wells. Shallow wells are extensively used for drinking water in the LRAs especially in Mukudahan and Sakon Nakhon. In these provinces, water quality seems to be better than other provinces such that this kind of micro-irrigation system can be recommended.

Table 4.3-3 Water Resources Development in the Study Area

Sub-LRAs	Farm Land (rai)	Existance of E Zone: Buffer Zone	Adjacent	Included	Existing Irrigation Projects: Numbers: Installed Projects	Well operated	MSIPs	SSIPs	Irrigated Area: Pump Irrigation	MSIPs, SSIPs (rai)	Pump irri. (rai)	Total(rai)	(%)	MSIP+SSIP: Storage Capacity (MCM)	Catchment (km2)
KK1	65,360	n	y	n	12	7		5	2	480	3,000	3,480	5.3%	0.318	6.4
KK2	13,940	n	y	n								0	0.0%	0	0
KK3	17,910	n	y	n								0	0.0%	0	0
KK4	11,490	n	y	n	1	1		1		200		200	1.7%	0.5	0.1
KK5	6,180	n	y	n								0	0.0%	0	0
KK6	147,920	n	a	y	10	4		4		1,070		1,070	0.7%	0.51	11.4
MHS1	2,640	n	y	n	2	1		1		20		20	0.8%	0.007	0.4
MHS2	59,680	n	a	y								0	0.0%	0	0
MHS3	3,080	n	n	y								0	0.0%	0	0
MHS4	9,510	n	n	y								0	0.0%	0	0
MHS5	14,600	n	a	y	1	0						0	0.0%	0	0
MHS6	29,660	n	y	n	6	2		2		530		530	1.8%	0.504	5.6
MHS7	10,940	n	n	y								0	0.0%	0	0
MHS8	79,610	n	n	y	2	0						0	0.0%	0	0
MHS9	310	n	n	y								0	0.0%	0	0
MHS10	4,830	n	n	y								0	0.0%	0	0
MKD1	102,760	y	n	n	2	2		2		800		800	0.8%	0.677	8.1
MKD2	74,900	y	n	n	2	1		1		500		500	0.7%	0.229	4
MKD3	104,180	y	n	n	5	5		5		1,900		1,900	1.8%	1.008	67.1
MKD4	1,760	y	n	n								0	0.0%	0	0
MKD5	6,020	y	n	n	1	1		1		100		100	1.7%	0.2	18
MKD6	710	y	n	n								0	0.0%	0	0
MKD7	44,890	y	y	n	2	2		2		80		80	0.2%	0.083	80
MKD8-1	32,810	y	n	n	7	7		7		4,950		4,950	15.1%	5.767	28
MKD8-2	8,600	y	n	n								0	0.0%	0	0
MKD8-3	9,920	y	n	n	1	1	1			1,500		1,500	15.1%	2.8	34
MKD8-4	5,710	y	n	n								0	0.0%	0	0
MKD9-1	28,400	y	n	n								0	0.0%	0	0
MKD9-2	23,640	y	n	n	1	0						0	0.0%	0	0
MKD10	1,180	y	n	n								0	0.0%	0	0
MKD11-1	6,880	y	y	n								0	0.0%	0	0
MKD11-2	6,550	y	y	n	1	1		1		200		200	3.1%	0.289	0.7
MKD12	11,480	y	n	n	2	2		2		4,500		4,500	39.2%	15	25
SKN1	22,560	n	y	n	1	1		1		800		800	3.5%	0.59	1.5
SKN2	43,260	n	y	n	6	1		1		500		500	1.2%	0.319	1.5
SKN3-1	80,100	y	n	y	14	0						0	0.0%	0	0
SKN3-2	6,650	y	n	y								0	0.0%	0	0
SKN3-3	31,720	y	n	y	3	2	2			6,600		6,600	20.8%	7.7	13.3
SKN4	85,530	y	n	y	2	0						0	0.0%	0	0
SKN5-1	16,060	y	n	y	1	1		1		600		600	3.7%	0.72	3.5
SKN5-2	65,740	y	n	y	4	4	2	2		8,400		8,400	12.8%	8.527	31.3
SKN6-1	22,780	y	n	n								0	0.0%	0	0
SKN6-2	21,760	y	n	n								0	0.0%	0	0
SKN7	13,200	n	y	y	2	0						0	0.0%	0	0
Total	1,357,610				91	46	5	39	2	33,730	3,000	36,730	2.7%	45.748	339.9

Proposed Irrigation Projects: Proposed: Number of MSIPs	Number of SSIPs	Rehabilitation: Dredging of Reservoir & Creek	Intake installation	Pump Irrigation	Total: Number of Projects	Irrigation Area (rai): MSIP+SSIP	Rehabilitation	Pump Irrigation	Total	(%)	Total: Storage Capacity (MCM)	Catchment (km2)
2	12			3	17	4,400	260		4,660	7.1%	4.52	41.7
	5				5	740			740	5.3%	0.513	5.6
	5				5	1,140			1,140	6.4%	0.924	7.4
	5				5	490			490	4.3%	0.324	1.3
					0				0	0.0%		
2	9			6	17	2,460	1,280		3,740	2.5%	3.426	16.9
					0				0	0.0%		
	3				3	270			270	0.5%	0.167	0.7
					0				0	0.0%		
					0				0	0.0%		
					0				0	0.0%		
	4		1		5	270	70		340	2.3%	0.186	0.7
			2		2		120		120	0.4%	0.061	6.8
					0				0	0.0%		
	7				7	820			820	1.0%	0.537	2.9
					0				0	0.0%		
					0				0	0.0%		
2	3			2	7	2,280		1,000	3,280	3.2%	2.35	53.4
2				4	7	2,770		2,000	4,770	6.4%	3.521	31
		16	16	1	17		2,850	500	3,350	3.2%	2.28	0
1	1				2	610			610	34.7%	0.548	2.2
	2				2	540			540	9.0%	0.475	2.5
					0				0	0.0%		
0	14				14	6,760			6,760	15.1%	9.159	44.2
	2*				2	3,800			3,800	11.6%	1.35	0.6
3	0			1	4	4,140		500	4,640	54.0%	6.021	99
					0				0	0.0%		
1	2				3	1,250			1,250	21.9%	1.328	7.6
	2		1		3	580		500	1,080	3.8%	0.523	2.3
	4		1		5	1,460	240		1,700	7.2%	1.62	9.9
	2				2	510			510	43.2%	0.424	2.1
1	1				2	820			820	11.9%	0.816	3.5
	2			2	4	700		1,000	1,700	26.0%	0.688	8.5
					0				0	0.0%		
	1				1	370			370	1.6%	0.35	3
	3		1	4	7	1,470	580		2,050	4.7%	2.082	15.7
1	2*			1	4	7,000	880		7,880	9.8%	12.366	52.5
					0				0	0.0%		
	1		1		2	220	760		980	3.1%	1.074	2.7
			2		2		410		410	0.5%	0.33	1.6
				3	3			1,500	1,500	9.3%	0	0
					0				0	0.0%		
	1*				1	?			0	0.0%	0	0.4
	1				1	330			330	1.5%	0.3	10
			2		2			1,000	1,000	7.6%	1.032	2
15	95	16	39	14	163	46,200	8,450	7,000	61,650	4.5%	59.295	439

Grand Total: Numbers of Projects: MSIPs	SSIPs	Rehabilitation	Pump Irrigation	Total	Total: Irrigation Area (rai)	(%)	Storage Capacity (MCM)	Catchment (km2)
2	17	3	2	24	8,140	12.4%	4.84	53
0	5	0	0	5	740	5.3%	0.51	6
0	5	0	0	5	1,140	6.4%	0.92	8
0	6	0	0	6	690	6.0%	0.82	2
0	0	0	0	0	0	0.0%	0.00	0
2	13	6	0	21	4,810	3.3%	3.94	32
0	1	0	0	1	20	0.8%	0.01	0
0	3	0	0	3	270	0.5%	0.17	1
0	0	0	0	0	0	0.0%	0.00	0
0	0	0	0	0	0	0.0%	0.00	0
0	4	1	0	5	340	2.3%	0.19	1
0	2	2	0	4	650	2.2%	0.57	13
0	0	0	0	0	0	0.0%	0.00	0
0	7	0	0	7	820	1.0%	0.54	3
0	0	0	0	0	0	0.0%	0.00	0
0	0	0	0	0	0	0.0%	0.00	0
2	5	0	2	9	4,080	4.0%	3.03	65
2	2	0	4	8	5,270	7.0%	3.75	39
0	5	16	1	22	5,250	5.0%	3.29	70
1	1	0	0	2	610	34.7%	0.55	3
0	3	0	0	3	640	10.6%	0.68	21
0	0	0	0	0	0	0.0%	0.00	0
0	16	0	0	16	6,840	15.2%	9.24	133
0	9	0	0	9	8,750	26.7%	7.12	36
3	0	0	1	4	4,640	54.0%	6.02	105
1	0	0	0	1	1,500	15.1%	2.80	37
1	2	0	0	3	1,250	21.9%	1.33	9
0	2	0	1	3	1,080	3.8%	0.52	3
0	4	1	0	5	1,700	7.2%	1.62	12
0	2	0	0	2	510	43.2%	0.42	3
1	1	0	0	2	820	11.9%	0.82	4
0	3	0	2	5	1,900	29.0%	0.98	10
0	2	0	0	2	4,500	39.2%	15.00	40
0	2	0	0	2	1,170	5.2%	0.94	5
0	4	4	0	8	2,550	5.9%	2.40	20
1	2	1	0	4	7,880	9.8%	12.37	65
0	0	0	0	0	0	0.0%	0.00	0
2	1	1	0	4	7,580	23.9%	8.77	25
0	0	2	0	2	410	0.5%	0.33	2
0	1	0	3	4	2,100	13.1%	0.72	4
2	2	0	0	4	8,400	12.8%	8.53	40
0	1	0	0	1	0	0.0%	0.00	0
0	1	0	0	1	330	1.5%	0.30	10
0	0	2	0	2	1,000	7.6%	1.03	3
20	134	39	16	209	98,380	7.2%	105	884

(Note) (1) "*" under-construction or plan by RID, (2) Number of dredging of the existing reservoirs is included in the number of intake installation

4.3.2 On-farm Development

1) On-Farm Development Concepts

Irrigation Development Area:

This area , only 7.2% of the study area, will be developed in the line of present land use to stabilize rice production and to perform integrated farming for fruit trees and vegetables by means of provision of small regulating ponds, farm roads and irrigation ditches.

Rainfed Area:

Development of this area which shares most area depends only on stock water in farm ponds due to scarce potential of groundwater. However, a 1,200 m^3 farm pond can support only one rai irrigation that is equivalent to only 5% of irrigation ratio. (1 rai / 20 rai = 5%, 20 rai = average landholding) If water is available, it is possible for a farmer to manage an irrigated 4 rai integrated forming by his family labor. In this case, he needs a 6,000 m^3 farm pond for irrigation. Therefore, it will be necessary to provide more larger farm ponds, some 6,000m^3 capacity, to the farmers who has a high intention to proceed integrated farming. For this purpose, long term credit with a low interest will be essential.

From above considerations, on-farm development will be planned shown in Table 4.3-4.

Table 4.3-4 Standard Criteria for On-farm Development

Land Categories		Irrigation	Major Crops	On-farm Development	Major On-farm Facilities
Reservoir Dependent Land (7.2% of total area)		Extensive (Basin Irrigation)	Rice	Intensive	- On-farm roads - Irrigation ditches (along owners boundaries)
		Extensive (Furrow Irrigation)	Sugarcane	Intensive	- On-farm roads - Small regulating ponds - Irrigation ditches (along owner boundary)
		Intensive (Micro Irrigation)	Fruit Trees Vegetables	Intensive	- On-farm roads - Small regulating ponds - Pipelines - Micro irrigation
Rainfed or Farm Pond Dependent Land (92.8 % of total area)	Rainfed Areas	None	Rice (rainfed) Sugarcane (rainfed) Cassava Fast growing trees	Extensive (Intensive for farm road where integrated farming is carried out)	- Main farm roads - On-farm roads (only where integrated farming is carried out) - Contour ditches
	Farm Pond Dependent Areas (Integrated Farming)	Intensive (Bucket Irrigation) or (Hose Irrigation)	Vegetables	Intensive	- Small farm ponds (1,200 m^3) - On-farm roads
		Intensive (Hose Irrigation) or (Micro Irrigation)	Fruit Trees Vegetables	Intensive	- Larger farm ponds (6,000 m^3) - On-farm roads - (Micro irrigation)

2) Recommended Irrigation Methods

- Paddy : Gravity irrigation system is recommended. Irrigation ditches are expected to be planned and constructed by farmers themselves, and they should also maintain them. Dike of paddy plot should be maintained to prevent water leakage and to be high enough to keep standing water in a plot.

- Upland crops : Sugarcane is supposed to be a major crop for irrigation from a scale of present planting in the study areas. Furrow irrigation is recommended utilizing land slope effectively. However, it is recommended to irrigate other crops with water saving irrigation, because furrow irrigation is low efficiency

- Fruit trees : Mini-sprinkler or basin irrigation is recommended.

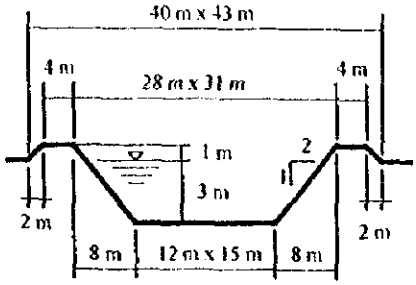
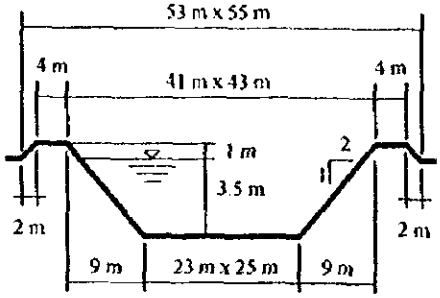
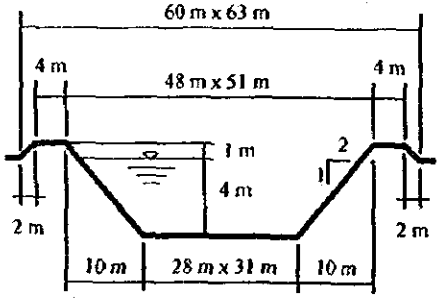
- Vegetables : Bucket, hand power, or portable pump irrigation is recommended because field is small and adjacent to farm pond.

3) Farm Pond Development

a) Summary of Farm Pond Development

Farm pond development has been considered for three cases, namely an ordinary farm pond of 1,200 m^3 capacity , a medium farm pond of 3,500 m^3 capacity, and a large farm pond of 6,000m^3 capacity. Elements of each case are summarized in Table 4.3-5. Farmer should select a preferable capacity of farm pond taking his farming mind, available family labor, landholdings, available catchment area and pond elements into consideration.

Table 4.3-5 Summary of Farm Pond Development

Farm Ponds	Elements	Khon Kaen Maha Sarakham	Mukdahan Sakhon Nakhon
Ordinary Farm Pond 1,200m³ 	Major Dimensions	Area Size = 40mx43m = 1,720m² (1.1rai) Depth = 3m, Side slope = 1:2	
	Min. Req. C. Area	3 rai	1.5 rai
	Irrigated Crops	1 rai (vegetables)	1 rai (vegetables)
	Irrigation System	Bucket Irrigation	Bucket Irrigation
	Construction Cost Pond Irrigation System Total	 B37,500 - B37,500	 B37,500 - B37,500
	Demarcation Government Farmer	 B37,500 0	 B37,500 0
	Min. Req. Labor	2 members	
	Net Agri. Income	B71,000/year	
Medium Farm Pond 3,500m³ 	Major Dimensions	Area Size = 53mx55m = 2,915m² (1.8rai) Depth = 3.5m, Side slope = 1:2	
	Min. Req. C.Area	16.5 rai	8.25 rai
	Irrigated Crops	1.0 rai (vegetables) 1.5 rai (Rice+D.S.crop) 2.5 rai	1.0 rai (vegetables) 1.5 rai (Fruit tree) 2.5 rai
	Irrigation System	Hose Irrigation by Tiller attached Pump	Micro-sprinkler System by Electric Pump
	Construction Cost Pond Irrigation System Total	 B98,900 B10,500 B109,400	 B98,900 B50,500 B149,400
	Demarcation Government Farmer	 B37,500 B71,900	 B37,500 B111,900
	Min. Req. Labor	2 members	
	Net Agri. Income	B98,500/year	
Large Farm Pond 6,000m³ 	Major Dimensions	Area Size = 60mx63m = 3789m² (2.4rai) Depth = 4m, Side slope = 1:2	
	Min. Req. C. Area	30 rai	15 rai
	Irrigated Crops	1 rai (vegetables) 3 rai (W.S.Rice+D.S.crop) 4 rai	1 rai (vegetables) 3 rai (Fruit tree) 4 rai
	Irrigation System	Hose Irrigation by Tiller attached Pump	Micro-sprinkler System by Electric Pump
	Construction Cost Pond Irrigation System Total	 B160,250 10,500 B170,750	 B160,250 68,000 B228,250
	Demarcation Government Farmer	 B37,500 B133,250	 B37,500 B190,750
	Min. Req. Labor	3 members	
	Net Agri. Income	B126,000/year	

(Note) Net agricultural income includes the income of rainfed land of a standard farmer who has a 20 rai farmland.

b) Annual Irrigation Amount from Farm Pond

Annual irrigation amount from farm pond has been estimated as shown in Table 4.3-6.

Table 4.3-6 Annual Irrigation Amount from Farm Pond

Area	Farm Pond (m^3)	Return Period (yr)	Irrigation Area (rai)				Irrigation Amount (mm)				Annual Irrigation (m^3)
			Vegetable	Paddy Rice	Dry S. Crops	Fruit Tree	Vegetable	Paddy Rice	Dry S. Crops	Fruit Tree	
KK, MHS	1,200	1/5	1				481				770
		1/2	1				426				682
	6,000	1/5	1		3		481	1,124	803		10,019
		1/2	1		3		426	1,007	767		9,199
MKD, SKN	1,200	1/5	1				532				852
		1/2	1				508				814
	6,000	1/5	1			3	532			1,299	7,086
		1/2	1			3	508			1,250	6,814

c) Recommendable Irrigation System of Farm Pond Dependent Land

Taking size of irrigation and farming into consideration, Recommendable irrigation system of farm pond dependent land will be as follows:

Table 4.3-7 Recommendable Irrigation System for Farm Pond Development

Farm Pond Size	Ordinary Farm Pond (1,200 m^3 Capacity)		Large Farm Pond (6,000 m^3 Capacity)	
Province	Khon Kaen Maha Sarakham	Mukdahan Sakon Nakhon	Khon Kaen Maha Sarakham	Mukdahan Sakhon Nakhon
Irrigable Crops	1 rai (vegetables)	1 rai (vegetables)	1 rai (vegetables) 3 rai (W.S. Rice + D.S. Crops) Total = 4 rai	1 rai (vegetables) 3 rai (Fruit Trees) Total = 4 rai
Recommended Irrigation System	Bucket Irrigation	Bucket Irrigation	Hose Irrigation by Tiller attached Pump	Micro-sprinkler System by Electric Pump
Reasons of Irrigation System Selection	Irrigation area is too small to introduce sprinkler system, and irrigable by bucket.		Irrigation area is too large for bucket irrigation, and basin irrigation by hose is suitable.	Micro-sprinkler system is suitable from a viewpoint of area scale, and electric pump is economical than engine pump.

d) Selection of Farm Pond Location

i) To ensure enough inflow to the pond, catchment area to be larger than following minimum required area to meet each farm pond capacity.

Table 4.3-8 Minimum Required Catchment Area of Farm Pond

Province	Ordinary Farm Pond (1,200 m^3 Capacity)	Large Farm Pond (6,000 m^3 Capacity)
Khon Kaen Mahasarakham	3 rai	30 rai
Mukdahan Sakon Nakhon	1.5 rai	15 rai

Catchment area is generally utilized several farm ponds mixedly. In this case, residual catchment area is to be equal to or larger than above minimun required catchment area at each farm pond site.

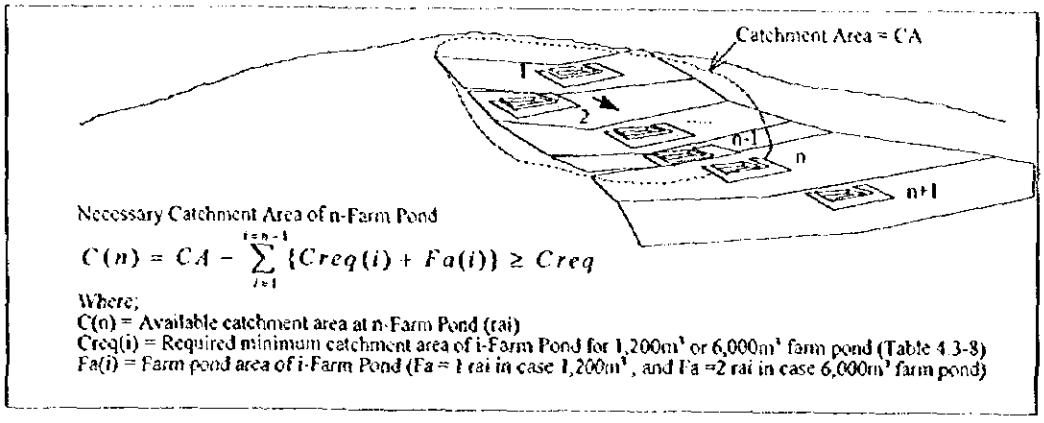


Figure 4.3-2 Check of Available Catchment Area of Farm Pond in the Area

ii) Soil texture should be clayey soil or containing clay at certain quantity able to retain water. The site should be able to install an excavated type farm pond, of which depth should be 3 meters for an ordinary farm pond and 4 meters for a large farm pond.

iii) Farm lot should be fronting on a farm road to ensure accessibility able to conduct and maintain integrated farming.

iv) In case the site locates in lowland paddy area, inundation depth should be less than 50 cm, and cottage and livestock yard and vegetable yard should be banked at 1 m height from ground level.

v) In case the pond is utilized for raising fish in lowland paddy area, pond should be protected with a dike from over flooding.

e) Residual Soil Disposal Plan of Farm Pond

i) Disposal Plan for the Ordinary Farm Pond 1,200m³

Development of ordinary farm ponds should be proceeded in parallel with development of farm roads to bear the subgrade material in the area as a whole. Disposal plan should be, therefore, in the balance with farm road development. Excavated soils will be utilized for farm roads by 400m³, and remaining 800m³ should be disposed in the farm land in the common LRAs. Out of 800m³, top soil 200m³ of 30cm thickness should be spread to the vegetable field and 600m³ should be filled in the cottage yard. Filling heights are about 10cm and 40cm respectively. This disposal plan is shown in Figure 4.3-3.

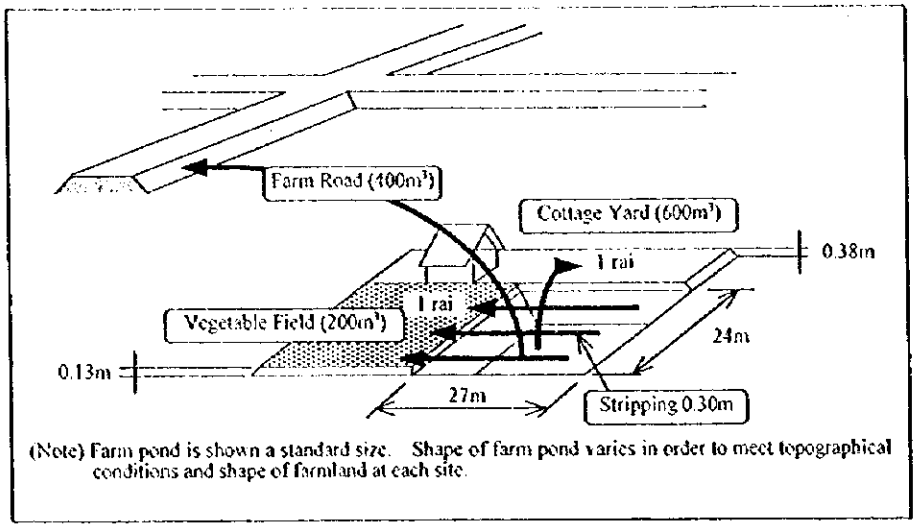


Figure 4.3-3 Residual Soil Disposal Plan for an Ordinary Farm Pond (1,200m³)

ii) Disposal Plan for the Large Farm Pond 6,000m³

Large farm ponds are to be enlarged by farmers themselves on their necessity with own investment. In this stage, farm roads are already completed so that all residual soil should be disposed in their farmland.

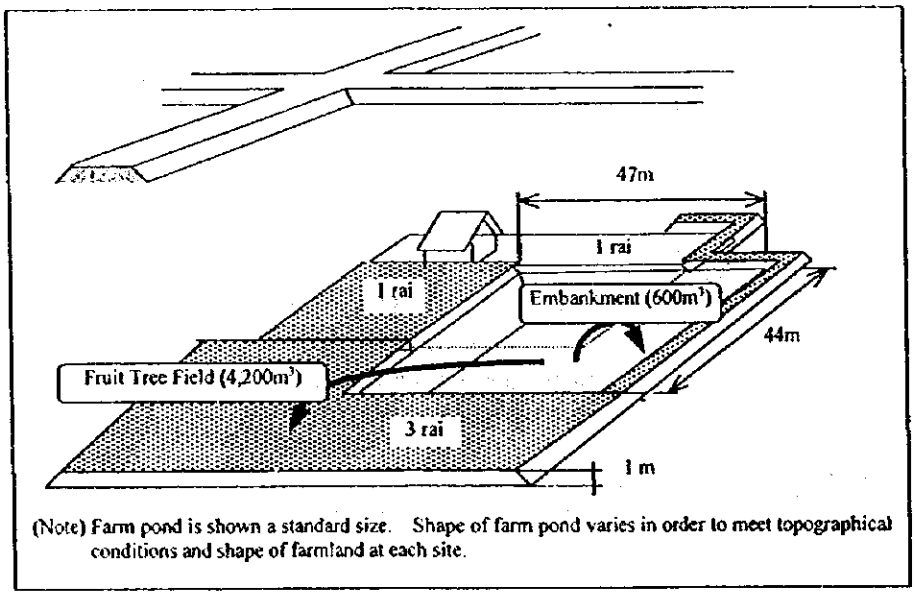


Figure 4.3-4 Residual Soil Disposal Plan for a Large Farm Pond (6,000m³)

Residual soil will be 4,800m³ in maximum by enlargement to a large farm pond. It is recommended to dispose the residual soil to the fruit tree field and to fill embankment surrounding the pond. In case disposing the soil to the fruit tree field of 3 rai, the filling height will be about 1 meter.

4) Design of Sprinkler System

It is recommended for a large farm pond to introduce sprinkler irrigation system to save water for fruit tree and vegetables. Recommendable sprinkler system is summarized as show in Table 4.3-9. (Details are in Appendix D, 4.2.4)

Table 4.3-9 Selected Sprinkler System for Vegetables and Fruit Trees

	Vegetables	Fruit Trees	Total
Area	1 rai	3 rai	4 rai
Specification of Sprinkler			
Discharge	10.0 lit/min/head	8.0 lit/min/head	
Water Spread Range (diameter)	10 m	5 m	
Necessary number of Sprinkler Heads	25 heads	70 heads	95 heads
Total Discharge (lit/min)	250 lit/min.	560 lit/min.	Operation Range 250 - 560 lit/min.
Necessary Pressure	2.1 kg/cm^2	1.8 kg/cm^2	2.1 kg/cm^2

Sprinkler system should be operated by an electric motor pump under a group electric incoming system of about 4 to 6 farmers. The group incoming system is recommended from an economical viewpoint. (Details are in Appendix D, 4.2.4.)

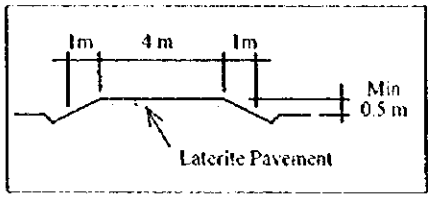
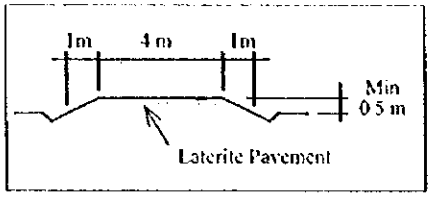
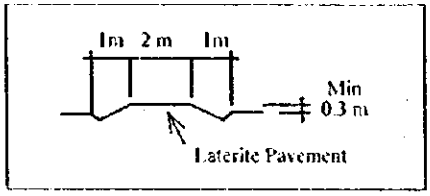
5) Farm Road Development

a) Definition of Farm Road

Although many farmers want asphalt pavements for farm roads, the cost will be high if complete pavements are provided. Pavements will be considered only for the parts suffered from erosion and flood or inundation where farm roads are crossing the depressed area or the lower paddy area.

Farm road will be classified into three categories taking their functions into consideration. All categories of farm road will be under responsibility of ALRO in LRAs.

Table 4.3-10 Definition of Farm Road

Farm Road	Functions	Definition of Road
Main Farm Road <Width: 4m for one truck> <Pavement> Laterite Asphalt if subject to flooding	Roads playing as a trunk road in the farming area, and utilized mainly for transportation of products and input materials, and access to community facilities.  	- Road frequently utilized by majority of farmers in the area. - Road from village to farm land area - Access road to community facilities (water sources, storage, cargo center etc.) - Outlet roads to market
Lateral Farm Road <Width: 4m for one truck> <Pavement> Laterite in upland Asphalt if subject to flooding	Roads linking several On-farm Roads for daily cultivation and hauling products.  	-Access road from Main Farm Road to On-farm Road.
On-farm Road <Width: 2m for one tiller> <Pavement> Laterite in upland Asphalt if subject to flooding	Roads linking several farm lots for daily cultivation.  	- Access road from Lateral Road to individual farm lots.

b) Alignment of Farm Roads

For ennobling to conduct integrated farming for many farmers as possible, farm road are to be provided to raise accessibility in the area.

i) Alignment of Main and Lateral Farm Roads

Main and lateral farm roads will be aligned utilizing existing farm roads as much as possible, because major access road systems are already established in most areas except in paddy dominant area. Improvement work as widening and laterite pavement will be major subjects for main and lateral farm roads.

ii) Alignment of On-farm Roads.

On-farm roads are not well developed yet in LRAs except where upland cash crops are dominant. In such areas, on-farm roads are already developed, and accessibility has reached some 60%. In those areas, improvement of on-farm roads is main subject, and additional new on-farm roads will be planned in accordance with the following criteria.

<Alignment Criteria of On-Farm Road>

- On-farm roads are to be aligned for farmers to able to conduct the integrated farming in many farm fields as possible.
- Many farm lands as possible are to be linked by a shorter road to minimize cost and land loss.
- On-farm roads are to be provided along the shorter side of land holdings to realize minimization of cost and land loss.
- When on-farm road is obliged to run along the longer side of land holdings, it should run along the boundary of larger holders.
- Existing footpaths are to be utilized as much as possible and widened as on-farm road.
- On-farm roads are to be aligned to link both ends to the lateral farm road to minimize the blind on-farm roads.
- In the area subject to flood, on-farm roads are to be paved with asphalt to protect from erosion.
- In such areas, generally paddy dominant area where land holdings are especially small and boundaries are complicatedly irregular, on-farm road development will be subject to delay until able to introduce land consolidation in the area.

6) Soil Conservation

There is no serious soil erosion in the LRAs, but some erosion can be observed in upland fields where plowed to the sloping direction. Some steep land accounts for about 7% or 15,500 ha of the area, where the slope is over 5 %. On such steep land, farming activities should avoid soil erosion, and contour ditches should be provided for sustainable farming.

In connection with provision of the farm ponds, when contour and collector ditches are aligned and connected to the ponds as shown in Figure 4.3-5, farm ponds will work as a sediment trap as well as a storage water tank. Ditches are usually grassed with useful grasses like lemon grass to protect from erosion. It is recommended that such ditches are provided by farmers in their farming works.

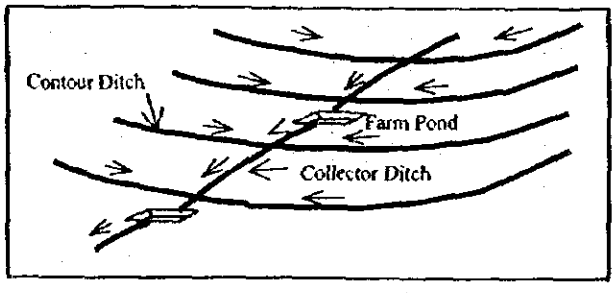


Figure 4.3-5 Provision of Contour and Collector Ditches in connection with Farm Pond

4.4 Rural Infrastructure Development

4.4.1 Rural Water Supply Development

As mentioned in Chapter 2, the rural water supply works, especially village water supply works, are now rapidly carried out in the study LRAs. The diffusion ratio of the village water supply works in the study LRAs has reached 79% that is higher than the target of 8th National Development Plan of 70%. The diffusion ratio in the LRAs in Khon Kaen and Mukdahan is already extremely high over 90% while it is little less than 70% in Maha Sarakham and Sakhon Nakhon.

From a viewpoint of high diffusion ratio, expansion of village water works is not so important subject in the area. However, regional gap is quite large as lower in Maha Sarakham and Sakhon Nakhon comparing to other provinces. Therefore, expansion of village water works have to be encouraged at 102 villages centering in the said two provinces for leveling up the living standard. Table 4.4-1 shows the necessary expansion of the village water works to reach 100% in diffusion ratio in the study LRAs. However, villagers prefer to drink rainjar water than supply water from an aspect of taste so that rainjar will remain even after equipped with a village water works.

Table 4.4-1 Necessary Number and Scale of Expansion of Village Water Works

Study Area No.	Number of Necessary Scale						Total Houshold 3)
	Small Scale	Medium Scale 1)	2)	Total	Large Scale	Total	
KK-1	1	1	2	3	0	4	157
KK-6	1	0	0	0	0	1	20
KK-Total	2	1	2	3	0	5	177
MHS-2	1	1	0	1	1	3	367
MHS-3	3	0	0	0	0	3	179
MHS-5	1	2	0	2	1	4	542
MHS-6	3	2	0	2	0	5	490
MHS-7	0	2	0	2	1	3	469
MHS-8	7	21	3	24	7	38	4,521
MHS-9	0	1	0	1	0	1	98
MHS-10	0	1	0	1	0	1	119
MHS-Total	15	30	3	33	10	58	6,785
MKD-6	0	1	0	1	0	1	85
MKD-7	0	1	0	1	0	1	80
MKD-8-3	0	0	1	1	0	1	
MKD-11	2	1	0	1	0	3	178
MKD-Total	2	3	1	4	0	6	343
SKN-2	0	0	1	1	4	5	1,458
SKN-3-1	0	1	1	2	5	7	1,694
SKN-3-3	1	0	0	0	0	1	47
SKN-4	1	4	0	4	3	8	1,811
SKN-5-1	0	1	0	1	0	1	153
SKN-5-2	2	6	0	6	0	8	685
SKN-6-2	0	0	0	0	1	1	302
SKN-7	0	0	0	0	2	2	604
SKN-Total	4	12	2	14	15	33	6,754
Grand-Total	23	46	8	54	25	102	14,059

(Note) 1) Villages of which number of households are reported.
2) Villages of which number of households are not reported. Those villages are provisionally classified into the medium scale water works.
3) Not including the households of the villages which are provisionally classified into the medium scale water works due to no information of household numbers.
4) Project scale is defined based on 70% of total households in each village taking present average subscription ratio into consideration.

4.4.2 Rural Road Development

As discussed in Chapter 2.11.3, rural roads have been rapidly improved by ARD and the Department of Highways. In the 8th National Plan, ARD plans to improve 3,700 km of village link roads in the country. Although there is insufficient information about present road improvement in the study LRAs, most LRAs are rapidly improved by the paved roads which are of two kinds. One is 6 m wide roads, provided by ARD to link villages and adjacent national highway, and the other is 8 m wide provincial highways by the Department of Highways.

Through observation, it is estimated that all villages in the LRAs will be linked to provincial highway or to village link road if 2 km is paved for each village in the areas. Total pavement required is estimated to be 970 km in the study LRAs as shown in Table 4.6-2.

Table 4.4-2 Requirement of Rural Road Improvement in the Study LRAs

Province	Study Area	Sub Area	Villages	Necessary Pavement (km)
KK	1	0	37	74
KK	2	0	11	22
KK	3	0	21	42
KK	4	0	8	16
KK	5	0	9	18
KK	6	0	37	74
MHS	1	0	3	6
MHS	2	0	19	38
MHS	3	0	9	18
MHS	4	0	9	18
MHS	5	0	13	26
MHS	6	0	18	36
MHS	7	0	8	16
MHS	8	0	64	128
MHS	9	0	3	6
MHS	10	0	17	34
MKD	1	0	19	38
MKD	2	0	11	22
MKD	3	0	9	18
MKD	4	0	2	4
MKD	5	0	4	8
MKD	6	0	6	12
MKD	7	0	8	16
MKD	8	1	4	8
MKD	8	2	5	10
MKD	8	3	3	6
MKD	8	4	3	6
MKD	9	1	3	6
MKD	9	2	9	18
MKD	10	0	2	4
MKD	11	1	8	16
MKD	11	2	6	12
MKD	12	0	3	6
SKN	1	0	2	4
SKN	2	0	12	24
SKN	3	1	15	30
SKN	3	2	1	2
SKN	3	3	6	12
SKN	4	0	22	44
SKN	5	1	4	8
SKN	5	2	24	48
SKN	6	1	1	2
SKN	6	2	5	10
SKN	7	0	2	4
Khon Kaen			123	246
Maha Sarakham			163	326
Mukdahan			105	210
Sakhon Nakhon			94	188
Total			485	970

4.4.3 Rural Electrification and Telecommunications Development

Rural electrification is planned for all households in the country by the 8th National Plan. However, it was found that all villages in the study LRAs were already electrified. Therefore, electrification has been provisionally completed in the areas. Public telephone system is now rapidly expanding in the LRAs, so that a considerable number of villages in the study LRAs will soon be connected to public telephone systems.

As a subject of further electrification in the study LRAs, it will be necessary to stabilize

electric supply strengthening the power network against storms and lightning.

4.4.4 Health Affairs and Services

According to the results of analysis on present conditions, health affairs and services should be carried out considering not only the construction of new health centers (Khon Kaen and Maha Sarakham) but also the qualitative level of services especially for increase of staffs and medicines in the existing health centers (Sakhon Nakhon).

4.4.5 Sanitary Affairs and Services

All households have their own sewage systems as mentioned in Section 2.11.3, and when a septic tank becomes full it is generally emptied by public or private services. Raw sewage is disposed and spread in forests which are far enough from villages and rivers. Therefore, this service is evaluated to be reasonable and good for the forest environment as long as disposal does not exceed natural capacity to deal with it.

4.5 Strengthening People's Organizations

According to a new development concept of the 8th Plan, there is to be a shift from growth-orientation to people-centered development. The role of people's organization is considered an important part of the program implementation.

At present, people's organizations in rural areas can be classified under several models promoted by various government agencies. Generally, many of the existing people's organizations are not strong enough due to urban migration for works during the dry season, a little self-reliance of farmers, lack of leaders, etc. In order to vitalize people' organization and rural communities, major source of farmers' income should be income from agriculture and urban migration should be decreased. The integrated agricultural development projects will be implemented to increase farmers' income and give a good effect to decrease the urban migration for works.

For enhancing the development potential of the regions and rural areas to promote better quality of life, the 8th Plan proposes to boost the capabilities of communities. Some of the guidelines designed for achieving these objectives are as follows:

- Empower all local communities to deal effectively with their own problems.
- Allocate government budget to support community organization, to support the formation of all types of popular organization.

It is expected that a greater self-reliance among rural people is promoted through the

implementation of the 8th Plan and thus people's organizations are strengthened.

Under such circumstances, ALRO should take necessary measures for strengthening people's organization under collaboration among relevant agencies such as DOAE, CPD, CDD, etc. In case that ALRO implements integrated agricultural development project in LRAs, ALRO should provide training course of progressive farmers to support people in strengthening people's organizations. In order to strengthen people's organizations in the Study Area, basic development approach is proposed as follows:

a) Promote systematic and effective collaboration between various relevant local organizations at the village level, particularly between farmers' organizations and regional peoples' organizations.
b) Provide communal facilities such as public parks, sports facilities, meeting halls and recreation centers to strengthen family and community ties.
c) Encourage the members of organizations to take the initiative in forming organizations, rather than relying on government prompting and recognition.
d) Promote the establishment of community funds, and low interest rate agricultural credit to support community organizations and the formation of all types of popular organization.
e) Promote training and development of administration and management capability for farmers' organizations by organization training courses in managerial skills, business, production know-how, marketing, finance and general administration.
f) Encourage women's groups, and youth groups to play a greater role in integrate farming, as well as cottage industries, handicrafts and home processing of agricultural products.

4.6 Necessary Supporting Services for Farmers

All LRAs in the Study Area are degraded forest land so there are many constraints against integrated agricultural development. Among these, poor physical conditions, low water resources potential, a little self-reliance are the major constraints. In order to achieve the development objectives, necessary supporting services for farmers should be considered.

Actually, the agricultural supporting services cover quite a broad scope of activities among which extension services for modern farming practices, training, credit, research and demonstration, post-harvest handling for quality control and marketing are essential works which can affect crop production and farmers' profits to a great extent. For effective implementation and strengthening necessary supporting services for farmers in the Study Area, ALRO should establish the project coordinating organization for coordinating the activities of relevant agencies such as DOA, DOAE, DOL, DOF, BAAC, etc.

4.6.1 Agricultural Extension Services

ALRO should implement agricultural extension services under collaboration among relevant agencies such as DOAE, etc. with an eye on the following items. DOAE has provincial extension office and Amphoe extension office which can coordinate necessary extension services in the cases that LRA belong to Tambons of more than two or is needed intensive services. The coordination among relevant agencies is carried out through the project coordinating organization to be newly established.

a) Formulate intensive consultation and public campaigns for changing traditional mono-culture to sustainable agricultural development scheme, particularly, integrated farming, agroforestry and ecological farming.
b) Change agricultural extension services from being the sole promoter of agricultural activities to provision of farming alternatives for farmers based on their needs and consistent with local conditions and market demand in each area.
c) Disseminate knowledge about modern agricultural technology, integrated farming, soil improvement, post-harvest techniques and marketing information via the mass media, such as radio, television, public relation services in villages in order to provide farmers with accurate and up to date information.
d) Provide technical materials and periodic visits by extension workers which should take special emphasis on technical know-how to enable agricultural workers to formulate their own farming plans.
e) Encourage on site visits to successful agricultural restructuring projects and off-farm income-generating projects of a similar nature implemented by farmers, NGOs and business groups. In addition, the facilities required for transfer of knowledge and experience form farmer to farmer should be provided.

In case that ALRO implements agricultural development project as a main implementing agency, ALRO should take responsibility for serving the farmers' training including training for crop production, animal production, integrated farming system, plant propagation and leadership. In addition, ALRO should carry out the technical supporting services to farmers in the project areas, if necessary. As shown in Chapter 2.8.5, there are some problems in implementing agricultural extension services and it is assumed that farmers have difficulty in understanding the technologies needed to grow new crops. Therefore, government agencies related to extension services are expected to implement perseveringly their services.

4.6.2 Employment Promotion Activities

The majority of LRAs in the Study Area have infertile soils and insufficient water during the dry season. Hence, farming activities in the Study Area predominantly take place in the wet season and the people working in farming are forced to seek off-farm employment elsewhere during the dry season. In order to absorb surplus farm labor in the dry season and to

increase family income, employment promotion activities are deemed necessary.

Generally, employment promotion activities in rural areas may be divided into two main groups, namely farming and non-farming employment. The following may be considered as a basic approach to employment promotion activities in the Study Area.

1) Farm Employment Promotion

a) Promote the restructuring of agricultural production programs from traditional mono-cropped farming production to integrated farming which is characterized by small farm plots with farmers engaging in many different but interrelated activities, i.e. crops, fishery, poultry, livestock and fruit trees.
b) Provide irrigation water at the farm level i.e. on-farm water storage or farm ponds to support an integrated farming program.
c) Encourage farmers to adopt integrated farming and prepare their own cropping plans under a Restructuring of Agricultural Produce Plan under which they receive advice from agricultural extension officers.
d) Provide necessary production inputs for agricultural restructuring such as, certified seeds, livestock breeds, agricultural credit at a reasonable rate of interest.

2) Non-farm Employment Promotion

At present, government agencies such as DOAE, CDD, CPD, the Department of Skil Development, the Department of Industrial Promotion, etc. carry out non-farm employment promotion. However, the supporting services for silk weaving and sewing is only implemented poorly in the Study Area. ALRO should provide effective supports for farmers in increasing non-farm employment opportunities under collaboration among relevant agencies. The basic direction for promoting non-farm employment will be as follows:

a) Promote off-farm employment in villages, particularly sub-contracted jobs such as weaving, precious stone cutting and manufacturing a part of industrial productions.
b) Create job opportunities for practical use by employing the skill of women as by processing and preserving agricultural products for better quality to meet market demand.
c) Promote cottage, rural and community industries in rural areas. The industrial products to be promoted should be selected considering, procurement of raw materials, market demand, skills and dissemination of skills.
d) Provide financial, technical and marketing assistance for supporting cottage industries and handicraft work in villages.
e) Provide relevant occupational skill training courses in various fields for farming people to give them a wider range of non-agricultural employment options.

3) Occupational Skill Training

In order to achieve the goals of occupational skill training mentioned in e) above, following measures are deemed necessary.

a) Improve the quality of occupational skill training programs in various fields, consistent with the actual capabilities of local communities, in order to upgrade the skills and basic knowledge of farmers and non-farming workers in the project areas. In addition, the provision of all types of media for building the capacity of a labor force in remote LRAs is needed.

b) Expand both formal and informal training courses for increasing labor force productivity, particularly for people working in farming and also those who want to shift from agriculture to a non-agricultural livelihood. Meanwhile, the efficiency and effectiveness of training methodologies should be extensively monitored and improved in quality.

c) Provide financial assistance and occupational skill training funding to assist workers in rural areas and for the private sector to arrange training courses for labor, so that they will have better employment opportunities.

d) Strengthen the role of the private sector and of peoples' organizations, i.e. farmers' groups, women's groups and youth groups, in operation and management of occupational skill training at all levels.

e) Develop an efficient labor and product market information system to be used for identifying local employment opportunities in response to market demand.

f) Provide training for trainers in various priority fields at all levels aimed at improving their teaching abilities and providing the requisite experience.

g) Establish effective collaboration among the relevant government agencies, i.e. ALRO, DOAE, CPD, CDD, the Department of Skill Development, leading to collaborative efforts towards occupational skill training.

4.6.3 Farmer Supporting Fund

For implementation of integrated agriculture development and securing farmer's income in LRAs, the following measures are deemed necessary.

a) Expand lending capacity of Land Reform Fund to facilitate integrated farming program and to cope with further requirement of development program in LRAs, moreover coordination.
b) Strengthen capability in financial management skills for staff working in Land Reform Fund services through increase of efficiency in loan appraisal , provision of information networks linking central office and provincial offices, training of staff and monitoring the program.
c) Expand the lending capacity of existing lending institutions to solve the various problems related to rural employment generating program, particularly, shortage of revolving fund for

promotion of cottage industry and handicraft..

d) Encourage private financial institutions to arrange various of credit to help farmers and communities towards integrated farming and non - farming employment generation program.
e) Establish systematic and effective collaboration among the relevant government agencies , particularly, ALRO, CPD, BAAC, CDD and Department of industrial Promotion.

4.6.4 Supporting Services for Post-Harvest Handling and Marketing

The major crops in the study areas are paddy, cassava and sugarcane. As sugarcane is mostly planted as contract farming between traders as representatives of sugarcane factories and farmers' groups, development of this crop is limited to for the producers, so supporting services for sugarcane are not to be considered.

Farmers harvest, dry cassava on the fields and transport it to a collecting point in the village. After that, traders buy and transport to their warehouse and to flour factory or do the slicing and drying and transport to the pellet factory. Sometimes large scale farmers transport fresh cassava to the flour factory themselves but not to the pellet factory because the pellet factory only accepts the sliced and dried cassava. The Thai government has suggested a decrease on production following to EEC import limitations. For these reasons, supporting services for cassava are deleted.

Consequently, supporting services for post-harvest handling and marketing for rice is to be considered. Moreover, since the integrated farming will prevail in future in the Study Area, supporting services for fruits, vegetables, and other farming are considered.

1) Concepts

The concepts underlying supporting services are as follows:

a) They should be for supporting farmers,
b) One of the supporting services should be for the farmers to operate and maintain farming and marketing themselves,
c) Supporting services should be so farmers can conduct sustainable agriculture,
d) According to the above, required supporting services are for post harvest handling and marketing for rice, fruits, vegetables and other products.

2) Points to be considered

Regarding the present conditions of rice production, the range of farmer's activities is very narrow. For example, cultivation for planting rice, harvesting, threshing and drying as well as processing, etc. are conducted by contract or hired labor. Farmers are thus indebted. It should therefore be considered how farmers can carry out, operate and maintain post-harvest and marketing work effectively. The following Table 4.6-1 shows work that can be done by farmers themselves under present conditions, and the problems and measures to be considered. At present, limited farmers are doing the integrated farming and products by the integrated farming are consumed for domestic consumption. Present integrated farming is not for marketing of the

product. If the new development plan is designed for marketing of the product, the following supporting services would be required for post-harvest handling and marketing and its development planning should be considered for gradual implementation.

3) Equipment and Facilities for Rice to be Considered

As for equipment and facilities to be introduced, simple, compact and unsophisticated equipment and facilities should be considered for easy maintenance and operation, such as

a) for drying and processing:
Concrete drying yard; (farmer or village level)
This should be attached to the marketing warehouse,

b) for threshing:
Threshing machine; (farmer or village level)
(for example)
One unit for each irrigated area of 30 ha which means the capacity of machine is half corresponding to the required capacity for taking the initial introduction of the machine into consideration,

c) for home consumption:
It is not selected because almost all households in the villages have already had the small warehouses for home consumption,

d) for seed storage:
It is not selected because DOAE has been implementing such a project for more than ten years,

e) for marketing:
Post-harvest and marketing warehouse with drying yard; (village or district level)
(for example)
When sufficient surplus such as over 100 tons is expected, one unit for 50 tons surplus would be introduced in each area or village. However, number of them should be deducted from the number of existing marketing facilities.

An illustration of a post-harvest and marketing warehouse with drying yard to be considered is shown below as an example.

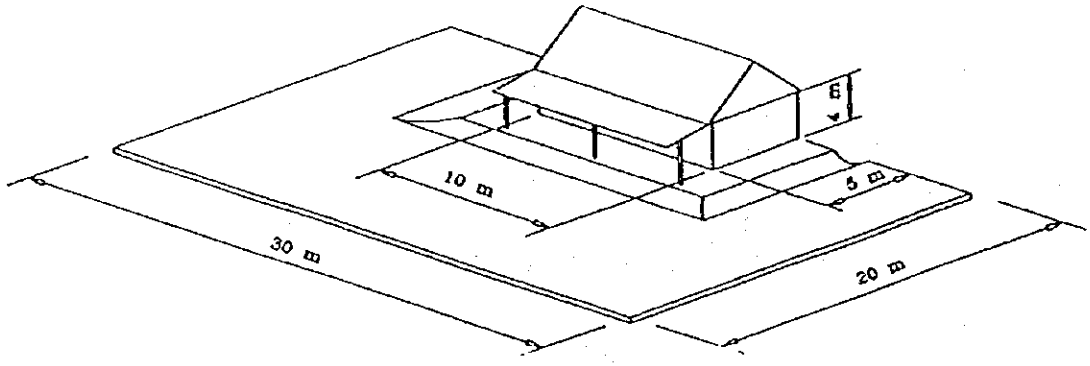


Figure 4.6-1 Proposed Post - Harvest / Marketing Warehouse with Drying Yard

Table 4.6-1 Present Conditions, Problems and Measures for Post Harvest and Marketing

	Present Conditions	Problems	Measures
1. Post Harvest 1) Drying, Processing	a) Drying on fields for 2 – 3 days, Spreading straw with paddy on fields.	a) Low quality depending on the weather, b) More processing loss, c) Requires collecting.	a) Introduction of machinery – Concrete drying yard – Drying machine Remarks: Conbine harvester requires drying facilities.
2) Threshing	a) Manual threshing, some by hired labor. b) Hired machine threshing.	a) Requires cash for payment, b) Threshing cost is high, c) Marketing route is fixed.	a) Introduction of machinery – Threshing machine – Conbine Harvester
3) Home Consumption	a) Carried out by rice mill in the village, b) Some farmers have rice milled to nearest rice miller.	a) Sometimes, needs to be transported a long way	a) Introduction of rice mill – Large scale rice mill in village – Small scale rice mill in village However, almost all villages have private rice millers.
2. Marketing 1) Temporary Storage	a) Almost all farmers own small warehouses for home consumption and temporary storage.	not particulars	–
2) Marketing	a) Person who is hired to thresh determines the marketing route. b) Sometimes, farmer transports rice to coop warehouse himself.	a) Farm gate price is low, b) Sometimes, marketing route is fixed. c) Coop warehouse is a long way.	a) Introduction of facilities – Warehouse only – Warehouse with drying yard – Warehouse with necessary facilities

4) Development Planning for Other Crops

Fruits

The expected fruits grown in the Study Area are mango as main fruit, banana, tamalindo, jack fruit, longan, sapodilla, etc. Their harvesting season is apt to one time. Therefore, it should be considered that the harvesting season will be expanded as long as possible taking farming system into consideration. If many kinds of fruits will be grown in the four provinces of the Study Area and harvesting period of them will be of three months, production volume would be expected 205,000 ton corresponding to the mango fruit and expected surplus would reach 198,000 ton, which volume would be able to be furnished to 5.9 million people provided 200g a day per person (refer to F-12 of Appendix F). As the population of four provinces of the Study Area is 4 million, it will be required to sell more than half of products to the other provinces, so that, it is considered the gradual implementation of development. It is important to develop the facility improvement in and around the Study Area for the marketing. The followings are considered for the development planning.

a) Farmer level
   i) Collecting and Loading Warehouse,
   ii) Selecting and Grading Facilities,
   iii) Quality Control Equipment.
b) Village and Amphoe level
   i) Marketing Center,
   ii) Grading and Packing Facilities,
   iii) Quality Control Equipment,
   iv) Supporting Equipment.
c) Provincial level
   i) Whole Sale Marketing Center,
   ii) Grading and Packing Facilities,
   iii) Quality Control Equipment,
   iv) Supporting Equipment

As the study area are far from the big cities and main roads, it is believed that the improvement of the roads and facilities is important. Since almost all fruits are easily perished within one week, it is required that the market routes should be firmly established. It is also one of the key points to set up the information system for receiving and notifying as early as possible the information of public marketing prices, demands and marketing routes and places. In future, it is possible to establish the processing firms as home industries such as dry mango processing, banana tips processing, fried banana processing, etc. Besides, it is possible to proceed the establishment of juice factories, puree factories, canning factories, etc. by means of the private enterprises. For those development promotion, the government supporting services are necessary, especially on the initial developing stage, in respects of technology transfer for methods of farming, harvesting and marketing as well as of information system for the technology transfer, collecting and notification of information.

Vegetables :

The expected vegetables grown in the study areas are cucumber, baby corn, string bean, water melon, tomato, etc. Their harvesting season is apt to one time like fruits. Therefore, it should be considered that the harvesting season will be expanded as long as possible. If many kinds of vegetables will be grown in the study areas and harvesting period of them will be of three months, production volume would be expected 76,000 ton corresponding to cucumber and expected surplus would reach 62,000 ton, which volume would be able to be furnished to 1.7 million people provided 400g a day per person (refer to F-13 of Appendix F) As the population of four provinces of the study areas is 4 million, almost all vegetables harvested will be consumed within the provinces. The followings are considered for the development planning.

a) Farmer level
    i) Collecting and Loading Warehouse,
b) Village and Amphoe level
    i) Collecting and Loading Center,
    ii) Supporting Equipment.
c) Provincial level
    i) Whole Sale Marketing Center,
    ii) Grading and Packing Facilities,
    iii) Quality Control Equipment,
    iv) Supporting Equipment

The vegetables might be the most desired because they are imported from other provinces even at present. However, almost all vegetables are perishable within one week like fruits. It is important to control the marketing of vegetables since quality and price of some vegetables are very variable between morning and afternoon. Therefore, it is necessary to establish the marketing system for the method of marketing information taking into consideration the balance of demand and supply. In future, it is possible to establish the processing firms as home industries such as kimuchi making, pickles making, etc. as well as to proceed the establishment of juice factories, retort factories, canning factories, etc. by means of the private enterprises. As there are some tomato canning factories and juice factories and their factories are getting larger, it may be possible to cooperate with these factories for promotion of the farming and marketing. For those development promotion, the government supporting services are necessary, especially on the initial developing stage, in respects of technology transfer for methods of farming, harvesting and marketing as well as of information system for the technology transfer, collecting and notification of information.

Livestock :

The expected livestock grazed in the study areas might be of small scale for meat cow, buffalo, pig, chicken, duck, etc. as pasturage. Since the deference between the wet and dry seasons is very severe, livestock has many problems such as high temperature, securing of the feed and water supply. Livestock farming plan might be designed considering the protection of direct sunshine to the livestock by means of growing the trees, securing the feed by means of stumps after harvested paddy and producing the feed and securing the water by means of the construction of small scale reservoirs. Since, on marketing of livestock, farmers would be able to control the selling days considering the marketing situations, it might be possible to sell their livestock at the reasonable marketing route and prices. However, there are some difficulties in the transportation for the small-scale farms far from the urban cities such as the Study Area. For marketing planing, it is required that the establishing the auction market outside the study areas at area, Amphoe and provincial levels for securing the reasonable marketing prices as well as infrastructure development inside the Study Area. The government supporting services are indispensable for those matters.

Fishery :

Small scale fishery in the reservoirs and ponds is expected in the study areas. Securing water for fish grazing would not be possible in the dry season for very high temperature and lack of rains. However, it would be possible to grazing fish in the wet season as well as by means of the larger reservoirs. Selling days of fish can be controlled like livestock. It would be required to establish the market at area, Amphoe and provincial levels for securing a reasonable marketing routes and prices.

Forestry :

It would be possible to produce eucalyptus, rubber tree, etc. in the study areas, though it is hilly and the farmers are small scale. Selling days of trees can be controlled more freely than that of livestock or fishery. Since there are some factories in the Khon Kaen Province and their capacity have been increased recently, it is considered that the reasonable marketing routes and prices would be secured easily under the government supports.

5) Necessary Government Support for Farmers

Since the field areas in the study areas are limited, soil is poor, water sources are scarce as well as rare marketing accesses because the places are far from big towns, the farmers in the study areas cannot help making a poor living. In these situations, the government supports are most important measures. Necessary government supporting services for farmers on post harvest handling and marketing are as follows:

a) Training and technology transfer to farmers for post harvest and marketing activities in cooperation with other agencies,
b) Training and technology transfer to farmers for quality control of the product,
c) Support to notify periodical information available to farmers concerning the marketing situations and prices of the products as well as better marketing routes and places. It might be considered that supporting services for setting up effective marketing channels

between farmers and traders or government agencies concerned such as BAAC and the Marketing Organization for Farmers who are conducting rice pledging schemes,

d) Support for farmers who would like to introduce equipment and facilities and to prepare the initial investment cost for the them,

e) Suggestions about the selection of the size and capacity of equipment and facilities to be introduced taking into consideration the farming system, harvesting method and production volume,

f) Support for farmers who operate and maintain equipment and facilities introduced, such as periodical training and repairing services,

g) Promotion of establishment or improvement of reasonable marketing places and auction places at the village, area, Amphoe and provincial levels,

h) This support should be conducted in cooperation with the ministries and agencies concerned.

4.6.5 Agricultural Research and Demonstration Activities

1) Research Subject

There are many works that have been carried out by several departments through Research Centers and Experimental Stations that are located in the region. Research centers and experimental stations have the main duty of conducting research works with the objective of finding the best and suitable crops, livestock, and fishery, for increasing farmer's income. It is also finding the new and appropriate technologies for the development of agriculture in the region.

Under existing agricultural condition and agricultural development plan of the region, following research subjects should be considered.

a) Agriculture

i) Improvement of soil fertility both paddy and upland field, especially on low organic matter.

ii) Selection of green manure crops for paddy and upland field and the method to plow in the green manure crops into soil.

iii) Using of cover crops and mulching material to reduce water loss from the soil.

iv) Technology on rice production in rainfed area for increasing yield.

v) Introduction of new promising crops, and new varieties of fruit trees and vegetables that will be suitable to the area e.g Mango Kaew variety.

vi) Improve variety of cassaba for higher yield and well adopt to the soil condition.

vii) Appropriate technologies on integrated farming.

viii) Technology on controlling the insects and disease of vegetables and some promising crops without using or minimum using of insecticides and fungicides.

ix) Combination of grass and leguminous plants for suitable pasture.

x) Processing of vegetables, fruits, young rattan shoot and herb.

b) Livestock
   i) Selection of suitable variety and strains of beef cattle in the region.
   ii) Selection of suitable variety and strains of dairy cows in the region.
   iii) Control of the parasitic worm and disease of beef cattle and chicken.
   iv) Introduction and generalization of artificial insemination to beef cattle.

c) Fishery
   i) Increase of fishery production.
   ii) Technology on raising fish in integrated farming system.
   iii) Size of farm pond in relating with integrated farming system.
   iv) Selection of higher price or higher income fish.

2) Sustainable Agricultural Extension Project

There are several governmental agencies involved in agricultural research and experiment activities directly or indirectly to the goal of promotion of agriculture and increase income of farmers. In addition to such activities, a sustainable agricultural extension project in LRAs in the Upper Northeastern Region should be implemented. The objectives of the project are to increase farmers' income , to upgrade the living standard of farmers and to contribute to the conservation of the forest reserve areas adjacent to LRAs by introduction of sustainable agriculture.

The main activities involved in the project are training, extension and demonstration on the following activities.

a) Farm pond based integrated farming
b) Agroforestry
c) Fruit tree production, horticulture, seedling production, plant propagation, etc.
d) Poultry, pig and cattle raising
e) Community forest management
f) Inland fishery

4.7 Environmental Considerations

Initial Environmental Examination (IEE) was carried out to clarify the outline of the environmental impact of project implementation. Though a development plan for priority areas will be formulated in Phase II from November 1997, IEE was examined on the assumption that the Project includes the construction of ponds, reservoirs, roads and irrigation facilities, change in cropping pattern and formation of farmers' organizations. The main impacts will be summarized as follows and the details are shown in Appendix H, Tables H-30 and 31.

4.7.1 Negative Impacts Expected and the Countermeasure

a) Resettlement may be necessary for the construction of reservoirs. Reservoirs will be planned in conservation and economic zones but some inhabitants and farmland may be in these areas. The compensation should be planned though it is illegal to reside or to have farmland in these area.

b) In the case that irrigation water will not be used impartially among villagers and in consideration of downstream villages, some conflicts may arise.

The adjustment of related agencies including the government office of Changwat, Ampoe and Tambon is required before the implementation. It is important that farmers' organizations work actively and observe the management of irrigation water and the government checks the water condition of downstream regularly and one of countermeasure is to establish an observation system of the river by the downstream farmers.

c) In the case that some components of the Project will not be accepted by villagers, they will not participate in the Project.

d) Meetings with villagers are essential before the planning of detail design and villagers should have a enough time to discuss among them. Detailed design should be planned after the modulation of villagers' opinion and the project should be implemented after agreement of villagers. For the construction of reservoir, afforestation of indigenous species in a substitute lot is desirable, for example in the economic forest.

e) In the case that no action is taken for soil conservation by villagers, soil erosion and deterioration of soil fertility will be serious. Therefore, the government should support farmers for the following items;

i) Input of green manure and compost
ii) Agroforestry with leguminous trees
iii) Crop rotation with leguminous crops
iv) Growing of deep rooted grass with the slope

Growing of Eucalyptus is not suitable for the soil conservation because it has a characteristics of fast growing by the strong fertilizer absorption power and it is logged every 5 years for the use of pulp, soil degradation will be increased. Leguminous trees that have nitrogen fixation capability such as Acacia is the best for the soil conservation. And the benefit from *Tectona grandis, Pterocarps macrocarpus*, etc. is much bigger than Eucalyptus in the long term and it is not bad for the soil conservation. RFD recommends to practice the mixed growing of some species.

The characteristics of some typical afforestation trees in the northeast are as follows:

Comparison of Afforestation Tree Species

	Eucalyptus	Acacia mangium	Tectona grandis (Teak)	Pterocarpus macrocarpus (Pra-du)
Strong Points	Fast growing. High disease resistance. No insect damage. Durability of infertile soil.	Fast growing. High disease resistance. No insect damage.	Fast growing. Strong against fire.	Fast growing. High disease resistance. No insect damage. Durability of infertile soil. Strong against fire.
Weak Points	Impossibility of inter cropping.		Insect damage.	
Natural Growth Area	Australia	Australia	North in Thailand	Northeast, central and west in Thailand
Seedling Production by REX	Yes	Yes	Yes	Yes
Logging	5 years	5 years	30 years	30 years
Main Use	Pulp	Pulp	Exclusive furniture	Exclusive furniture
Potential of Using Wood	Fair	N.A.	Excellent	N.A.
Market Price	750 B/ton	650 B/ton	16,700 B/m^3	4,900 B/m^3
Export Price (1995)	1,215 B/m^3	-	66,600 B/m^3	43,836 B/m^3
Thai Government Estimation	Afforestation species in the Northeast	Afforestation species in the Northeast	Afforestation species in the North	Most important afforestation species.

Source: JALDA 92-G-02.

4.7.2 Positive Impacts Expected

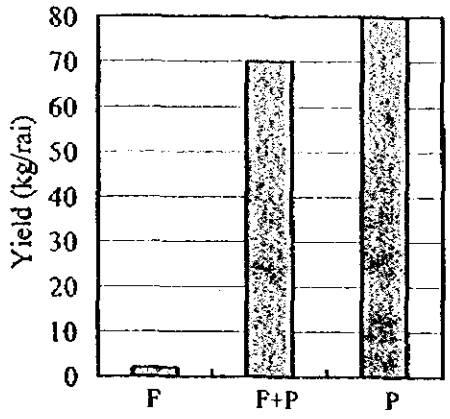
a) Construction of reservoirs and irrigation facilities will bring stable yield for farmers of rainfed rice farming areas.
b) Construction of farm ponds will bring high income and improvement of food life from fisheries and irrigated farming of upland crops, and the number of workers outside Tambons may decrease.
c) Through the positive participation of villagers, their lives will be stable and illegal farming in the conservation forest will decrease.
d) Through the practice of sustainable agriculture, degradation of natural environment will be reduced including soil erosion and deterioration of soil fertility.

4.7.3 Development Strategy in Consideration of the Environment

1) Practice of Sustainable Agriculture

a) Input of compost; Production of compost by DLD. The results of the ADRC (Agricultural Development Research Center in Northeast Thailand) Project show that input of organic materials is the most useful method for the amelioration of soil. Coconut shell collected in large quantities is crushed and input in seed bed in the nursery center of Maha Sarakham. The chip of wood collected from furniture factories is burnt to ashes and input in seed bed of *Vetier grass* in DLD Mukdahan.

b) Growing leguminous pasture after the rice harvest and in orchards for the use of green manure and feed where water use is available.



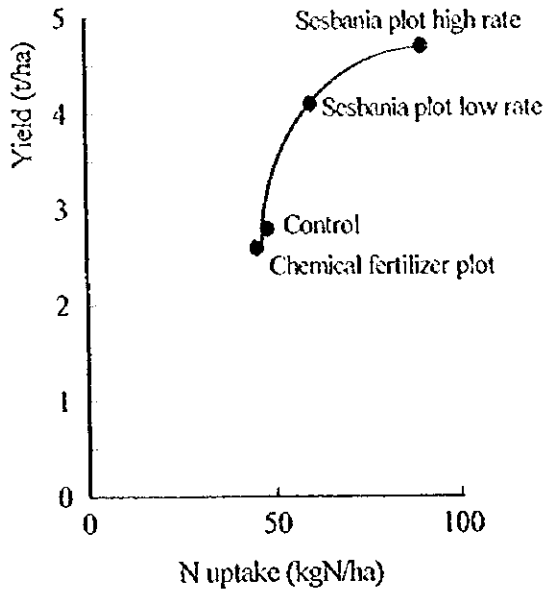
Yield of Cotton as Affected by Chemical Fertilizer (F) and Compost (P)

Source: Sustainable Agriculture in Northeast Thailand, 1996, JIRCAS

The results of the ADRC Project show the effect of compost illustrated in the figure shown on left. The yield of the compost plot was more than 20 times of the chemical fertilizer plot. The results of the study of green manure by *Sesbania rostrata* in rice fields was 4.7 t/ha for Sesbania plot and 2.5 t/ha for chemical fertilizer plot shown as the figure below.

c) Plantation of indigenous and leguminous trees along roads, ponds, reservoirs and on farmland for the improvement of soil fertility as well as for food, construction materials and feed; RFD should study indigenous trees to find the species that are strong against dry-weather, diseases and pests in cooperation with universities. Cooperation of NGOs is effective for enlightening villagers and the appropriation for NGOs should be made.

MOAC should support farmers in the above activities by visiting villages regularly with perseverance. And farmers' organizations should be established as well as the training of farming leaders. It will be effective to receive the support of NGOs since they have actual results in this field.



Effect of Green Manure on Rice Yield
Source: Sustainable Agriculture in Northeast Thailand, 1996, JIRCAS

2) Promotion of Community Forests

In many villages, a community forest is used for the collection of fuel wood, mushrooms, vegetables, etc. It is prohibited to fell trees by village regulation and natural forest is preserved. However, there is no community forest in the six Study Areas in the four provinces. (Refer to Appendix H, Table H-12)

Therefore, the promotion of community forest is recommended for the use of forest resources and for enlightening villagers to conserve natural forest. The most effective method is that a forestry specialist stays in the village for several years as a leader of reforestation as mentioned in Appendix H, Table H-29. Although it is difficult to station a RFD officer in all the project areas, RFD will need the cooperation of NGOs. Actually, some NGOs work for the Government and they are full of vitality (see Appendix H.7.4.)

3) Watershed Management

Watershed management is very important to maintain the good condition of reservoirs planned by the Project. The cooperation of villagers is essential since patrolling all watersheds will be a heavy burden for RFD and the protection of watersheds benefits villagers.

Therefore, MOAC should educate villagers about the importance of watersheds and a guarding system by villagers should be established. One method is to treat watershed as community forest, though Community Forest Regulations are still under discussion by the Government.

5) Improvement of Sanitary Condition

According to Kor Chor Chor Data, some households have no toilets in some villages. Support for sanitation is necessary in these villages. The quality of drinking water in rain jars regarding colon bacilli and other bacteria can be improved by sanitary education and improved rain jars with faucets.

6) Monitoring

Monitoring must be given in the downstream areas after the dam construction about the change in the condition of rivers. Though the dam construction will be executed with consideration of the water flow to the downstream, it is required to check the impact on the condition of water use at downstream area.

4.7.4 Environmental Impact Assessment (EIA)

EIA is carried out to clarify the environmental impact of the project implementation in one of the F/S Areas, Mukdahan No. 8-2. (see Appendix H.12.)

830 km^2 of Huai Huat National Park, established in 1988, is located in Sakhon Nakhon, Nakhon Phanom and Mukdahan including the conservation forest around MK8-2. One reservoir is planned in the conservation forest in this area, outside of the National Park as shown blow.

Development Plan in MK8-2

	Present	Project	Project Area
Reservoir	-	Effective storage capacity: 3.3 MCM Surface area: 106 ha (663 rai) Maximum water level: 182.5 m Height: 17.5 m, Length: 439 m	Conservation Forest
Weir	-	Height: 1.8 m, Length: 42 m Water distribution system by open canal or pipeline covers 231 ha (1,446 rai) of irrigation.	Huai Bang Sai within LRA
Farm pond	60 H.H.	1,200 m^3 for 270 households 6,000 m^3 for 61 households depending on their request.	Within farmland
Farm road	12 km	45 km of laterite road (newly constructed) (Main road: 4 m wide, on farm level: 2 m wide)	LRA including farmland

There are many illegal farmlands in the conservation forest including 106 ha of reservoir area. That area is occupied by 26 families from Ban Nong Mu and 2 families from Ban Na Lak being used for paddy, cassava and corn, but there are no houses.

The compensation should be agreed with the owners of farmlands in the reservoir area, even if they are illegal farmlands. The procedure of compensation shall be done with sufficient exchange of views in the village meeting including village committee. Money compensation may be the cause of another illegal farming for landless farmers and the mitigation plan should be discussed in the meeting. The presentation of countermeasure by the government side may be not useful if the villagers' side does not agree at bottom. Therefore it is important to discuss among villagers for the agreement of villagers themselves.

According to the proclamation for types and sizes of dam projects requiring EIA, EIA is required for dams and reservoirs that have a storage capacity of more than 100 MCM and a surface area of more than 15 km^2 in the Conservation Forest. (Refer to Appendix H, Tables H-28 and 29). EIA is also required for projects costing over 200 million Baht, IEE for 50 -

200 million Baht projects and a check list for projects costing less than 50 million Baht. As the cost of the dam project in MK8-2 will be approximately 254 million Baht, it is necessary to conduct EIA in accordance with the MOSTE procedure. (Refer to Appendix II, Figure II-6)

According to the EIA report, the same size with the proposed reservoir shall be reforested by RFD in the desolated forest in Mukdahan. Therefore, the dam construction cost shall include the compensation cost and reforestation cost. The area for the reforestation will be selected by RFD and should be selected after sufficient surveying as to whether the neighboring inhabitants are cooperative or not.

As for the proposed weir, the catchment area of Huai Bang Sai is 564 km^2 in the conservation forest, the water level is 0.2 m in the dry season (January) and the drought flow of 1/10 years is 1.5 m^3/sec. The water flow of down stream will be 4/5 after the weir construction and it is supposed that the negative impact to the down stream is not serious. For the stable supply of irrigation water, it is necessary for villagers to understand the importance of conservation of catchment area and the enlightening by ALRO will be required.

Farm pond and farm road development plans will not bring negative impact to the natural environment as they are small scale in farmland. These plans will be implemented with reflection of villagers' request. The government budget for the project will not be only for the completion of constructions, and should include the regular support for farming.

The Project is based on the participation of villagers. In case that villagers participate in the project actively and ALRO supports villagers in consideration of environment and villagers' needs, the negative impacts stated in IEE will not be expected. The success of the Project will bring some positive impacts in natural and social environment.

4.8 Plan Justification

A paddy/cassava farm with typically 20 rai (which is most dominant in LRAs) is substantially compensating household expenses from non-agri income because one farm's total annual expense of 32,770 baht now far exceeds the income from agriculture of 20,930 baht. According to the proposed basic development plan, paddy/cassava farms can reorient their current farming to integrated farming through the provision of a farm pond and a low-interest agricultural loan.

In order to understand a suitable size of integrated farming to be introduced, the following two cases are analyzed.

Case 1 : Mango (5 rai) and Vegetable (1 rai) cultivation, having a farm pond of 1,200 m^3 prepared free of charge by ALRO.

Case 2 : Mango (3 rai) and vegetable (1 rai) cultivation, having farm ponds of 6,000 m^3 in total. Cost for a farm pond of 1,200 m^3 is subsidized by ALRO and a farmer pays cost for farm pond of remaining 4,800 m^3 by borrowing a long- term loan with a 5 % interest.

Typical current farming	Integrated Farming w/project		
		Case1	Case2
Paddy 10 rai	Paddy	12 rai	8 rai
Cassava 10 rai ⇒	Sugarcane	-	6 rai
	Fruit (mango)	5 rai	3 rai
	Vegetables	1 rai	1 rai
	Farm Pond	1 rai	2 rai
	House, etc.	1 rai	1 rai

In the Case 1 with farm pond of 1,200 m^3, cash-saving would be about 50,000 baht annually. On the other hand, in the Case 2 with farm ponds of 6,000 m^3 in total, cash-saving would increase by about 71,000 baht annually.

Table 4.8-1 Comparison of Income/Expenditure

(Baht/year/farm)	Paddy/cassava farm	Integrated farming Case1	Integrated farming Case2	Difference of paddy/cassava farm and Case2
Agri Income	20,930	97,430	188,350	167,420
Agri Expenses	8,970	26,340	62,070	53,100
Net Agri Income	11,960	71,090	126,280	114,320
Non-Agri Expenses	23,800	21,300	21,300	-2,500
Total Income	20,930	97,430	188,359	167,420
Total Expenses	32,770	47,640	83,370	50,600
Cash-savings	-11,840	49,790	104,980	116,820

Note : Income and expenditure generated by the introduction of eucalyptus and mango is annualized in the above table. Farm income and expenditure don't include the value of consumption of self-made agricultural produce.

Reorientation of current farming will need financial support for initial investment. Because fast-growing trees and fruit trees cannot benefit farmers until the trees have grown enough to sell. This indicates that a long-term loan with low interest should be provided for farmers who intend to reorient their agriculture.

Table 4.8-2 shows cash flow analysis in providing a long-term loan of 80,000 baht with a 5% interest rate for 15 years for investment of agriculture, of about 190,750 baht with same loan condition for preparing farm ponds of 4,800 m^3 in total and a short-term loan of 57,000 baht with a 5% interest rate. The analysis shows that farmers can accumulate net savings of about 870,000 baht by the 15th year. And these savings will facilitate new investment for the expansion of their cultivation and/or replanting fruit.

Finally, providing long-term loans with a low interest rate and farm ponds of 1,200 m^3 or about 6,000 m^3 will make it possible to reorient their agricultural practices and promote the settlement of farmers in their villages.

Table 4.8-2 Cash Flow Analysis : 6,000 m^3 Farm Pond Type

Table G-FB-CF-12 Cash Flow Analysis : 6,000m3 Pond MK/Shed case : Short term loan 48,000 baht interest rate 5%, Long term loan 40,000 baht interest rate 6%

	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Farm income	Rice glutinous	7,740	7,740	7,740	7,740	7,740	7,740	7,740	7,740	7,740	7,740	7,740	7,740	7,740	7,740	7,740
	Sugarcane	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760	23,760
	Mango (Intercropping)	0	0	0	15,600	19,500	39,000	54,600	70,200	85,800	85,800	85,800	85,800	85,800	85,800	85,800
	Papaya (Intercropping)	18,000	18,000	18,000	0	0	0	0	0	0	0	0	0	0	0	0
	Vegetables (String bean)	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500
	Vegetables (Chili)	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800
	Chicken (Native)	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600	15,600
	Fish (Tilapia)	31,150	31,150	31,150	31,150	31,150	31,150	31,150	31,150	31,150	31,150	31,150	31,150	31,150	31,150	31,150
	Handicraft and hired in agriculture	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Non-farm income	Sub total	125,550	125,550	125,550	122,150	127,050	146,550	162,150	177,750	193,350	193,350	193,350	193,350	193,350	193,350	193,350
Loan																
Short term loan		59,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000
	Sub total	190,150														
Long term loan	For Pond & Sprinkler holders	20,000	20,000	20,000	10,000	10,000										
	Sub total	210,750	20,000	20,000	10,000	10,000	0	0	0	0	0	0	0	0	0	0
Total disbursement of loan		269,750	77,000	77,000	67,000	67,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000
Total Cash income*4		264,550	202,550	202,550	190,150	194,050	203,550	219,150	234,750	250,350	250,350	250,350	250,350	250,350	250,350	250,350
Farm Cash Expense	Rice glutinous	3,296	3,296	3,296	3,296	3,296	3,296	3,296	3,296	3,296	3,296	3,296	3,296	3,296	3,296	3,296
	Sugarcane	13,026	13,026	13,026	13,026	13,026	13,026	13,026	13,026	13,026	13,026	13,026	13,026	13,026	13,026	13,026
	Mango (Intercropping)	1,770	1,770	1,770	1,770	1,770	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520
	Papaya (Intercropping)	594	594	594	0	0	0	0	0	0	0	0	0	0	0	0
	Vegetables (String bean)	3,283	3,283	3,283	3,283	3,283	3,283	3,283	3,283	3,283	3,283	3,283	3,283	3,283	3,283	3,283
	Vegetables (Chili)	6,672	6,672	6,672	6,672	6,672	6,672	6,672	6,672	6,672	6,672	6,672	6,672	6,672	6,672	6,672
	Chicken (Native)*3	9,200	9,200	9,200	9,200	9,200	9,200	9,200	9,200	9,200	9,200	9,200	9,200	9,200	9,200	9,200
	Fish (Tilapia)	12,470	12,470	12,470	12,470	12,470	12,470	12,470	12,470	12,470	12,470	12,470	12,470	12,470	12,470	12,470
	O&M for Farm Pond	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790
	Sub total	66,800	59,103	59,103	58,507	58,507	59,257	59,257	59,257	59,257	59,257	59,257	59,257	59,257	59,257	59,257
Household Cash Expense*2		21,300	21,300	21,300	21,300	21,300	21,300	21,300	21,300	21,300	21,300	21,300	21,300	21,300	21,300	21,300
	Total	88,900	80,403	80,403	79,807	79,807	80,557	80,557	80,557	80,557	80,557	80,557	80,557	80,557	80,557	80,557
Loan payment																
Interest payment for short term		2,950	2,950	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850	2,850
Principal payment for short term		59,000	59,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	59,000
Interest payment for long term		0	0	0	0	0	34,613	40,113	26,398	12,164	10,830	9,476	7,446	5,415	2,708	0
Principal payment for long-term		0	0	0	0	0	0	0	13,528	13,528	27,075	27,075	40,613	40,613	54,150	54,150
Total payment for loan		61,950	61,950	59,850	59,850	59,850	94,463	99,963	99,786	86,571	97,755	96,401	107,908	105,878	116,708	116,100
Total Cash Expense		748,853	142,353	140,253	139,657	139,657	175,020	180,520	180,343	166,128	178,312	176,958	188,465	186,435	197,265	196,657
Net saving		55,697	60,197	62,297	50,493	54,393	28,531	38,631	54,407	84,222	72,038	73,392	61,885	63,916	53,085	53,693
		55,697	115,894	178,191	228,684	283,077	311,608	350,238	404,646	488,867	560,905	634,297	696,182	760,097	813,183	866,875

4.9 Project Implementation Program

1) Project Area (Study Area =35 LRAs)

-	Present Irrigated Area :	36,730rai	37,000rai (2.7%)
-	Potential Development Area :	61,650rai	62,000rai (4.5%)
-	Rainfed Area :	1,288,170rai	1,288,000rai (92.8%)
	Total	1,386,550rai	1,387,000rai (100%)

2) Project Cost

The project cost consists of costs for investment, loan preparation and engineering services, and is estimated at 9,670 million baht corresponding to 7,000 baht/rai, as shown below.

Investment

a) Present Irrigated AreaNo investment

b) Potential Development Area

-	Water Resources Development	62,000rai×25,000 B/rai =	1,550 M
-	Farm & Village link road, etc.	62,000rai×2,500 B/rai =	155 M
	Sub-total		1,705 M

d) Rainfed Area (40% of households in rainfed area)

-	Farm Pond (1,200 m3)	1,288,000rai×2,500 B/rai×0.4 =	1,288 M
-	Farm & Village link road, etc.	1,288,000rai×2,400 B/rai =	3,091 M
	Sub-total		4,379 M

e) Others

-	Soil Conservation Work	96,900rai×2,100 /rai =	204 M
-	Community Pond (20%)	440villages×3.0 M×0.2=	264 M
	Sub-total		468 M
	Investment (Total)		6,552 M

Loan Preparation

a) Support for farming
(only for 57% of household in potential development area and rainfed area)

-	Support for farming	1,350,000rai×2,400 /rai×0.57 =	1,847 M

b) Farm Pond (add. 4,800 m^3) (only for 10% of household in rainfed area)

-	Farm Pond Construction	1,288,000rai×5,800 B/rai×0.1=	747 M
	Loan (Total)		2,594 M

Engineering Services (8% of Investment)	524 M
Project Cost (Grand Total)	9,670 M (7,000B/rai)

3) Implementation Schedule

Development to match the progress of land distribution is expected, but a target for LRA development seems not to have been defined yet. A target or master plan for developing all LRAs in the country should be prepared in the near future by ALRO and necessary budgetary allocation to the development projects should be carried out. As ALRO's ability to implement the development projects can be strengthened largely by recruiting consulting firms, the budgetary allocation is key element for satisfactory progress of the development projects.

The implementation schedule of the development projects in the Study Area should be established according to the development target for all LRAs in the country and order of priority given to each LRA. However, the following implementation schedule has been prepared on assumption that the projects proposed in the Study Area of 1.38 million rai will be completed in ten years at the rate of project implementation of about 140,000 rai/year

Table 4.9-1 Implementation Schedule and Disbursement

Item \ Year	1	2	3	4	5	6	7	8	9	10	11	12
Stage 1 Project												
Stage 2 Project												
Stage 3 Project												
Stage 4 Project												
Stage 5 Project												
Disbursement Total (Mill	29	567	702	1,218	700	1,218	700	1,218	700	1,218	700	700
Investment			657	655	655	655	655	655	655	655	655	655
Loan Preparation		522		518		518		518		518		
Engineering Services	29	45	45	45	45	45	45	45	45	45	45	45

: Project Preparation
: Construction Work