		UNIT	Left	Upper Rig.	Lower Rig.	Whole Area
- Manure use						
Rice	Glutinous	Kg/rai		100.00	1,300.00	100.00
	Non-glutinous	Kg/rai		300.00	1,300.00	300.00
- Pesticide use						
Rice	Glutinous	Baht/rai	29.50	8.70	6.30	9.30
	Non-Glutinous	Baht/rai	40.00	7.50	9.30	15.40
Upland	Crops 1/	Baht/rai	62.50			62.50
	Soybean	Baht/rai			150.00	150.00
	Cucumber	Baht/rai			733.00	733.00

Note: Groundnut, soybean and cucumber are cultivated in the dry season.
1/ Upland crops include cassava, kenaf and jute.
Source: Agro-Economic Survey 11-12/1991

As described in the main report, the low agricultural productivity in the Study Area is caused by lack of water and poor soil fertility under rainfed conditions. It seems that such agricultural conditions have a bad effect upon a farmer's zeal for production. A number of farmers are seriously conscious of the lack of water and crop diseases. Through the implementation of the project, an increase in farmer's zeal for production can be expected by supplying the irrigation water and improving the farm management. The farmers' consciousness based on the results of an agro-economic survey are shown in Figure H-17.

3.4 Live Stock

Animal husbandry in the Study Area includes cattle, buffalo, swine, chickens and ducks. The number of livestock are shown in Figure H-18. For the most farmers, buffalo or cattle are owned as property and a labor source. Chickens, an easy-to-obtain animal food and source of cash income, are staple domestic fowl. Swine raising is generally practiced in house gardens and they are fattened by leftover food, the custom of feeding them is comparatively rare. The number of feeding farms and owned animals per farm are as follows.

Table H-26 Number of Feeding Farms

	Cattle		Buffalo		Swine		Chicken		Duck	
	Farm	Head	Farm	Head	Farm	Head	Farm	Head	Farm	Head
Right Bank	605	4.3	5,659	3.0	247	9.1	5,894	11.6	2,415	8.1
Left Bank	288	5.2	2,262	2.9	166	5.7	2,722	10.3	956	7.4

Source: National Statistics Office (NSO) 1991

3.5 Farm Management Plan

The wet season paddy planted and grown from May to October is the most staple crops in the Project Area. However, the natural conditions in the area frequently cause the abnormal and severe drought at the beginning of the wet season and June to August, therefore, its yield is extremely low compared with that of other regions. In order to prevent the crop damages due to these droughts, D-28 storage reservoir for irrigation was proposed in the project. Accordingly, the water stored in the reservoir will be used to irrigate the wet season paddy.

In the dry season, the irrigation water will be supplied to the benefited area of 15 percent for Type I and 16 percent for Type II. The planting of groundnut, soybean, watermelon, chilli and vegetables represented by string bean was proposed.

Improvement in productivity of paddy is a pressing need for the Project Area. Besides, Crop diversification is indispensable to increase and to stabilize agricultural income for each farmer. In the wet season, a part of irrigation water will be supplied to vegetable area to promote development effect. Introduction of mango as cash crop will be planned to increase farm income for all of the farmers in the area.

The standard cropping patterns are formulated as shown in main report taking into account the interview with the village chief and consultation with extension workers of Provincial and Amphoe Agricultural Extension Offices concerning soil quality, farmer's experience, agricultural policy and marketability of the crops in and around the Project Area.

The target yield of main crops as described in main report is set up taking into account the achievement of similiar projects and the experimental results of the rice and upland crop research centers related with the Project Area. However, the said yield will be attained under the such conditions that the appropriate distribution and management of irrigation water, installation of terminal irrigation facilities, establishment of irrigated farming techniques, effective extension activities on guidance and technical assistance by agricultural extension services and agricultural financing supported by public banking system are fully provided. The varieties and management practices for main crops are recommended as shown below. The utilization plan of farming inputs are shown in Table H-27.

(1) Paddy

- Varieties
  Photosensitive
    Glutinous: RD6, RD8 (HYV)
    Non-glutinous: RD15 (HYV), Khao Dowk Mali 105 (LIV)
  Non-photosensitive
    Glutinous: RD4, RD10 (HYV)
    Non-glutinous: RD23 (HYV)
  * HYV: High Yield Variety LIV: Local Improvement Variety
- Planting Time
  Seeding: May to June Planting: June to August
- Seed Rate: 36 Kg/ha
- Fertilizers

For nursery bed:		16-16- 8	11.9 Kg/ha
For paddy field:	Basal dressing	16-16- 8	300.6 Kg/ha
	Top dressing	45- 0- 0	62.5 Kg/ha

- Spacing: Transplanting 25 to 30 days after sowing
  20 x 20 cm or 20 x 25 cm
- Irrigation: About 10 cm depth
- Disease and Chemicals:
  Yellow orange leaf disease - Sevin
  Rice orange leaf disease, Rice yellow dwarf disease

Rice blaet - kasugamaycin

- Insects: Rice stem borer, Yellow stem borer, Paddy borer, White rice borer, Pink rice borer, Pink gall midge, brown planthopper, grassy stunt
- Others : Weeding is carried out by deep water control and pulling by hand.

(2) Groundnut

- Varieties: Thainan 9, So Kho Thai 38, Lampang, Korat,
- Planting time:
  At beginning of wet season (May to June)
  At end of wet season (August to September)
  Dry season (October to January)
- Harvesting: Random sampling before harvesting time by pulling it out slowly and let it dry in the field. After that, the pod is picked out by hand and dried to prevent the fungi that produce aflatoxin.
- Seed rate: 125 Kg/ha with dry shell, 94 kg/ha without shell
- Fertilizers: 12-24-12 156 Kg/ha or 16-16- 8 94 Kg/ha
  Application of 50 percent after germination, 50 percent 20 days after germination.
- Spacing: 50 x 20 cm
- Irrigation: During drought
- Disease and Chemicals:
  Downy mildew - Ridmil
- Insects and Chemicals:
  Bean fly, Pod borer, Leaf worm - Dimethioate, Sevin, Azodrin
- Others: Seed moisture should not be more than 8 percent and seeds should be kept in a plastic bag.

(3) Soybean

- Varieties: So Cho 1,2,4,5, So Kho 1, No Wo 1, SJ-1, ST-2, SB-60
- Planting time:
  Wet season is May to June and August to September.

Dry season is October to January.

- Harvesting time:
  Harvest by age, observing the color of the pods.
  Cut the stem about at the ground by sickle or pull out.
- Seed rate: 60 Kg/ha
- Fertilizer: 12-24-12 or 16-16- 8 156 Kg/ha
- Spacing: 50 x 20 cm
- Irrigation: During drought
- Disease and Chemicals:
  Rust, Downy mildew - Ridmil
- Insects and Chemicals:
  Bean fly, Aphid, White fly - Monocrotophos, Dimthoa
- Others: Same as groundnut

(4) Watermelon

- Varieties: Sugar baby, Charleston grey
- Planting time:
  Beginning of November to March
- Harvesting time:
  Sugar baby: 65 days Charleston grey: 85 days.
- Seed rate: Sugar baby: 250 to 300 g/ha
  Charleston grey: 1.5 to 3.0 Kg/ha
- Fertilizers: Manure: 12 to 25 ton/ha
  Chemical: 13-13-21 600 to 900 Kg/ha
- Spacing: Between rows: 2 to 3 m, Between holes: 0.9 m
- Irrigation: During the fruiting stage
- Disease and Chemicals:
  Downy mildew - Ridmil
- Insects and Chemicals:
  Thrip beetle - Monocrotophos
- Others: Suitable temperature: 25 to 30 degrees centigrade.

(5) Chilli

- Varieties: Chinda huarua, Huai sithon, Chinda yotson, Chinda latya, Duai kai, Pak puan
- Planting time:
  October to February

- Harvesting time:
  Seedling age: 30 to 40 days
  From transplanting to harvest: 60 to 90 days
- Seed rate: 640 to 850 g/ha or 1.5 to 2.0 liter/ha
- Fertilizers: Manure: 7.5 to 18.8 ton/ha
  Chemical: 15-15-15 or 13-13-21 313 to 625 Kg/ha
  45- 0- 0 63 to 125 Kg/ha
- Spacing: Between rows: 1.2 m, Between holes: 0.5 m
- Irrigation: Chilli requires constant supply of sufficient water at the first stage of vegetative period.
- Disease: Anthracnose, Blight, Stem rot, Mosaic disease
- Insects: Thrip, Aphid, White mite
- Others: Soil pH 6.0 to 6.8,
  Suitable temperature: 25 to 30 degrees centigrade.

(6) String bean
- Varieties: Ratchaburi, Black seed, Bang buathong
- Planting time:
  Entire season. The best time is in February to November.
- Harvesting time:
  Every 2 to 4 days, can be harvested 10 to 20 times
- Seed rate: 44 Kg/ha
- Fertilizers: Animal dung or compost: 188 to 313 Kg/ha
  Chemical: 12-24-12 or 5-10- 5 313 to 625 kg/ha
- Spacing: Double row 50 to 75 cm or 30 to 100 cm
- Irrigation: Requires constant supply of sufficient water.
- Disease: Anthracnose, Leaf spot
- Insects: Blight bean, Pod borer, Bean aphid, Bean fly
- Others: Soil pH 5.5 to 6.0
  Suitable temperature: 16 to 24 degrees centigrade

(7) Cucumber
- Varieties: Giant climbing, Belcanto hybrid, Spring swallow hybrid, Ofra hybrid
- Planting time:
  Entire season. The best time is in February to March

- Harvesting time:
  Seedling to first harvesting is 30 to 40 days. After that, it can be harvested every day for about one month.
- Seed rate: 2.3 to 3.4 Kg/ha or 1.2 to 1.6 liter/ha
- Fertilizers: 13-13-21 or 14-14-21 313 Kg/ha
  45- 0- 0 125 Kg/ha
- Spacing: Single row without stake: 50 x 150 cm
  Double row with stake: 50 x 100 cm
- Irrigation: Requires constant supply of sufficient water.
  Furrow irrigation system is suitable.
- Disease: Anthracnose, Downy mildew, Mosaic disease
- Insects: Cucurbit leaf beetle, Thrip, Mite
- Others: Soil pH 5.5 to 6.8 sandy loam
  Suitable temperature: 18 to 24 degrees centigrade.

(8) Sweet corn
- Varieties: Thai super sweet, DMR No.1, Hawaiian sugar super sweet
- Planting time: Entire season
- Harvesting time:
  Seedling to harvesting: 75 to 95 days
- Seed rate: 15.6 to 18.8 Kg/ha
- Fertilizers: 15-15-15 or 13-13-21 313 to 625 Kg/ha
  46- 0 - 0 94 to 125 Kg/ha
- Spacing: Single row: 50 x 75 cm
- Irrigation: Furrow irrigation 7.6 to 10.2 cm/week
- Disease: Downy mildew, Leaf spot, Leaf blight
- Insects: Thrip, Aphid, Stem borer, Locust
- Others: Soil pH 5.5 to 6.8
  Suitable temperature: 16 to 24 degrees centigrade.

Table H-27(1) Proposed Farming Inputs for Major Crops per rai and ha

[Paddy]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(A) Qn't rai	W/ Project(A) Qn't ha	W/ Projec(M) Qn't rai	W/ Projec(M) Qn't ha
1. Seeds	Kg	5.8	36.3	5.8	36.3	5.8	36.3
2. Fertilizer							
For bed 16-16-8	Kg			1.9	11.9	1.9	11.9
1/ Basal dressing 16-16-8	Kg	16.5	103.1	48.1	300.6	48.1	300.6
1/ Top dressing 45- 0-0	Kg			10.0	62.5	10.0	62.5
3. Chemical		1.0	6.3				
fungicide Diatane				M-45		M-15	
(For seeds treetment)	Kg			0.2	1.5	0.2	1.5
Isecticide Furadan	Lit.			0.1	0.6	0.1	0.6
4. Labor Family	M/D	10.6	66.3	11.5	71.9	10.3	64.4
Hired	M/D	0.6	3.8	1.0	6.3		
5. Animal	A/D	0.1	0.6	1.0	6.3		
6. Machinery	M/D					0.5	3.1

Note: 1/ For field

[Groundnuts]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(A) Qn't rai	W/ Project(A) Qn't ha	W/ Projec(M) Qn't rai	W/ Projec(M) Qn't ha
1. Seeds	Kg	13.3	83.1	20.0	125.0	20.0	125.0
2. Fertilizer							
Basal dressing 16-16-8	Kg	16.6	103.8	15.0	93.8	15.0	93.8
Lime	Kg			200.0	1,250.0	200.0	1,250.0
Manure	Kg			500.0	3,125.0	500.0	3,125.0
3. Chemical							
Fungicide Aldrex							
(Pre planting appliciation)	Kg			1.0	6.3	1.0	6.3
Insecticide Malathion	lit.			0.1	0.6	0.1	0.6
4. Labor Family	M/D	27.3	170.6	10.3	64.4	10.3	64.4
Hired	M/D			2.0	12.5	2.0	12.5
5. Animal	A/D	0.1	0.6	1.5	9.4		
6. Machinery	M/D					0.5	3.1

[Soybean]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(A) Qn't rai	W/ Project(A) Qn't ha	W/ Projec(M) Qn't rai	W/ Projec(M) Qn't ha
1. Seeds	Kg		0.0	9.6	60.0	9.6	60.0
2. Fertilizer							
Basal dressing 16-16-8	Kg		0.0	25.0	156.3	25.0	156.3
Lime	Kg		0.0	200.0	1,250.0	200.0	1,250.0
3. Chemical							
Fungicide Aldrex	Kg		0.0	1.0	6.3	1.0	6.3
Insecticide Malathion	lit.		0.0	0.1	0.6	0.1	0.6
4. Labor Family	M/D		0.0	10.5	65.6	10.5	65.6
Hired	M/D		0.0	2.0	12.5	1.0	6.3
5. Animal	A/D		0.0	1.5	9.4		
6. Machinery	M/D		0.0			0.5	3.1

Note: W/O: Without Porject W: With Project
(A)=With animal, (M)=With Machinary

Table II-27(2) Proposed Farming Inputs for Major Crops per rai and ha

[Watermelon]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(A) Qn't rai	W/ Project(A) Qn't ha	W/ Project(M) Qn't rai	W/ Project(M) Qn't ha
1. Seeds	Kg		0.0	0.5	3.0	0.5	3.0
2. Fertilizer							
Basal dressing 15-15-15	Kg		0.0	40.0	250.0	40.0	250.0
Top dressing 13-13-21	Kg		0.0	60.0	375.0	60.0	375.0
Lime	Kg		0.0	200.0	1,250.0	200.0	1,250.0
3. Chemical							
Fungicide Phoes	Kg		0.0	1.0	6.3	1.0	6.3
Insecticide Phosdrin	Lit.		0.0	0.5	3.1	0.5	3.1
4. Labor Family	M/D		0.0	34.5	215.6	30.5	190.6
Hired	M/D		0.0				
5. Animal	A/D		0.0	1.5	9.4		
6. Machinery	M/D		0.0			1.0	6.3

[Chilli]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(A) Qn't rai	W/ Project(A) Qn't ha	W/ Project(M) Qn't rai	W/ Project(M) Qn't ha
1. Seeds	Kg		0.0	0.1	0.6	0.1	0.6
2. Fertilizer							
For bed 13-13-21	Kg		0.0	10.0	62.5	10.0	62.5
1/ Basal dressing 13-13-21	Kg		0.0	40.0	250.0	40.0	250.0
1/ Top dressing 45- 0- 0	Kg		0.0	10.0	62.5	10.0	62.5
Manure: Chicken's Dung	Kg		0.0	1,000.0	6,250.0	1,000.0	6,250.0
Lime	Kg		0.0	200.0	1,250.0	200.0	1,250.0
3. Chemical							
Insecticede Worldcron	Lit.		0.0	0.3	1.9	0.3	1.9
Herbicide Alachlor	Lit.		0.0	0.2	1.25	0.2	1.25
4. Labor Family	M/D		0.0	117.4	733.8	105.0	656.3
Hired	M/D		0.0	120.0	750.0	120.0	750.0
5. Animal	A/D		0.0	2.0	12.5		
6. Machinery	M/D		0.0			1.2	7.5

Note: 1/: For field

[String bean]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(A) Qn't rai	W/ Project(A) Qn't ha	W/ Project(M) Qn't rai	W/ Project(M) Qn't ha
1. Seeds	Kg	1.0	6.3	3.0	18.8	3.0	18.8
2. Fertilizer							
Basal dressing 15-15-15	Kg	100.0	625.0	100.0	625.0	100.0	625.0
Manure	Kg	100.0	625.0	100.0	625.0	100.0	625.0
Lime	Kg			200.0	1,250.0	200.0	1,250.0
3. Chemical							
Fungicide Curatare	Kg	6.1	38.1	6.1	38.1	6.1	38.1
Insecticide Phosdrin	Lit.			0.5	3.1	0.5	3.1
4. Labor Family	M/D	44.1	275.6	33.4	208.8	31.8	198.8
Hired	M/D	28.8	180.0	37.7	235.6	37.7	235.6
5. Animal	A/D	2.5	15.6	2.0	12.5		
6. Machinery	M/D					0.4	2.5

Note: W/O: Without Project W: With Project
(A)=With animal (M)=With machinery

Table H-27(3) Proposed Farming Inputs for Major Crops per rai and ha

[Cucumber for TYPE II]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(A) Qn't rai	W/ Project(A) Qn't ha	W/ Project(M) Qn't rai	W/ Project(M) Qn't ha
1. Seeds	Kg		0.0	0.5	3.1	0.5	3.1
2. Fertilizer							
Basal dressing 13-13-21	Kg		0.0	50.0	312.5	50.0	312.5
Top dressing 45- 0- 0	Kg		0.0	20.0	125.0	20.0	125.0
3. Chemical							
Fungicide Antracal	Kg		0.0	1.0	6.3	1.0	6.3
Green-zeb	Kg		0.0	0.5	3.1	0.5	3.1
Insecticide Phosdrin	Lit.		0.0	0.2	1.3	0.2	1.3
4. Labor Family	M/D		0.0	24.0	150.0	22.4	140.0
Hired	M/D		0.0	20.2	126.3	16.0	100.0
5. Animal	A/D		0.0	12.2	76.3		
6. Machinery	M/D		0.0			3.6	22.5

[Sweet corn for TYPE II]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(A) Qn't rai	W/ Project(A) Qn't ha	W/ Project(M) Qn't rai	W/ Project(M) Qn't ha
1. Seeds	Kg		0.0	6.5	40.6	6.5	40.6
2. Fertilizer							
Basal dressing 15-15-15	Kg		0.0	30.0	187.5	30.0	187.5
Top dressing 15-15-15	Kg		0.0	20.0	125.0	20.0	125.0
Manure	Kg		0.0	2,000.0	12,500.0	2,000.0	12,500.0
3. Chemical							
Fungicide Antracal	Lit.		0.0	1.0	6.3	1.0	6.3
Insecticide Phosdrin	Lit.		0.0	1.0	6.3	1.0	6.3
4. Labor Family	M/D		0.0	11.2	70.0	9.6	60.0
Hired	M/D		0.0	7.4	46.3	6.9	43.1
5. Animal	A/D		0.0	3.6	22.5		
6. Machinery	M/D		0.0			1.2	7.5

Note: W/O: Without Project W: With Project
(A)=With animal (M)=With machinery

[Mango]

Input	unit	W/O Project Qn't rai	W/O Project Qn't ha	W/ Project(M) Qn't rai	W/ Project(M) Qn't ha	W/ Project(I) Qn't rai	W/ Project(I) Qn't ha
1. Seeds	Kg					25.0	156.3
2. Fertilizer							
Basal dressing 15-15-15	Kg	24.0	150.0	50.0	312.5	45.0	281.3
Manure: Dung	Kg			500.0	3,125.0		
Lime	Kg			200.0	1,250.0	200.0	1,250.0
3. Chemical		4.0	25.0				
Fungicide Antracal	Kg			4.0	0.0	0.3	1.9
Insecticide Phosdrin	Lit.			1.0	6.3	0.1	0.6
4. Labor Family	M/D	23.5	146.9	18.5	115.6	10.0	62.5
Hired	M/D						
5. Animal	A/D						
6. Machinery	M/D	4.0	25.0	10.0	62.5	2.0	12.5

Note: W/O: Without Project W: With Project
(M)=Maintenance (I)=Investment

3.6 Farm Labor Force and Mechanization Plan

Through the implementation of the project, paddy cultivation under rainfed condition is changed entirely to that introducing irrigation systems. The monthly labor requirement plan for a transplanting paddy is shown in Figure H-19. Land preparation has depended on rainfall until the present, but it will be carried out between June and July through appropriate irrigation water supply in the project. It will be possible to ensure an adequate vegetative period for the photosensitive varieties grown under the project. The labor requirement can not exceed the limit of the economically active persons per farm, because rice cropping is mainly carried out by family labor.

Figure H-20 shows the labor requirement for all crops throughout the year. The periodic unemployment can be decreased by introducing dry season crops. Wet season vegetable cropping for the Type II plan will promote effective labor utilization in September and October.

At present, farm mechanization levels in the Project Area are comparatively low. According to the agro-economic survey, only 1.9 percent of farms own power tillers. Land preparation for paddy and upland crops relies mainly on animal and human labor, and mechanization of crop management and post harvest activities is also uncommon because distortions in the price ratio of labor to capital have been a primary factor responsible for speeding mechanization.

The labor bottlenecks at the first cultivation stage of paddy currently limit cropping intensification in the Project Area. The favorable farming conditions created by the project will help to introduce power tillers to the farmers through increase of their agricultural income. A major benefit of this mechanization will be not only increased agricultural output from deep plowing but also promotion of agricultural diversification through speed-up of land preparation for the pre and post rice crops. Mechanization is also the key to increased cropping intensity, which will permit labor absorption at other times during the production cycle.

3.7 Improvement Plan of Rainfed Agricultural Farming

Depending on the site conditions of the arable land, there will be cultivated areas that are excluded from the irrigable area in the project. The area to be irrigated will be fixed by physical boundaries. Therefore, the following types of beneficiaries will appear among farmers;

- Whole land belongs to the irrigated area.
- A part of land belongs to the irrigated area.
- Whole land remains under rainfed condition.

The results of the studies on the "Northeast Rainfed Agricultural Development (NERAD) Project" conducted by the Northeast Regional Office of Agriculture, MOAC, are useful for rainfed agricultural development in the Project Area. In these cultivated areas to be excluded from the benefited area, the following improvement of farming methods recommended by NERAD could be established except as described in the main report;

1) Pre-rice green manuring

The major annual crops, paddy and cassava, cultivated in the Northeast region are traditionally grown year after year with little or no fertilizer application. However, minimal crop residues from both crops are returned to the soil; cassava due to its high harvest index, and rice because most of the straw is removed as cattle feed. The result is that traditional annual cropping has been eroding soil fertility.

The NERAD Project turned to green manuring as the most feasible, low-cost means of increasing soil fertility levels because of the limited availability of animal manure and the high cost of chemical fertilizers. NERAD has been exploring utilization of early rains during the wet season to produce a green manure crop that is plowed under before rice transplanting with the objective of increasing rice yield in a low-cost, low-risk manner acceptable to farmers. Green manure trials using various crop materials, conducted in a number of project sites for five years, gave rice yield increases ranging from 3 to 20 percent, as shown below.

Table H-28 NERAD Green Manure Trials (1983 - 87)

Green Manure Crop Material	Site	Yield (Kg/ha) G.M.Crop	Rice	Fallow-Rice	% Increase Over Control
Cowpea	Roi Et	27,200	2,994	2,719	10.1
Red Cowpea	Roi Et	11,475	2,788	2,719	2.5
Blackgram	Roi Et	23,300	3,012	2,719	10.8
Sword Bean	Roi Et	13,800	2,806	2,719	3.2
Sesbania	Sisaket	-	3,394	2,550	33.1
Cowpea	Sisaket	-	3,719	3,194	16.4

Source: NERAD Project Technology Documentation 3/1988

2) Modified Shallow Wells

In most areas of the Northeast region, water supply for vegetables and other high value crops can be obtained in limited quantities from shallow wells dug in the lower paddy fields. However, during the dry season, the water table recedes and is too deep to supply sufficient water for crop production. These wells are used for production of home-consumption vegetables for 1 to 2 months after the end of the rains and are then abandoned. Farmers have to re-dig the wells every year because their deterioration during the wet season.

NERAD attempted to improve such shallow wells by supplying concrete ring-riners to farmers. Labor was saved by this trial as the wells did not have to be re-dig every year. Vegetable production could begin earlier after rice harvesting because the wells were already in place. Farmers can thus grow vegetables during the cool period favorable to growth and ship them at a time when the price is high.

3) Kenaf Varietal Improvement

Kenaf is not only a low-risk, low-input crops on poor soils but is also relatively tolerant to drought. It is well-suited agricultural conditions in the Northeast region. The attention reeded for its cropping from planting to harvesting is only little cultural care and a single hand-weeding, generally.

Thai Kenaf and Cuban Kenaf are major kinds of crop in the region. There are two types of cropping system for kenaf under the rainfed condition. Kenaf is grown both as a main crop on upland areas and as a pre-rice crop in paddy fields. The former is observed throughout the region on the higher, flood-free land, Thai Kenaf is most common under this systems. The latter has been adapted by farmers for reducing the risk associated with erratic rainfall, in dry years, when rice transplanting is delayed or impossible, kenaf grown as a pre-rice crop can be left in the ground to compensate for the reduced rice yield.

Thai Kenaf has a number of problems in the latter system. Crop damage due to prolonged water-logging, Phytopthora root-rot problems, and so on. The NERAD trials have shown that Cuban Kenaf is more appropriate for the lower paddy fields where water-logging is common. The trials have also shown that row planting significantly increases yields of Cuban Kenaf over the traditional method of broadcasting, and that it is responsive to nitrogen applications of up to 7.5 kg per rai.

4) Soil Fertility Improvement by Liming

NERAD conducted research on soil acidity because soil pH was frequently found to be at or below the levels that cause crop injury. Field trials showed that lime response doesn't occur in rice, except under very dry conditions at pH 4.5 or less; water saturation alone raises the pH above critical levels. Lime causes response in upland crops. Soil acidity has been a more generally limiting factor. The remedy, however, is easy and inexpensive because of the country's abundant supply of limestone and small amount of this needed to raise pH in sandy soils.

3.8 Livestock and Freshwater Fisheries

Domestic animal and freshwater fish are important items for supplying protein or source of cash income. Raising conditions of domestic animals in the Project Area are harsh because of high temperature, lack of water, and diseases. Freshwater fishery largely depends on fish in the river, swamp, and so on. The NERAD Project as described above also conducted a livestock and freshwater fisheries plan in the Northeast region. In order to promote these items in the Project Area, the realization of a project similar to that mentioned below is desired.

1) Native Chicken Development

Chickens are raised mostly from broken rice and leftover food as traditional practice. Farmers pay little attention to management, and if the chickens survive, they will be sold or eaten when mature. However, a large percentage of the chickens die from various diseases, and farmers lack knowledge of disease control, feeding, and general management.

In order to overcome the above problems, the NERAD Project provides vaccine for 400,000 chickens and ducks in nine villages through the specialist farmers. Mortality rates have been reduced from an average of 80 to 90 percent to only 25 to 30 percent.

Through disease prevention, chicken populations have been increased from 11-12 to 30-45 per household. With these population levels, farmers are able to sell or consume 4-6 chickens monthly. However, the project has urged farmers to select chickens for sale in order to reduce the density of the population, because competition for food is a major cause of mortality in chicks.

Some specialist farmers have had success in poultry raising from November through July. Farmers select about 10-15 young female chickens to breed from November; these hens produce about 300-500 chicks by July depending on the farmers ability. These chickens are alternately released into the paddy fields and provided with adequate supplemental feed. By

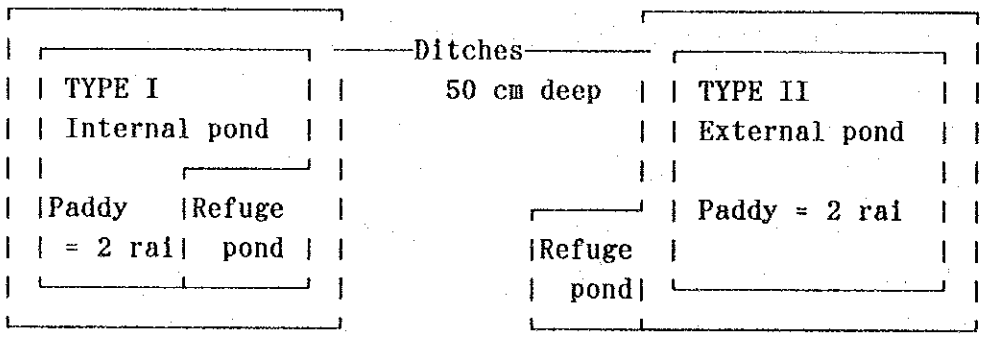
this method, chickens increase their weight by about 15-18 grams per day compared with weight gains of only 10 grams per day under traditional management practices.

2) Fish in the Rice Paddy

Farmers in the Northeast region traditionally obtain fish from their paddy field. The fish move with the floodwater in the wet season and, when water-levels recede, they become trapped in the paddy field. They are caught by farmers for self consumption and for sale to markets. However, some farmers have obtained technology for stocking their rainfed paddy field with fish, and that was potentially viable.

NERAD began testing the raising of fish in the paddy field through the arrangement shown figure below. Plots were stocked with Common Carp, Tilapia and Rohu in the ratios shown below. Initial result were promising and farmer interest was extremely high.

Generalized layout of the NERAD rice-fish system



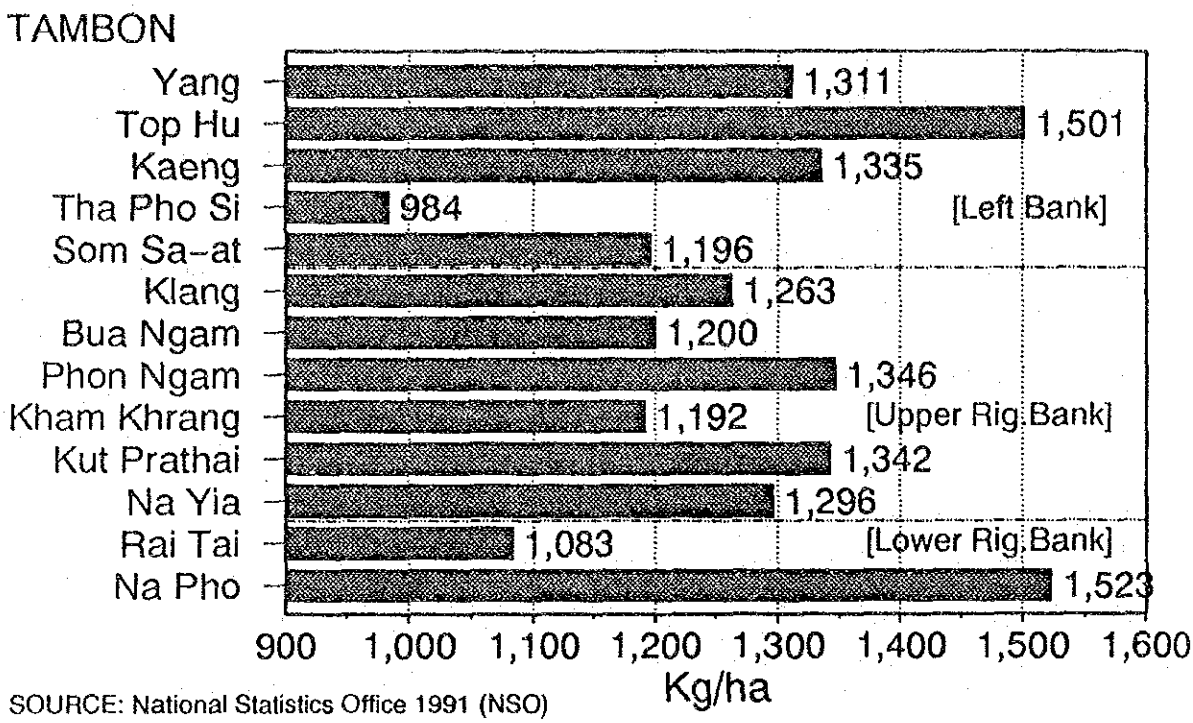
Recommended stocking rates and fish species mixtures

Stock Ratio	Carp	Rohu	Tilapia	Carp	Rohu	Tilapia	Size of Fingerlings
	6 :	3 :	1	7 :	2 :	1	
800 /rai	480	240	80	560	160	80	7 - 10 cm
10,000 /rai	600	300	100	700	200	100	7 - 10
1,200 /rai	700	360	120	840	240	120	7 - 10
1,500 /rai	900	450	150	1,050	300	150	3 - 5

Source: NERAD PROJECT TECHNOLOGY DOCUMENTATION 3/1988

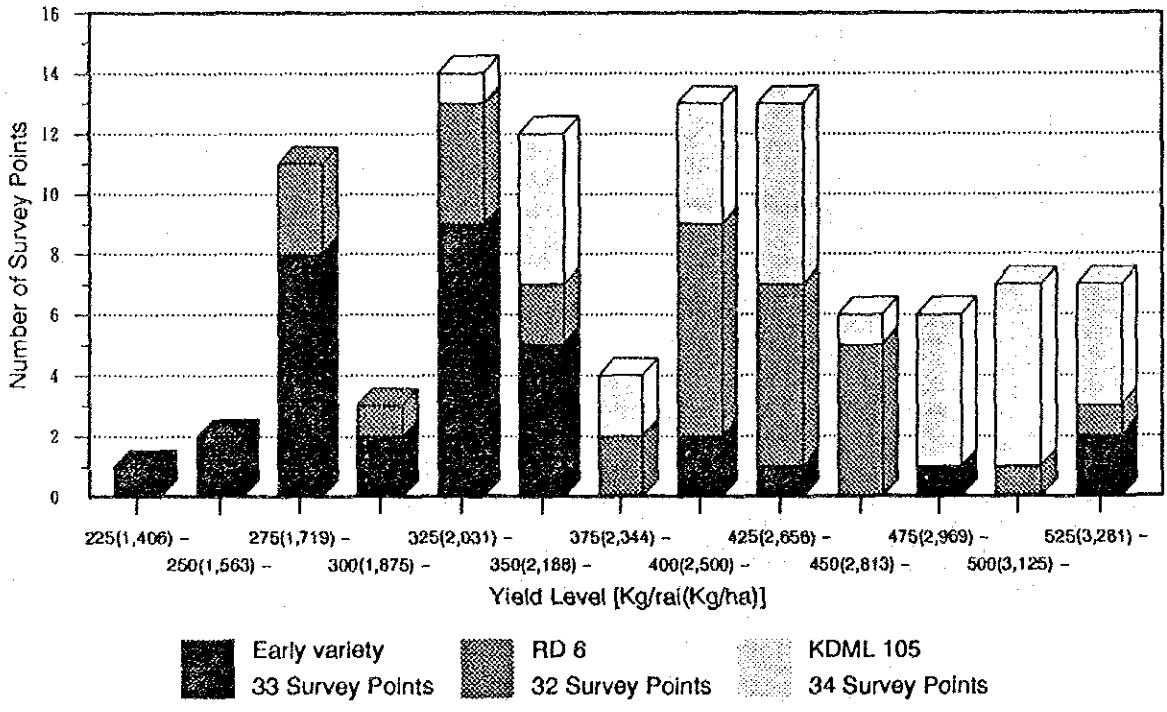
The NERAD trials also showed impressive increases in paddy yield through fish culture. Various hypotheses have been advanced to explain the effect; namely improved pest, disease and weed control, soil nutrient effects, physical effects of fish, improved water management and improved cultural care of the paddy. According to analysis of paddy yield, grain weight is increased and fish have no effect on tilling or panicle initiation. It seems that fish have a favorable effect on soil nutrient availability during the grain filling stage.

Figure H-14 Present Yield of Paddy



SOURCE: National Statistics Office 1991 (NSO)

Figure H-15 The Result of Yield Survey in the Study Area [Total Survey Points = 99]



Source: Conducted by Det Udom Agricultural Extension Office 1991

Figure H-16 Labour Balance in Wet & Dry Season Crop

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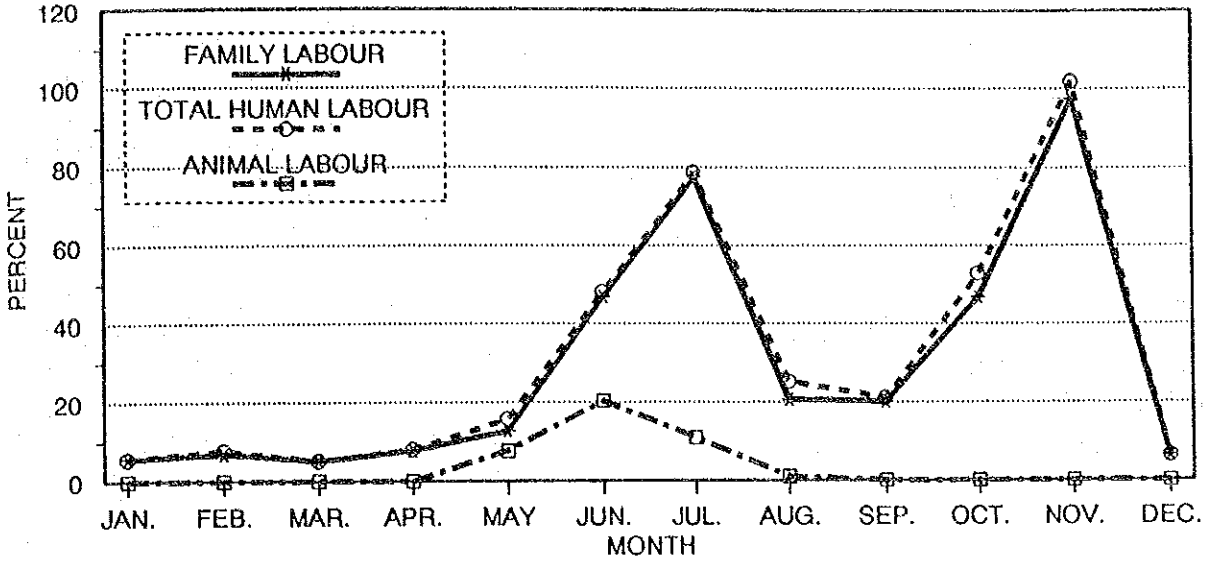

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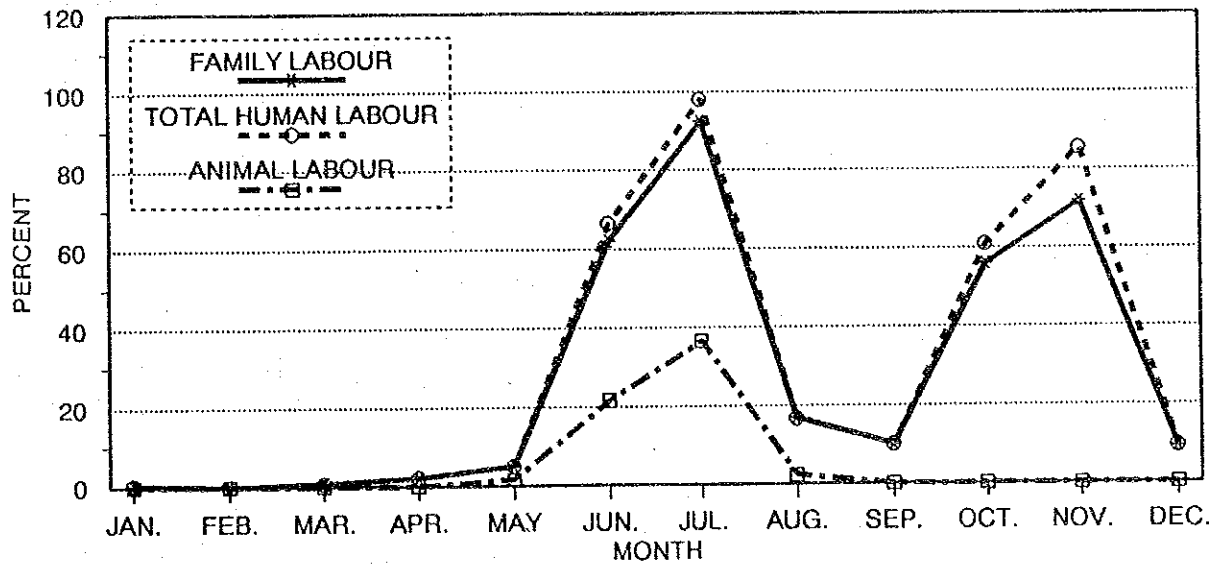

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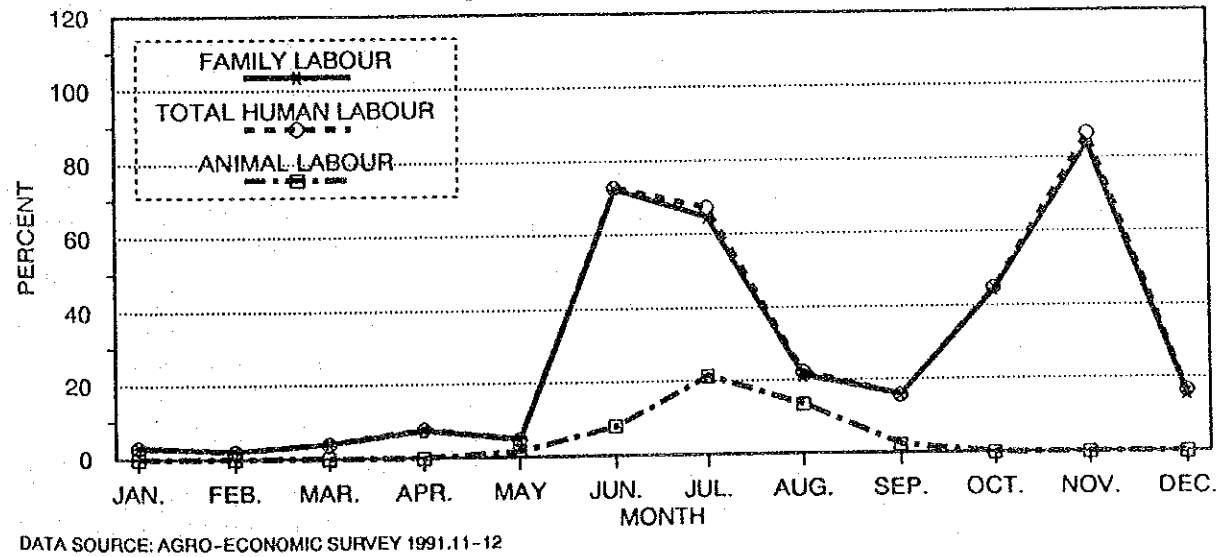
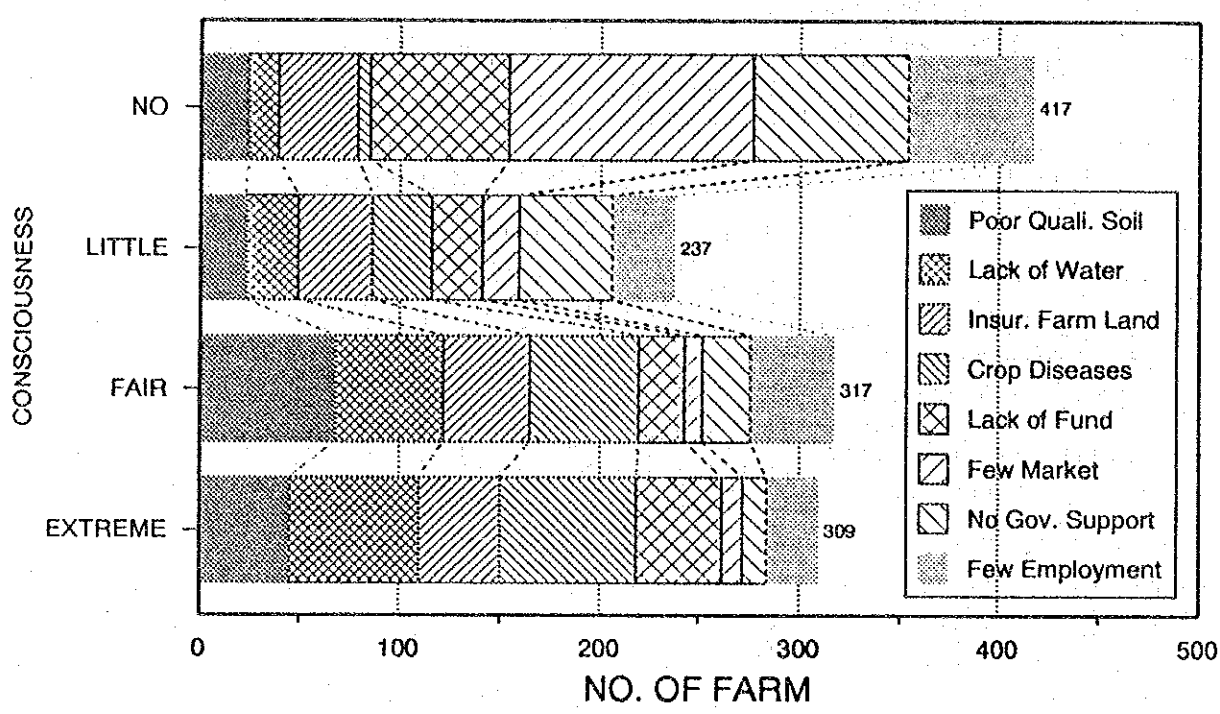


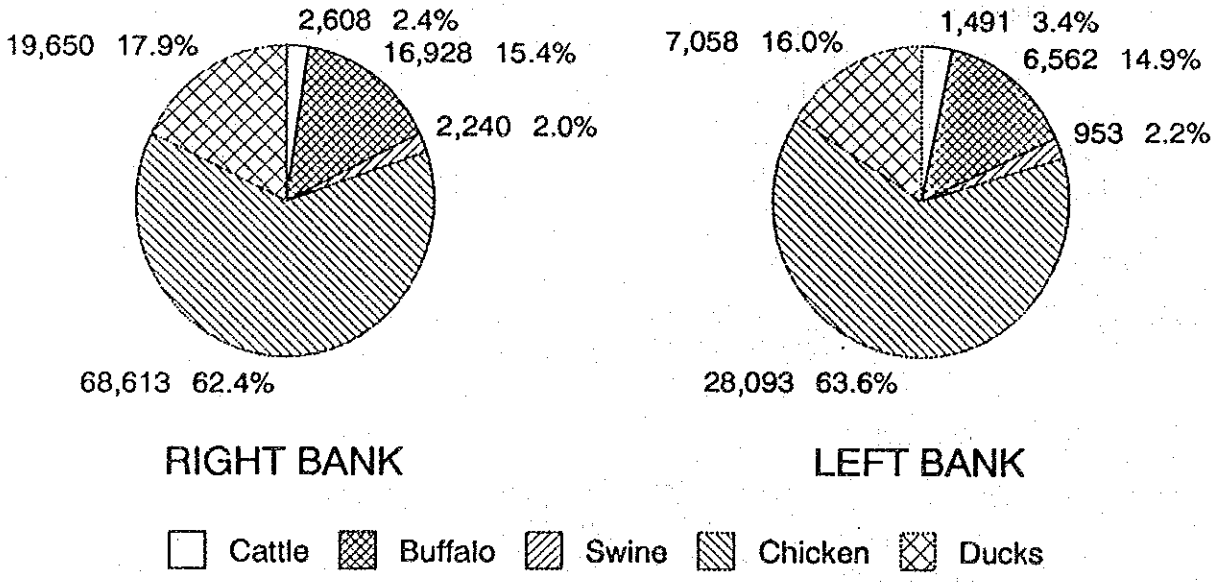
DATA SOURCE: AGRO-ECONOMIC SURVEY 1991.11-12

Figure H-17 Farming Problem of Farmers



Note: Total No.of farm surveyed is 160.
Source: Agro-Economic Survey 1991.11-12

Figure H-18 Number of Livestock



Source: National Statistics Office (NSO) 1991

Figure H-19 Labor Plan by Month in Transplanting Rice

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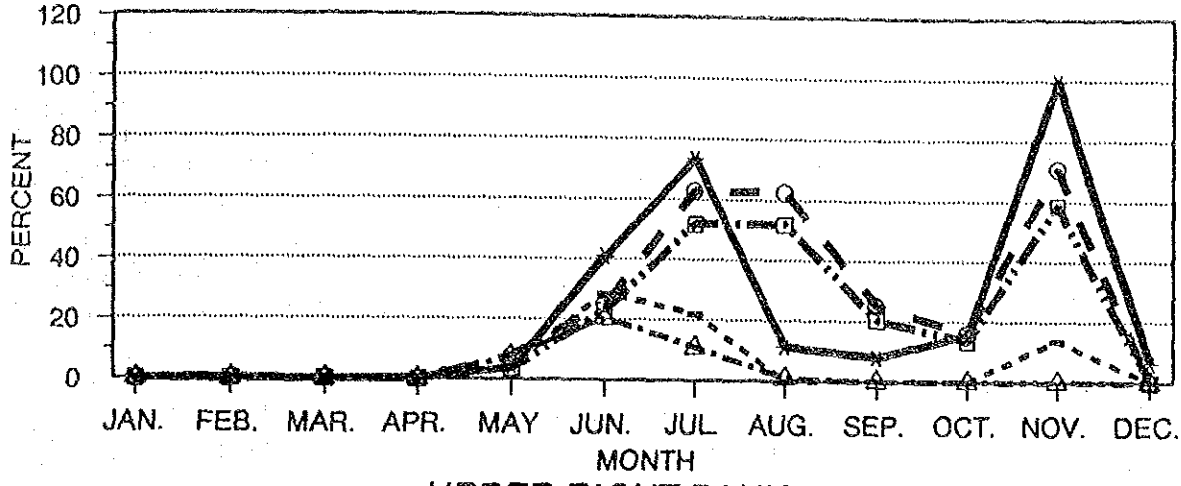

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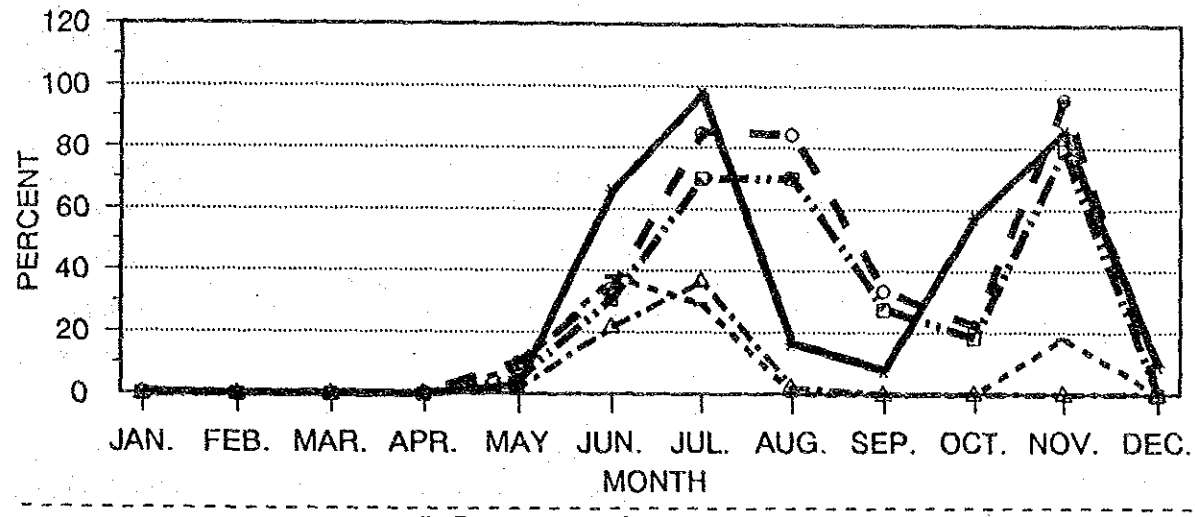

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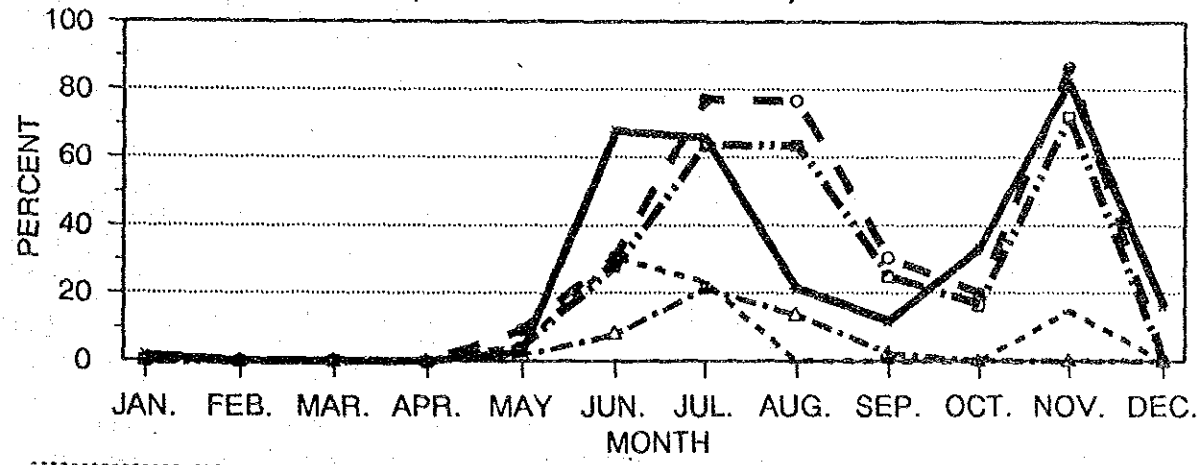

TOTAL HUMAN LABOR WITHOUT PRO.

TOTAL HUMAN LABOR BY ANIMAL WITH PRO.

TOTAL HUMAN LABOR BY MACHINE WITH PRO.

ANIMAL LABOR WITHOUT PRO.

ANIMAL LABOR WITH PRO.

DATA SOURCE: AGRO-ECONOMIC SURVEY 1991.11-12 (Without Pro. Only)

Figure H-20 Labor Plan by Month in Wet & Dry Season Crops

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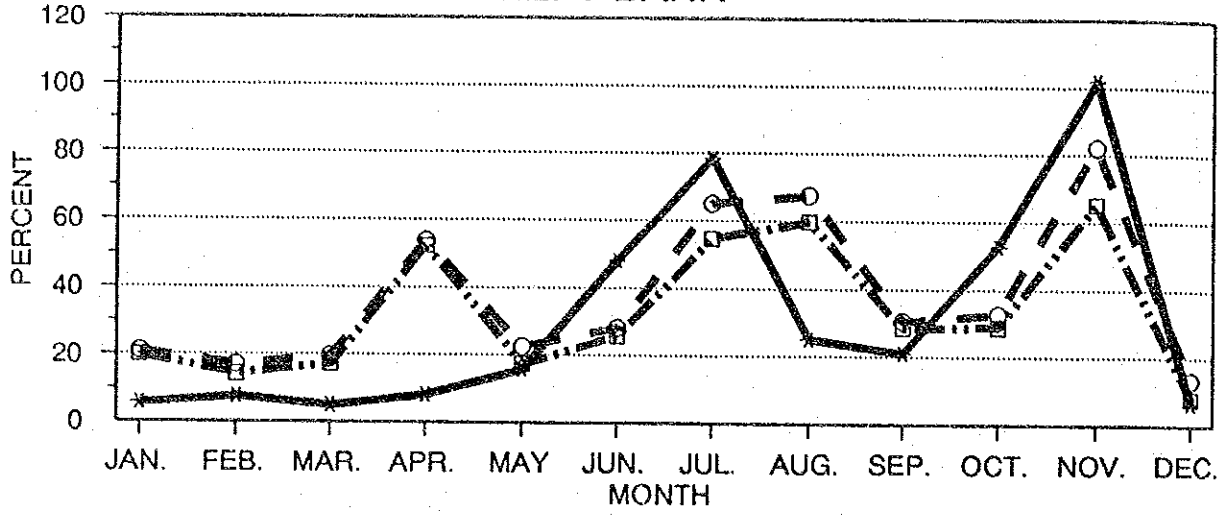

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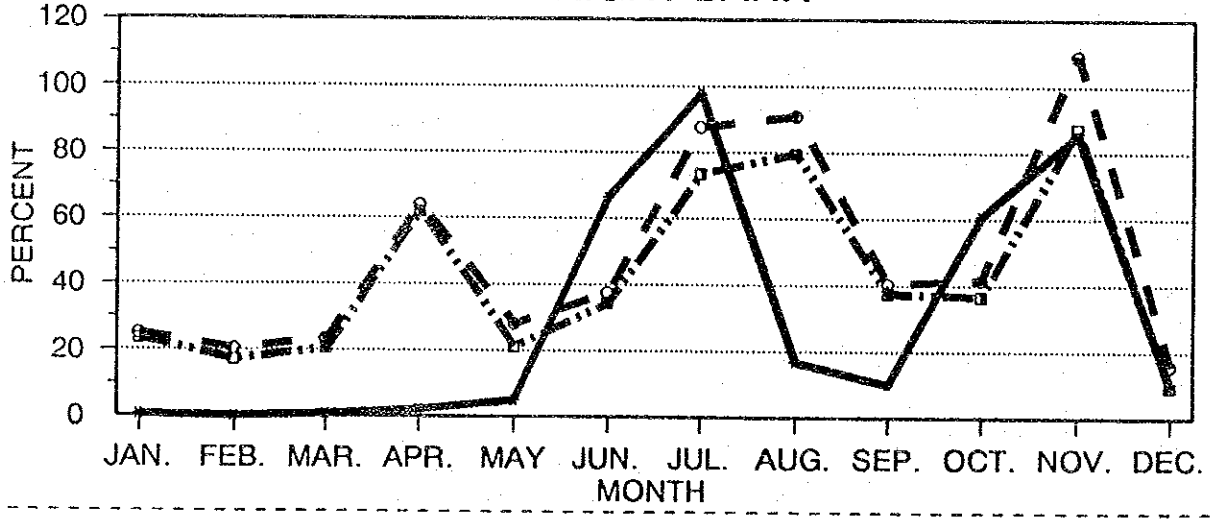

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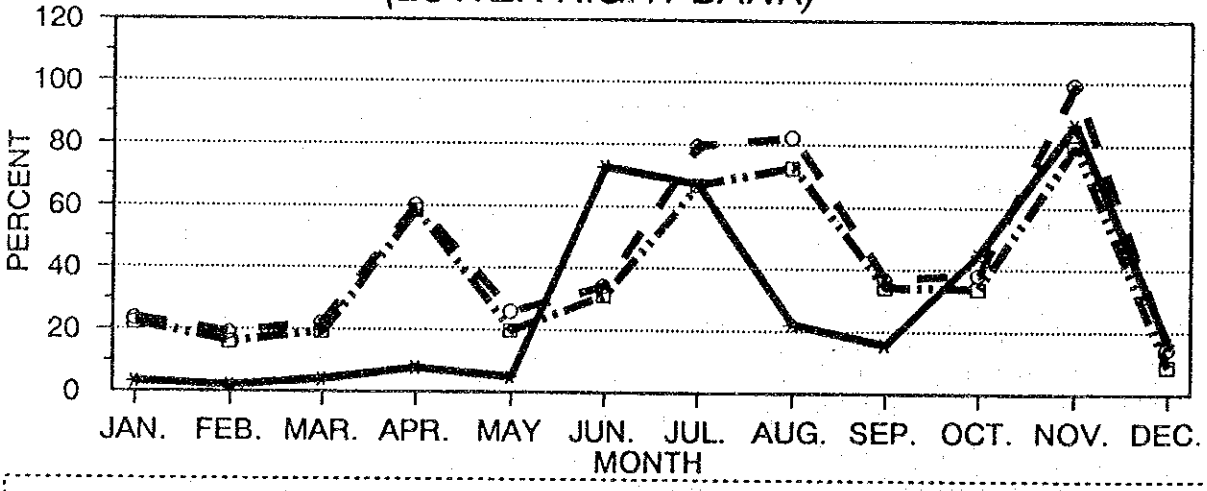


TOTAL HUMAN LABOR WITHOUT PRO.

TOTAL HUMAN LABOR BY ANIMAL WITH PRO.

TOTAL HUMAN LABOR BY MACHINE WITH PRO.

DATA SOURCE: AGRO-ECONOMIC SURVEY 1991.11-12 (Without Por. Only)

IV AGRO-ECONOMY

4.1 Agricultural Economy in the Study Area

4.1.1 Population, Farm Household and Land Tenure

1) Population

The total population in the area is 56,893 habitants with 9,668 households. Details are shown in Table H-29.

2) Farm Household

Farm households in the area is 8,890 househols. Details are shown in Table H-29.

3) Land Tenure

Most farmers in the area are an owner farmer according to the farm survey. Actual conditions of land tenure obtained by the farm survey are tabulated in Table H-30 and H-31.

In the Study Area, the national reserved forests and the lands without title deed extend widely in the upstream area, Amphoe Na Chaluai, and the downstream area, Amphoe Phibun Mangsahan, along the Dom Yai River. The majority of the land in Amphoe Det Udom is arranged and provided the land certificate Nor Sor 3 Kor except for urban area.

The land registration of the area belonging the ALRO's Land Reform Project located on the right bank of the Dom Yai River has been already made with the land certificate Nor Sor 2 (ALRO).

4.1.2 Marketing

In the Study Area, farm products are shipped and dealt with directly local merchants (middlemen). Some farmers, surrounding of rice mill, sell paddy to rice mill. Marketing systems of crops produced in the area are the same as the mentioned in 2. 3. 3 Marketing Systems of Products.

Table H-29 Population and Household in the Study Area

Name of Tambon	Area (km2)	No. of Village	Population	No. of Household	No. of Farm Household	Family Size (pn/hh)	Population Density (pn/km2)
Left Bank							
Amphoe Det Udom							
D- 1 Muang Det	3.7	0	0	0	0	0.0	0
D- 5 Som Sa-at	14.1	2	1,569	260	260	6.0	382.7
D- 8 Kaeng	68.9	10	6,287	1,071	1,065	5.9	96.7
D-11 Top Hu	67.8	10	7,709	1,345	1,276	5.7	120.6
D-12 Tha Pho Si	23.4	3	773	136	103	5.7	57.7
D-15 Na Khasem	2.1	0	0	0	0	0.0	0.0
D-18 Kut Rua	1.2	0	0	0	0	0.0	0.0
Sub-Total	181.2	25	16,338	2,812	2,704	5.8	106.5
Amphoe Nam Yun							
Y- 3 Yang	5.4	1	520	88	85	5.9	96.3
Sub-Total	5.4	1	520	88	85	5.9	96.3
Amphoe Na Chaluai							
N- 2 Non Sawan	1.5	0	0	0	0	0.0	0.0
Sub-Total	1.5	0	0	0	0	0.0	0.0
Total	188.1	26	16,858	2,900	2,789	5.8	105.2
Right Bank							
Amphoe Det Udom							
D- 6 Kut Prathai	91.5	10	6,517	1,085	1,051	6.0	71.2
D- 7 Klang	87.2	8	4,500	764	701	5.9	51.6
D-10 Na Yia	39.7	3	5,101	634	616	8.0	128.5
D-12 Tha Pho Si	6.6	1	485	86	80	5.6	73.5
D-14 Bua Ngam	43.4	6	2,674	485	468	5.5	61.6
D-16 Kham Khrang	61.3	7	3,903	723	509	5.4	63.7
D-19 Phon Ngam	37.2	7	6,157	1,138	1,089	5.4	165.5
Sub-Total	366.9	42	29,337	4,915	4,514	6.0	80.0
Phibun Mangsahan							
P- 2 Rai Tai	54.7	11	6,444.0	1,078.0	925.0	6.0	117.8
P- 3 Na Pho	70.6	4	4,254.0	775.0	662.0	5.5	60.3
Sub-total	125.3	15	10,698.0	1,853.0	1,587.0	11.5	178.1
Total	492.2	57	40,035.0	6,768.0	6,101.0	17.5	258.1
Grand Total	680.3	83	56,893	9,668	8,890	5.9	83.6

Data Source: Provincial Statistical Office

Table H-30 Land Tenure by Average in the Study Area

(Unit: rai)

Items	Left Bank		Right Bank			
			Upstream Area		Downstream Area	
	No.of Plot	Area	No.of Plot	Area	No.of Plot	Area
Owned Land	3.1	30.95 (4.95 ha)	2.4	30.45 (4.87 ha)	2.5	28.88 (4.62 ha)
Rented Land						
Addition. rent	0.0	0.17 (0.03 ha)	0.0	0.00	0.0	0.00
Rented only	0.0	0.08 (0.01 ha)	0.0	0.00	0.0	0.42 (0.07 ha)
Other Farms give to Operate Free	0.1	0.42 (0.07 ha)	0.0	0.23 (0.04 ha)	0.0	0.73 (0.12 ha)
Other Land						
Co-op. land	0.0	0.00	0.0	0.00	0.0	0.00
Resettle. land	0.0	0.00	0.0	0.00	0.0	0.00
Public land	0.0	0.13 (0.02 ha)	0.0	0.00	0.0	0.00
Reserve. forest	0.0	0.00	0.0	0.00	0.0	0.00
Others	0.0	0.00	0.0	0.00	0.0	0.00
Total Area	3.3	31.74 (5.08 ha)	2.4	30.68 (4.91 ha)	2.5	30.02 (4.80 ha)

Data source: Farm household economic survey

Table H-31 Land Certificate for Arable Land (Owned Land) in the Study Area

(Unit: %)

Type of Land Title Document	Left Bank	Right Bank		Total Area
		Upstream A.	Downstream A.	
Title Deed	3.3	0.0	0.0	1.10
Nor Sor 3 Kor	21.7	35.9	36.7	31.43
Nor Sor 3	27.8	31.3	26.8	28.64
Nor Sor 2 (ALRO)	0.0	0.0	0.0	0.00
Sor Kor 1	1.2	4.2	5.2	3.53
Phor Bor Thor 6	41.9	27.6	20.4	29.97
Sor Thor Ko	0.0	0.0	0.0	0.00
No Certificate	4.1	1.0	10.9	5.33
Total	100.0	100.0	100.0	100.00

Data source: Farm household economic survey
Note: Title Document;

Title Deed : who possesses a complete land right certificate.
Nor Sor 3 Kor: who has land right capable of dealing with.
(whose land has already been surveyed)
Nor Sor 3 : who has a land right capable of dealing with.
(whose land has only been confirmed in aerophoto)
Nor Sor 2(ALRO): who has a land right by land reform, but only cultivation and dwelling rights incapable of dealing with.
(whose land is located in the place where land reform has been executed)
Sor Kor 1 : Who is able to have only cultivation and dwelling rights incapable of dealing with.
(who is obtainable when it is 10 to 15 years after illegal instruction and the good second generation only is able to apply for Nor Sor 3 in his generation)
Phor Bor Thor 6: who has only cultivation and dwelling rights incapable of dealing with.
Sor Thor Ko : who has only cultivation and dwelling rights incapable of dealing with.
No Certificate : who is an illegal farmer.

4.1.3 Agricultural Supporting Services

Agricultural supporting services in the Study Area are the same as the mentioned in 2. 3. 4 Agricultural Supporting Services.

4.1.4 Farm Household Economy

Farm household economy in the Study Area have been analyzed based on the farm household economic survey. The survey (sample farm: 160) was conducted in the upstream and downstream areas of the right bank and the left bank. The results are shown in Table H-32.

Viewing the results of the survey, it is clarified that farm household economy in each area of the area is realized by family labor as same as that of the basin. In the area, a disposable income per capita is about 5,100 Baht in average, and the Engel's coefficient indicates; 54.98 % in the left bank, 54.01% in the upstream area and 60.85% in the

downstream area of the right bank. Propensity to consume in the living expenses shows about 91% in average.

Table H-32 Farm Household Economy in the Study Area

(Unit: Baht)

Item	Left Bank	Right Bank	
		Upstream Area	Downstream Area
Income			
Farm Income	32,072	23,037	23,621
Off-farm Income	8,002	12,934	10,266
Gross Income	40,074	35,971	33,887
Expenditure			
Production Cost	7,123	7,142	5,577
Living Expenses	24,000	18,856	17,259
Sub-total	31,123	25,998	22,836
Surplus of Farm Household Economy	8,951	9,973	11,051
Family Labor	16,740	12,779	12,095
Surplus of Farm Household Economy (including family labor)	- 7,789	- 2,806	- 1,044
Farm Size (rai)	29.4	28.9	28.6
Family Size (person)	6.8	5.6	5.2

Data source: Farm household economic survey

4.2 Agro-Economy Development Plan

4.2.1 Supporting Services Plan

In order to achieve the aim of the Project, integrated assistance and support by the authorities concerned and positive participation of farmers to the supporting system are indispensable.

In particular, the cooperative agencies for agricultural supporting services pushing forward the project are esteemed as the following agencies and farmers' institutions.

- RID : Guidance of irrigation technology and water users group
- DOAE : Guidance and assistance of farming, and strengthening of farmers' group
- DOA : Agricultural research and experiment
- DOF : Promotion and extension of freshwater fishery
- ARLO : Land consolidation
- DLD : Livestock promotion
- RFD : Promotion of aforestation
- CPD : Guidance and strengthening of cooperatives and marketing
- BAAC : Agricultural credit and coordination of marketing
- MOF : Strengthening of marketing
- MOI : Assistance to rural development
- Farmers' institutions : Strengthening of agricultural cooperatives and farmers' group

In the Seventh National Economic and Social Development Plan, MOAC (Ministry of Agriculture and Agricultural Co-operatives) has set up the operation plan of water resource conservation and development. Then the water use cooperation system for farmers under the CPD (Cooperatives Promotion Department) is established to manage water use, water distribution, maintenance and repairing of irrigation system which is constructed by the authorities concerned, otherwise, the water use cooperation has duty on the operating of this system in order to protect benefit of members. This system will operate as a project for which it assists water user to obtain fully benefit from the irrigation system and also assists to maintain and repair the irrigation system. Accordingly, the practical use of this system in the project is desirable.

4.2.2 Marketing Plan

The marketing system for oil crops which are newly introduced with the project, such as groundnuts and soybeans, should be established in the Project Area or the surrounding area, owing to no marketing system in the Lower Northeast Region.

As a marketing center for oil crops, the effective use of business section of the Det Udom Agricultural Cooperatives in Tambon Muang Det, Amphoe Det Udom is considered. The BAAC will assist and support the business activities of the cooperatives with financing and coordination between cooperatives and oil factory or private company. Also, CPD will support this business by guidance and assistance of management and operation.

ANNEX I. DAM

ANNEX I. DAM

Page

PART - II (FEASIBILITY STUDY)

LIST OF FIGURES

PART-2 (FEASIBILITY STUDY)

CHAPTER I. DAM DESIGN

1.1 Seismology

According to "A Seismic Zoning Map for Thailand and Neighbouring Regions" as shown in Figure I-1, the project sites locate in the Zone 0 "No damage area of earthquake".

While the earthquake records "Statistics of Earthquakes in Thailand 1975 - 1985" provided by the Meteorological Department (MD) indicates that the earthquakes of more than 4.0 Magnitude occurred 38 times in Thailand during 13 years from 1975 to 2530 (2518 to 2530), and happened in the northern part especially nearby Burma.

The maximum acceleration at a site can be presumed by applying the Okamoto's formula as shown below:

$$\text{Log10}\ \ Ac/640 = (D+40)/100 \times (-7.604 + 1.7244\ M - 0.1036\ M^2)$$

where, Ac : Maximum acceleration (Gal)
M : Magnitude
D : Distance from the dam site to the earthquake epicenters (km)

In case that M = 8 and D = 400 km were substituted in the above formula, the maximum acceleration becomes 7.5 Gal and the ratio K of seismological acceleration to gravity acceleration is 0.008.

Basin on the said records, the biggest acceleration during 13 years was calculated as follows:

Earthquake epicenter

Date : 17 Feb., 1975 (2518)

Location : Latitude 17.6 N
Longitude 97.9 E
Depth 6 km
Magnitude : 5.6

Maximum acceleration
at Ubon Ratchathani
Province : 9.2×10^{-9} (gal)

In addition, according to the information by MD, the earthquake which happened at the nearest place from the project sites was as follows:

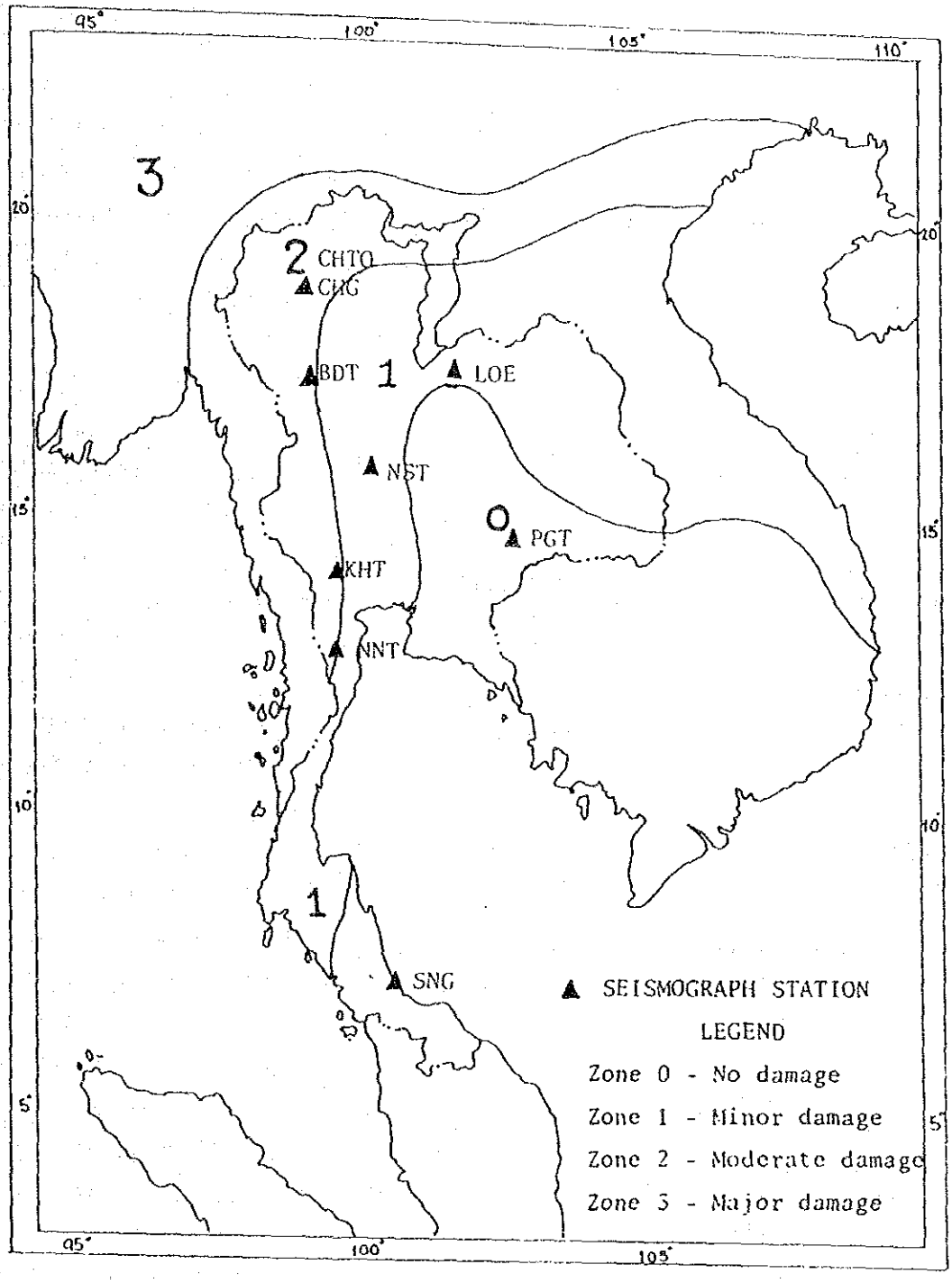
Earthquake epicenter

Date : 18 Oct., 1985
Location : Laos
Latitude 18.03 N
Longitude 104.79 N
Depth 21 km
Magnitude : 4.7

Maximum acceleration
at Ubon Ratchathani
province : 4.27×10^{-7} (gal)

From the results of the above study, the project areas are not considered to be affected by any earthquake; however considering the importance of such structure as a dam, the ratio K of seismological acceleration shall be 0.05 g as minimum one.

FIGURE I-1 A SEISMIC ZONING MAP FOR THAILAND AND NEIGHBORING REGIONS



(Source)

" 1st Workshop on Earthquake Engineering and Hazard Mitigation "/organized by Southeast Asia Association of Seismology and Earthquake Engineering (SEASEE) National Earthquake Committee of Thailand/Nov. 1986.

1.2 Embankment Materials

1) Borrow Area

The geology around the damsite consists of sandstone as basic rock, covered with residuals, terrace deposit and flood plain deposit.

It has been found out by borrow area survey and materials tests in the Phase I and II, whether these deposits are suitable for embankment material, because it consists mainly of fine sand, as a result of augar boring test.

Both the banks of the flood plain form mild slopes in which terrace deposits are found. The terrace deposits containing clayey soil are classified into SC, CL and SM-SC according to the standardized classification method and usable as impervious material. The layer, however, is about only about 2m thick resulting in being hard to obtain the required amount.

The most prospective borrow area is situated in the terrace on the right bank of the damsite which was investigated concentratively by test pitting and augar boring. However, judging from the location map of soil test in Figure D-5 and soil columnar figures in Figure D-2 in ANNEX D, mainly CL soil 3m thick is distributed on A-A' measuring line, CL and SM-SC soils 2 to 3m thick on B-B' line and SP and SM soils on C-C' and D-D' lines. Only SC, CL and SM-SC soils can be used as impervious material. Since these material deposit amount is estimated as 850 thousand cu.m less than the necessary volume of 1,560 thousand cu.m corresponding to twice as much as the volume of impervious material required, the utilization of residuals distributed on the terrace on the left bank of the damsite should be taken into consideration.

2) Filter Drain Material and Fine Aggregate for Concrete

Sand taken from the Mun river can be used as filter drain for the dam body and fine aggregate for concrete. According to the sieving test of the samples taken from the site, the sand occupying 99 percent of

the samples, the gradation control by adding coarse sand and gravel is needed.

3) Rip-rap Material, Rock Material and Coarse Aggregate for Concrete

There being no quarry sites around the damsite, basalt distributed in the watershed can be used as rip-rap material, rock material and coarse aggregate for concrete. The quarries are located at Phu Huai in Si Sa Ket Province and at Nam Yun in Ubon Ratchathani Province.

1.3 Dam Body

1) Dam type

Generally the dam is classified into two types, that is, fill type dam and concrete dam. The selection is influenced by the topography and geological condition.

Particularly, in case of the concrete dam, rock foundation with sufficient bearing force and shearing force is required. The feature coefficient of this damsite indicates about six that is a large figure. In geology of the dam foundation, a soft layer reaches to 3.5 m thick at a maximum corresponding to CL-D soil on the river bed, and 5.0 m at a maximum on both the abutments, amounting to considerable bed excavation volume, including deposit layer excavation. Owing to the rock with high permeability, water blockage treatment by grouting is needed on the whole foundation surface. The construction cost for concrete dam is estimated as more than twice of the cost for fill-type dam including foundation treatment cost, because of less dam volume but very high concrete unit cost as compared with the fill-type dam.

On the other hand, as compared with the concrete dam, since the stress of the fill-type dam acting on the foundation the dam can be constructed even under the geological condition that the concrete dam construction is hard. Considering the feature coefficient of the damsite, the properties of the materials distributed near the damsite and

besides the actual construction results of fill-type dams in Thailand, this damsite is most suitable for fill-type dam construction. The type of fill dam is determined by the kinds and volumes of the materials to be obtained near the damsite. As a result of borrow area investigations and material tests, SC, CL and SM-SC soils classified by the standardized classification method, are distributed on the right bank of the damsite and can be used as impervious materials. Rock material cannot be seen around the damsite. For the above stated reasons, the homogeneous earth fill-type dam will be adopted.

2) Design Condition and Soil Condition

a) Design Condition

(1) Topographic map

Plane figure of damsite:	Scale 1/10,000 (Phote-interpreted Map)
	Scale 1/50,000 (Original Map)
	Scale 1/2,000 (Actually measured)
Profile of damsite:	Scale Vertically 1/100 (Actually measured)
	Scale horizontally 1/2,000

(2) Geology

Boring: on Dam axis 9 holes 180m
on Spillway axis 2 holes 20m

(3) Embankment Materials

Borrow area: Augar holes 35
Test pits 19
Collecting Samples 17

(4) Seismic Coefficient

Design horizontal seismic intensity Kh = 0.05

(5) Design Flood Discharge

Qd = 641 cu.m/sec

b) Soil Condition

(1) Borrow Area: Located on the terrace on the right-bank of dam axis SC, CL and SM-SC in soil classification. The characteristics of the soil materials are shown in a soil test table.

(2) Filter Drain: Purchased material (Sand in the Mun river)

(3) Rip-rap and Rock

materials: Purchased material (Basalt)

(4) Design Values of Embankment Materials

The design values of impervious zone, pervious zone and filter drain zone for the stability analysis of dambody are determined based on the material test result and the past actual results as shown below;

Design Value of Embankmet Materials

Item	Impervious zone	Pervious zone	Drain	Foundation ground
Dry density (t/cu.m)	1.80	1.96	1.80	1.80
Moist density (t/cu.m)	2.08	2.02	1.89	2.08
Saturated weight (t/cu.m)	2.13	2.23	2.13	2.13
Cohesive force (t/sq.m)	1.4	0	0	0
Friction angle (degree)	21.0	40.0	36.0	30.0

The calculation bases of the design values of respective zones are shown below:

(1) Impervious Zone

It is determined as a result of soil test, as follows:

Design Density

Specific gravity of soil particle	Gs = 2.69
Dry density	ρd = 1.80 (t/cu.m)
Moisture content	W-15.8 (t/cu.m)
Wet density	$\rho t = \rho d$ (1t w/100) = 2.08 (t/cu.m)
Void ratio	e = Gs/ρd - 1.0 = 0.494
Saturated weight	ρsat = (Gs + 1)/(1 + e) = 2.13 (t/cu.m)

Mean Value Obtained by Test

Item	A-A' TP-2	C-C' TP-2	C-C' TP-4	C-C' TP-6	D-D' TP-1	Mean Value
Specific gravity	2.78	2.65	2.61	2.63	2.76	2.69
Moisture content	12.1	11.3	12.9	11.7	17.7	13.1
Standard classification	CL	SM-SC	SM-SC	SC	CL	-
0.074 mm remaining	18.5	61.5	58.0	61.0	49.0	49.6
0.074 mm passing	81.5	38.5	41.0	39.0	51.0	50.4
Liquidity limit	39.4	18.6	19.4	21.9	38.9	-
Plasticity limit	19.2	13.1	12.4	14.3	19.5	-
Plasticity index	20.2	5.5	7.0	7.6	19.4	11.9
Maximum dry density	1.722	2.002	1.999	1.971	1.800	-
Optimum moisture content	17.1	10.2	10.0	10.7	15.4	-

Design Shearing Strength

Since the shearing strength is the value obtained by a direct shearing test, 80 percent of the value is adopted and a dispersion of the value is considered.

That is,

Design value = Mean value - Standard deviation/2

C' = 1.4 (t/sq.m)

ϕ' = 21.0 (degree).1h12

Standard Deviation of ' Value Obtained by Test X 80%'

Item	A-A' TP-2	C-C' TP-2	C-C' TP-4	C-C' TP-6	D-D' TP-1	Mean Value	Standard deviation
Cohesive force (C')	2.8	1.2	1.9	1.7	2.3		
Friction angle (ø')	19.61	30.18	32.04	30.98	28.25		
C' x 80%	2.2	1.0	1.5	1.4	1.8	1.6	4.0
ø' x 80%	15.7	24.1	25.6	24.8	22.6	23.0	21.0

(2) Pervious Zone

The tested result of rock material is shown as follows:

	Specific gravity	abrasion loss (%)
Si Sa Ket	2.70	19.0
Ubon	2.70	20.5

The general properties favorable as rip-rap and rock materials have the standard values shown in the following table.

The tested result of the materials concerned is situated within the range of the standard values.

Standard Value

Specific gravity	above 2.50
Water absorption amount	below 30.0%
Stability	below 12.0%
Abrasion loss	below 40%
Compressive strength	400 kgf/sq.cm
Adapted rocks	Basalt, Andesite, Hard sandstone, Hard limestone

Since the physical and mechanical tests for the material concerned have not been executed, the tested result of the same kind of rock for the other dam constructed, will be adopted as follows:

Specific gravity :	2.68
Dry density :	ρ_d = 1.96 (t/cu.m)
Wet density :	ρt = 2.02)t/cu.m)
Saturated weight :	ρsat = 2.23 (t/cu.m)
Cohesive force :	C' = 1.4 (tf/sq.m)
Friction angle :	ϕ' = 21.0 (degree)

(3) Filter Drain Zone

For this zone, sand, sand and gravel, macadam, etc. meeting the filter condition below 5 percent of fine particles content under 0.074 mm such as silt, clay, etc. are used.

The tested result of the sand produced in the Mun river near the damsite is shown as follows;

Specific gravity :	2.67
Moisture content :	2.5%
Standard classification :	SP
Gravel content :	0.5%
Sand content :	99.0%
Silt under 0.074 mm :	0.5%

This material consisting of 99 percent of sand, the gradation adjustment by adding some amount of coarse sand and gravel will be needed, so as to meet the filter condition.

According, considering that the density is expected to be larger in physical properties, the design value is determined as follows;

Design Density

Specific gravity of soil particle : Gs = 2.67
Dry density : ρd = 1.80 (t/cu.m)
Moisture content : w = 5.0 (%)
Wet density : $\rho t = \rho d$ (1tw/100) = 1.89 (t/cu.m)
Void ratio : e = Gs/ρd - 1.0 = 0.483
Saturated weight : ρsat = (Gs + 1)/(1 + e) = 2.13 (t/cu.m)

Design Shearing Strength

Generally, mixed materials with sand and gravel in good gradation can easily obtain a relative density over 70 percent by compaction.

There being no value tested, the design shearing strength will be estimated by the past actual result as follows:

Cohesive force : C' = 0 (t/sq.m)
Friction angle : ϕ = 36.0 (degree)

(4) Foundation Ground

The loose alluvial deposit under 20 in N-value is distributed on the upper part of the foundation rock, and is not suitable for dam foundation.

The dam foundation is therefore required on the deposit layer over 20 in N-value, with sufficient bearing force. Since soil tests for this deposit layer have not been executed, the shearing strength will be estimated with Dunham's formula using N-value obtained by standard penetration tests in boring holes.

ϕ = 12N + 15 (N = 20)
= 30 (degree)
C = Assuming to be 0 considering safety due to sandy ground

As the design, the same value as that in case of impervious zone is used.

3) Standard Cross Section

The standard dam cross section is determined considering the below items:

a) Non-overflow Part Elevation

The non-overflow part elevation is determined by the following expression.

Non-overflow part elevation = HWL + hw + he/2 + 1.0

where, HWL: Design flood level WL 139.50 m
hw : Wave height by wind
he : Wave height by earth quake
1.0: Clearance height

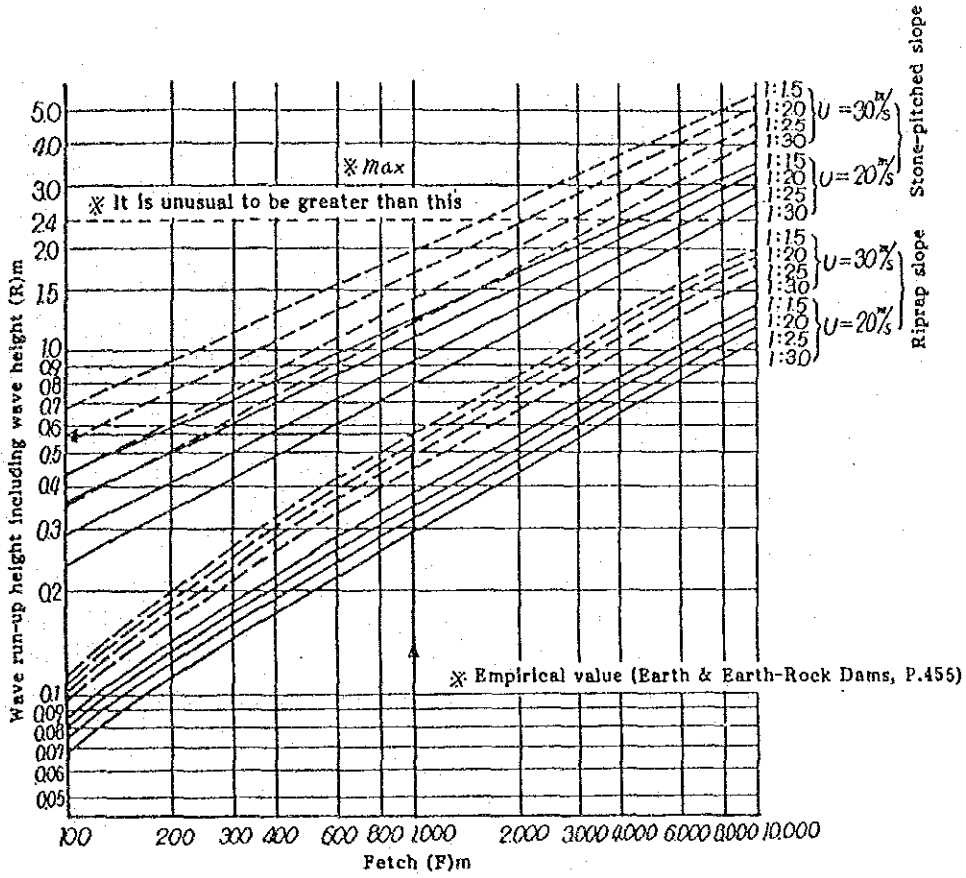
The wave height by wind (hw) is obtained in combination with S.M.B. method and Saville method (cf. Figure I-2). Annual mean 10-minute wind velocity in this watershed is 31.7 knot (16.5 m/sec). Considering the safety on design, a wind velocity of 20 m/sec is adopted. The distance from this bank to the other bank is 6,000 m. Assuming that the slope gradient of the dam body is 1 : 3.0, the wave height by wind will be 0.82 m on rip-rap surface using Figure I-2.

The wave height by earthquake is calculated by Sato's formula as follows:

$$he = 1/2 \cdot \frac{k \cdot \tau}{\pi} (gHo)1/2$$

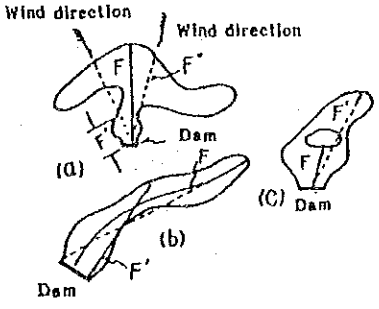
where, k : Design seismic intensity on normal water level k = 0.05
τ : Seismic cycle = 1.0 sec
Ho: reservoir water depth on normal water level Ho = 12.6 m
g : Gravity acceleration 9.8 m/sec^2

FIGURE I-2 WAVE HEIGHT BY WIND



In order to determine wave run-up height (R), fetch (F), wind velocity (V), wave height (hw) and wave length (L) are required to be found by the S.M.B method, and slope and slope roughness by the Saville method

Wave run-up height by the S.M.B method and Saville method



Fetch

By the above formula, the wave height by earthquake is calculated to be 0.09 m.

Non-overflow part elevation

= 141.00 + 0.82 + 0.09/2 + 1.0

= 142.865

= 143.00 m

b) Slope Gradient of Dam Body

The slope gradients of the dam body are determined, as a result of synthetic examination of foundation ground condition, embankment materials, etc., and the stability analysis of dam body, as follows:

Upper slope gradient	1 : 3.0
Lower slope gradient	1 : 2.5

c) Dam Crest Width

As a result of the homogeneous earth fill type dam construction in Thailand, the dam crest width has been adopted according to dam height (H), as follows:

$H < 20$	6 m
$20 \leq H \leq 40$	8 m
$H > 40$	10 m

The crest width of this dam of 8 m is adopted.

d) Filter Drain

In case of the homogeneous fill-type dam, a saturation line is formed in the dam body after water storage, and an oozing front comes out at the toe of lower slope. It exerts bad influence upon dam body stability. Hence, a vertical filter drain in the dam body and a horizontal filter drain on the whole lower dam bed are set up.

e) Cut-off Trench

In order to intercept water permeating from the foundation, the cut-off trench is set up down to base rock.

f) Slope Protection

The rip-rap 1.0 m in thickness is set up on the upper slope so as to prevent wave and stored water variation from washing out. The sodding is applied on the lower slope to prevent erosion.

g) Downstream Rock Zone

Since the river downstream of the dam has always been influenced by the water level of the Mun river, the lower slope toe of the dam body is protected by establishing rock zone.

h) Grouting

For highly permeable bed rock, grouting is applied to cut off water.

4) Stability Analysis

Considering the material properties of the dam body, the foundation ground condition, etc., the stability analyses of the innerpart of the dam body, the joint part with foundation ground and the surroundings are executed using circular slip surface method.

The examination of slip failure is made on the condition of normal water level and constant state of permeating flow. The calculating expression is as follows:

$$SF = \frac{c' \cdot l + (N-U-Ne) \cdot \tan\phi'}{(T + Te)}$$

where, SF: Safety factor, Minimum safety rate > 1.2
c': Cohesive force of material on slip surface
ϕ': Inner friction angle of material on slip surface
l : Length of slip surface
N : Vertical component of load resultant acting on slip surface
T : Tangent component of load resultant acting on slip surface
Ne: Vertical component of seismic load acting on slip surface
Te: Tangent component of seismic load acting on slip surface
U: Void pressure acting on slip surface

The analyzed results show the planned cross section fill the minimum requirements for stability, ie, the safety factors were more than 1.2. The safety contour chart is shown in Figure I-3 to I-4.

1.4 Foundation Treatment

1) General

The following items will be examined as the plan of the foundation treatment for Lam Dom Yai dam.

i) Determination of dam base excavation line
ii) Determination of water cut-off treatment method

2) Dam Base Excavation Line

The base of cut-off trench for executing grouting and that of damsite are examined respectively.

a) Cut-off Trench Base

The cut-off trench is planned on the dam axis, so that the

FIGURE I-3 STABILITY ANALYSIS OF DAM (UP-STREAM)

CASE	:	NORMAL WATER LEVEL
WATER LEVEL	:	WL 139.50
EARTHQUAKE FORCE	:	K=0.05
MIN. SAFTY FACTOR	:	1.315

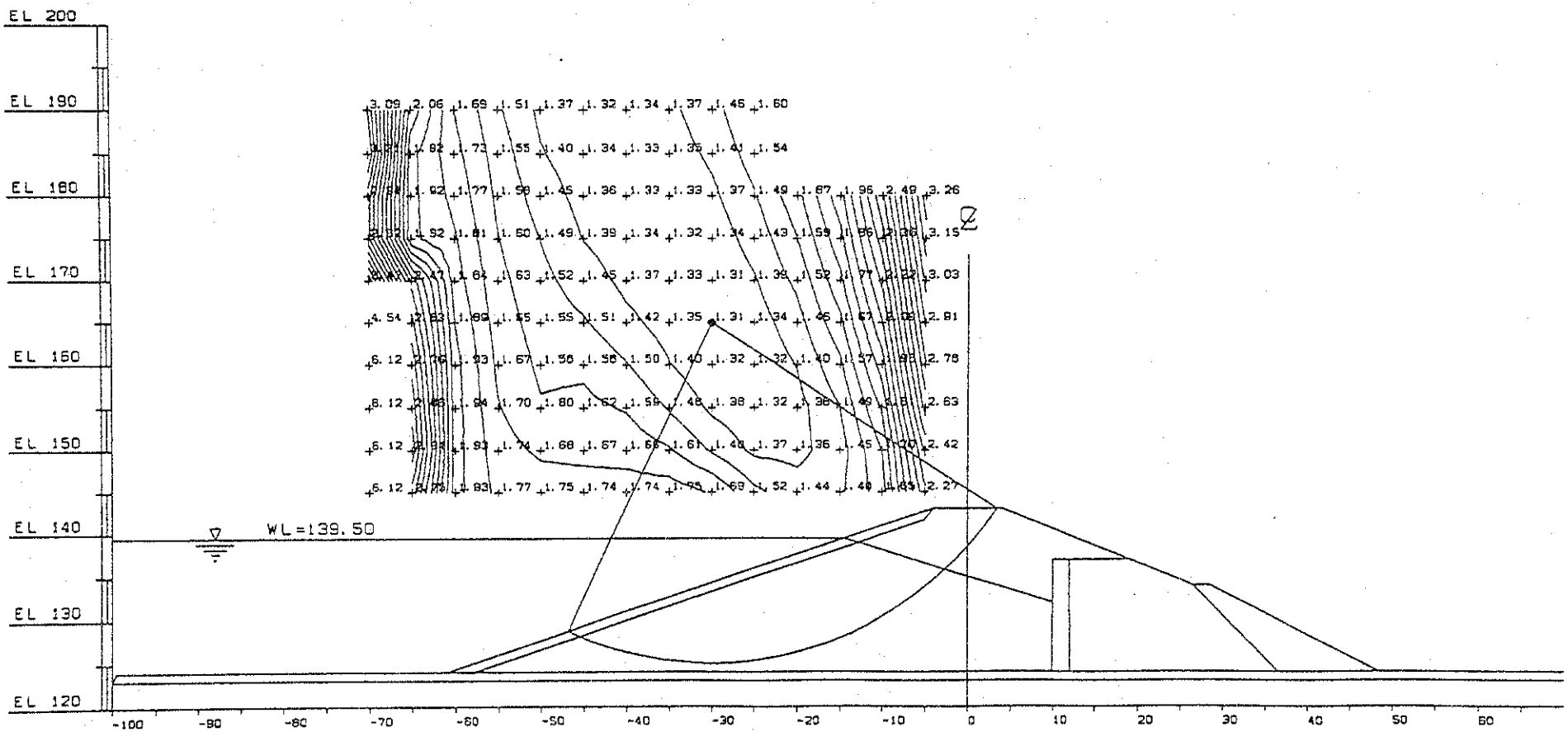
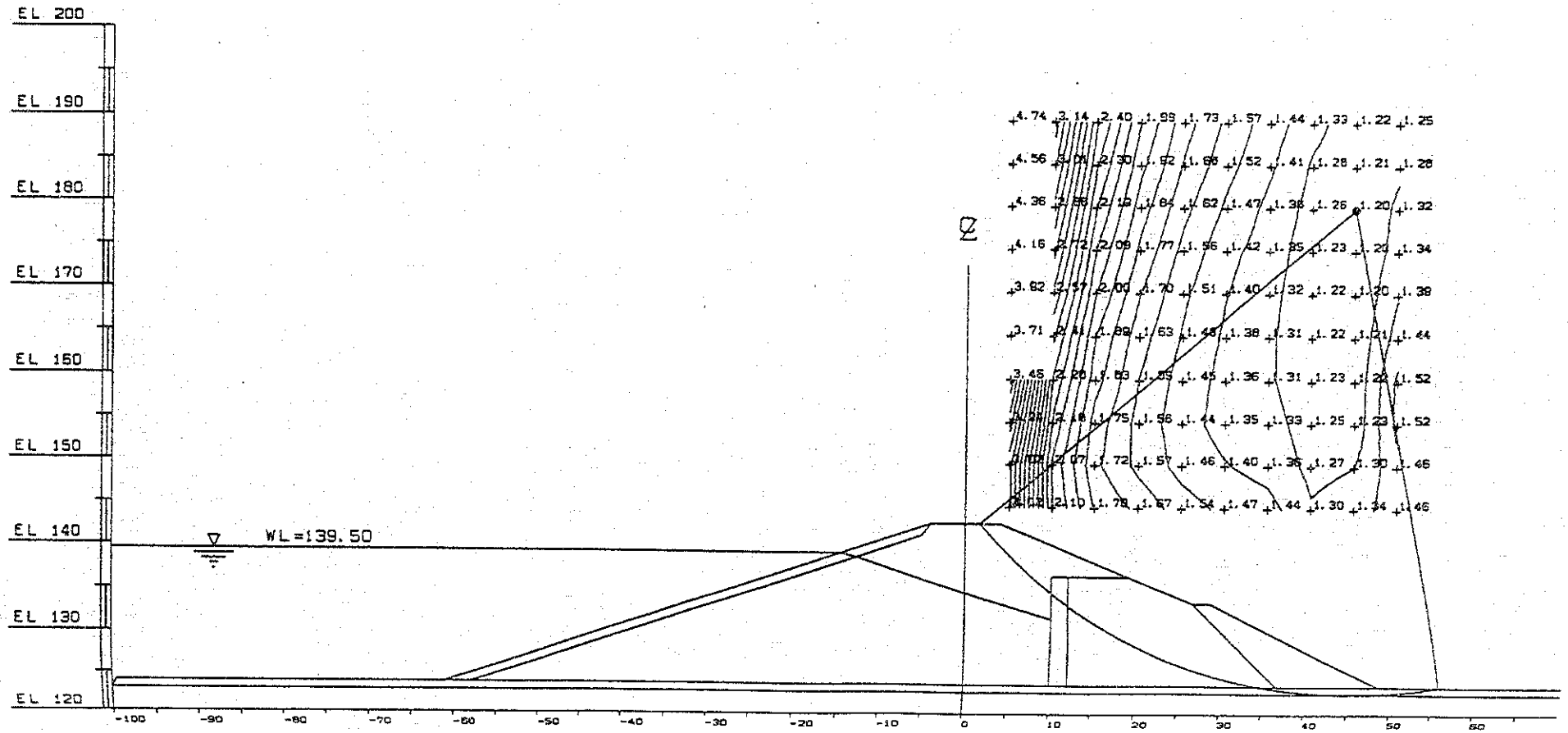


FIGURE I-4 STABILITY ANALYSIS OF DAM (DOWN-STREAM)

CASE	:	NORMAL WATER LEVEL
WATER LEVEL	:	WL 139.50
EARTHQUAKE FORCE	:	K=0.05
MIN. SAFTY FACTOR	:	1.201



executing length of grouting may be made shortest.

The scale of the cut-off trench is planned to be 8 m to secure the executing width of grouting and to observe water leakage.

The conditions as cut-off trench base are;

i) To have sufficient bearing force against dam body load.
ii) To have sufficient imperviousness or a possibility of imperviousness improvement, etc.

The cut-off trench base is determined as follows:

River bed part: The basic sandstone and siltstone are regarded as cut-off trench base, removing flood plain deposit (sand layer).

Right bank part: The medium part of residual soil layer meeting $N \geq 15$ and also sufficiently meeting imperviousness, is regarded as the base.

Left bank part: The residual soil layer is regarded as the base, removing surface layer 2 to 3 m in thickness.

b) Damsite Base

The necessary conditions as the damsite base except cut-off trench base, are that the base is stable against the slip surface passing through the base, and has sufficient bearing force against the dam body load. In the vicinity of the maximum cross section, the flood plain deposit meeting $N > 20$ is regarded as the base.

In the parts on both the abutments, where the dam body scale becomes smaller, the residual soil layer meeting $N > 15$ is regarded as the base.

The above-stated cut-off trench and dam body cutting lines are

shown in the profile of the dam body.

3) Water Cut-off Treatment Method

As the water cut-off treatment for Lam Dom Yai dam, grouting method is adopted for the following reasons:

i) The flood plain deposit consisting mainly of sand, showing partly high permeability of 10^{-2} order, in which soft part intervenes, has an anxiety of piping due to the stored water permeation.

ii) The flood plain deposit is the sand layer with uneven N-values, that is N = 2-50, and must be removed owing to unsuitableness for dam foundation. After the removal, basic sandstone and siltstone will mostly be the dam foundation.

iii) The basic sandstone and siltstone having a characteristic permeability passing through the cracks, show partly large Lugeon value. Cutting-off the water with earth blanket has anxieties of wash out of soil material and outbreak of piping.

a) Grouting Extent

The extent carrying out grouting is determined as a part of basic sandstone and siltstone possible between the measured point Sta. 1 + 80 and Sta. 9 + 40, 760 m in length.

b) Grouting Depth

The grouting depth is determined in order to cover the extent of Lu > 50 situated near the surface layer, that is, to be 10 m, about 50% of the stored water depth.

c) Grouting Hole Disposition

The hole disposition is planned to be two lines 1.5 m in space, holes on a line 2.0 m at interval in zigzags.

d) Target Value to be Improved

The target value to be improved is planned to be 3 to 5 Lu, and will be judged using test holes after an execution of grouting.

CAPTER II. SPILLWAY AND OUTLET

2.1 Spillway

1) Design Discharge

Design Discharge of Spillway was calculated taking into account effective storage of the design flood above normal water surface. The relationship between inflow and outflow in a reservoir can be expressed by the following equation;

$$Vtn = Vtn\text{-}1 + [\ (Qtn + Qtn\text{-}1)/\ 2 - Qdtn\ ]\ X\ \Delta T$$

where;

Vtn	;	storage accumulated at tn time
Vtn	;	storage accumulated at tn-1 time
Qtn	;	inflow at tn time
Qdtn	;	average outflow during T(tn -tn-1)
t	;	interval of time from tn to tn-1

Appling the above formula, discharge of spillway was calculated, and the inflow and outflow hydrographs are shown in paragraph 6.1.3 in main report.

2) Type of Spillway

Taking into account the topographical conditions at the damsite, shute type weir with a crest length of 170 m is adopted at the right bank.

2.2 Outlet

1) Design Discharge

Main function for the outlet works are as follows;

i) to flow the river runoff at the dam site down to lower stream

during the dry season of final embankment stage in construction period

ii) to release stored water into the Dom Yai river for supplemental water supply to the down stream area in the dry season after completion of dam construction

Since the water supply to the down stream area in the wet season could be made by using the runoff gethering from remainng watershed area in the down stream , the design discharge of outlet is planned to be 5.5 cu.m/sec corresponding to return period of 1/10- year in the dry season.

2) Conduit Pipe

In case that the conduit pipe would be built in the dam body, the tension stress and deformation settlement will be caused around the area contacted with the pipe. The conduit pipe ,therfore, shall be embedded in the original rock ground.

ANNEX J. ON-FARM DEVELOPMENT WORKS

ANNEX J. ON-FARM DEVELOPMENT WORKS

LIST OF TABLES

CHAPTER 1. DESIGN CRITERIA OF ON-FARM FACILITIES

Standard design and design criteria of on-farm facilities are shown as follows:

Unit discharge:

For irrigation requirement	2.17 lit./sec/ha
for drainage requirement	8.14 lit./sec/ha

Flow formula:

Mannings' open channel formula is used to determine the ditch elements

Coefficient of roughness:

n = 0.018 for main farm ditch and supplement farm ditch (with concrete lining)

n = 0.03 for farm drain (without lining)

Allowable maximum velocity:

1.0 ~ 1.5 m/s for farm ditches

0.7 m/s for farm drain

Inside and outside slopes:

1 : 1 for cut section and fill section

Profile slope of ditches:

0.001 for main farm ditch at the minimum

Elements of ditches :

(unit: cm)

Item	MFD 1/	SFD 2/	Farm Drain
Berm Width	50 ~ 210	50 ~ 210	30
Bottom Width	30	30	30
Free Board	20	20	20

Note; 1/ MFD : Main Farm Ditch

2/ SFD : Supplementary Farm Ditch

CHAPTER 2. ON-FARM FACILITIES

On-farm facilities are planned based on RID criteria with regard to on-farm facilities adding some proposed modifications aiming at better water management by farmers' group. The on-farm facilities are outlined as follows:

2. 1 Turnout

The turnout point will be selected along lateral/sub-lateral canals based on the physical condition of rotation area to be convenient to supply water for all rotation units.

When the rotation area extends along lateral canal or a ridge line with long span, the turnout point will be selected around the middle section of rotation area so as to covey water evenly to each rotation units.

2. 2 Main Farm Ditch

The main farm ditch is planned to convey water from the turnout to each supplementary farm ditch. No direct turnout from the main farm ditch to farm lots is designed.

2. 3 Supplementary Farm Ditch

The supplementary farm ditches are planned in each rotation area with the purpose of distributing water to farm lots in each rotation area. The route of supplementary farm ditch is selected along ridge line or across the terraces depending on the local conditions.

2.4 Farm Drains

Farm drains are planned along the present paddy field as required so as to remove excess water from the paddy field. The farm drain can be used for the irrigation purpose of the present paddy field.

2.5 On-Farm Road

On-farm road is planned for better farm management of the community, and operation and maintenance of on-farm facilities. In this connection, on-farm road is provided independently.

The total width of farm road is assumed to be 2.10 m in view of future requirement for small-scale public transportation, mechanized farm management and operation and maintenance work of on-farm facilities.

CHAPTER 3. TYPICAL LAYOUT FOR ON-FARM DEVELOPMENT

3. 1 General Description of Sample Area

Layout of on-farm development was planned at selected two sample areas in the Project Area based on the topographic maps of 1 : 4,000 in scale. One sample area (Area-1) is located at Ban Nong Yai, and the other sample area (Area-2) is located at Ban Khitum.

3. 2 Layout of On-Farm Facilities

As a result of home works based on the topographic maps, proposed routes of irrigation and drainage ditches and on-farm road followed along the property line.

The quantities of on-farm facilities are shown in Table J-1 and J-2.

TABLE J - 1 SUMMARY OF ON-FARM FACILITIES IN SAMPLE AREA - 1

Item	Unit
Gross Area	41.4 ha
Irrigation Area	39.8 ha
No. of Irrigation Unit	5 unit
Main Farm Ditch	500 m
Supplementary Farm Ditch	1,400 m
Farm Drain	480 m
Farm Road	500 m

TABLE J - 2 SUMMARY OF ON-FARM FACILITIES IN SAMPLE AREA - 2

Item	Unit
Gross Area	54.8 ha
Irrigation Area	54.4 ha
No. of Irrigation Unit	8 unit
Main Farm Ditch	500 m
Supplementary Farm Ditch	2,320 m
Farm Drain	1,020 m
Farm Road	500 m

ANNEX K. PROJECT COST

ANNEX K. PROJECT COST

LIST OF TABLES

LIST OF FIGURES

CHAPTER I. PROJECT COST

1.1 Conditions of Cost Estimation

The project cost is estimated under the following conditions;

i) The civil works are constructed on the contract basis. The construction machinery and equipment required for consruction works will be provided by the contractors. Therefore, only depreciation costs of machinery and equipment are included in the estimated construction cost.

ii) The project consists of construction cost and associated cost. Component of the project cost is shown in Table k-1.

iii) The exchange rate between Thailand Baht and U.S. Dollar is fixed as follows.
U.S Dollar = 25.0 Thailand Baht

iv) The physical contingency related to the construction and asso ciated cost is set at 10 percent of the direct costs. The price escalation is predicted applying the international inflation index established by the World Bank.

1.2 Construction Cost

1.2.1 Basic Rate

The basic rate of labor, material and construction equipment is estimated considering the prevailing rate in Thailand, as of October 1991.

1.2.2 Unit Cost

Unit cost of construction work is calculated, according to the proposed items, which are classified by construction method since the construction of the project will be executed on the contract basis with the following costs of overhead, profit and taxes used in current RID project.

- Overhead : 3.5 percent of material and wage costs
- Profit : 6.5 percent of material and wage costs
- Tax : 4.1 percent of above two items

1.2.3 Construction Cost

The construction cost is estimated based on the unit cost for individual working items. The construction cost will be divided into foreign and local currency portions. Local currency portion is to be estimated on the basis of the current price in Bangkok in 1991, while foreign currency portion is estimated on the CIF price in Bangkok.

1.3 Associated Cost

Associated cost is composed is composed of four items, such as on-farm development cost, land acquisition and compensation cost, engineering and administration cost, and O & M equipment cost. As for the land purchase price, the land values issued by the Department of Land, Ministry of Interior were used.

1.4 Project Cost and Disbursement Schedule

1.4.1 Project Cost

The project cost is estimated at 4,846 million Baht. The summary of the project cost is shown in Table K-2.

1.4.2 Annual Disbursement Schedule

The annual disbursement schedule of the project cost is estimated on the basis of the project implementation schedule, and the summary is as follows;

Annual Disbursement Program

(unit : '000 Baht)

	With On-farm Facility			Without On-farm Facilities		
Year	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total
1995	26,010	8,970	34,980	26,010	8,970	34,980
1996	31,420	85,350	116,770	31,420	85,350	116,770
1997	505,880	598,050	1,103,930	371,240	501,740	872,980
1998	909,580	764,940	1,674,520	723,460	631,820	1,355,280
1999	1,289,240	626,910	1,916,150	1,144,510	523,390	1,667,900
Total	2,762,130	2,084,220	4,846,350	2,296,640	1,751,270	4,047,910

Note; Details are shown in Table K- 13.

1.5 Operation and Maintenance Cost

The operation and maintenance cost annually required for the project is composed of the annual salaries and wages of O/M organization staff, administration and general expenditure, pump operation cost, equipment repair and maintenance costs, fuel cost and office maintenance cost.

The operation and maintenance cost was estimated at 32.6 million Baht per annum as shown in Table K-16.

1.6 Replacement Cost

Some facilities, especially mechanical works have shorter useful life than the project life of 50 years, and require replacement of the facilities within the project life. Following table shows the useful life of the mechanical works.

- Pumps and gates : 25 years
- O/M equipments : 10 years

1.7 Land Purchase Price

At the initial stage of the project implementation, compensation and acquisition of lands and structures related to the project will be required. These compensation costs can be categorized into two groups according to the property nature, that is, the costs for structural properties and that for land and tree crops.

For the structural properties, the cost estimation was made based on four major cost elements, including the costs for dismantlement, material damages, transportation and reconstruction. On the other hand, for the land and tree crops, the estimation will include the costs of land value and of tree crops grown on the land.

The required compensation costs for public facilities like temples, schools, weirs, bridges, health centers, which will be caused by the resettlement plan in the project, will be categorized into

compensation costs. However, these costs will not be included for the project evaluation.

The land value is presently evaluated based on the official land values issued by the Department of Land, Ministry of Interior. According to the official land price in the project area in 1991, agricultural land price is evaluated in the range of about 8,000 to 30,000 Baht as shown below. These values can be applied to the land possessing the complete land right certificate.

Land Purchase Price

		Land Price (Baht/rai)
- Right bank upstream basin		
Village and residential area	:	40,000
Land along main road	:	30,000
Paddy field adjacent to village	:	20,000
Paddy field far from village	:	10,000
- Right bank downstream basin		
Village and residential area	:	35,000
Paddy field adjacent to village	:	20,000
Paddy field far from village	:	10,000
- Left bank area		
Village and residential area	:	40,000
Paddy field adjacent to village	:	20,000
Paddy field far from village	:	10,000
- D-28 Reservoir area		
Village and residential area	:	20,000
cultivation land and paddy field	:	10,000

The structural property cost, especially privately-owned structural property, is decided at 60,000 Bath per household, making reference the costs in case of the Kaeng Sue Ten Project.

TABLE K-1 PROJECT COST COMPONENTS

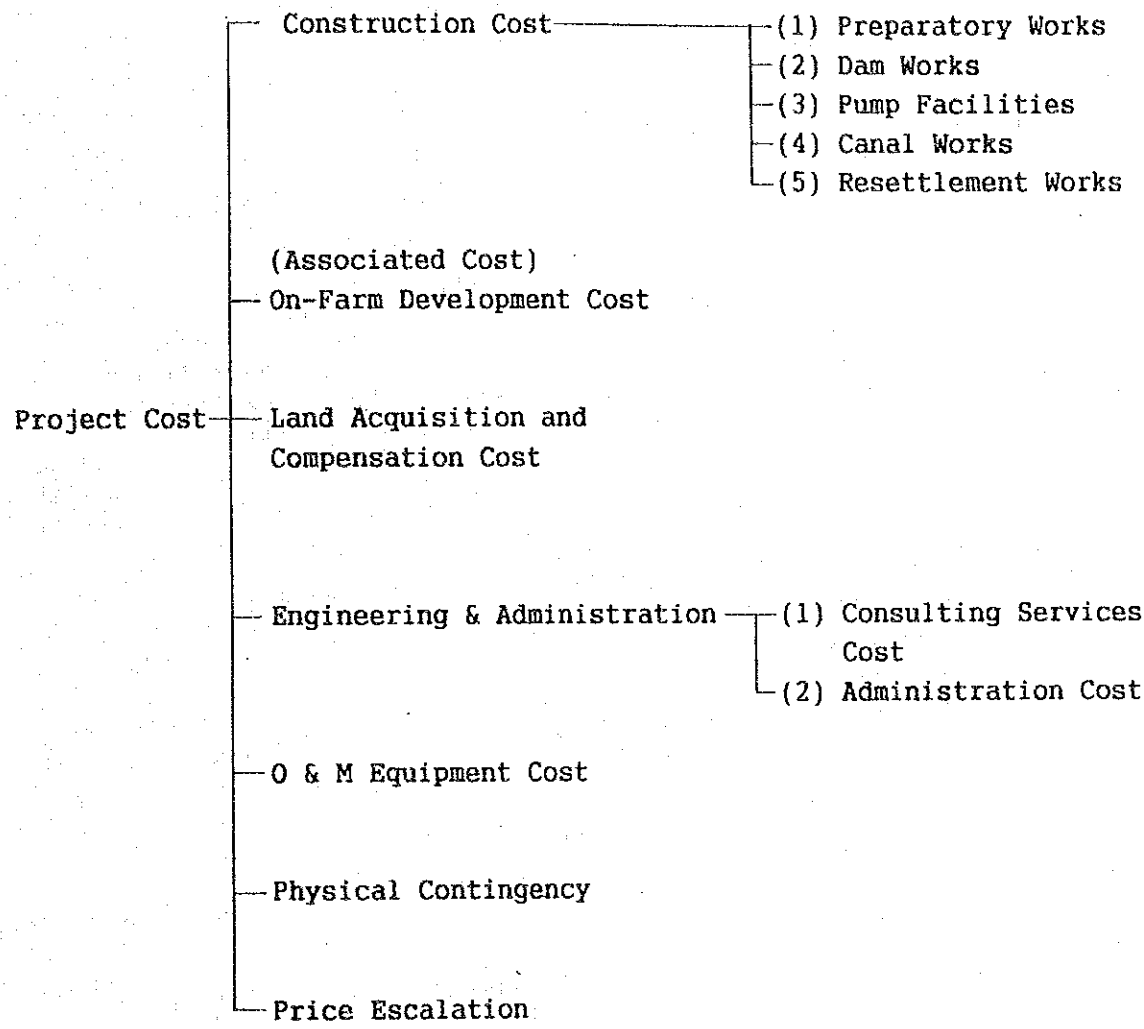


TABLE K-2 PROJECT COST

(unit : '000 Baht)

Item	F/C	L/C	Total
1. Civil works			
1.1 Preparatory Works	1,840	19,190	21,030
1.2 Dam Works	150,510	134,580	295,090
1.3 Pump Facilities	594,760	24,410	619,170
1.4 Canal Works	612,190	535,800	1,147,990
1.5 Resettlement Works	28,700	349,900	378,600
Sub-Total	1,388,000	1,063,880	2,451,880
2. On-Farm and Rural Developments			
2.1 On-Farm Facilities	307,150	218,390	525,540
2.2 Community Center	5,960	5,560	11,520
Sub-Total	313,110	223,950	537,060
3. Land Acquisition	-	66,030	66,030
4. Engineering and Administration			
4.1 Consulting Services	97,520	33,620	131,140
4.2 Administration	6,890	14,050	20,940
Sub-Total	104,410	47,670	152,080
5. O & M Equipment	38,440	5,770	44,210
6. Total (1 - 5)	1,843,960	1,407,300	3,251,260
7. Physical Contingencies (10%)	184,400	140,730	325,130
8. Total (6 - 7)	2,028,360	1,548,030	3,576,390
9. Price Escalation	733,770	536,190	1,269,960
10. Grand Total			
With On-Farm and Rural Dev.	2,762,130	2,084,220	4,846,350
Without On-Farm and Rural Dev.	2,296,640	1,751,270	4,047,910

TABLE K-3 PREPARATORY WORKS (Plan A-1)

Description	Unit	Q'ty	Unit Rate (Baht) F/C	Unit Rate (Baht) L/C	Amount ('000 Baht) F/C	Amount ('000 Baht) L/C	Amount ('000 Baht) Total
1. Project Facility for Construction Supervision							
Main Office	sq.km	400	1,300	3,700	520	1,480	2,000
Staff Residence	sq.km	500	1,500	4,500	750	2,250	3,000
Guest House	sq.km	200	1,300	3,700	260	740	1,000
Equipment Warehouse	sq.km	300	250	750	75	225	300
Farniture	LS			400		400	400
Sub-total					1,605	5,095	6,700
2. Additional Survey and Investigation							
2.1 Reservoir and Dam							
a) Topographic Survey							
- Dam axis and cross section	km	4.9		6,200		30	30
- Temporary diversion channel alignment and cross section	km	3.1		6,200		19	19
- Access road profile and cross section	km	3.0		6,200		19	19
- Bench mark survey	km	5.0		4,800		24	24
b) Geological Investigation							
- Seismic survey for dam-site	m	3,300		90		297	297
- Drilling works							
. Core drilling	m	450		6,200		2,790	2,790
. Permeability test	time	330		1,400		462	462
. Standard penetration test	time	270		1,800		486	486
- Test pit excavation	place	30		1,800		54	54
- Soil laboratory test							
. Physical test	sample	30		13,900		417	417
. Mechanical test	sample	30		13,900		417	417
- Rock test	sample	5		13,900		70	70
Sub-total						5,085	5,085
2.2 Pumping Station							
a) Topographic Survey							
- Plane survey	ha	0.2		1,800		0	0
- Intake canal alignment and cross section	km	3.6		6,200		22	22
- Pipeline alignment and cross section	km	8.0		5,000		40	40
b) Geological Investigation							
- Core drilling	m	60		6,200		372	372
- Standard penetration test	time	30		1,800		54	54
Sub-total						489	489
2.3 Canal Systems							
a) Topographic Survey							
- Strip topographic survey							
. Main canal	km	111.4		18,200		2,027	2,027
. Lateral /sub-lateral canal	km	188.4		18,200		3,429	3,429
b) Geological Investigation							
- Corn penetration test	place	300		300		90	90
- Soil laboratory test	place	60		5,000		300	300
Sub-total						5,846	5,846

Description	Unit	Q'ty	Unit Rate (Baht) F/C	Unit Rate (Baht) L/C	Amount ('000 Baht) F/C	Amount ('000 Baht) L/C	Amount ('000 Baht) Total
2.4 Reservoir Area Survey							
- Present land use	m-m	1.0		50,000		50	50
- Population and household	m-m	0.7		50,000		35	35
- Land holding and ownership	m-m	0.7		50,000		35	35
- Public facility	m-m	0.7		50,000		35	35
Sub-total						155	155
2.5 Miscellaneous (10%)					161	1,667	1,828
Total					1,766	18,337	20,103
3. Overhead, Profit and Tax					79	852	931
Grand Total					1,845	19,189	21,034

TABLE K-4 DAM WORKS

Discription	Unit	Q'ty	Unit Cost (B) F/C	L/C	Total Cost	Amount ('000 B) F/C	L/C	Total Cost
A. Dam								
1.Temporary works	L.S	1				12,245	11,040	23,285
2. Dam Body								
- Stripping	cu.m	144,000	10	6	16	1,440	864	2,304
- Excavation (Earth)	cu.m	634,000	13	4	17	8,242	2,536	10,778
- Excavation (Rock)	cu.m	14,000	20	7	27	280	98	378
- Embankment (Imperivious)	cu.m	782,000	32	12	44	25,024	9,384	34,408
- Embankment (Rock)	cu.m	35,000	125	288	413	4,375	10,080	14,455
- Filter/Drain (Sand)	cu.m	38,000	60	134	194	2,280	5,092	7,372
- Filter (Random)	cu.m	19,000	40	90	130	760	1,710	2,470
- Riprap	cu.m	26,000	125	288	413	3,250	7,488	10,738
- Back Fill	cu.m	134,000	32	12	44	4,288	1,608	5,896
- Sodding	sq.m	32,000	0	22	22	0	704	704
- Top Soil	cu.m	10,000	13	12	25	130	120	250
- Asphalt Pavement	cu.m	7,000	600	300	900	4,200	2,100	6,300
- Instrumentation	L.S	1	900,000	900,000	1,800,000	900	900	1,800
Sub-Total						55,169	42,684	97,853
3. Foundation Treatment								
- Grout Hole Drilling 46mm	m	8,000	770	330	1,100	6,160	2,640	8,800
- Grouting (Cement)	ton	300	3,200	1,800	5,000	960	540	1,500
- Test Hole NX	m	800	1,750	750	2,500	1,400	600	2,000
- Permiability Test	test	200	630	270	900	126	54	180
Sub-Total						8,646	3,834	12,480
4. Spillway								
- Stripping	cu.m	52,000	10	6	16	520	312	832
- Excavation (Earth)	cu.m	167,000	13	4	17	2,171	668	2,839
- Back Fill	cu.m	24,000	32	12	44	768	288	1,056
- Embankment	cu.m	3,000	32	12	44	96	36	132
- Concrete Works	cu.m	24,000	1,880	2,280	4,160	45,120	54,720	99,840
- Riprap	cu.m	5,000	125	288	413	625	1,440	2,065
- Bridge	sq.m	212	9,000	11,000	20,000	1,909	2,332	4,240
Sub-Total						51,208	59,796	111,004
5. Outlet								
- Excavation (Earth)	cu.m	38,000	13	4	17	494	152	646
- Excavation (Rock)	cu.m	1,000	20	7	27	20	7	27
- Back Fill	cu.m	2,000	32	12	44	64	24	88
- Concrete Works	cu.m	600	1,880	2,280	4,160	1,128	1,368	2,496
- Gate & Valve								
(1) Jet Flow Gate ϕ1100	unit	1	2,800,000	1,200,000	4,000,000	2,900	1,200	4,000
(2) Sluice Valve ϕ1100	unit	1	1,750,000	750,000	2,500,000	1,750	750	2,500
(3) Closure Gate (1.5*1.5*0.1	unit	1	21,000	9,000	30,000	21	9	30
(4) Trashrack (3.0*3.0*1.0)	unit	1	315,000	135,000	450,000	315	135	450
- Conduit Pipe ϕ1300	m	84	8,713	3,734	12,447	732	314	1,046
- Conduit Pipe ϕ1100	m	12	4,900	2,100	7,000	59	25	84
- Gate House	sq.m	25	1,750	4,250	6,000	44	106	150
Sub-Total						7,426	4,090	11,517
6. Other Works								
- Detour Road	m	6,000	410	200	610	2,460	1,200	3,660
7. Miscellaneous Works	L.S					6,858	6,132	12,990
Total						144,012	128,777	272,789
7. Overhead,Profit,Tax						6,495	5,808	12,303
Grand Total						150,507	134,585	285,092

TABLE K-5 PUMP FACILITIES (Plan A-1)

Discription	Unit	Q'ty	Unite Cost(B) F/C	L/C	Total Cost	Amount ('000 B) F/C	L/C	Total Cost
B. Pump Facilities								
1. Left Bank								
- Excavation	cu.m	61,375	13	4	17	798	246	1,043
- Embankment	cu.m	6,169	21	10	31	130	62	191
- Riprap	cu.m	5,848	125	288	413	744	1,713	2,457
- Concrete Works	cu.m	2,316	2,590	1,110	3,700	5,998	2,571	8,569
- Pump Unit 800mm	unit	6	15,620,000	0	1,562,000	93,720	0	93,720
- House	sq.m	248	4,000	6,000	10,000	992	1,488	2,480
- Substation & Transeformer	L.S		12,930,000			12,930	0	12,930
- Power Cable	km	1	288,200		288,200	288	0	288
- Miscellaneous Works	L.S					5,780	304	6,084
Sub-Total						121,380	6,383	127,762
2. Right Bank								
- Excavation	cu.m	119,508	13	4	17	1,554	478	2,032
- Embankment	cu.m	5,062	21	10	31	106	51	157
- Riprap	cu.m	17,846	125	288	413	2,231	5,140	7,370
- Concrete Works	cu.m	6,626	2,590	1,110	3,700	17,161	7,355	24,516
- Pump Unit 1000mm	unit	12	33,264,000	0	3,326,400	399,168	0	399,168
- House	sq.m	524	4,000	6,000	10,000	2,096	3,144	5,240
- Transeformer	L.S		2,930,000	0		2,930	0	2,930
- Power Cable	km	4	288,200	0	288,200	1,153	0	1,153
- Miscellaneous Works	L.S			371	181,438	21,320	808	22,128
Sub-Total						447,719	16,976	464,694
Total						569,098	23,358	592,457
3.Overhead,Profits,Tax						25,666	1,053	26,720
Grand Total						594,765	24,412	619,177

TABLE K-6 CANAL SYSTEMS (Plan A-1)

Discription	Unit	Q'ty	Unit Cost (B) F/C	Unit Cost (B) L/C	Unit Cost (B) Total Cost	Amount ('000 B) F/C	Amount ('000 B) L/C	Amount ('000 B) Total Cost
C. Canal								
1. Main Canal								
- Stripping	cu.m	913,597	10	6	16	9,136	5,482	14,618
- Excavation	cu.m	1,241,322	13	4	17	16,137	4,966	21,102
- Embankment	cu.m	1,522,894	21	10	31	31,981	15,229	47,210
- Drain Filter	cu.m	44,102	53	118	171	2,337	5,204	7,541
- Linig Conorete	cu.m	39,916	864	1,056	1,920	34,487	42,151	76,639
- Laterite	cu.m	363,802	54	126	180	19,645	45,839	65,484
- Sodding	sq.m	564,622	0	22	22	0	12,422	12,422
- Related Structure	L.S					17,859	19,694	36,752
- Miscellaneous Works	L.S					6,539	7,549	14,088
Sub-Total						137,322	158,535	295,857
2. Lateral Canal								
- Stripping	cu.m	1,632,852	10	6	16	16,329	9,797	26,126
- Excavation	cu.m	730,898	13	4	17	9,502	2,924	12,425
- Embankment	cu.m	2,967,061	21	10	31	62,308	29,671	91,979
- Drain Filter	cu.m	69,257	53	118	171	3,671	8,172	11,843
- Linig Conorete	cu.m	56,813	864	1,056	1,920	48,395	59,150	107,545
- Laterite	cu.m	631,080	54	126	180	34,078	79,516	113,594
- Sodding	sq.m	890,216	0	22	22	0	19,585	19,585
- Related Structure	L.S					26,142	31,322	57,465
- Miscellaneous Works	L.S					10,021	12,007	22,028
Sub-Total						210,446	252,143	462,589
3. Pipe Line								
- Pipe Line φ2000*3	m	4,000	59,500	25,500	85,000	238,000	102,000	340,000
Total						585,768	512,678	1,098,446
4. Overhead,Profit,Tax						26,418	23,122	49,540
Grand Total						612,186	535,800	1,147,986

TABLE K-7 RESETTLEMENT WORKS

Description	Unit	Q'ty	Unit Rate (Baht) F/C	Unit Rate (Baht) L/C	Amount ('000 Baht) F/C	Amount ('000 Baht) L/C	Amount ('000 Baht) Total
1. Compensation Cost							
1.1 Structural Properties							
Privately-owend structural property	household	122		60,000		7,320	7,320
Public owened structural properties							
- Road and bridge	km	6	201,000	99,000	1,206	594	1,800
- Power transmission line	km	6	49,000	21,000	294	126	420
Others (15%)					225	1,206	1,431
Sub-Total					1,725	9,246	10,971
1.2 Land and Tree Crops							
Land							
- Farm land (paddy field)	ha	1,930		62,500		120,625	120,625
- Forest and others	ha	2,400		47,100		113,040	113,040
Tree Crops (10%)						23,367	23,367
Sub-Total						257,032	257,032
Total					1,725	266,278	268,003
2. Resettlement Cost							
2.1 Land Acquisition For Resettlement							
- ALRO area	ha	300		70,300		21,090	21,090
- Forest Department area	ha	300		70,300		21,090	21,090
2.2 Construction of Protection Dike	m	4,060	201	99	816	402	1,218
2.3 Provision of Pump Facility	Place	3	5,600,000	1,400,000	16,800	4,200	21,000
2.4 Construction of Farm Fasilities							
- ALRO area	ha	260	11,250	7,500	2,925	1,950	4,875
- Forest Deptment area	ha	260	11,250	7,500	2,925	1,950	4,875
2.5 Construction of Social Infrastructures (school, temple, public health center)	L.S					12,000	12,000
2.6 Others (10%)					2,347	6,268	8,615
Total					25,813	68,950	94,763
3. Overhead, Profit, Tax (4.5 %)					1,162	14,669	15,831
Grand Total					28,699	349,897	378,596

TABLE K-8 ON-FARM DEVELOPEMENT (Plan A-1)

Discription	Unit	Q'ty	Unit Cost (B) F/C	Unit Cost (B) L/C	Unit Cost (B) Total Cost	Amount ('000 B) F/C	Amount ('000 B) L/C	Amount ('000 B) Total Cost
1. On-Farm Development								
- Left Bank	ha	8,888	8,644	6,146	14,798	76,867	54,985	130,152
- Right Bank	ha	25,200	8,644	6,146	14,798	217,829	154,879	372,708
Sub-Total						293,896	208,864	502,860
2. Community Center	place	68	83,761	78,291	162,052	5,696	5,324	11,020
Total						299,592	214,288	513,880
3. Overhead,Profit,Tax						13,512	9,664	23,176
Grand Total						313,103	223,952	537,056

TABLE K-9 LAND AQUISITION (Plan A-1)

Discription	Unit	Q'ty	Unit Cost (B)	Total Cost ('000B)
A. Dam				
- Bollow Area	ha	16	47,100	754
B.Pump Facilities				
- Pump Station	ha	0.2	70,300	14
C. Canal				
- Main Canal	ha	308	70,300	21,652
- Lateral Canal	ha	615	70,300	43,235
- Pipe Line	ha	5.3	70,300	373
Sub-Total				65,259
Total				66,027

TABLE K-10 CONSULTING SERVICE COST

Item	Description	Quantity	Unit	Rate (B' 000)	Total Amount Foreign Currency (B' 000)	Total Amount Local Currency (B' 000)
1.	Detailed Design Stage					
	1-1. Foreign Currency					
	Consultants Remuneration	53	month	500	26,500	
	Out-of Poket Expenses					
	International Travel Expense	11	trip	80	880	
	Reimbursable Cost Items and Others (10%)		LS		2,738	
	Miscellaneous (10 %)		LS		3,012	
	Sub-total				33,130	
	1-2. Local Currency					
	Consultants Remuneration	38	month	150		5,700
	Consultants Perdiem					0
	Foreign	53	month	20		1,060
	Local	10	month	18		180
	Living Allowance and Quatter					0
	Foreign	53	month	30		1,590
	Local	10	month	25		250
	Local Communication and Transportation		LS			496
	Printing of Report		LS			100
	Miscellaneous (10 %)		LS			928
	Sub-total					10,304
2.	Construction Supervision Stage					
	2-1. Foreign Currency					
	Consultants Remuneration	93	month	500	46,500	
	Out-of Poket Expenses					
	International Travel Expense	8	trip	80	640	
	Reimbursable Cost Items and Others (10 %)		LS		4,714	
	Miscellaneous (10 %)		LS		5,185	
	Sub-total				57,039	
	2-2. Local Currency					
	Consultants Remuneration	74	month	150		11,100
	Consultants Perdiem					
	Foreign	93	month	20		1,860
	Local	74	month	18		1,332
	Living Allowance and Quatter					
	Foreign	93	month	10		930
	Local	74	month	9		666
	Local Communication and Transportation		LS			551
	Printing of Report		LS			300
	Miscellaneous (10 %)		LS			1,644
	Sub-total					18,383
3.	Supporting Services and Management Stage					
	3-1. Foreign Currency					
	Consultants Remuneration	12	month	500	6,000	
	Out-of Poket Expenses					
	International Travel Expense	1	trip	80	80	
	Reimbursable Cost Items and Others (10%)				608	
	Miscellaneous (10 %)				669	
	Sub-total				7,357	

Item	Description	Quantity	Unit	Rate (B' 000)	Total Amount Foreign Currency (B' 000)	Total Amount Local Currency (B' 000)
3-2.	Local Currency					
	Consultants Remuneration	22	month	150		3,300
	Consultants Perdiem					
	Foreign	12	month	20		240
	Local	22	month	18		396
	Living Allowance and Quatter					
	Foreign	12	month	10		120
	Local	22	month	9		198
	Local Communication and Transportation		LS			132
	Printing of Report		LS			100
	Miscellaneous (10 %)					449
	Sub-total					4,935
	Total				97,526	33,622

Note; Proposed schedule of consulting services is shown in Figure K-1.

FIGURE K - 1 PROPOSED SCHEDULE FOR CONSULTING SERVICES

Description	Man - Month		1995			1996			1997			1998			1999		
	Foreign	Local	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
I. Detailed Design																	
1. Leader	12																
2. Hydrologist	2																
3. Irrigation Engineer	3																
4. Engineering Geologist		4															
5. Soil Mechanical Engineer		5															
6. Design Engineer (Dam)	9																
7. - do - (Pump)	6																
8. - do - (Canal)	9																
9. - do - (Canal)		9															
10. - do - (Structure)		6															
11. - do - (On - Farm)		9															
12. - do - (Architecture)		2															
13. Mechanical Engineer (Equipment)	2																
14. Construction Planner	3																
15. Cost Estimator	3																
16. Specialist for Tender Document	2																
17. Specification Writer	2																
18. Agronomist		3															
19. Economist		2															
20. Extension Specialist		3															
21. Environmental Expert		4															
Sub - Total	53	38															
II. Construction Supervision																	
II - 1. Tendering																	
1. Project Engineer (Leader)	2																
2. Mechanical Engineer	2																
3. Cost Estimator	1																
Sub - Total	5																
II - 2. Construction Supervision																	
4. Project Engineer (Leader)	36																
5. Dam Engineer	32																
6. Pump Engineer	12																
7. Canal Engineer		32															
8. Engineering Geologist		12															
9. Soil Mechanical Engineer		8															
10. Mechanical Engineer	3																
11. Economist		2															
12. Surveyor		20															
Sub - Total	93	74															
III. Supporting Services & Management																	
1. Agronomist		10															
2. Extension Service Specialist		12															
3. Water & Farm Management Expert	12																
Sub - Total	12	22															
Total	158	134															

Note: Foreign Consultants Local Consultants

TABLE K-11 ADMINISTRATION COST

1. Personal Cost

(unit : '000 Baht)

a). Detailed Design Stage			
RID Design Staff	8,000 Baht/month x 120 man-month		960
b) Construction Stage			
Project Management Branch			
Project Manager	180,000 Baht/year	x 1 person	180
Assistant Manager	144,000	x 1 person	144
Secretary	72,000	x 1 person	72
Administration Branch			
Section Chief	108,000	x 1 person	108
Accounting Clark	72,000	x 1 person	72
Assistant Accounting Clark	60,000	x 2 person	120
Administration Clark	60,000	x 1 person	60
Typist	60,000	x 2 person	120
Land Acquisition Branch			
Section Chief	108,000	x 1 person	108
Clark	72,000	x 2 person	144
Assistant	60,000	x 2 person	120
Typist	60,000	x 2 person	120
Engineering Branch			
Section Chief	108,000	x 1 person	108
Civil Engineer	96,000	x 2 person	192
Technician	96,000	x 5 person	480
Topo-surveyor	96,000	x 2 person	192
Mechanical Branch			
Driver (vehicles)	84,000	x 2 person	168
Operator (heavy equipment)	84,000	x 2 person	168
Security Guard	36,000	x 3 person	108
Janitor	30,000	x 4 person	120
Sub-total			2,904
	2,904,000 x 4 years		11,616
c) Total			12,576

2. Equipment Cost for Construction Supervision

(unit : '000 Baht)

Description	Q'ty	Unit Rate F/C	Unit Rate L/C	Amount F/C	Amount L/C	Total
Jeep	6	500	-	3,000	-	3,000
Motorcycle	10	45	-	450	-	450
Theodrite	2	70	-	140	-	140
Current Meter	2	45	-	90	-	90
Radio Set	1	150	-	150	-	150
Walkie-Talkie	10	10	-	100	-	100
Automatic Rain Gaug	1	45	-	45	-	45
Personal	2	220	-	440	-	440
Miscellaneous (5 %)			-	221	-	221
Transportation Cost	L.S		50		50	50
Total				4,636	50	4,686

3. Repair and Maintenance Cost

(unit : '000 Baht)

Vehicle Repair	500,000 x 15 % x 6 units	450
Vehicle Fuel	9 Baht/lit. x 5 lit./day x 250 days x 10 unit	113
Building Maintenance	5,095,000 x 5 %	255
Office Supply		100
Total		918
918,000 Baht x 4 years		3,672

4. Grand Total

	F/C	L/C	Total
Personal Cost	-	12,576	12,576
Equipment Cost for Construction Supervision	4,636	50	4,686
Repair and Maintenance Cost	2,252	1,420	3,672
	6,888	14,046	20,934

TABLE K-12 O & M EQUIPMENT COST

Discription	Q'ty	Unit Cost('000B) F/C	L/C	Total	Total ('000B) F/C	L/C	Total
- Moter Grader	2	2,800	-	2,800	5,600	-	5,600
- Bulldozer 3.0t	2	1,212	-	1,212	2,424	-	2,424
- Loader Backhoe Combination	2	2,050	-	2,050	4,100	-	4,100
- Flat Bet Truck	7	630	-	630	4,410	-	4,410
- Pick Up Truck	8	288	-	288	2,304	-	2,304
- Station Wagon 4WD	2	784	-	784	1,568	-	1,568
- Motor Bicycle 145CC	130	44	-	44	5,720	-	5,720
- Diesel Generating Set 15Kw	5	215	-	215	1,075	-	1,075
- Diesel Generating Set 5Kw	5	90	-	90	450	-	450
- ϕ4 Centrifugal Pump	10	38	-	38	380	-	380
- Concrete Mixer 7cu.ft	5	140	-	140	700	-	700
- Air Compressor 15cfm	5	28	-	28	140	-	140
- Back-fill Vibrating Tamper	5	33	-	33	165	-	165
- Concrete Vibrator 1/2"	5	23	-	23	115	-	115
- Hand Tool Set For Field Workshop	6	340	-	340	2,040	-	2,040
- VHF/FM Comunication System	1	750	-	750	750	-	750
- Desk Top Computer	1	300	-	300	300	-	300
- Climeterological System	6	200	-	200	1,200	-	1,200
- Other O&M Equipment	L.S					5,016	5,016
Sub-Total					33,441	5,016	38,457
- Spare Parts	L.S				3,344	502	3,846
Sub-total					36,785	5,518	42,303
Overhead,Profit,Tax					1,659	249	1,908
Total					38,444	5,767	44,211

TABLE K-13 DISBURSEMENT SCHEDULE

Description	1995 F/C	1995 L/C	1995 Total	1996 F/C	1996 L/C	1996 Total	1997 F/C	1997 L/C	1997 Total	1998 F/C	1998 L/C	1998 Total	1999 F/C	1999 L/C	1999 Total	Total F/C	Total L/C	Total Total
1. Civil Works																		
1.1 Preparation Works	-	-	-	1,845	19,189	21,034	-	-	-	-	-	-	-	-	-	1,845	19,189	21,034
1.2 Dam Works	-	-	-	-	-	-	45,152	40,375	85,527	60,203	53,834	114,037	45,152	40,375	85,527	150,507	134,585	285,092
1.3 Pump Facilities	-	-	-	-	-	-	-	-	-	148,691	6,103	154,794	446,073	18,309	464,382	594,765	24,412	619,177
1.4 Canal Works	-	-	-	-	-	-	183,656	160,740	344,396	244,875	214,320	459,194	183,656	160,740	344,396	612,186	535,800	1,147,986
1.5 Resettlement Works	-	-	-	-	-	-	8,610	104,969	113,579	11,480	139,959	151,438	8,610	104,969	113,579	28,699	349,897	378,596
Sub-Total	-	-	-	1,845	19,189	21,034	237,418	306,084	543,502	465,248	414,216	879,464	683,491	324,393	1,007,885	1,388,002	1,063,882	2,451,884
2. On-Farm and Rural Development	-	-	-	-	-	-	93,931	67,186	161,117	125,241	89,581	214,822	93,931	67,186	161,117	313,103	223,952	537,056
3.Land Acquisition	-	-	-	0	33,814	33,814	0	33,814	33,814	-	-	-	-	-	-	0	66,827	66,827
4. Engineering & Administration																		
4.1 Consulting service	19,585	6,724	26,238	19,585	6,724	26,238	19,585	6,724	26,238	19,585	6,724	26,238	19,585	6,724	26,238	97,526	33,622	131,148
4.2 Administration	-	-	-	1,378	2,809	4,187	2,868	4,214	6,288	2,868	4,214	6,288	1,378	2,809	4,187	6,888	14,046	28,934
Sub-Total	19,585	6,724	26,238	20,883	9,534	30,416	21,572	10,938	32,510	21,572	10,938	32,510	20,883	9,534	30,416	104,414	47,668	152,082
5. O&M Equipment	-	-	-	-	-	-	-	-	-	-	-	-	38,444	5,767	44,211	38,444	5,767	44,211
6. Total (1-5)	19,585	6,724	26,238	22,728	61,736	84,464	352,920	417,222	770,142	612,061	514,735	1,126,796	836,749	406,879	1,243,628	1,843,963	1,407,296	3,251,260
7. Physical Contigencies	1,951	672	2,623	2,273	8,174	8,446	35,292	41,722	77,014	61,206	51,473	112,680	83,675	40,688	124,363	184,396	148,730	325,126
8. Total (6-7)	21,456	7,397	28,853	25,001	87,910	92,910	388,212	458,944	847,156	673,267	566,208	1,239,475	920,424	447,567	1,367,991	2,028,360	1,548,026	3,576,386
9. Price Escalation	4,553	1,578	6,123	6,420	17,438	23,859	117,667	139,196	256,773	236,317	138,739	436,056	368,814	179,940	548,154	733,771	536,194	1,269,965
10. Grand Total	26,009	8,966	34,975	31,421	85,349	116,770	505,879	598,058	1,103,929	909,584	764,947	1,674,531	1,289,236	626,987	1,916,145	2,762,131	2,084,220	4,846,350

TABLE K-14 UNIT COST VARIOS WORKS

Description	Unit	F/C	L/C	(Baht) Total
A Dam				
- Stripping	cu.m	10	6	16
- Excavation (Soft Rock)	cu.m	13	4	17
- Excavation (Earth)	cu.m	20	7	27
- Embankment	cu.m	32	12	44
- Drain	cu.m	60	134	194
- Filter	cu.m	100	124	324
- Riprap	cu.m	125	288	413
- Asphalt Pavement	sq.m	600	300	360
- Drilling (46mm)	m	770	330	1,100
- Drilling (66mm)	m	1,750	750	2,500
- Cement For Grout	cu.m	3,200	1,800	5,000
- Permeability Test	set	630	270	900
- Sodding	sq.m	0	22	22
- Rainforced Concrete	cu.m	1,880	2,280	4,160
B Pumping Station				
- Excavation	cu.m	10	6	16
- Embankment	cu.m	21	10	31
- Riprap	cu.m	125	288	413
- Rainforced Concrete	cu.m	1,665	2,035	3,700
- Houses	sq.m	4,000	6,000	10,000
C Canal				
- Stripping	cu.m	10	6	16
- Excavation	cu.m	13	4	17
- Embankment	cu.m	21	10	31
- Drain Filter	cu.m	53	118	171
- Lining Concrete	cu.m	864	1,056	1,920
- Latarite	cu.m	54	126	180
- Sodding	sq.m	0	22	22
- Rainforced Concrete	cu.m	1,665	2,035	3,700
- Steel Pipe	t	24,500	10,500	35,000
- Sand Bed	cu.m	140	50	190

TABLE K-15 LABORER AND MATERIALS COST

Description	Rate (Baht/day)
Laborer	102.15
Skilled-Laborer	102.15
General Foreman	126.10
Carpenter	102.15
Head Carpenter	126.10
Mason	102.15
Head-Mason	126.10
Steel Man	102.15
Head Steel Man	126.10
Welder	126.10
Driver(Light)	115.20
Driver(Heavy)	174.84
Driver(General)	115.20
Mechanic	126.10
Master Mechanic	156.10
Electrician	126.10
Driller	102.15
Plumper	126.10
Batch Plant	126.10
Watch Man	102.15
Janitor	102.15
Surveyor	126.10

Description	Unit	Rate (Baht)
Sand	cu.m	140.00
Gravel	cu.m	380.00
Riprap	cu.m	380.00
Rainforced Concrete (Light)	cu.m	3,257.00
Rainforced Concrete (Medium)	cu.m	3,639.00
Rainforced Concrete (Heavy)	cu.m	4,021.00
Rainforced Concrete (Lining)	cu.m	1,811.00
Laterite	cu.m	146.00
Asphalt	cu.m	113.33
Sod	sq.m	18.50
RC-Pipe ϕ500	m	485.00
RC-Pipe ϕ600	m	530.00
RC-Pipe ϕ700	m	795.00
RC-Pipe ϕ900	m	1,080.00
RC-Pipe ϕ1000	m	1,250.00
RC-Pipe ϕ1200	m	1,755.00
RC-Pipe ϕ1500	m	2,430.00
Steel Bar	kg	14.75
Flat steel Bar	kg	15.40
Steel Pipe	t	35,000.00

TABLE K-16 OPERATION AND MAINTENANCE COST

Description	Annual Cost ('000 Baht)
- Salary and Wage	10,404
- Administration and General Expenditure	1,561
- Pump Operation Cost	14,963
- Equipment Repair & Maintenance Cost	4,421
- Fuel Cost	875
- Office Maintenance Cost	380
Total	32,604

1. Salary and Wage

Position	No. of Staff	Rate (Baht/year)	Total Cost ('000 Baht)
1.1 Project Office			
Project Manager	1	180,000	180
Administration Branch			
- Administration	1	84,000	84
- Accounting	1	72,000	72
- Material	1	60,000	60
- Security and Labour	4	36,000	144
Sub-total	7		360
Enginnering Branch			
- Budget Planning	1	84,000	84
- Pre-Survey	1	60,000	60
- Design	3	60,000	180
Sub-total	5		324
Water Management Branch			
- Water Distribution Management	2	84,000	168
- Irrigation	2	84,000	168
Sub-total	4		336
Mechanical Branch			
- Vehicles	5	72,000	360
- O & M Machinary	2	72,000	144
- Communication	2	60,000	120
Sub-total	9		624
1.2 Section Office (Five Offices)			
- Chief	5	84,000	420
- Administration	5	72,000	360
- Operation			
Irrigation Technician	10	60,000	600
Gate Tender	65	48,000	3,120
Canal Tender	65	48,000	3,120
- Reparing & Maintenance	20	48,000	960
Sub-total	170		8,580
Total			10,404

	('000 Baht)
2. Administration and General Expenditure Cost	
10,404,000 Baht x 0.15	1,561
3. Pump Operation Cost	
(5,460 hrx370 kw + 10,916 hrx880 kw)x1.17 Baht/kwh	13,603
Drainage pump in protected area (10 %)	1,360
Sub-total	14,963
4. Equipment Repair and Maintenance Cost	
44,211 Baht x 0.10	4,421
5. Fuel Cost	
Heavy equipment	
8.5 Baht/lit. x 20 lit./day x 200 days/year x 6 units	204
Truck	
8.5 Baht/lit. x 20 lit./day x 200 days/year x 15 units	510
Vehicle	
9.0 Baht/lit. x 15 lit./day x 300 days/year x 2 units	81
Motor Bicycle and others (10 %)	80
Sub-total	875
6. Office Maintenance Cost	
Building maintenance cost	
6,700,000 x 4 % / year	268
Office Supplies	112
Sub-total	380

ANNEX L. PROJECT ECONOMY

LIST OF TABLES

1. Economic Justification

2. Financial Analysis of Typical Farmers

LIST OF FIGURES

Table L-1-1 Farm-gate Prices of Agricultural Inputs and Outputs

	Items	Unit	Financial	Economic
A. Inputs				
1. Seeds	a) Paddy (w/o)	B/kg	3.20	3.40
	b) Paddy (w)	"	6.50	6.00
	c) Cassava (w/o)	"	0.05	0.05
	d) Kenaf (w/o)	"	28.33	26.06
	e) Groundnuts (w)	"	11.64	10.70
	f) Soybeans (w)	"	15.00	13.80
	g) Watermelon (w)	"	62.00	57.00
	h) Chilli (w)	"	250.00	230.00
	i) Vegetables (w/o)*1	"	49.00	45.08
2. Fertilizer				
	a) 13-13-21	"	5.40	
	b) 15-15-15	"	6.30	
	c) 16-16-8	"	5.40	
	d) 45-0-0	"	5.20	5.40
	e) Manure	"	1.50	1.50
	f) Lime	"	0.30	0.30
3. Animal for land preparation		B/day	95.00	95.00
4. Machinery for land preparation		B/rai	100.00	95.00
B. Agricultural Outputs				
	a) Paddy	B/kg	3.40	4.20
	b) Cassava	"	0.60	0.60
	c) Kenaf	"	4.80	4.80
	d) Groundnuts	"	7.10	11.70
	e) Soybean	"	7.30	7.90
	f) Watermelon	"	0.90	0.90
	g) Chilli	"	7.00	7.00
	h) Vegetables	"	7.10	7.10
	i) Fruit *2	"	4.00	4.00
C. Other	a) Freshwater Fish	"	16.00	16.00

Table L-1-2 Economic Price of Paddy Rice

Description	Unit	Economic Price
1) IBRD Projection Price in 2000 in 1990 current price (white rice, 5% broken, FOB Bangkok)	US$/MT	406
2) Converted to Thai Baht (US$1.00=25 Baht)		10,150
3) Average exported price *1		8,323
4) Port charges *2		175
5) Exporter's margin		416
6) Wholesale price		7,732
7) Transport(Port-Project Area) *3		258
8) Wholesaler's margin		387
9) Ex-mill price		7,087
10) Processing (%)		66
11) Miller's margin		234
12) Mill-gate price		4,443
13) Local merchant's margin		222
14) Transport (Farm-Mill)		12
15) Farm-gate price		4,209

Note: *1 Grade differential of average exported rice price from non-glutinous white rice 5% broken is 82%.

*2 0.92 of conversion factor for port charge is applied to convert to economic price.

*3 0.92 of conversion factor for transport is applied to convert to economic price.

Table L-1-3 Economic Price of Soybeans

Description	Unit	Economic Price
1) IBRD Projection Price in 2000 in 1990 current price (soybeans, CIF Rotterdam)	US$/MT	310
2) Ocean freight		45
3) CIF, Bangkok		355
4) Converted to Thai Baht (US$1.00=25 Baht)		8,875
5) Port charge *1		175
6) Importer's margin		444
7) Wholesale price		9,494
8) Transport (Port-Project Area) *2		258
9) Wholesaler's margin		475
10) Ex-mill price		8,761
11) Local merchant's margin		876
12) Transport (Farm-Mill)		12
13) Farm-gate price		7,873

Note: *1 0.92 of conversion factor for port charge is applied to convert to economic price.

*2 0.92 of conversion factor for transport is applied to convert to economic price.

Table L-1-4 Economic Price of Groundnuts

Description	Unit	Economic Price
1) IBRD Projection Price in 2000 in 1990 current price (groundnuts, CIF Rotterdam)	US$/MT	784
2) Ocean freight		45
3) CIF, Bangkok		829
4) Converted to Thai Baht (US$1.00=25 Baht)		20,725
5) Port charge *1		175
6) Importer's margin		1,636
7) Wholesale price		21,936
8) Transport (Port-Project Area) *2		258
9) Wholesaler's margin		1,097
10) Shelled nut price		20,581
11) Unshelled nut price *3		14,407
12) Shelling cost *4		662
13) Shelling factory's margin		720
14) Input price of groundnuts at factory		13,025
15) Local merchant's margin		1,305
16) Transport (Farm-Factory)		12
17) Farm-gate price		11,708

Note: *1 0.92 of conversion factor for port charge is applied to convert to economic price.

*2 0.92 of conversion factor for transport is applied to convert to economic price.

*3 The shelling ratio of bunch groundnuts is 70 percent.

*4 Five percent of unshelled nuts cost, 0.92 of conversion factor is applied to convert to economic price.

Table L-1-5 Economic Price of Fertilizer

Description	Unit	Urea	DAP	TSP	PC *1
1) IBRD Projection Price in 2000 in 1990 current price	US$/ton	120	143	114	73
2) Ocean freight		20	50	50	45
3) CIF, Bangkok		140	193	164	118
4) Converted to Thai Baht (US$1.00=25 Baht)		3,500	4,825	4,100	2,950
5) Port charge *2		175	175	175	175
6) Importer's margin		350	482	410	295
7) Wholesale price		4,025	5,482	4,685	3,420
8) Transport (Port-Project Area) *3		258	258	258	258
9) Retailer's margin		400	548	469	342
10) Transport (Farm-Shop)		12	12	12	12
11) Farm-gate price		4,695	6,300	5,424	4,032

Note: *1 Potassium Choloride
*2 0.92 of conversion factor for port charge is applied to convert to economic price.
*3 0.92 of conversion factor for transport is applied to convert to economic price.

Table L-1-6 Economic Labor Wage

1. Monthly Fam Labor Requirement per Ha *1

Unit: man-day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Total Requirement	0.69	0.56	0.56	1.06	1.94	13.00	17.31	4.63	3.25	10.94	19.44	2.69

2. Total Monthly Requirement per Farm *2

Unit: man-day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Total Requirement per Farm	3.23	2.62	2.62	4.96	9.08	60.84	81.01	21.67	15.21	51.20	90.98	12.59

3. Percentage of Potential Full Employment (Monthly labor supply *3=100)

Unit: man-day

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
5.4	4.4	4.4	8.3	15.1	101.4	135.0	36.1	25.4	85.3	151.6	21.0

4. Economic Wage Rate (Baht/man-day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
30	30	30	30	31	40	43	33	32	38	45	32	35

Note: *1 Farm survey in the Project Area
*2 Average sample farm in the Project Area
*3 Monthly labor supply of the farm is considered 60 man-day

Age class	Persons	Day/M	Total man-day
16 - 20	1	10	10
21 - 60	2	25	50
Total	3		60

Table L-1-7 Crop Budgets per Hectare (Economic)

Without Project

Unit: Baht

Crop	Yield (kg/ha)	U/Price (Baht/kg)	G. Income (A)	Production Cost							N.P.V (B)	B/A
				Seeds	Fertil.	Chem.	Labor	D.Animal	Others	Total		
Paddy	1,250	4.2	5,250	105	557	11	2,520	59	353	3,605	1,645	31%
Cassava	13,125	0.6	7,875	339	820	0	4,638	30	324	6,151	1,724	22%
Kenaf	1,581	4.8	7,589	244	675	0	4,900	0	326	6,145	1,444	19%
Vegetables	6,875	7.1	48,813	845	3,637	10,637	13,125	1,187	1,565	30,996	17,817	36%
Fruit	4,675	3.0	14,025	0	810	3,680	5,031	50	569	10,140	3,885	28%

Note: Vegetables are represented by string bean.
Fruit is represented by mango(kaeo variety as traditional one).

With Project

Unit: Baht

Crop	Yield (kg/ha)	U/Price (Baht/kg)	G. Income (A)	Production Cost							N.P.V (B)	B/A
				Seeds	Fertil.	Chem.	Labor	Machinery	Others	Total		
Paddy	3,438	4.2	14,440	218	2,025	46	2,253	288	515	5,345	9,095	63%
Groundnut	1,563	11.7	18,287	1,338	2,350	949	2,691	288	430	8,046	10,241	56%
Soybean	1,250	7.9	9,875	828	1,219	949	2,778	293	323	6,390	3,485	35%
Watermelon	25,000	0.9	22,500	178	3,750	1,403	6,672	575	677	13,255	9,245	41%
Chilli	15,625	7.0	109,375	144	11,775	978	49,219	690	3,492	66,298	43,077	39%
Vegetables	9,375	7.1	66,563	844	1,313	12,852	15,203	230	1,631	32,073	34,490	52%
Fruit	9,375	4.0	37,500	0	4,250	4,830	4,047	2,300	800	16,227	21,273	57%

Note: Vegetables and fruit are represented by string bean and mango respectively.

Table L-1-8(1) Benefits from Crop Production(Economic)

1. Without Project

Crop	Planted Area (ha)	Production Value (Baht)	Production Cost (Baht)	Net Income (Baht)
Paddy	31,428	164,997,000	113,297,940	51,699,060
Cassava	906	7,134,750	5,572,806	1,561,944
Kenaf	2,164	16,422,163	13,297,780	3,124,383
Vegetables	138	6,736,125	4,277,448	2,458,677
Fruit	362	5,077,050	3,670,680	1,406,370
Fallow	1,502	0	0	0
Total	36,500	200,367,088	140,116,654	60,250,434

2. With Project - Type-I

Crop	Planted Area (ha)	Production Value (Baht)	Production Cost (Baht)	Net Income (Baht)
Paddy	32,750	472,896,900	175,048,750	297,848,150
Groundnut	3,417	62,487,021	27,493,182	34,993,839
Soybean	1,122	11,079,750	7,169,580	3,910,170
Watermelon	357	8,032,500	4,732,035	3,300,465
Chilli	51	5,578,125	3,381,198	2,196,927
Vegetables	153	10,184,063	4,907,169	5,276,894
Fruit	1,250	10,940,000	20,283,750	-9,343,750
Total	39,100	581,198,358	243,015,664	338,182,694

2. With Project - Type-II

Crop	Planted Area (ha)	Production Value (Baht)	Production Cost (Baht)	Net Income (Baht)
Paddy	31,700	457,735,320	169,436,500	288,298,820
Groundnut	3,757	68,704,635	30,228,822	38,475,813
Soybean	1,122	11,079,750	7,169,580	3,910,170
Watermelon	357	8,032,500	4,732,035	3,300,465
Chilli	51	5,578,125	3,381,198	2,196,927
Vegetables	1,203	80,074,688	38,583,819	41,490,869
Fruit	1,250	46,875,000	20,283,750	26,591,250
Total	39,440	678,080,017	273,815,704	404,264,313

Table L-1-8(2) Benefits from Crop Production

1. Crop Production Value With Project

Crop	Yr.	Yield (kg/ha)	Farmgate Price(B)	Value (B)	Type-I Value(B)	Type-II Value(B)
Paddy	w/o	1,250	4.2	5,250	171,937,500	
	1	1,688	4.2	7,090	232,184,400	457,735,320
	2	2,125	4.2	8,925	292,293,750	457,735,320
	3	2,563	4.2	10,765	352,540,650	457,735,320
	4	3,000	4.2	12,600	412,650,000	457,735,320
	5	3,438	4.2	14,440	472,896,900	457,735,320
Groundnuts	1	1,356	11.7	15,865	54,211,388	68,704,635
	2	1,406	11.7	16,450	56,210,333	68,704,635
	3	1,450	11.7	16,965	57,969,405	68,704,635
	4	1,500	11.7	17,550	59,968,350	68,704,635
	5	1,563	11.7	18,287	62,487,021	68,704,635
Soybean	1	1,150	7.9	9,085	10,193,370	11,079,750
	2	1,175	7.9	9,283	10,414,965	11,079,750
	3	1,200	7.9	9,480	10,636,560	11,079,750
	4	1,225	7.9	9,678	10,858,155	11,079,750
	5	1,250	7.9	9,875	11,079,750	11,079,750
Watermelon	1	20,000	0.9	18,000	6,426,000	8,032,500
	2	21,250	0.9	19,125	6,827,625	8,032,500
	3	22,500	0.9	20,250	7,229,250	8,032,500
	4	23,750	0.9	21,375	7,630,875	8,032,500
	5	25,000	0.9	22,500	8,032,500	8,032,500
Chilli	1	14,125	7.0	98,875	5,042,625	5,578,125
	2	14,500	7.0	101,500	5,176,500	5,578,125
	3	14,875	7.0	104,125	5,310,375	5,578,125
	4	15,250	7.0	106,750	5,444,250	5,578,125
	5	15,625	7.0	109,375	5,578,125	5,578,125
Vegetables (String bean)	w/o	6,875	7.1	48,813	7,468,313	
	1	7,375	7.1	52,363	8,011,463	65,164,688
	2	7,875	7.1	55,913	8,554,613	68,892,188
	3	8,375	7.1	59,463	9,097,763	72,619,688
	4	8,875	7.1	63,013	9,640,913	76,347,188
	5	9,375	7.1	66,563	10,184,063	80,074,688
Fruit (Mango)	w/o					
	1					
	2					
	3					
	4	375	4.0	1,500	1,875,000	46,875,000
	5	2,188	4.0	8,752	10,940,000	46,875,000
	6	3,125	4.0	12,500	15,625,000	46,875,000
	7	6,250	4.0	25,000	31,250,000	46,875,000
	8	6,250	4.0	25,000	31,250,000	46,875,000
	9	6,250	4.0	25,000	31,250,000	46,875,000
	10	6,250	4.0	25,000	31,250,000	46,875,000
	11	9,375	4.0	37,500	46,875,000	46,875,000

2. Crop Production Value Without Project

Crop	Yr.	Yield (kg/ha)	Farmgate Price(B)	Value (B)	A-I Value(B)
Paddy		1,250	4.2	5,250	164,997,000
Cassava		13,125	0.6	7,875	7,134,750
Kenaf		1,581	4.8	7,589	16,422,163
Vegetables		6,875	7.1	48,813	6,736,125
Fruit		4,675	3.0	14,025	5,077,050

Table L-1-8(3) Production Cost

1. Production Cost With Project

Type-I

Crop	Area (ha)	Cost/ha (B)	Total Cost (B)
Paddy	32,750	5,345	175,048,750
Groundnut	3,417	8,046	27,493,182
Soybean	1,122	6,390	7,169,580
Watermelon	357	13,255	4,732,035
Chilli	51	66,298	3,381,198
Vegetables	153	32,073	4,907,169
Fruit	1,250	16,227	20,283,750
Fruit-inv		8,458	10,572,500
TOTAL	39,100		

Type-II

Crop	Area (ha)	Cost/ha (B)	Total Cost (B)
Paddy	31,700	5,345	169,436,500
Groundnut	3,757	8,046	30,228,822
Soybean	1,122	6,390	7,169,580
Watermelon	357	13,255	4,732,035
Chilli	51	66,298	3,381,198
Vegetables	1,203	32,073	38,583,819
Fruit	1,250	16,227	20,283,750
TOTAL	39,440		

2. Production Cost Without Project

Crop	Area (ha)	Cost/ha (B)	Total Cost (B)
Paddy	31,428	3,605	113,297,940
Cassava	906	6,151	5,572,806
Kenaf	2,164	6,145	13,297,780
Vegetables	138	30,996	4,277,448
Fruit	362	10,140	3,670,680
TOTAL	34,998		

Table L-1-9 Benefits from Freshwater Fish Culture

1. Freshwater Fish Raising in Paddy Fields

Unit: Baht

Item	Estimation	
	Financial	Economic
(1) Cost of fry		
Fry 10,000 m2 x 2 frys x 0.1 Baht/fry =	2,000	1,840
(2) Labor cost		
4 man-day x 40 Baht/day =	160	140
- Receiving fry: 1 day x 2 persons = 2 man-day		
- Transplanting: 1 day x 2 persons = 2 man-day		
Total	2,160	1,980
(3) Production cost per ha (Baht/ha)	2,160	1,980
(4) Production value per ha		
500 kg/ha x 16 Baht/kg =	8,000	8,000
- Yield: 500 kg/ha		
(5) Net production value per ha	5,840	6,020
(6) Production cost in raising fields		
(3) x 5,380 ha =	11,620,800	10,652,400
(7) Production value in raising fields		
(4) x 5,380 ha =	43,040,000	43,040,000
(8) Net production value in raising fields		
(5) x 5,380 ha =	31,419,200	32,387,600

2. Freshwater Fish Raising in Villege Pond

Unit: Baht

Item	Estimation	
	Financial	Economic
A. Fixed cost		
(1) Salary for manager and assistants of committee	408,000	367,200
- Assistant : 500 Baht/month x 12 months x 68		
(2) Depreciation expense for seine net	34,000	30,600
- Seine net : 5,000 Baht x 68 units/ 10 years		
(3) Others	22,100	19,890
[(1)+(2)] x 0.05		
Sub-total(a)	464,100	417,690
B. Variable cost		
(1) Cost of fry (Baht/ha)	4,000	3,680
Fry 10,000 m2 x 2 frys x 0.1 Baht/fry x 2 times =		
(2) Labor cost (Baht/ha)	320	280
8 man-day x 40 Baht/day =		
- Receiving fry: 2 day x 2 persons = 4 man-day		
- Transplanting: 2 day x 2 persons = 4 man-day		
- Sub-total(Baht/ha)(b)	4,320	3,960
- Production cost: (a)+(b)x8 ha	498,660	449,370
- Production value	1,024,000	1,024,000
4,000 kg/ha x 16 Baht/kg x 8 ha x 2 times =		
- Yield: 4,000 kg/ha x 2 times		
- Net production value	525,340	574,630

3. Freshwater Fish Culture in Reservoir

Unit: Baht

Item	Estimation	
	Financial	Economic
A. Fixed cost		
(1) Salary for manager and assistants of committee	60,000	60,000
- Manager : 2,000 Baht/month x 12 months x 1		
- Assistant : 1,000 Baht/month x 12 months x 3		
(2) Depreciation expense for seine net	18,000	16,920
- Seine net : 15,000 Baht x 6 units/5 years		
(3) Others	3,900	3,846
[(1)+(2)] x 0.05		
Sub-total	81,900	80,766
B. Variable cost		
(1) Labor cost		
7,200 man-day x 40 Baht/day =	288,000	252,000
- Harvesting: 12 months x 3 times x 200 persons		
(2) Others		
(1) x 0.05	14,400	12,600
Sub-total	302,400	264,600
Total	384,300	345,366
- Production cost	384,300	345,366
- Production value		
150 kg/ha x 16 Baht/kg x 567 ha =	1,360,800	1,360,800
- Yield: 150 kg/ha		
- Net production value	976,500	1,015,434

Note; Price of fish : Tilapias ..... 11 Baht/kg
Common Carp ... 23 Baht/kg
Local Carp ... 15 Baht/kg
Average 16 Baht/kg

Net production value

Unit: Baht

	Estimation	
	Financial	Economic
Paddy Fields	31,419,200	32,387,600
Villege Pond	525,340	574,630
Reservoir	976,500	1,015,434
TOTAL	32,921,040	33,977,664

Table L-1-10 Domestic Water Use Benefits

1. Water Consumption of Household

Item	Labor Requirement(hr/family) Drinking Water	Other Water	Total Daily	Total Annual	Annual Benefit (B/family)
Without Project	0.56	0.69	1.25	207.5	
With Project	0.19	0.44	0.63	104.6	257

Note: 1. Expected benefit period of domestic water use is 166 days, from December to the middle of May.

2. Annual benefit per family is estimated at 257 Baht.
(207.5 - 104.6) x 2.5 Baht/hr = 257 Baht

3. Average water consumption per family
45 litre/day/person x 5.9 = 265 litre/family
(water requirement per person, ARD) (average family size of sample farm)

4. Without Project: Total of water source is assumed in dry season.
With Project : Only deep and shallow well is assumed in wet season.

- Benefit from domestic water use:
7,970 families x 257 Baht = 2,048,290 Baht
(benefitial family in future-2000)

2, Drinking Water for Animal

	Labor Requirement			Annual Benefit (B/head)
	hr/ton	B/ton	B/head/year	
Without Project	2.83	7.08	58.8	
With Project	1.81	4.53	37.6	21.2

Note: 1. Animal is assumed to be baffalo.
2. Drinking water for animal is considered equally other domestic water for family.
3. Expected benefit period of drinking water for animal is considered the same to water consumption of family.
4. Water consumption of animal(baffalo): 50 litre/day

- Benefit from drinking water for animal:
20,722 head x 21.20 Baht = 439,306 Baht/year
(No. of head
in future-2000)

3. Domestic Water Use Benefits

2,048,290 Baht + 439,306 Baht = 2,487,596 Baht/year

Table L-1-11 Benefits by Saving Cost of Transportation

1. Condition

	Capacity	Velocity	Transported Distance
Without Project	2.0 ton truck	15 km	6 km
With Project	4.5 ton truck	30 km	2 km

2. Benefit and Cost

Description	Without Project	With Project
Capacity (90%)	1.80 ton	4.05 ton
Traveling hour	0.40 hour	0.07 hour
Traveling hour per ton	0.22 hour	0.02 hour
Depreciation	67.20 Baht	119.00 Baht
Fuel	22.05 Baht	66.60 Baht
Driver	12.50 Baht	12.50 Baht
Operating cost per hour	101.75 Baht	198.10 Baht
Transporting cost per ton	22.39 Baht	3.96 Baht

Benefit: 22.39 - 3.96 = 18.43 Baht/ton

3. Saving Benefits

Year	Production(ton)	Farm Input(ton)	Total(ton)	Benefits (1000 B)
1	70,145	38,268	108,413	1,998
2	85,247	38,268	123,515	2,276
3	100,312	38,268	138,580	2,554
4	115,833	38,268	157,920	2,910
5	133,229	38,268	175,316	3,231
6	144,834	42,087	186,921	3,445
7	145,869	42,087	187,956	3,464
8	146,903	42,087	188,990	3,483
9	147,938	42,087	190,025	3,502
10	148,978	42,087	191,065	3,521
11	160,697	42,087	202,784	3,737

Table L-1-12 Minus Benefits

(Crop production in the dam reservoir without project)

1. Net Production Value

Item	Paddy	Cassava	Kenaf
Yield	1,250 kg	13,125 kg	1,581 kg
Gross Income (A)	4,250 Baht	7,875 Baht	7,589 Baht
Production Cost (B)	3,885 Baht	6,813 Baht	6,840 Baht
N.P.V (A-B)	365 Baht	1,062 Baht	749 Baht
B/A	19 %	13 %	10 %

Note: Prices are based on financial price.

2. Minus Benefits

Crop	Planted Area(ha)	N.P.V(Baht)
Paddy	1,930	704,450
Cassava	100	107,600
Kenaf	140	106,260
Total	2,170	918,310

Minus benefits (Crop production in the dam reservoir without project)
= 804,440 Baht/year

Table L-1-13 Incremental Benefits

Unit: 1,000 Baht

Year	Crop Benefits	Fishery Benefits	Other Benefits	Minus Benefits	Incremental Benefits
1	29,678	23,784	4,481	918	57,025
2	88,345	28,880	4,759	918	121,066
3	151,664	33,977	5,037	918	189,760
4	207,224	33,977	5,393	918	245,676
5	280,367	33,977	5,714	918	319,140
6	300,288	33,977	5,928	918	339,275
7	319,641	33,977	5,947	918	358,647
8	323,368	33,977	5,966	918	362,393
9	327,096	33,977	6,004	918	366,159
10	330,823	33,977	6,220	918	370,102
11	346,448	33,977	6,220	918	385,727

Table L-1-14 Project Cost

Unit: 1,000 Baht

Description	F/C	L/C	Total
1. Civil Works	1,388,002	999,727	2,387,729
2. Land Acquisition	0	60,745	60,745
3. Consulting Services	97,526	33,622	131,148
4. Administration	6,888	14,046	20,934
5. O&M Equipment	38,444	5,651	44,095
6. On-farm Cost	313,103	197,078	510,181
7. Total (1-6)	1,843,963	1,310,869	3,154,832
8. Physical Contingencies a/	184,396	131,087	315,483
9. Physical Contingencies b/	153,086	111,379	264,465
10. Grand Total with On-farm Cost	2,028,359	1,441,956	3,470,315
11. Grand Total without On-farm Cost	1,683,946	1,225,170	2,909,116

Note: a/ with On-farm Cost b/ without On-farm Cost

Table L-1-15 Disbursement Schedule of Project Cost

1. Grand Total with On-farm Cost

Unit: 1,000 Baht

Item	1st year (1995)	2nd year (1996)	3rd year (1997)	4th year (1998)	5th year (1999)	Total
F/C	21,456	25,000	388,212	673,267	920,424	2,028,359
L/C	7,397	65,005	426,644	526,477	416,434	1,441,958
Total	28,853	90,005	814,856	1,199,745	1,336,858	3,470,317

2. Grand Total without On-farm Cost

Item	1st year (1995)	2nd year (1996)	3rd year (1997)	4th year (1998)	5th year (1999)	Total
F/C	21,456	25,000	284,888	535,502	817,100	1,683,946
L/C	7,397	65,005	361,608	439,763	351,398	1,225,171
Total	28,853	90,005	646,496	975,265	1,168,498	2,909,117

Table L-1-16 Operation and Maintenance Cost

Description	Annual Cost (1000 Baht)
1. Salary and Wage	10,404
2. Administration and General Expenditure	1,561
3. Pump Opration Cost	13,467
4. Equipment Repair & Maintanance Cost	4,421
5. Fuel Cost	875
6. Office Maintenance Cost	380
7. Total	31,108

Table L-1-17(1) Estimation of EIRR (Without On-farm Cost)

Unit:1,000 B

Year	Project Cost				Incremental Benefits	Return
	Capital	O/M Cost	Replace. Cost	Total		
1	28,853			28,853	0	-28,853
2	90,005			90,005	0	-90,005
3	646,496			646,496	0	-646,496
4	975,265			975,265	0	-975,265
5	1,168,498			1,168,498	0	-1,168,498
6		31,108		31,108	57,025	25,917
7		31,108		31,108	121,066	89,958
8		31,108		31,108	189,760	158,652
9		31,108		31,108	245,676	214,568
10		31,108		31,108	319,140	288,032
11		31,108		31,108	339,275	308,167
12		31,108		31,108	358,647	327,539
13		31,108		31,108	362,393	331,285
14		31,108		31,108	366,159	335,051
15		31,108		31,108	370,102	338,994
16		31,108		31,108	385,727	354,619
17		31,108		31,108	385,727	354,619
18		31,108		31,108	385,727	354,619
19		31,108		31,108	385,727	354,619
20		31,108		31,108	385,727	354,619
21		31,108		31,108	385,727	354,619
22		31,108		31,108	385,727	354,619
23		31,108		31,108	385,727	354,619
24		31,108		31,108	385,727	354,619
25		31,108		31,108	385,727	354,619
26		31,108		31,108	385,727	354,619
27		31,108		31,108	385,727	354,619
28		31,108		31,108	385,727	354,619
29		31,108		31,108	385,727	354,619
30		31,108	492,888	523,996	385,727	-138,269
31		31,108		31,108	385,727	354,619
32		31,108		31,108	385,727	354,619
33		31,108		31,108	385,727	354,619
34		31,108		31,108	385,727	354,619
35		31,108		31,108	385,727	354,619
36		31,108		31,108	385,727	354,619
37		31,108		31,108	385,727	354,619
38		31,108		31,108	385,727	354,619
39		31,108		31,108	385,727	354,619
40		31,108		31,108	385,727	354,619
41		31,108		31,108	385,727	354,619
42		31,108		31,108	385,727	354,619
43		31,108		31,108	385,727	354,619
44		31,108		31,108	385,727	354,619
45		31,108		31,108	385,727	354,619
46		31,108		31,108	385,727	354,619
47		31,108		31,108	385,727	354,619
48		31,108		31,108	385,727	354,619
49		31,108		31,108	385,727	354,619
50		31,108		31,108	385,727	354,619
51		31,108		31,108	385,727	354,619
52		31,108		31,108	385,727	354,619
53		31,108		31,108	385,727	354,619
54		31,108		31,108	385,727	354,619
55		31,108		31,108	385,727	354,619
Total	2,909,117	1,555,400	492,888	4,957,405	18,158,323	13,200,918
					EIRR =	8.5%

Table L-1-17(2) Estimation of EIRR (With On-farm Cost)

Unit:1,000 B

Year	Project Cost				Incremental Benefits	Return
	Capital	O/M Cost	Replace. Cost	Total		
1	28,853			28,853	0	-28,853
2	90,005			90,005	0	-90,005
3	814,856			814,856	0	-814,856
4	1,199,745			1,199,745	0	-1,199,745
5	1,336,858			1,336,858	0	-1,336,858
6		31,108		31,108	57,025	25,917
7		31,108		31,108	121,066	89,958
8		31,108		31,108	189,760	158,652
9		31,108		31,108	245,676	214,568
10		31,108		31,108	319,140	288,032
11		31,108		31,108	339,275	308,167
12		31,108		31,108	358,647	327,539
13		31,108		31,108	362,393	331,285
14		31,108		31,108	366,159	335,051
15		31,108		31,108	370,102	338,994
16		31,108		31,108	385,727	354,619
17		31,108		31,108	385,727	354,619
18		31,108		31,108	385,727	354,619
19		31,108		31,108	385,727	354,619
20		31,108		31,108	385,727	354,619
21		31,108		31,108	385,727	354,619
22		31,108		31,108	385,727	354,619
23		31,108		31,108	385,727	354,619
24		31,108		31,108	385,727	354,619
25		31,108		31,108	385,727	354,619
26		31,108		31,108	385,727	354,619
27		31,108		31,108	385,727	354,619
28		31,108		31,108	385,727	354,619
29		31,108		31,108	385,727	354,619
30		31,108	492,888	523,996	385,727	-138,269
31		31,108		31,108	385,727	354,619
32		31,108		31,108	385,727	354,619
33		31,108		31,108	385,727	354,619
34		31,108		31,108	385,727	354,619
35		31,108		31,108	385,727	354,619
36		31,108		31,108	385,727	354,619
37		31,108		31,108	385,727	354,619
38		31,108		31,108	385,727	354,619
39		31,108		31,108	385,727	354,619
40		31,108		31,108	385,727	354,619
41		31,108		31,108	385,727	354,619
42		31,108		31,108	385,727	354,619
43		31,108		31,108	385,727	354,619
44		31,108		31,108	385,727	354,619
45		31,108		31,108	385,727	354,619
46		31,108		31,108	385,727	354,619
47		31,108		31,108	385,727	354,619
48		31,108		31,108	385,727	354,619
49		31,108		31,108	385,727	354,619
50		31,108		31,108	385,727	354,619
51		31,108		31,108	385,727	354,619
52		31,108		31,108	385,727	354,619
53		31,108		31,108	385,727	354,619
54		31,108		31,108	385,727	354,619
55		31,108		31,108	385,727	354,619
Total	3,470,317	1,555,400	492,888	5,518,605	18,158,323	12,639,719
					EIRR =	7.3%

Table L-2-1 Estimation of Loss and Profit Statement of Typical Farmers

CROPPING PATTERN: TYPE-I (5th year after completion of the project implementation)

Description	Left Bank Area		Right Bank Area			
			Upper Area		Lower Area	
	Without	With	Without	With	Without	With
Cultivated Area (ha)	4.80	5.59	4.62	5.28	4.57	5.29
Production Value	32,072	68,643	23,035	64,323	23,595	66,568
Production Cost	6,527	22,059	6,424	20,322	4,988	21,574
Living Expenses	24,000	24,000	18,855	18,855	17,259	17,259
Interest (credit)	0	2,020	0	1,834	0	2,185
O/M Charge (on-farm)	0	1,574	0	1,805	0	1,717
Return (profit)	1,545	18,990	-2,244	21,507	1,348	23,833

CROPPING PATTERN: TYPE-II (5th year after TYPE-I)

Description	Left Bank Area		Right Bank Area			
			Upper Area		Lower Area	
	Without	With	Without	With	Without	With
Cultivated Area (ha)	4.80	5.59	4.62	5.33	4.57	5.36
Production Value	32,072	79,761	23,035	70,249	23,595	68,971
Production Cost	6,527	27,933	6,424	23,524	4,988	23,000
Living Expenses	24,000	24,000	18,855	18,855	17,259	17,259
Interest (credit)	0	2,268	0	2,022	0	2,179
O/M Charge (on-farm)	0	1,574	0	1,805	0	1,717
Return (profit)	1,545	23,986	-2,244	24,042	1,348	24,816

Note: - Land holding

Left bank area ..... 3.93 ha
Right bank area
Upper area ..... 4.51 ha
Lower area ..... 4.29 ha

Table L-2-2(1) Estimation of Cash Flow of Typical Farmer (Left Bank Area)

Unit: 1,000 Baht

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
Initial Fund	0	-9,578	-12,450	-9,703	-500	17,273	39,911	65,670	92,128	119,284	147,139
Farm Credit (Medium)	1,217	2,208	2,208	2,208	2,208	2,208	2,208	2,208	2,208	2,208	2,208
Farm Credit (Short)	13,299	13,299	13,299	13,299	13,299	17,052	17,052	17,052	17,052	17,052	17,052
Sub-total (A)	14,516	15,507	15,507	15,507	15,507	19,260	19,260	19,260	19,260	19,260	19,260
Required Fund (Stage I)											
Production Cost	13,299	13,299	13,299	13,299	13,299	17,052	17,052	17,052	17,052	17,052	17,052
Living Expenses	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Sub-total (B)	25,299	25,299	25,299	25,299	25,299	29,052	29,052	29,052	29,052	29,052	29,052
Farm Income											
Sub-total (C)	26,539	33,420	40,301	47,181	54,062	62,067	62,765	63,464	64,162	64,861	64,861
Interest (Short)	831	831	831	831	831	1,066	1,066	1,066	1,066	1,066	1,066
Repayment (Short)	13,299	13,299	13,299	13,299	13,299	17,052	17,052	17,052	17,052	17,052	17,052
Sub-total (D)	14,130	14,130	14,130	14,130	14,130	18,118	18,118	18,118	18,118	18,118	18,118
Balanced Carried Forward	1,626	-80	3,929	13,556	29,640	51,430	74,766	101,224	128,380	156,235	184,090
Farm Credit (Short)											
Sub-total (E)	4,424	4,424	4,424	4,424	4,424	4,647	4,647	4,647	4,647	4,647	4,647
Required Fund (Stage II)											
Production Cost	6,432	7,644	7,644	7,644	7,644	7,887	7,887	7,887	7,887	7,887	7,887
Living Expenses	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Sub-total (F)	18,432	19,644	19,644	19,644	19,644	19,887	19,887	19,887	19,887	19,887	19,887
Farm Income											
Sub-total (G)	9,231	9,581	9,840	10,559	12,248	13,352	15,552	15,552	15,552	15,552	17,752
Term-end Fund											
O/M Charge	1,574	1,574	1,574	1,574	1,574	1,574	1,574	1,574	1,574	1,574	1,574
Interest (Short)	277	277	277	277	277	290	290	290	290	290	290
Repayment (Short)	4,424	4,424	4,424	4,424	4,424	4,647	4,424	4,424	4,424	4,424	4,424
Interest (Medium)	152	456	760	912	912	912	912	912	912	912	912
Repayment (Medium)	0	0	1,217	2,208	2,208	2,208	2,208	2,208	2,208	2,208	2,208
Sub-Total (H)	6,427	6,731	8,252	9,395	9,395	9,631	9,408	9,408	9,408	9,408	9,408
Balanced Carried Forward	-9,578	-12,450	-9,703	-500	17,273	39,911	65,670	92,128	119,284	147,139	177,194

Note: Stage I ... Wet Season
Stage II .. Dry Season