Table E-1 Factors Accounting for Preparing a Reforestation Program Involving Smallholders

Factor	Possible Interventions
1. Competition for land	
i) Competition for forest land	- Intercrop forest trees and cash crops (agroforestry systems) - Allocate land rationally between tree and cash crops - Offer improved benefits to local communities including : forest crop cultivation/forest industries employment; secondary forest product income; social infrastructure.
ii) Competition for crop/grazing land to reforest	- Plant trees on : roadsides, river banks, field boundaries and other unused areas; marginal soil areas; erodible areas unsuitable for crop production or grazing - Improve productivity on more arable areas in order to release land for tree growing - Plant multiple-use species or mixtures of species to increase productivity - Intercrop trees with other crops - Introduce alternative sources of supplementary income
2. Delayed returns from trees growing	
i) Output from trees will not meet immediate needs	- Plant multiple-use species, or mixture for some early return - Provide financial support during establishment periods: low-in-terest loans, grants, subsidies, salaried employment, etc. - Introduce of expand complementary nonforestry sources of income
ii) The risk that the producer will not benefit from harvested trees	- Ensure security of tenure of land use for tree crops
iii) The risk in selling of tree products	- Establish marketing network with guaranteed prices for standard quality wood
3. Lack of a tradition of tree planting (unfamiliarity with technology lack of understanding direct & indirect benefits of forest, inappropriate institutional framework)	- Provision of guidance and support through extension services: of education of the people, technical advice and technical inputs, grassroots training - Demonstration and pilot projects - Encourage producer groupings (cooperatives, etc.) - Legislation and regulation revisions

Table E-2 Planting Area and Guidelines in Hedgerow Intercropping Scheme

The target area for the hedgerow intercropping is the farmland on the upper area, 200-230 m of elevation. The agricultural crops are mostly upland rice, cassava, maize, sugarcane, mung bean and so on. After the appropriate site is selected, the establishment can be done by the following steps.

STEP 1 : DEVELOP CONTOUR LINES

After the contour lines is established using appropriate equipment, then plowing and harrowing the contour is to be done for ready planting. The width of each contour line should be one meter.

STEP 2 : ESTABLISH HEDGEROW OF LEGUMINOUS SHRUBS AND TREES

On each contour line, two furrows are made one-harf meter apart, for planting the legume at least 2-3 seeds per hill at distance of one-fourth inch between hills. The seeds have to be covered with soil. The recommended trees and shrubs are nitrogen-fixing trees (NFTs) such as *Gliricidia sepium, Leucaena diversifolia, L. leucocephala and Calliandra carothrysus.* Some of them are exotic species which trial should be carried out to observe their establishment.

STEP 3 : CULTIVATE LAND FOR AGRICULTURE CROPS

The strip of land between the rows of trees and shrubs can be cultivated, if needed, to favor crop growing. However, the alternate cultivation should be done to prevent erosion, say, cultivate on strips 2, 4, 6, 8 and so on. The unplowed strips will hold the soil in place.

STEP 4 : PLANT TREE ALONG BOARDERS AND LONG-TERM CROPS ON EVERY THIRD STRIP

Permanent crops may be planted at the same time the seeds of NFTs are sown. Only the spots for planting are cleared and dug; later only ring weeding is employed until the NFTs are large enough to hold the soil so full cultivation can begin. The permanent crops may be shrubs like citrus sp., papaya, banana and so on. In addition, woody species such aforementioned should be planted along farm boarders.

STEP 5 : PLANT SHORT-TERM CROPS ON EVERY FIRST AND SECOND STRIP

Short and medium-term crops should be planted in between the strips of permanent crops as a source of food and regular income while waiting for permanent crops to bear fruits. The suggested crops may be upland rice, maize, mung bean, ginger, castor bean, cassava, etc. To avoid shading, short plants should be planted away from the tall ones.

Tending/management operations

To sustain this kind of agroforestry, the following steps have to be done ;

STEP 6 : TRIM THE CONTOUR HEDGEROWS REGULARLY

After the hedgerows are established successfully, the continuously growing NFTs have to be cut down to 1-m height about once a month or when they begin to shade the crops. Cut leaves and twigs can be piled at the base of the crops. They serve as an excellent organic fertilizer. This way, only a minimal amount of commercial fertilizer can be used if desired. However, the use of commercial fertilizer may be gradually decreased when the crops already look healthy and productive.

STEP 7 : MANIPULATE CROP ROTATION

Technically, a good way of crop rotation is to plant grains, tubers and other crops on strips(see APPENDIX E-3) where legumes were previously planted and vice versa. This practice will help maintain the fertility and good of soil.

Other management practice in crops growing like weeding and pest and insect control should be done regularly.

Table E-3 Cost of Establishment

Year	Activities	Mandays per 100 rai	Baht @40
1	Selection of area, marking of blocks and lines	32	1,280
	Clearing of lines	170	6,800
	Digging of planting holes	48	1,920
	Production of planting stock	80	3,200
	Planting and replanting	64	2,560
	Weeding	32	1,280
	Total		17,040
2	Weed control, climber cutting	48	1,920
3	Weed control, climber cutting	48	1,920
4	Weed control, climber cutting	48	1,920
5	Weed control, climber cutting	48	1,920
6	Weed control, climber cutting	48	1,920

Note : The estimated cost above is excluding material cost as well as nursery operation cost

Table E-4 Cost and Revenue for the Model

Items	Year (baht/rai)			
	1	2	3	4
Cost:				
Trees along boarder (40 trees)				
- seedlings	100	30	-	-
- labor for planting	40	40	40	400
Hedgerow				
- seeds	50	-	-	-
- pruning labor	40	40	40	40
Crop area (0.8 rai)				
- land preparation	220	160	160	160
- fertilizer	150	120	100	80
- seeds (C2 & C3)	100	100	100	100
- seedlings (C1 & C4)	400	-	-	-
Total Cost	1,100	490	440	420
Revenue:				
Fruit trees along boarder (30%)	-	-	-	8,000
Permanent crops				
- papaya (0.2 rai)	-	1,000	1,500	1,500
- citrus (0.2 rai)	-	900	1,800	1,800
Annual crops				
- rice (0.2 rai)	195	195	195	195
- mung bean (0.2 rai)	132	132	132	132
Total Revenue	327	2,227	3,627	11,627

Table E-5 Cost of Shading/Fodder Tree Planting

Items	Year (baht/rai)			
	1	2	3	4
1. Land preparation	400	-	-	-
2. Seedlings	300	-	-	-
3. Planting	150	-	-	-
4. Grasses seeds	300	-	-	-
5. Sowing	100	-	-	-
6. Material costs	50	-	-	-
7. Fertilizer for trees	140	-	-	-
8. Fertilizer for grass	140	140	-	-
9. Fire lines preparation	35	-	-	-
10. Maintenance	150	150	150	150
Total	1,765	290	150	150

Table E-6 Possible Cropping Model for Multistory Planting

Crop	Period	Planting	Harvesting	Phase out
1. Mango	Year I	July	- begin on 4th year	12th year
2. Papaya	Year I	May	- begin on 8th month	4th year
3. Upland rice	Year I	May-June	- October	At harvest
4. Mulberry	Year I	June-July	- first crop after 6 months	4th year
5. Chilli	Year I	May	- begin on 4th month after planting depend upon the variety	2nd year

Table E-7 Cost of Multistory Planting

Items	Year (baht/rai)			
	1	2	3	4
1. Trees planting along boarder	80	-	-	-
2. Mango planting	480	-	-	-
3. Land preparation	400	200	-	-
4. Planting upland rice	100	100	-	-
5. Planting papaya	200	-	-	-
6. Planting mulberry	200	-	-	-
7. Planting chilli	100	-	-	-
8. Fertilizing & maintenance	200	200	200	200
Total	1,740	500	200	200

Note : Planting cost include seedlings and labor.

APPENDIX F IRRIGATION AND WATER MANAGEMENT

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APPENDIX F-1 IRRIGATION/WATER MANAGEMENT

F-1 Investigation of Infiltration Capacity and Field Water Requirement

Measurement of upland infiltration capacity and paddy field water requirement was carried out as field investigation.

Sites of the field investigation are shown in Figure F-1.

F-1-1 Investigation of paddy field water requirement

(1) Equipments

Required equipments for this investigation are as follows.
* 2 types of cylinders, bottom less and with bottom. Diameter and height of both cylinders are 30 cm and 40 cm, respectively.
* 1 Rain gauge
* 1 Hook gauge or floating gauge

(2) Installation of equipments and selection of site

The bottomless cylinder was set vertically at 10 cm depth into the paddy field, while cylinder with bottom was set at the paddy field surface.

Rainfall amount was also measured.

In the study area, there are 3 typical soil series and 4 investigation sites were selected as below.

No. of Site	Name of Soil Series	Location of Site
G-1	Roi Et	5541 IV-510069
G-2	Roi Et	5541 IV-488036
G-3	Roi Et, high phase	5541 IV-508059
G-4	Korat	5541 IV-503025

(3) Result of the Investigation

Result of the Investigation is shown as below:

	No. 1	No. 2	No. 3	No. 4
bottomless cylinder	3.1	4.6	3.4	1.9
cylinder with bottomed	3.1	3.1	2.0	1.9
percolation	0.0	1.5	1.4	0.0

In the NW-NP Project, percolation loss amounted to 3 mm/week-6 mm/week.

F-1-2 Infiltration capacity test for upland irrigation

The manner applied for the investigation is mentioned below.

(1) Equipments for investigation

Required equipments for this investigation are as follow:

* Two steel cylinders, a small one is used as inside ring of with diameter of about 30 cm, and a large one as outside ring of with diameter of about 60 cm. The height of both cylinders is 30 cm.
* 1 Floating gauge and guide

(2) Site selection and installation of equipment

According to the findings on the soil survey made in the Pilot Area, four investigation sites were selected in the proposed paddy field as follows: (Refer to Figure F-1)

No. of Site	Soil Type	Location
I-1	Sandy loam	Ban Bo kae
I-2	Loamy sand	1 km West of Ban Chad
I-3	Sandy clay	0.5 km North-west of Nong Bua
I-4	Sandy clay loam	0.8 km of Ban Hua Bung

Both cylinders were set vertically with the same center at 10 cm depth into the soil using a driving disk and a hammer.

(3) Observation

Inside both cylinder water was put to a depth of about 10 cm. The first observation shall be done by reading the scale on the floating gauge just after putting water. 1-minute intervals measurements shall be carried out in the first 10 minutes. The measurement will be

reduced into 5-minutes to 1-hour intervals, depending on the infiltrating speed. The observation shall be continued for more than 3,4 hours.

(4) Finding of the Investigation

Findings of the investigation are shown in FIGURE F-2~5.

F-2 Irrigation Water Requirement and Relevant Irrigation Factors

F-2-1 Evapotranspilation

The evapotranspilation (ETo) was estimated by applying the Modified Penman Method as shown in Table F-1, and which was based on 30 years meteorological data (1956 -1985) at Khon Kaen.

F-2-2 Grop Consumptive Use

The crop consumptive use (ET crop) can be obtained as a product of the crop coefficient (kc), which depponed on the crop growing stage, and the evapotranspilation (ETo). The crop coefficient on a 10 days basis are shown in Table F-2.

F-2-3 Cross Irrigation Requirement

The proposed cropping calendar for the Pilot Area along with the corp coefficient (kc) value at each growing stage are shown in FIGURE F-1. As described in the FAO irrigation and drainage paper No. 24, the gross irrigation water requirement on the 10-days basis for single croping (paddy) and double cropping (paddy and upland crop) in shown in Table F-3 to -4.

F-2-4 Water Balance Analysis for Upper Area and Lower Area in The Yai River Basin

To decide for the required storage capacity of storage pond, the water balance analysis for the planned irrigation areas in the pilot area were carried out as shown in Table F-5. Therefore, the volume of the storage pond in the upper Yai area required more than 546,000 ton.

F-3 Irrigation Facilities

Existing irrigation facilities are shown in FIGURE F-6 and existing SSIP is shown in Table F-6.

Table F-1 Monthly Evapotranspilation Estimated by Modified Penman Method

Meteorological Station : Khon Kean (Latitude=16°26'N., Altitude=165m MSL)

Month	Radiation Term						Aerodynamic Term					Adjustment Factor	Reference Crop Evapotranspiration ETo	
	Weighting Factor	Net Radiation					Weighting Factor	Wind Function	Vapour Pressure					
	W	Ra	Rs	Rms	Rnl	Rn	1-W	f(a)	ea	ed	ea-ed	C	mn day	mn month
Jan.	0.72	11.9	7.9	5.9	2.0	3.9	0.28	0.46	27.8	17.8	10.0	1.00	4.10	127
Feb.	0.74	13.2	8.4	6.1	1.7	4.4	0.26	0.47	32.8	20.5	12.3	1.04	4.95	139
Mar.	0.77	14.7	8.7	6.5	1.4	5.1	0.23	0.50	41.1	21.4	16.7	1.03	6.02	187
Apr.	0.78	15.6	9.1	6.8	1.4	5.4	0.22	0.50	42.7	26.9	15.8	1.01	6.01	180
May.	0.78	16.0	8.9	6.7	1.1	5.6	0.22	0.50	40.6	29.2	11.4	1.07	6.02	187
Jun.	0.77	16.0	7.8	5.9	0.9	5.0	0.23	0.53	39.2	29.6	9.6	1.02	5.12	154
Jul.	0.77	16.0	7.6	5.7	0.8	4.9	0.23	0.51	37.8	29.3	8.5	1.00	4.83	150
Aug.	0.76	15.7	7.1	5.3	0.8	4.5	0.23	0.52	37.0	29.5	7.5	0.99	4.32	134
Sep.	0.76	15.0	7.1	5.3	0.8	4.5	0.24	0.44	35.7	29.3	6.4	1.01	4.14	124
Oct.	0.76	12.8	7.9	5.9	1.3	4.6	0.24	0.47	31.7	26.8	7.9	1.05	4.61	143
Nov.	0.74	12.3	7.8	5.9	1.6	4.3	0.26	0.50	31.3	22.1	9.2	1.03	4.51	135
Dec.	0.72	11.5	7.6	5.7	1.9	3.8	0.28	0.50	27.8	18.5	9.3	1.02	4.12	128

Table F-2 Crop Coefficient on a 10 Days Basis

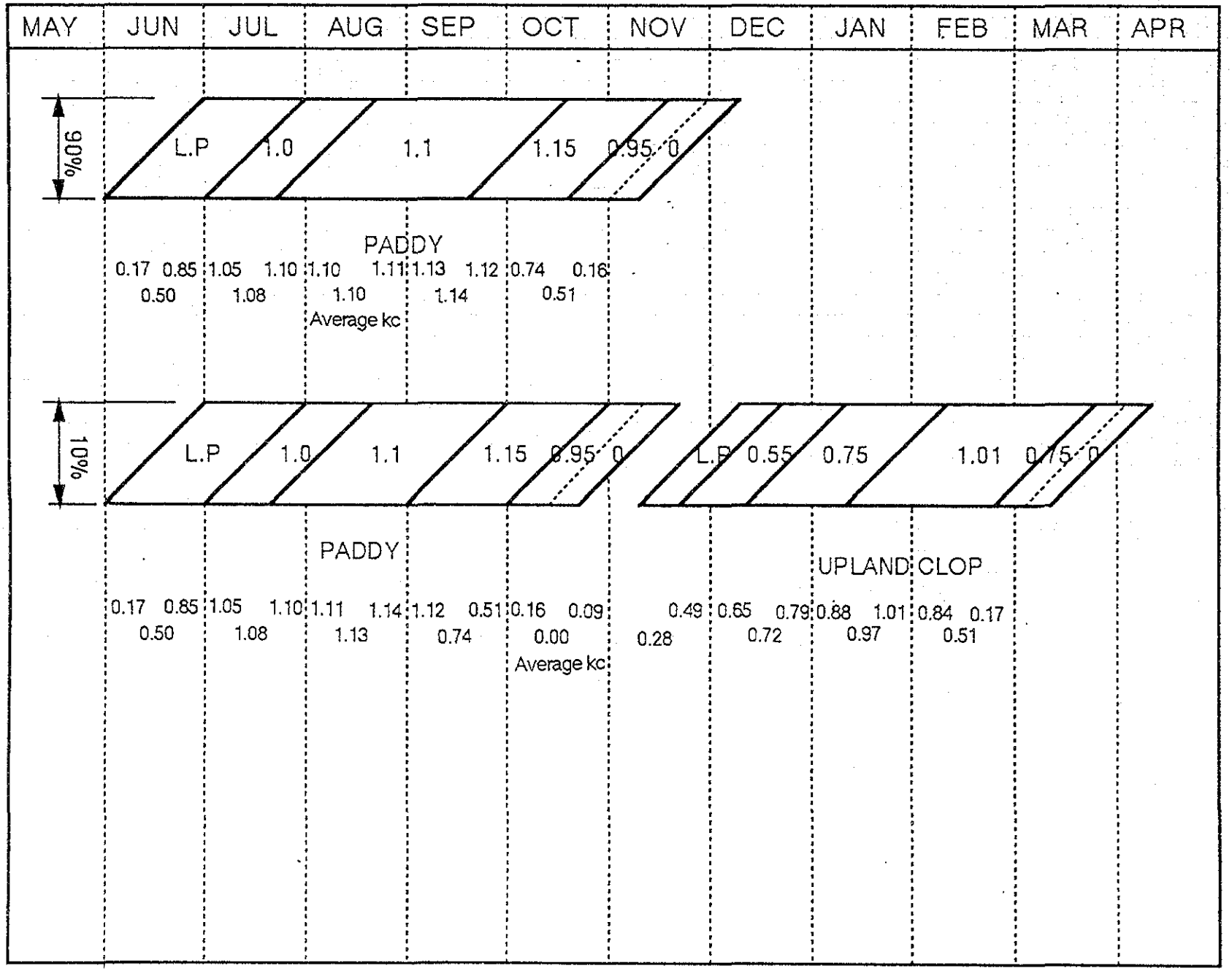


Table F - 3 Gross Irrigation Requirment (Paddy)

	Average Kc Paddy	ETo day	No. of Date	ETo decade	ET crop	Percoration Pad	Land Preparation	Sub Total	Rainfall	Effective Rainfall Pd.	Irrigation Requirment	Gross I.R.	
Apr.2		6.01	10	60.10	0.00			0.00			0.00	0.00	Apr.2
Apr.3		6.01	10	60.10	0.00			0.00	39.00		0.00	0.00	Apr.3
May.1		6.02	10	60.20	0.00			0.00			0.00	0.00	May.1
May.2		6.02	10	60.20	0.00			0.00			0.00	0.00	May.2
May.3		6.02	11	66.22	0.00			0.00	98.00		0.00	0.00	May.3
Jun.1		5.12	10	51.20	0.00		16.67	16.67	101.20	12.65	4.02	6.70	Jun.1
Jun.2		5.12	10	51.20	0.00		50.00	50.00	23.50	8.81	41.19	68.65	Jun.2
Jun.3		5.12	10	51.20	0.00		83.33	83.33	4.50	2.80	80.53	134.22	Jun.3
Jul.1	0.17	4.83	10	48.30	8.21	1.11	83.33	92.65	83.10	62.33	30.33	50.54	Jul.1
Jul.2	0.50	4.83	10	48.30	24.15	5.00	50.00	79.15	32.00	24.00	55.15	91.92	Jul.2
Jul.3	0.85	4.83	11	53.13	45.16	8.33	16.67	70.16	65.80	49.35	20.81	34.68	Jul.3
Aug.1	1.05	4.32	10	43.20	45.36	10.00		55.36	10.40	7.80	47.56	79.27	Aug.1
Aug.2	1.08	4.32	10	43.20	46.66	10.00		56.66	96.20	72.15	0.00	0.00	Aug.2
Aug.3	1.10	4.32	11	47.52	52.27	11.00		63.27	75.80	56.85	6.42	10.70	Aug.3
Sep.1	1.10	4.14	10	41.40	45.54	10.00		55.54	82.20	61.65	0.00	0.00	Sep.1
Sep.2	1.10	4.14	10	41.40	45.54	10.00		55.54	23.20	17.40	38.14	63.57	Sep.2
Sep.3	1.11	4.14	10	41.40	45.95	10.00		55.95	71.50	53.63	2.33	3.88	Sep.3
Oct.1	1.13	4.61	10	46.10	52.09	10.00		62.09	43.70	32.78	29.32	48.86	Oct.1
Oct.2	1.14	4.61	10	46.10	52.55	10.00		62.55	25.60	19.20	43.35	72.26	Oct.2
Oct.3	1.12	4.61	11	50.71	56.80	11.00		67.80		0.00	67.80	112.99	Oct.3
Nov.1	0.74	4.51	10	45.10	33.37	10.00		43.37		0.00	43.37	72.29	Nov.1
Nov.2	0.51	4.51	10	45.10	23.00	8.33		31.33			31.33	52.22	Nov.2
Nov.3	0.16	4.51	10	45.10	7.22	5.00		12.22			12.22	20.36	Nov.3
Dec.1		4.12	10	41.20	0.00	1.11		1.11			1.11	1.85	Dec.1
Dec.2		4.12	10	41.20	0.00			0.00			0.00	0.00	Dec.2
Dec.3		4.12	11	45.32	0.00			0.00			0.00	0.00	Dec.3
Jan.1		4.10	10	41.00	0.00			0.00			0.00	0.00	Jan.1
Jan.2		4.10	10	41.00	0.00			0.00			0.00	0.00	Jan.2
Jan.3		4.10	11	45.10	0.00			0.00			0.00	0.00	Jan.3
Feb.1		4.95	10	49.50	0.00			0.00			0.00	0.00	Feb.1
Feb.2		4.95	10	49.50	0.00			0.00			0.00	0.00	Feb.2
Feb.3		4.95	9	44.55	0.00			0.00			0.00	0.00	Feb.3
Mar.1		6.02	10	60.20	0.00			0.00			0.00	0.00	Mar.1
Mar.2		6.02	10	60.20	0.00			0.00			0.00	0.00	Mar.2
Mar.3		6.02	11	66.22	0.00			0.00			0.00	0.00	Mar.3
Apr.1		6.01	10	60.10	0.00			0.00			0.00	0.00	Apr.1
TOTAL			366		583.88	130.88	300.00	1014.76	875.70	481.38	554.98	924.96	TOTAL

Table F - 4 Gross Irrigation Requirment (Paddy and Upland)

Dcade	Av. Kc Pd+Up	ETo day	No. of Date	ETo decade	ET crop	Percoration Pd+Up	Land Preparation	Sub Total	Rainfall	Effective R. Pd+Up	Irrigation Requirment	Gross I.R.	Dcade
Apr.2		6.01	10	60.10	0.00			0.00			0.00	0.00	Apr.2
Apr.3		6.01	10	60.10	0.00			0.00	39.00		0.00	0.00	Apr.3
May.1		6.02	10	60.20	0.00			0.00			0.00	0.00	May.1
May.2		6.02	10	60.20	0.00			0.00			0.00	0.00	May.2
May.3		6.02	11	66.22	0.00			0.00	98.00		0.00	0.00	May.3
Jun.1		5.12	10	51.20	0.00		16.67	16.67	101.20	12.65	4.02	6.70	Jun.1
Jun.2		5.12	10	51.20	0.00		50.00	50.00	23.50	8.81	41.19	68.65	Jun.2
Jun.3		5.12	10	51.20	0.00		83.33	83.33	4.50	2.80	80.53	134.22	Jun.3
Jul.1	0.17	4.83	10	48.30	8.21	1.11	83.33	92.65	83.10	62.33	30.33	50.54	Jul.1
Jul.2	0.50	4.83	10	48.30	24.15	5.00	50.00	79.15	32.00	24.00	55.15	91.92	Jul.2
Jul.3	0.85	4.83	11	53.13	45.16	8.33	16.67	70.16	65.80	49.35	20.81	34.68	Jul.3
Aug.1	1.05	4.32	10	43.20	45.36	10.00		55.36	10.40	7.80	47.56	79.27	Aug.1
Aug.2	1.08	4.32	10	43.20	46.66	10.00		56.66	96.20	72.15	0.00	0.00	Aug.2
Aug.3	1.10	4.32	11	47.52	52.27	11.00		63.27	75.80	56.85	6.42	10.70	Aug.3
Sep.1	1.11	4.14	10	41.40	45.95	10.00		55.95	82.20	61.65	0.00	0.00	Sep.1
Sep.2	1.13	4.14	10	41.40	46.78	10.00		56.78	23.20	17.40	39.38	65.64	Sep.2
Sep.3	1.14	4.14	10	41.40	47.20	10.00		57.20	71.50	53.63	3.57	5.95	Sep.3
Oct.1	1.12	4.61	10	46.10	51.63	10.00		61.63	43.70	32.78	28.86	48.10	Oct.1
Oct.2	0.74	4.61	10	46.10	34.11	10.00		44.11	25.60	19.20	24.91	41.52	Oct.2
Oct.3	0.51	4.61	11	50.71	25.86	9.75		35.61		0.00	35.61	59.35	Oct.3
Nov.1	0.16	4.51	10	45.10	7.22	5.00		12.22		0.00	12.22	20.36	Nov.1
Nov.2	0.00	4.51	10	45.10	0.00	1.11		1.11			1.11	1.85	Nov.2
Nov.3	0.09	4.51	10	45.10	4.06			4.06			4.06	11.28	Nov.3
Dec.1	0.28	4.12	10	41.20	11.54			11.54			11.54	32.04	Dec.1
Dec.2	0.49	4.12	10	41.20	20.19			20.19			20.19	56.08	Dec.2
Dec.3	0.65	4.12	11	45.32	29.46			29.46			29.46	81.83	Dec.3
Jan.1	0.72	4.10	10	41.00	29.52			29.52			29.52	82.00	Jan.1
Jan.2	0.79	4.10	10	41.00	32.39			32.39			32.39	89.97	Jan.2
Jan.3	0.88	4.10	11	45.10	39.69			39.69			39.69	110.24	Jan.3
Feb.1	0.97	4.95	10	49.50	48.02			48.02			48.02	133.38	Feb.1
Feb.2	1.01	4.95	10	49.50	50.00			50.00			50.00	138.88	Feb.2
Feb.3	0.84	4.95	9	44.55	37.42			37.42			37.42	103.95	Feb.3
Mar.1	0.51	6.02	10	60.20	30.70			30.70			30.70	85.28	Mar.1
Mar.2	0.17	6.02	10	60.20	10.23			10.23			10.23	28.43	Mar.2
Mar.3	0.00	6.02	11	66.22	0.00			0.00			0.00	0.00	Mar.3
Apr.1	0.00	6.01	10	60.10	0.00			0.00			0.00	0.00	Apr.1
TOTAL			366		823.77	111.30	300.00	1235.07	875.70	481.38	774.88	1672.80	TOTAL

Table F - 5 Water Balance Calculation (Upper Stream)

	Rainfall	Runoff discharge	Runoff Discharge 1	Gross I.R.	Gross I.R.	Ave.Gross I.R.	Irrigation Rq.(m3)	Required Storage Ca.	Aqumulated S.C.
Apr.2				0.00	0.00	0.00		0.00	0.00
Apr.3	39.00	0.80	8560.00	0.00	0.00	0.00		8560.00	8560.00
May.1			0.00	0.00	0.00	0.00		0.00	8560.00
May.2			0.00	0.00	0.00	0.00		0.00	8560.00
May.3	98.00	9.40	100580.00	0.00	0.00	0.00		100580.00	109140.00
Jun.1	101.20	13.80	147660.00	6.70	6.70	6.70	8944.50	138715.50	247855.50
Jun.2	23.50	3.20	34240.00	68.65	68.65	68.65	91647.75	-57407.75	190447.75
Jun.3	4.50	0.60	6420.00	134.22	134.22	134.22	179183.70	-172763.70	17684.05
Jul.1	83.10	17.00	181900.00	50.54	50.54	50.54	67470.90	114429.10	132113.15
Jul.2	32.00	6.50	69550.00	91.92	91.92	91.92	122713.20	-53163.20	78949.95
Jul.3	65.80	13.40	143380.00	34.68	34.68	34.68	46297.80	97082.20	176032.15
Aug.1	10.40	2.10	22470.00	79.27	79.27	79.27	105825.45	-83355.45	92676.70
Aug.2	96.20	19.80	211860.00	0.00	0.00	0.00	0.00	211860.00	304536.70
Aug.3	75.80	15.60	166920.00	10.70	10.70	10.70	14284.50	152635.50	457172.20
Sep.1	82.20	16.30	174410.00	0.00	0.00	0.00	0.00	174410.00	631582.20
Sep.2	23.20	4.60	49220.00	63.57	65.64	63.78	85142.30	-35922.30	595659.91
Sep.3	71.50	14.20	151940.00	3.88	5.95	4.09	5456.15	146483.86	742143.76
Oct.1	43.70	2.60	27820.00	48.86	48.10	48.78	65126.64	-37306.64	704837.12
Oct.2	25.60	1.50	16050.00	72.26	41.52	69.19	92363.31	-76313.31	628523.81
Oct.3				112.99	59.35	107.63	143680.71	-143680.71	484843.10
Nov.1				72.29	20.36	67.10	89574.50	-89574.50	395268.61
Nov.2				52.22	1.85	47.18	62989.31	-62989.31	332279.30
Nov.3				20.36	11.28	19.45	25968.42	-25968.42	306310.88
Dec.1				1.85	32.04	4.87	6500.12	-6500.12	299810.77
Dec.2				0.00	56.08	5.61	7486.68	-7486.68	292324.09
Dec.3				0.00	81.83	8.18	10924.31	-10924.31	281399.78
Jan.1				0.00	82.00	8.20	10947.00	-10947.00	270452.78
Jan.2				0.00	89.97	9.00	12011.00	-12011.00	258441.79
Jan.3				0.00	110.24	11.02	14717.04	-14717.04	243724.75
Feb.1				0.00	133.38	13.34	17806.23	-17806.23	225918.52
Feb.2				0.00	138.88	13.89	18540.48	-18540.48	207378.04
Feb.3				0.00	103.95	10.40	13877.33	-13877.33	193500.71
Mar.1				0.00	85.28	8.53	11384.88	-11384.88	182115.83
Mar.2				0.00	28.43	2.84	3795.41	-3795.41	178320.43
Mar.3				0.00	0.00	0.00	0.00	0.00	178320.43
Apr.1				0.00	0.00	0.00	0.00	0.00	178320.43
TOTAL	875.70	141.40	1,512,980.00	924.96	1672.81	999.75	1,334,659.58	178,320.43	

TABLE F-6 (1/3) EXISTING FACILITIES BY S.S.I.P.

1) Project Name	Huai Yai Weir	Ban Tao Weir	Nong Khwai Yai Reservoir
2) Water Shed Area	171.0 km²	195.0 km²	1.0 km²
3) Storage Capacity	—	—	22,000 m³
4) Irrigable Area	1,000 Rai (Wet Paddy)	—	45 Rai
5) Main Structure	L=45.0m, H=2.0m	L=30.0m, H=2.5m	L=430.0m, H=3.2m, W=4.0m
6) Purpose	· I · D · L		· D · L · F

1) Project Name	Nong Hai Reservoir	Nong Pra Yun Reservoir	Sokka Reservoir
2) Water Shed Area	5.0 km²	1.0 km²	2.2 km²
3) Storage Capacity	64,000 m³	100,000 m³	18,000 m³
4) Irrigable Area	65 Rai (Wet Paddy)	30 Rai	150 Rai
5) Main Structure	L=420.0m, H=2.70m, W=5.0m	L=1,247m, H=3.00m, W=6.0m	L=580m, H=2.4m, W=4.0m
6) Purpose	· I · D · L · F	· I · D · L · F	· I · D · L · F

Note in "6)" I=Irrigation, D=Domestic Use, L=Livestock Use, F=Fish Catch/Culture, I.G=Irrigation for Gorden Crops.

TABLE F-6 (2/3) EXISTING FACILITIES BY S.S.I.P.

1) Project Name	Nong Non Ton Reservoir	Ban Por Reservoir	Huai Pa Nua Weir 3
2) Water Shed Area	0.5 km²	0.7 km²	44 km²
3) Storage Capacity	80,000 m³	22,000 m³	—
4) Irrigable Area	100 Rai	—	700 Rai
5) Main Structure	—	L=410.0m, H=3.0m, W=6.0m	—
6) Purpose	· D · I · F	· D · L · F	· D · L · I. G

1) Project Name	Huai Pra Nua Weir 4	Huai Aui Weir 1	Huai Aui Weir 2
2) Water Shed Area	33.0 km²	47.0 km²	66.0 km²
3) Storage Capacity	—	—	—
4) Irrigable Area	700 Rai	700 Rai	700 Rai
5) Main Structure	—	—	—
6) Purpose	· D · L · I. G	· D · L · I. G	· D · L · I. G

Note in "6)" I=Irrigation, D=Domestic Use, L=Livestock Use, F=Fish Catch/Culture, I.G=Irrigation for Gorden Crops.

TABLE F-6 (3/3) EXISTING FACILITIES BY S.S.I.P.

1) Project Name	Huai Pra Nua Weir 2	Nong Ku Reservoir	Huai Yang Weir
2) Water Shed Area	64 km²	17 km²	38 km²
3) Storage Capacity	–	100,000 m³	–
4) Irrigable Area	700 Rai	100 Rai	700 Rai
5) Main Structure	L=46.9m, H=3.0m, W=40m	–	–
6) Purpose	· D · I · I. G	· D · L · F	· D · L · I. G

1) Project Name	Huai Pra Nua Weir 1	Huai Sri Peing Reservoir	Huai Wary Hin Reservoir
2) Water Shed Area	11 km²	4 km²	6 km²
3) Storage Capacity	–	60,000 m³	100,000 m³
4) Irrigable Area	300 Rai	100 Rai	100 Rai
5) Main Structure	L=47.8m, H=3.5m, W=13.0m	–	–
6) Purpose	· D · L · I. G	· D · L · F	· D · L · F

Note in "6)" I=Irrigation, D=Domestic Use, L=Livestock Use, F=Fish Catch/Culture, I.G=Irrigation for Gorden Crops.

FIGURE F-1 LOCATION MAP OF FIELD INVESTIGATION SITES

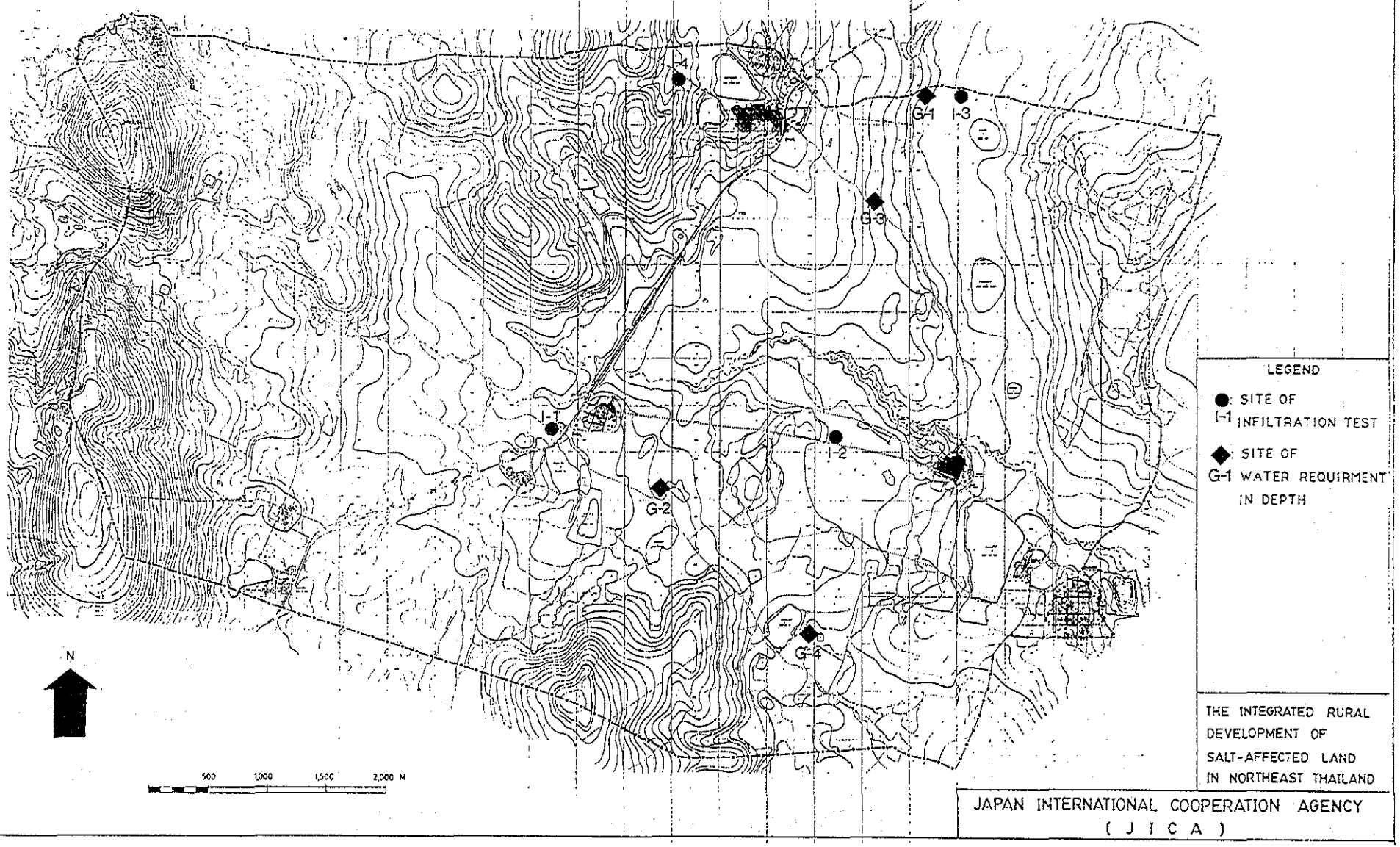


FIGURE F —2 Infiltration I-1

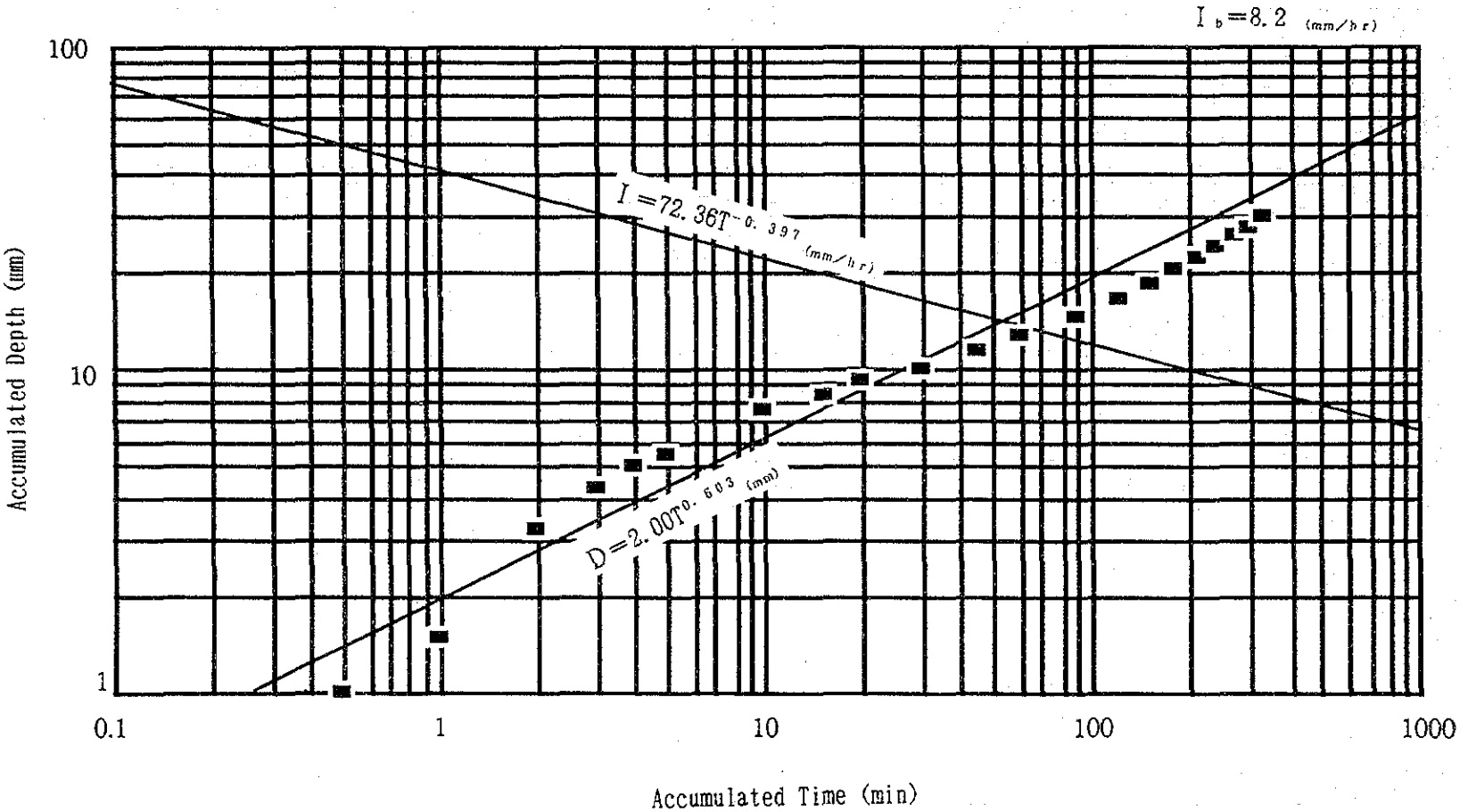


FIGURE F –3 Infiltration I-2

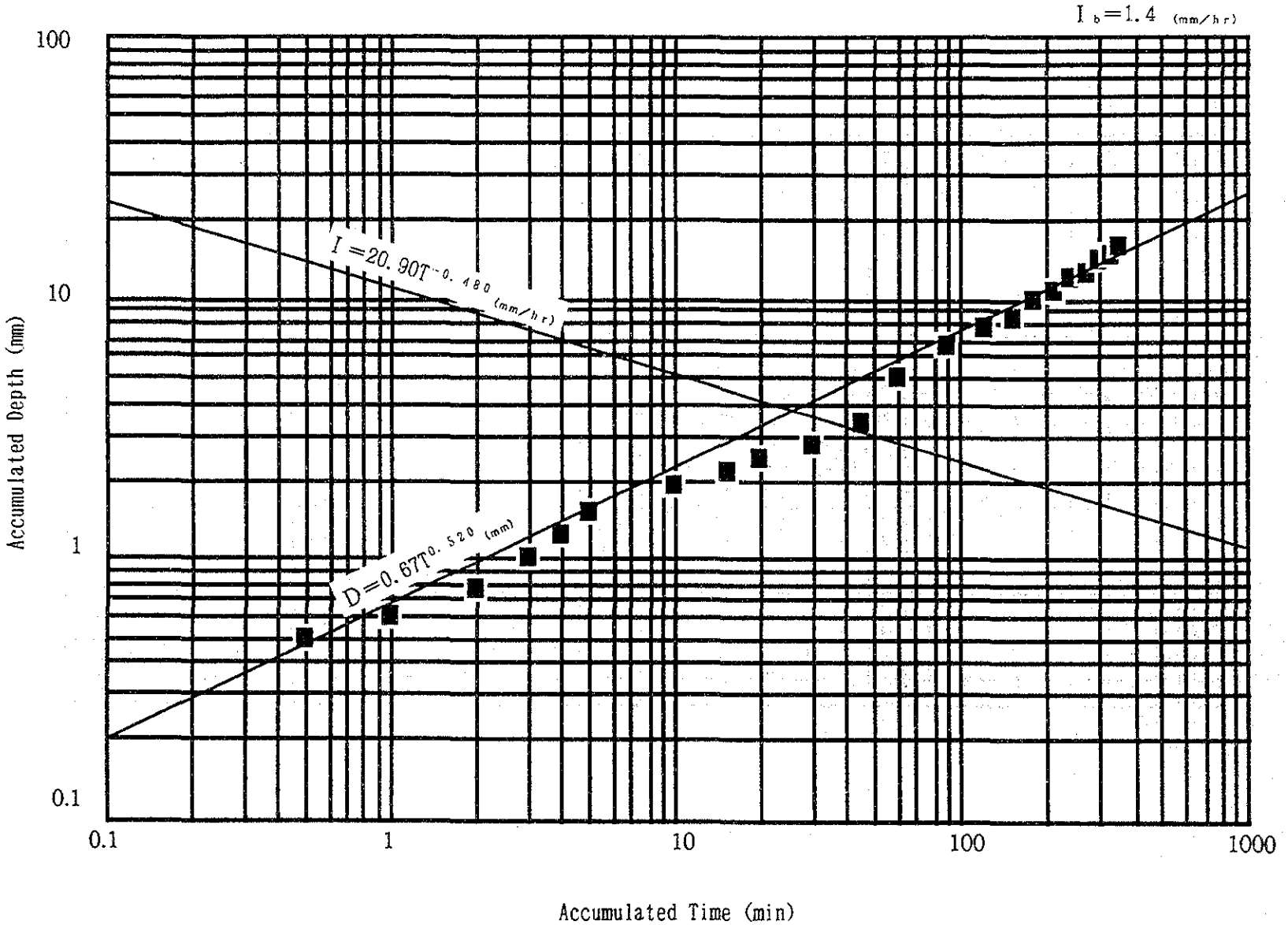


FIGURE F –4 Infiltration I-3

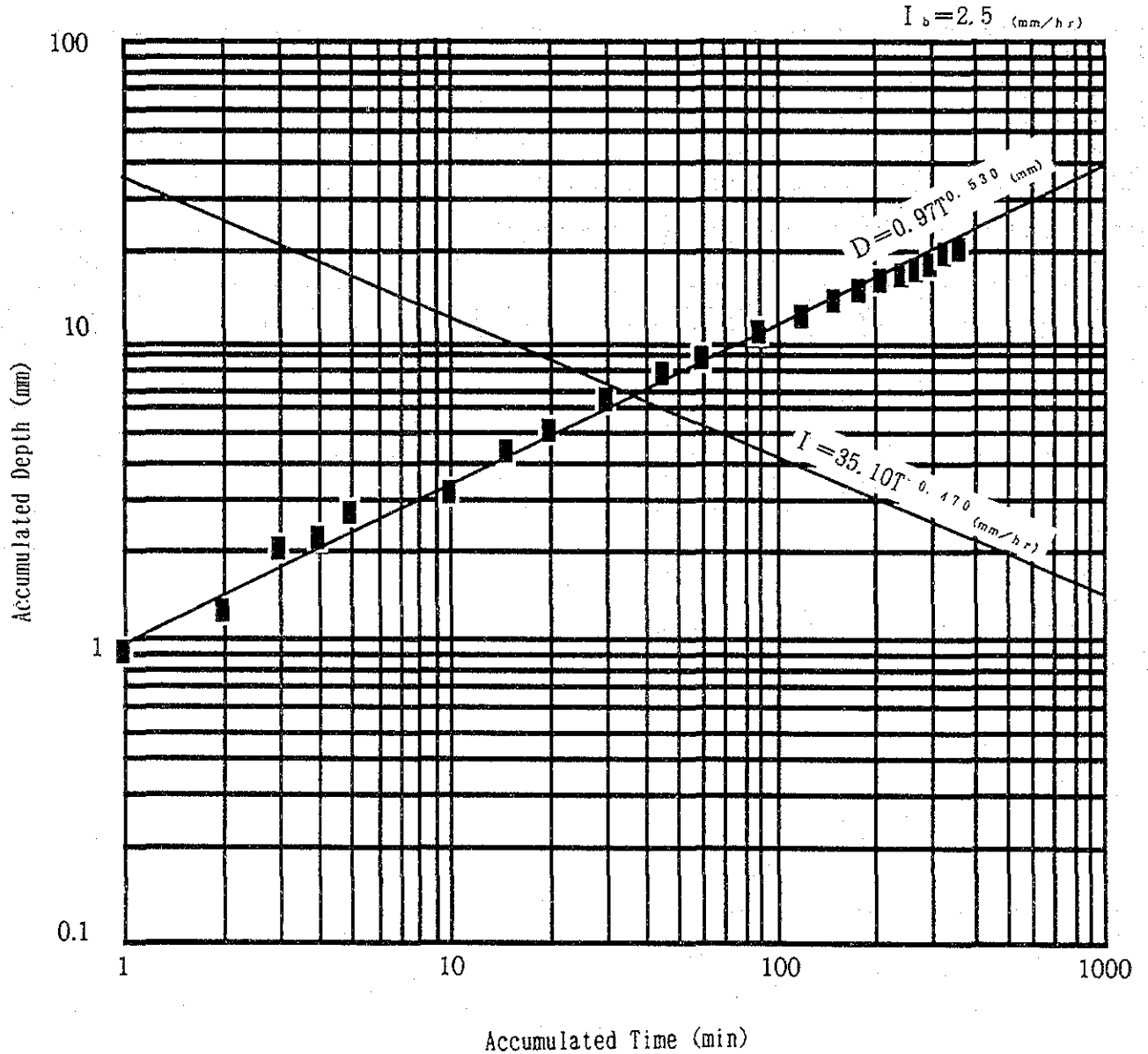


FIGURE F —5 Infiltration I-4

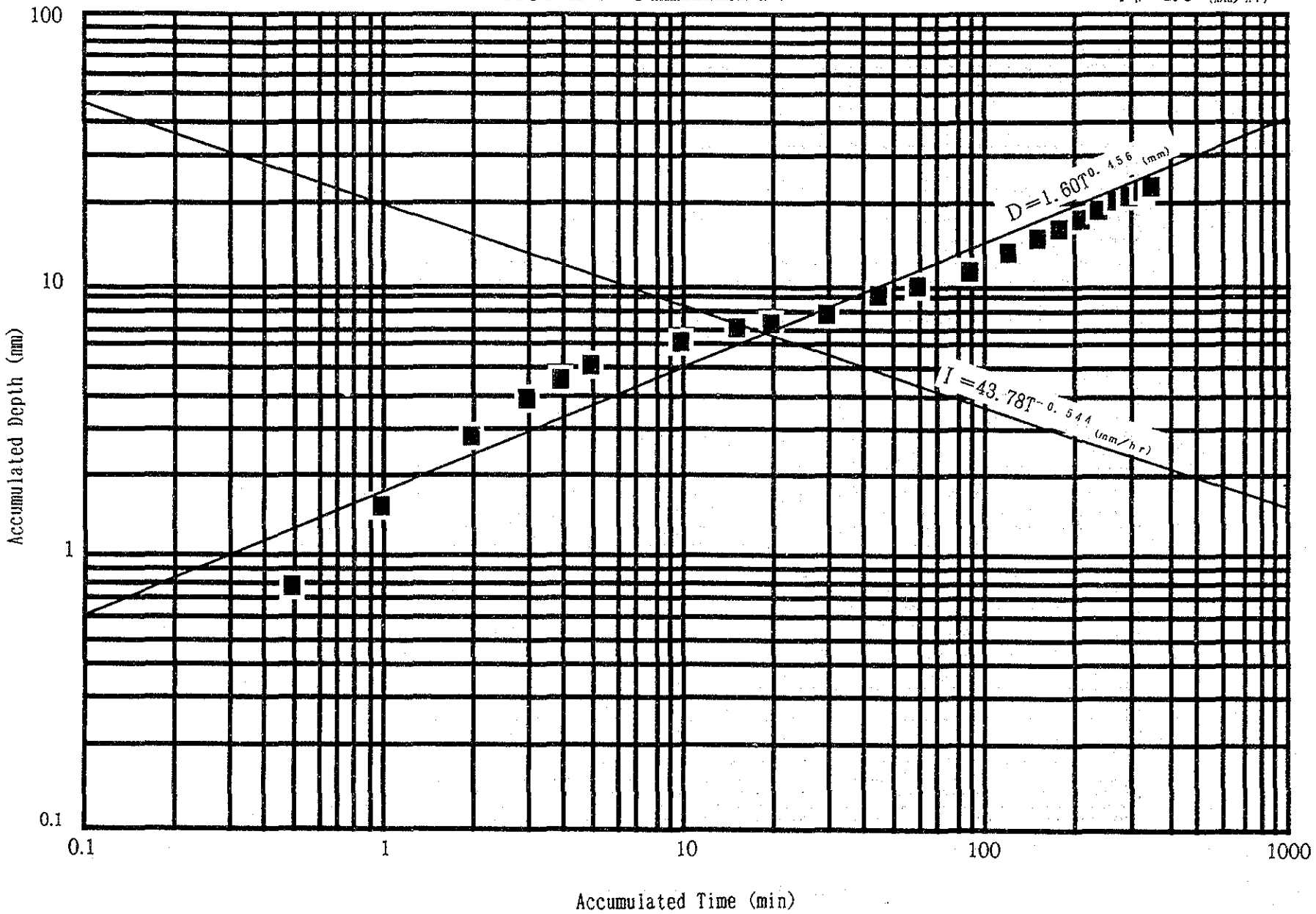
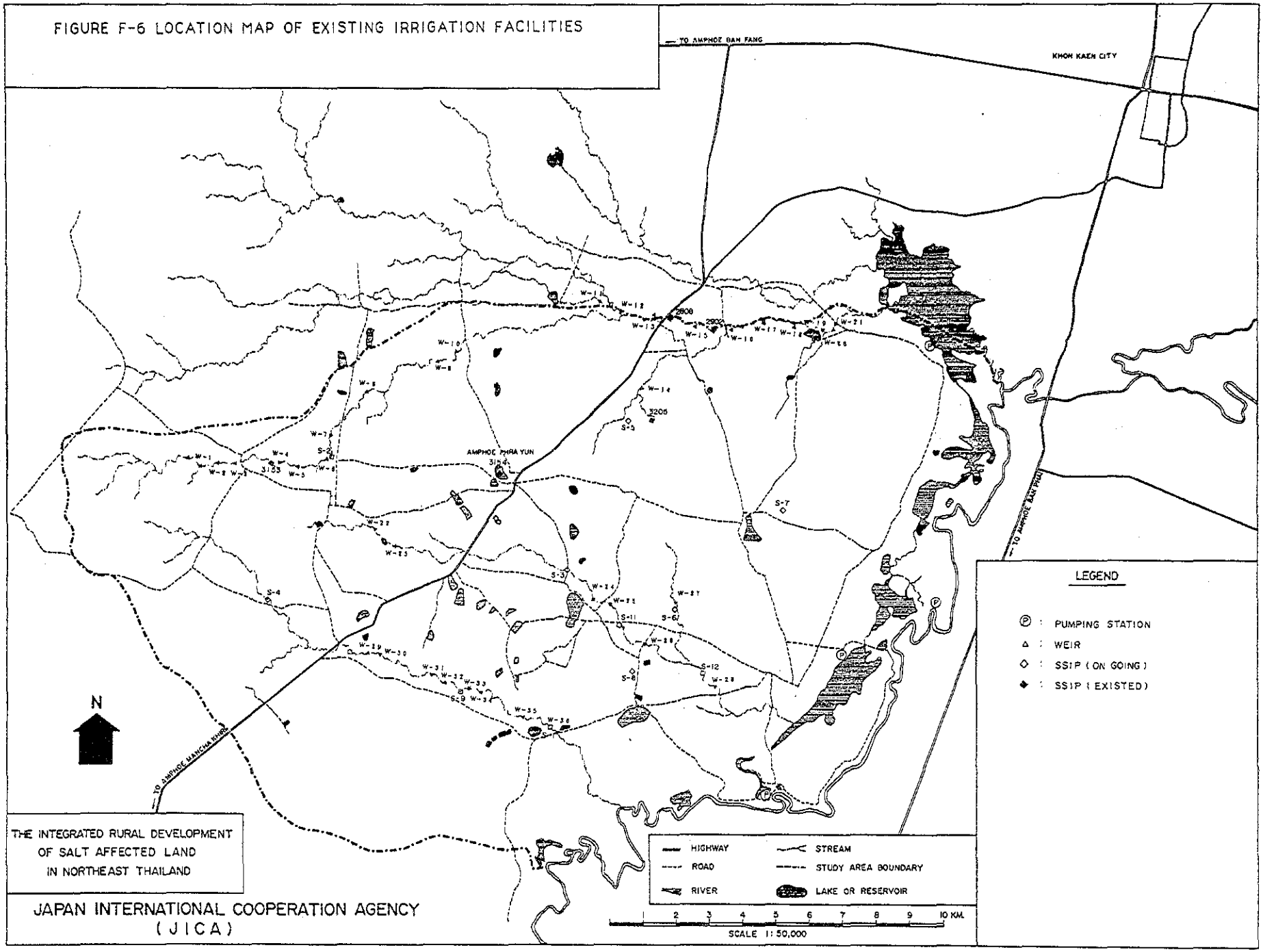


FIGURE F-6 LOCATION MAP OF EXISTING IRRIGATION FACILITIES



THE INTEGRATED RURAL DEVELOPMENT OF SALT AFFECTED LAND IN NORTHEAST THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

APPENDIX G DRAINAGE

CONTENTS

LIST OF TABLES

LIST OF FIGURES

G-1. Interceptor Drain

G-1-1. Groundwater Flow to the Interceptor Drain

The Groundwater flow to the proposed interceptors was calculated by the two dimensional groundwater flow model of the finite element method.

The model forms a grid of 400 x 400 m and it optionally subdivided more dense near the proposed interceptors.

Following equation for the horizontal two dimensional steady-state flow is applied for the calculation program.

$$S \frac{\sigma\phi}{\sigma t} = \frac{1}{2} Kx \frac{\sigma^2(\phi^2)}{\sigma x2} + \frac{1}{2} Ky \frac{\sigma^2(\phi^2)}{\sigma y^2} + q$$

where S = storativity
K = permeability
ϕ = potential
q = specific discharge

Two different permeability and storativity are applied for the model. For the elements of boundaries which are located on an upper and both sides, 1.0×10^{-2} cm/sec and 0.1 are applied for permeability and storativity and the rest are 5.0×10^{-4} cm/sec and 0.01 respectively. The former represent hydraulic characteristics of the gravel beds and the latter represent the terrace deposits.

The groundwater potential map is prepared as an initial water levels for the calculation based on the observed water levels in December 1990 from thirty piezometers, as shown in FIGURE G-1.

The water tables in the proposed interceptors are fixed at minus 2 m from the initial water levels.

The water levels in the boundaries also fixed at the initial water levels.

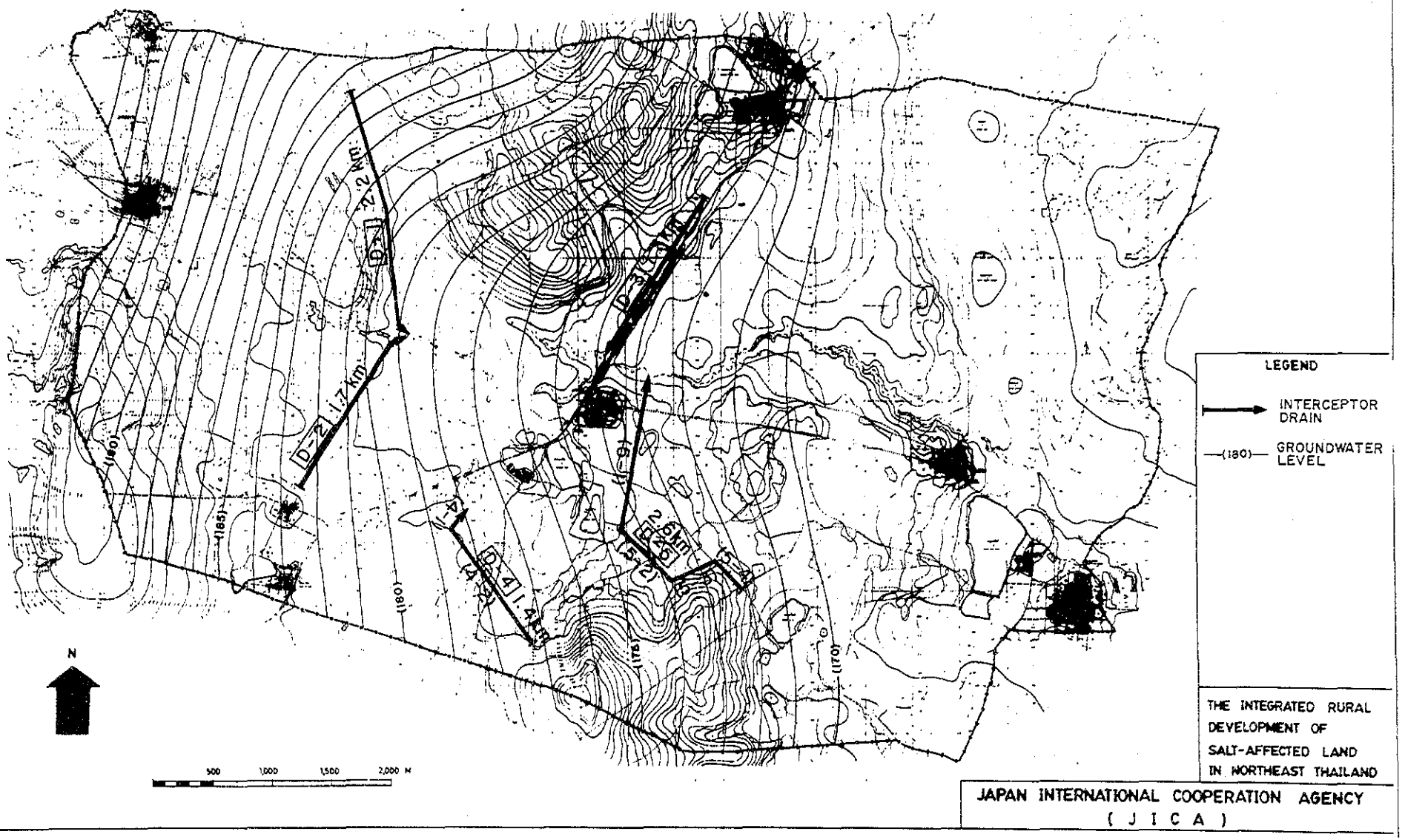
Calculated groundwater velocity for respective elements can be converted into specific groundwater discharge when it multiply by the area.

The specific discharges for area of 1 sq.m for respective interceptors are summarized in the following table.

Table G-1 Specific Discharge

Interceptor	No. of Elements	Average Velocity (m/day)	Specific Discharge (cu.m/day/sq.m)
D-1	11	9.0×10^{-4}	9.0×10^{-4}
D-2	7	6.0×10^{-4}	6.0×10^{-4}
D-3	8	1.0×10^{-3}	1.0×10^{-3}
D-4	6	9.0×10^{-4}	9.0×10^{-4}
4-1	1	5.9×10^{-4}	5.9×10^{-4}
4-2	5	9.0×10^{-4}	9.0×10^{-4}
D-5	12	9.0×10^{-4}	9.0×10^{-4}
5-1	6	1.2×10^{-3}	1.2×10^{-3}
5-2	2	6.0×10^{-4}	6.0×10^{-4}
5-3	1	3.7×10^{-4}	3.7×10^{-4}
5-4	1	8.1×10^{-4}	8.1×10^{-4}

FIGURE G-1
INTERCEPTOR DRAIN AND INITIAL GROUNDWATER LEVEL



G-1-2. Evaporation Pond

(1) Daily Discharge

Table G-2 Daily Dscharge

Name of Drain	Specific Discharge (m^3/day/m)	Drain Length (m)	Discharge (m^3/day)
D-1	9.0×10^{-4}	2,200	1.98
D-2	6.0×10^{-4}	1,700	1.02
D-3	1.0×10^{-3}	1,700	1.70
D-4	9.0×10^{-4}	1,400	1.26
D-5	9.0×10^{-4}	2,600	2.34

(2) Rainy Season Discharge of Interceptor Drain (APR.-OCT.)

Qr = $2.34m^3/day \times 210day + 0.914m$(Rainfall)$\times 6.0m$(Width of Drain) $\times$ 2,600m = 491.4+14,258.4 = $14,749.8m^3$

Saline Ground Water/Rainfall = 491.4/14,258.4 = 1/29

Rainy season discharge will be directly released to the river

(3) Dry Season Discharge of Interceptor Drain (NOV.-MAR)

Qd = $2.34m^3/day \times 150day = 351m^3$

Dry Season discharge will be Treated at evaporation pond.

(4) Size of Evaporation Pond

(Pond Size)

20m×20m×0.83m (Dry season Evaporation) = 332m^3

Capacity of 2ponds = 664m^3>351m^3 (Dry Season Discharge)

Table G-3 Rainfall and Evaporation

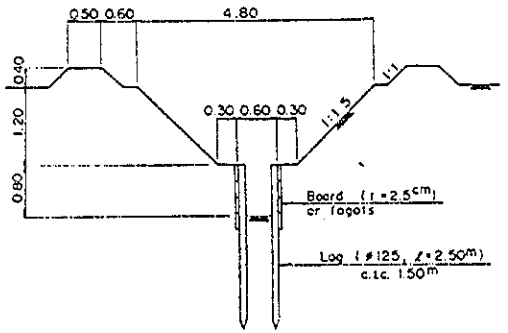
unit:mm

	Dry Season			Rainy Season						
	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.
Mean Rainfall	3.4	13.2	23.9	54.6	139.1	145.1	126.1	151.7	226.5	71.1
Evaporation	154.2	161.4	211.7	216.6	196.5	171.4	165.5	150.0	137.0	152.3

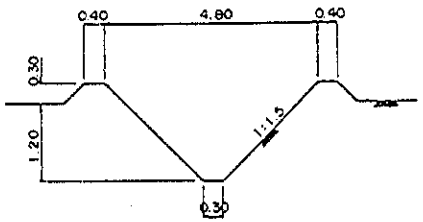
	Dry Season		Year
	Nov.	Dec.	
Mean Rainfall	11.4	2.2	968.5
Evaporation	151.0	152.4	2020.0

FIGURE G-2 DRAINAGE FACILITIES

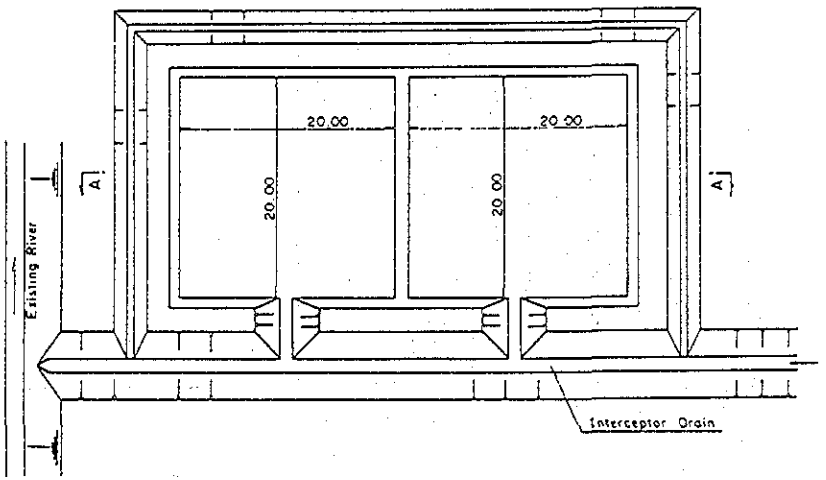
Interceptor Drain



Field Drain

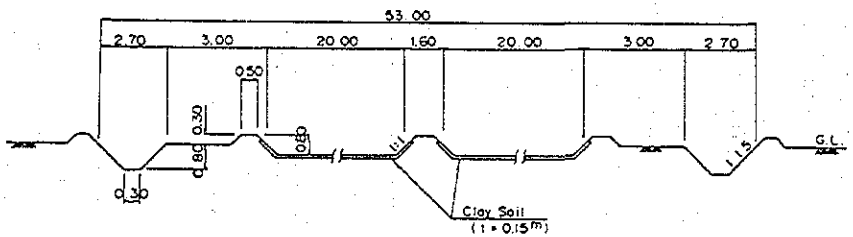


Evaporation Pond



PLAN

SECTION A-A



G-2. Leaching Test

(1) Location and Number of Places

The Leaching tests were conducted at four places and their locations are shown in FIGURE G-3. Two places, L-1 and L-2, are located in severely salt-affected area (class 1). Other two places, L-3 and L-4, are located in moderately salt-affected area (class 2).

(2) Method of Test

The field leaching tests were carried out providing a polyvinyl sheet frame. When the frame was set, soil samples were taken for analysis, and then the frame was supplied by leaching water to the depth of 50 mm, so called the 1st leaching water. After 24 hours or after complete filtration of leaching water, soil sampling was made again. Then the 2nd leaching water with the depth of 100 mm was supplied into the frame for the 2nd leaching test. The same manner was taken up to 4 times, or until the EC value of soil turned down to a low figure.

(3) Sampling and Analysis

Soil samples were taken from four points at each test site and from three layers at each point, i.e. 0-15 cm, 15 - 30 cm and 30-45 cm depth. Water sample was also taken from each leaching water. The results of analysis are shown in Table G-4.

Based on the results of EC analysis, leaching curves of soil salinity (ECe) vs cumulative leaching water in depth were plotted, as shown in FIGURE G-4.

(4) Conclusion

1) Two leaching test sites (L-1, L-2) were selected in severely salt-affected area (class 1), and other two sites (L-2, L-3) were selected in moderately salt-affected area (Class 2). These sites are using for paddy fields in present land use. Though the all test sites were set close by salt patches, L-3 and L-4 sites were not salt-affected lands severely.

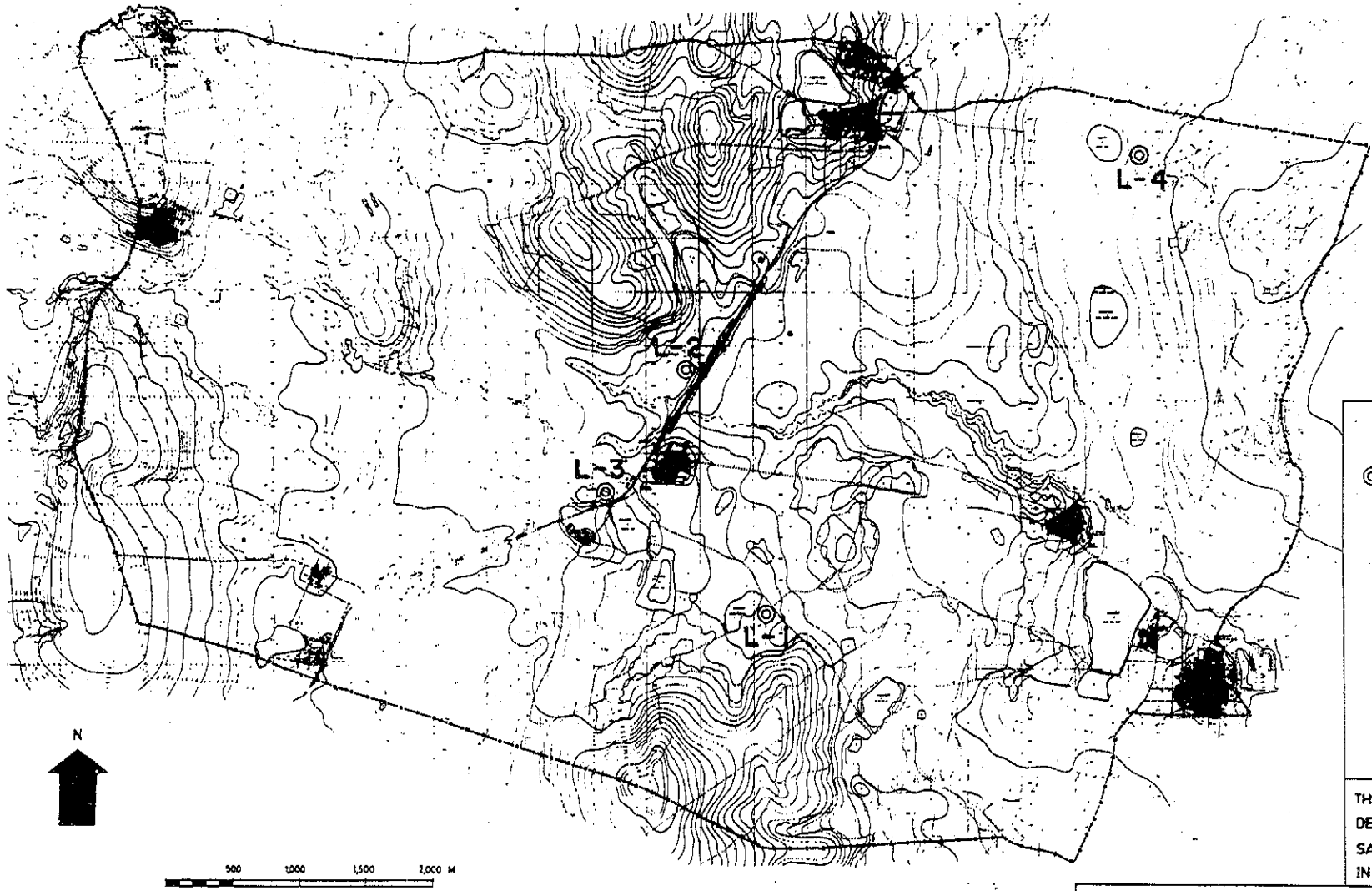
2) Salt was accumulated at top soil in dry season and spreaded into soils by supplying first leaching water.

3) It takes 5-8 days for complete filtration of 20 cm depth of leaching water after soil was saturated by water.

4) Leaching is effective at salt-affected area because salt composition in this area is mainly Nacl.

5) In drainage planning, intrusion of saline ground water would be prevented by providing of interceptor drain. The rain water (970 mm/year) will be used for natural leaching for washing out the accumulated salt because the salt-affected area will be used for paddy field in land use planning. Target value of ECe by leaching would be aimed at 3-4 mmhos/cm.

FIGURE G-3 LOCATION MAP OF LEACHING TEST



LEGEND

◎ SITE OF LEACHING TEST

THE INTEGRATED RURAL DEVELOPMENT OF SALT-AFFECTED LAND IN NORTHEAST THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY
(J I C A)

Table G-4 Results of Leaching Test

Site No.	Sample Depth - No. (cm)	ECe (mmho/cm) Before Leach.	1st Leach.	2nd Leach.	3rd Leach.	4th Leach.
L-1	15-1	4.8	7.3	12.0	6.5	4.7
	2	6.0	1.2	8.7	3.6	2.7
	3	3.7	9.6	10.8	8.0	3.4
	4	2.7	5.6	5.6	4.2	3.0
	(Ave.)	4.3	6.1	9.3	5.6	3.4
	30-1	2.7	5.9	8.8	7.8	4.3
	2	6.0	7.9	9.8	5.9	3.0
	3	3.9	7.8	11.2	6.9	5.7
	4	3.1	6.5	6.6	5.4	4.3
	(Ave.)	3.9	7.0	9.1	6.5	3.8
	45-1	3.0	5.6	8.3	5.0	2.0
	2	5.8	3.5	6.8	5.9	3.7
	3	7.1	10.0	9.5	8.2	2.3
	4	3.1	2.7	7.3	5.2	4.0
	(Ave.)	4.8	5.5	8.0	6.1	3.0
L-2	15-1	1.4	3.1	1.4	2.0	1.2
	2	1.5	2.9	1.4	1.4	1.9
	3	0.2	1.8	1.3	1.5	2.0
	4	2.8	1.4	2.0	1.3	2.3
	(Ave.)	1.5	2.3	1.5	1.5	1.8
	30-1	1.1	2.2	1.2	1.3	1.5
	2	1.0	1.5	1.2	1.4	1.3
	3	2.3	8.2	1.1	1.4	1.2
	4	1.5	1.8	1.3	1.3	1.5
	(Ave.)	1.5	3.4	1.2	1.3	1.4
	45-1	1.8	1.6	1.0	0.7	0.8
	2	1.0	0.9	1.0	1.1	1.2
	3	1.0	0.7	1.3	0.8	1.1
	4	1.8	0.9	0.8	1.2	1.4
	(Ave.)	1.4	1.1	1.0	0.9	1.1

※ Date ; FEBRUARY, 1991
ECe of Leaching Water ; 0.19 mmhos/cm

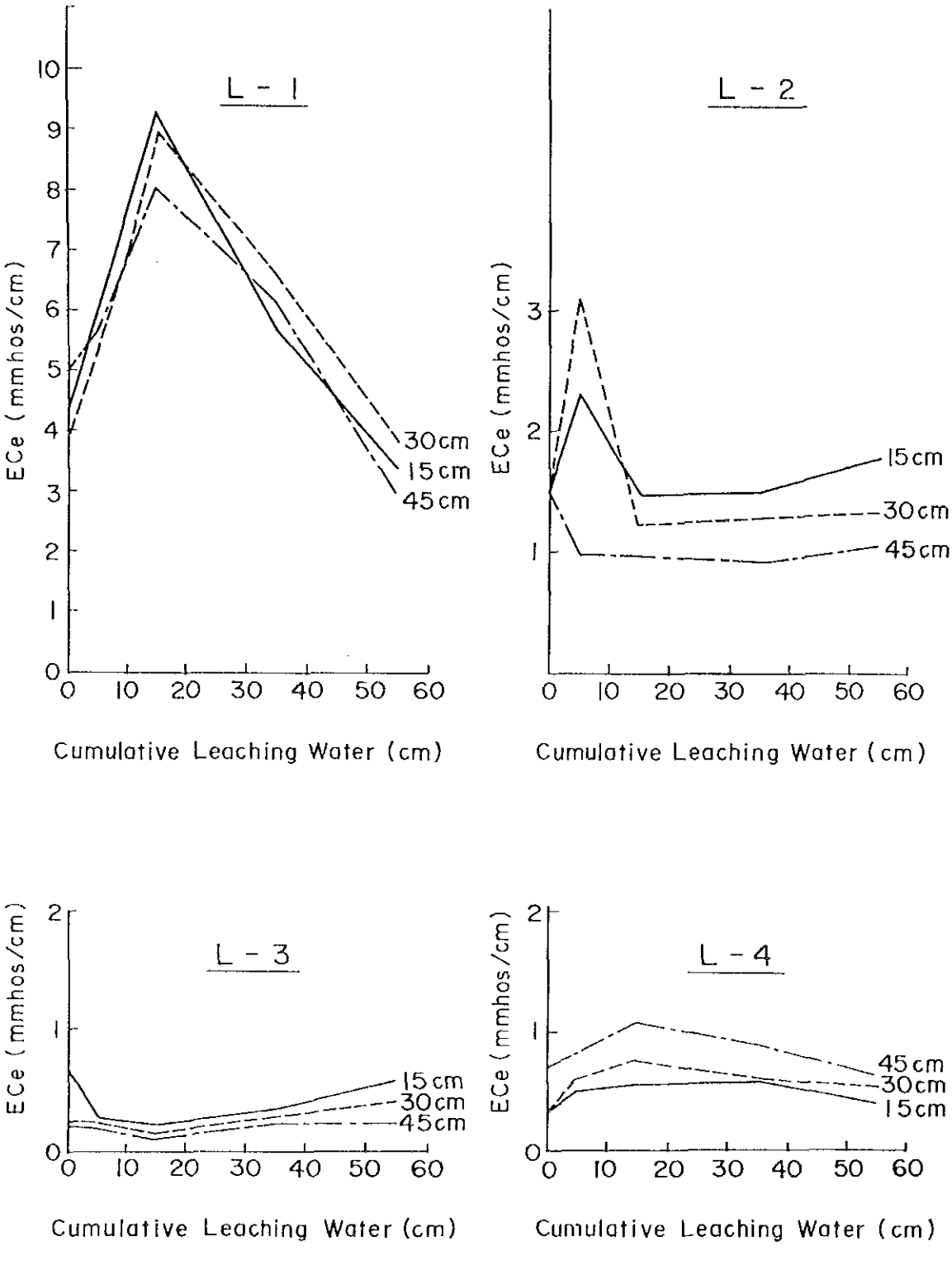
Table G-4 Results of Leaching Test

Site No.	Sample Depth -No. (cm)	ECe (mmho/cm) Before Leach.	1st Leach.	2nd Leach.	3rd Leach.	4th Leach.
L-3	15-1	0.5	0.4	0.3	0.4	0.6
	2	1.7	0.3	0.3	0.3	1.2
	3	0.3	0.3	0.2	0.5	0.7
	4	0.3	0.3	0.2	0.3	0.4
	(Ave.)	0.7	0.3	0.3	0.4	0.8
	30-1	0.3	0.4	0.3	0.5	0.4
	2	0.3	0.3	0.3	0.2	0.5
	3	0.1	0.3	0.2	0.4	0.5
	4	0.2	0.3	0.2	0.2	0.4
	(Ave.)	0.2	0.3	0.3	0.3	0.4
	45-1	0.3	0.3	0.3	0.4	0.4
	2	0.2	0.3	0.3	0.2	0.5
	3	0.2	0.3	0.3	0.2	0.4
	4	0.2	0.2	0.2	0.2	0.4
	(Ave.)	0.2	0.3	0.3	0.3	0.4
L-4	15-1	0.4	0.5	0.7	0.5	0.4
	2	0.1	0.5	0.5	0.4	0.5
	3	0.3	0.5	0.6	0.6	0.4
	4	0.2	0.5	0.5	0.5	0.3
	(Ave.)	0.2	0.5	0.5	0.5	0.4
	30-1	0.4	0.5	0.7	0.5	0.5
	2	0.1	1.0	0.5	0.4	0.7
	3	0.5	0.4	1.1	0.8	0.5
	4	0.3	0.7	1.2	0.6	0.6
	(Ave.)	0.3	0.6	0.9	0.6	0.6
	45-1	0.4	0.7	0.7	0.8	0.6
	2	0.5	0.9	0.7	0.6	0.7
	3	1.2	0.6	1.2	0.9	0.9
	4	0.7	1.0	2.0	1.1	0.7
	(Ave.)	0.7	0.8	1.2	0.8	0.7

※ Date ; FEBRUARY, 1991
ECe of Leaching Water ; 0.19 mmhos/cm

FIGURE G-4

RELATION BETWEEN SOIL SALINITY AND LEACHING WATER



APPENDIX H PROJECT FACILITIES

APPENDIX H PROJECT FACILITIES AND COST ESTIMATE

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H-1 FACILITIES

H-1-1 Irrigation Canals

(1) Design of Irrigation Canals

1) Canal cross section

All irrigation canals are concrete and soil-cement lined canals with trapezoidal sections. A ratio of cement and soil is planned at 1 : 7 in accordance with the result of the construction of the experimental pond. (refer to H-1-3)

2) Canal bed gradient

The longitudinal bed slope of a canal is selected considering the topograhic conditions of the irrigation area and the allowable velocity in the canal. The maximum allowable velocity in the canal is to be 1.5 m/sec due to lining by concrete and soil-cement. The minimum allowable velocity is 0.2 m/sec as a non-silting velocity.

3) Hydraulic design

The manning formula is used to calculate the flow capacity of canals as presented below:

$$V=1/n \cdot R^{2/3} \cdot I^{1/2}$$

$$Q=A \cdot V$$

where, V ; Mean velocity (m/sec)
n ; Coefficient of roughness = 0.016
R ; Hydraulic mean radius (m)
I ; Canal bed slope
A ; Cross sectional area (m^2)
Q ; Design canal discharge (m^3/sec)

4) Side slope of canal

Taking into consideration the soil characteristics in this area, a side slope of 1: 1.0 is employed for inside of the canal and 1 : 1.5 for outside.

5) Freeboard

The freeboard of the canal embankment is given by the following formula:

$$F=0.20+0.2D$$

where, F ; Freeboard (m)
D ; Design water depth (m)

6) Canal bed width

The canal bed width is determined in consideration of b/d ratio (canal bed width/water depth) which gives the most effective cross-section of a canal to ensure good flow conditions. A minimum bed width of the canal is considered at 0.3 m.

(2) Standard Canal Cross Sections

The following canal types are proposed for the standard irrigation canals:

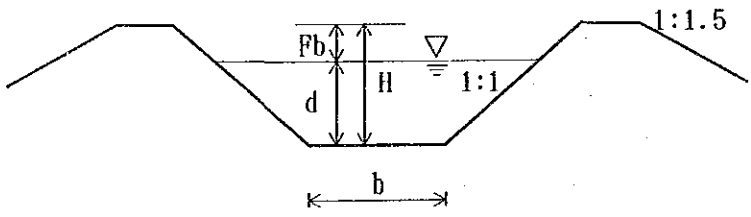


Table H-1 Dimensions of Irrigation Canals

Canal Type	Canal Slope	Q (m3/s)	b (m)	d (m)	Fb (m)	H (m)
Head race canal	1/1,000	2.50	0.90	1.02	0.38	1.40
Secondary canal - 1	1/1,000	0.20	0.40	0.38	0.32	0.70
Secondary canal - 2	1/1,000	0.16	0.40	0.34	0.31	0.65
Tertiary canal	1/5,000	0.04	0.30	0.28	0.27	0.55

H-1-2 Irrigation Pump Facilities

A pumping station is installed at each storage pond in the irrigation area. Two types of pumping capacity are selected for determining the specifications of pumps.

1) Pump discharge

Type - 1 : Design discharge 0.16 m^3/sec
Type - 2 : Design discharge 0.20 m^3/sec

2) Number of pumps

At least two (2) pumps are required in order to respond to the fluctuation of irrigation water discharge during a year. Beside, a same size pump diameter is preferable in order to make easy to change parts during maintenance.

3) Pump head

Total pump head is estimated at 8.0 m as presented below:
Total pump head (H) = Actual pump head (Ha)
+ Loss head inside of pump facilities (Hl)
= 5.0 + 3.0 = 8.0m

4) Pump power

Pump power is calculated by the following formula:

$$Q = K \cdot r \cdot Q \cdot H \ (1 + R) \ / \ np$$

where, P ; Pump power (kw/ps)
k ; 0.163/0.222
r ; Specific gravity of water 1.00
Q ; Pump discharge (m^3/min)
H ; Total pump head (m)
np ; Pump efficiency 0.65
R ; Pump surplus factor 0.15

5) Specification of pumps

The specification of pumps for irrigation are shown in Table H-2.

Table H-2 Specifications of Pumps

Item	Type - 1	Type - 2
Total discharge (m^3/sec)	0.16	0.20
Number of pumps	2	2
Pump diameter (mm)	ø 200	ø 200
Pump discharge (m^3/min)	4.8	6.0
Total pump head (m)	8.0	8.0
Power (kw/ps)	11/15	15/20

H-1-3 Experiments on Construction of Ponds

(1) Construction of the Experimental Ponds

1) Objectives for construction of the experimental ponds

To determine the structure of a storage pond of highest efficiency at the salt-affected area, several types of ponds were constructed. After construction, the fluctuation in water level and salt content were checked periodically.

2) Location of the experimental pond and its characteristics.

The experimental ponds were constructed at a site located about 4 km (south of Ban Phra Yun. The site was selected taking into account the following conditions.

a) Its location in areas seriously affected by salt.
b) Ground water level is high at the site and the pond water is easily affected by salty ground water. Thus, the effects of salty ground water on the pond water will be easily checked.
c) The site is located in the Pilot Area. Thus, the fluctuation in the ground water will be easily checked through setting up pyrometers and electric prospecting which will be carried out on the area during the proposed feasibility study. A topographic map of the area reduced to the scale of 1 to 4,000 will be used, which will allow a clear determination of the undulation around the ponds.
d) The access road to the site is kept in good condition; thus, construction and succeeding observation in this ponds will be easier.
e) The site is located next to an existing pond which is installed with a staff-gauge. The observation of this pond can be compared with that in the proposed experimental pond.
f) the site has been kept free. The landowner was quite understanding to this trial;, and was quite willing to make his land available to us.

3) Outline of experimental ponds

a) Types of the structure

The following three types of structure were selected with the intention to reduce the construction cost and utilize materials easily available around the Pilot Area.

No.1: Dug out only

No.2: Dug out and lined with clay up to a thickness of 12 cm ~ 15 cm.

No.3: Lined with soil cement (with 15 percent of cement and 85 % of clay) up to a thickness of 10 cm.

b) Shape and others

Depth: Minimum depth where the effects of ground water appear in dry season. Actually, it was 2.2 ~ 2.3 m from the soil surface.

Shape:

A pond measures 1.5 x 1.5 meter at the bottom and 8.5 x 8.5 meter at the top The inclination of side wall was kept at 1 : 1.5 taking into account the properties (sandy loan) of the soil and the depth of the pond.

Embankment :

Embankment (measuring 3.0 m wide and 0.5 m high) was constructed around the ponds to protect them from flooding in rainy season and also to facilitate the observations . A pipe (ø 75 mm) was set up at the bottom of the embankment to collect surface water into the ponds and drain surplus water.

Others:

A staff-gauge was installed at each pond to check water level. Wire entanglement were stretched on the embankment to prevent domestic animals from trespassing.

4) Construction of the experimental ponds

Acquisition of the land and arrangement of labors were initiated on 20 August and completed on 21 September.

After the initiation the ground water level rose up to 0.5 m from the soil surface due to successive heavy rainy days. Thus, the earthworks were very difficult and took much more days than expected.

The excavation works were entirely carried out by manpower; water and mud which were coming into the ponds during the works were taken out by using a pump and buckets. To protect surface soil from sliding after excavation, wooden piles were driven for sheathing.

Soil mixed up with cement to compose soil-cement was collected from the soil dug out for the pond construction. Clay for lining was carried in from places where clay layer was found close to the surface soil., which were located at about 8 km from the site. Cement, wire entanglements, support, etc. were collected near the site.

Salt contents were measured in such materials as clay, soil-cement and water which were used for the construction of the experimental ponds. The construction cost of the ponds were compared according to deduced cost indices allocated to each of the 3 types of structure previously cited. Those indices were: 100 for structure No.1 and 210 for both structure No.2 and No.3. For structure No.3, 20% of the cost were for cement. For structure No.2, a similar percentage was allocated for carrying clay and procuring bamboo reinforcement for lining.

5) Plan in the future

After completion of the experimental ponds, the water level and salt content in each pond will be checked once a week; the data obtained will be examined and analyzed.

Change in the shape and structure of the ponds will be observed as well.

(2) Observation of the Experiment Ponds

1) Observation

- Fluctuation of water level in each pond as well as ground water level at the site.
- Fluctuation of water salt content in each pond
- Change in shape and structure of each pond

2) Period and frequency of observation for the items above

- From 25 September 1990 to 26 February 1991
- Three to four times a month for observation of the pond water level
- Twice a month for the ground water level

3) Change in water level

a) Relation between ground water level and pond water level

When observations started mid September 1990, the ground water level was 0.2~ 0.6 m higher than that in the ponds. This situation was reversed from October 4 to October 8 when 95 mm of rain were collected in the site. Water level in the ponds decreased gradually thereafter but remained still higher than that in the groundwater until the end of the observations at the end of February 1991 where the pond water level was recorded 0.2 m ~ 0.65 m higher.

b) Water level of the experimental ponds

The water level of the pond No.1 (dug out only) was highest exceeding No.2 (lined with clay) and No.3(lined with soil cement) by 0.45 m, when the observation started. Probably, water infiltrated into the pond No.1 from the outside owing to the higher ground level.

The surface water ran into the ponds when it rained in early October; water level in every pond rose up to the level of the earth outside the ponds after the rain on 19-20 October. The pond water level rose up by 0.9 ~ 0.4 m; water volume running into the pond No.3 was highest among the three.

After that, the pond water level began to lower; the extent of lowering was most at the pond No.1 and least at pond No.3. The actual value of the lowering in each pond 155 day from 21 October 1990 to 26 February 1991 was 1.45 m (9.4 mm/day) pond No.1, 1.31 m (8.5 mm/day) in pond No.2 and 1.00 m (6.5 mm/day) in pond No.3. The pond water level on 26 February 1991 (the last observation day) was 0.14 m higher in pond No.2 0.45 m in pond No.3 as compared with that in pond No.1.

c) Observation

There are no data of evaporation available at the site but it is estimated at 5.1 mm/day in average during the observation period through investigation of the evaporation values observed at Khon Kaen for the past 40 years. Since the water level dropped for 6.5 mm/day in average in the pond No.3, it was safely assumed that there was very little water leaking in that pond. Thus, it is highly probably that lining with soil cement is very effective in protecting a storage pond from water leaking.

4) Fluctuation in water salt content (EC)

The salt content or EC of the ground water was higher than 20 ms/cm(ca. 13,000 ppm) throughout the observation period.The EC value in pond water were 1.2-1.5 ms/cm (ca.780 - 975 ppm) when the observation started. The values rose up to 8.7 - 10.8 ms/cm (ca. 5,650 - 7,020 ppm) after surface water ran into the ponds during the period of continuous rain in early October. Probably it was because soil of salt content higher than 10,000 ppm around the ponds came in together with the surface water.

After that, EC of pond water dropped a little when it was diluted by rain water which did not cause surface water running into the ponds; it began to rise gradually when the pond water level dropped offsetting rainwater coming in.
The difference in EC between the pond pond No.2 and No.3 was small but EC of the pond No.1 was much higher than those two. It was most probable that the pond No.1 was more affected by ground water of higher salt content than that in the other two ponds.

After January 1991, EC of water in every pond rose up considerable due to concentration of salt in pond water caused by the decreasing water level in the ponds. This was especially noted in pond No.1. EC of the pond water rose up remarkably due to much higher rate of decreasing water quantity than in the other two; EC rose up higher than that of ground water at the end of January.

5) Changes in the shape and structure of the ponds

There was not found any sliding or collapsing of the ponds side slope; the structures remained stable. However, a kind of rill erosion was found at the side slope of pond No.1 (dug out only); it was caused by rain of high intensity.Probably, those damages will be prevented by sodding the side slope.
In the case of pond No.2 (lining with clay), The lining works were carried out under rainy conditions. Thus, the thickness of lining was not uniform; configuration was found in some pleaches. Careful lining works in dry season will not cause such problems.
No problem was recorded in pond No.3.

Table H - 3 Water Levels and E.C. Values of Experimental Ponds

	P - No.1		P - No.2		P - No.3		G W	
Date	W.L.(m)	E.C.(ms/cm)	W.L.(m)	E.C.(ms/cm)	W.L.(m)	E.C.(ms/cm)	W.L.(m)	E.C.(ms/cm)
25-Sep	1.82	1.30	1.38	1.18	1.36	1.50	1.99	>20
5-Oct	1.95	10.79	1.94	8.68	1.92	9.93	2.04	>20
14-Oct	2.07	10.55	2.07	8.14	2.08	9.33		
21-Oct	2.20	9.44	2.20	6.95	2.25	8.01	1.70	32.08
28-Oct	1.98	9.83	2.11	7.11	2.20	8.32		
7-Nov	1.73	10.38	1.95	7.79	2.11	8.98	1.73	>20
13-Nov	1.78	9.47	1.92	6.81	2.08	7.86		
23-Nov	1.56	10.28	1.75	7.49	1.94	8.72	1.23	26.40
5-Dec	1.34	11.37	1.53	7.82	1.75	8.81		
11-Dec	1.27	13.27	1.46	9.12	1.70	10.14	1.11	28.80
25-Dec	1.12	14.52	1.34	9.61	1.58	10.78	0.94	30.02
8-Jan	1.04	18.42	1.27	11.23	1.49	12.38	0.93	33.42
25-Jan	0.90	29.60	1.17	12.70	1.40	13.92	0.83	29.66
10-Feb	0.84	36.96	1.06	14.70	1.30	15.37	0.61	26.32
26-Feb	0.75	59.16	0.89	17.35	1.20	19.27	0.55	27.76

FIGURE H-1 Fluctuation of Water Levels of Experimental Ponds

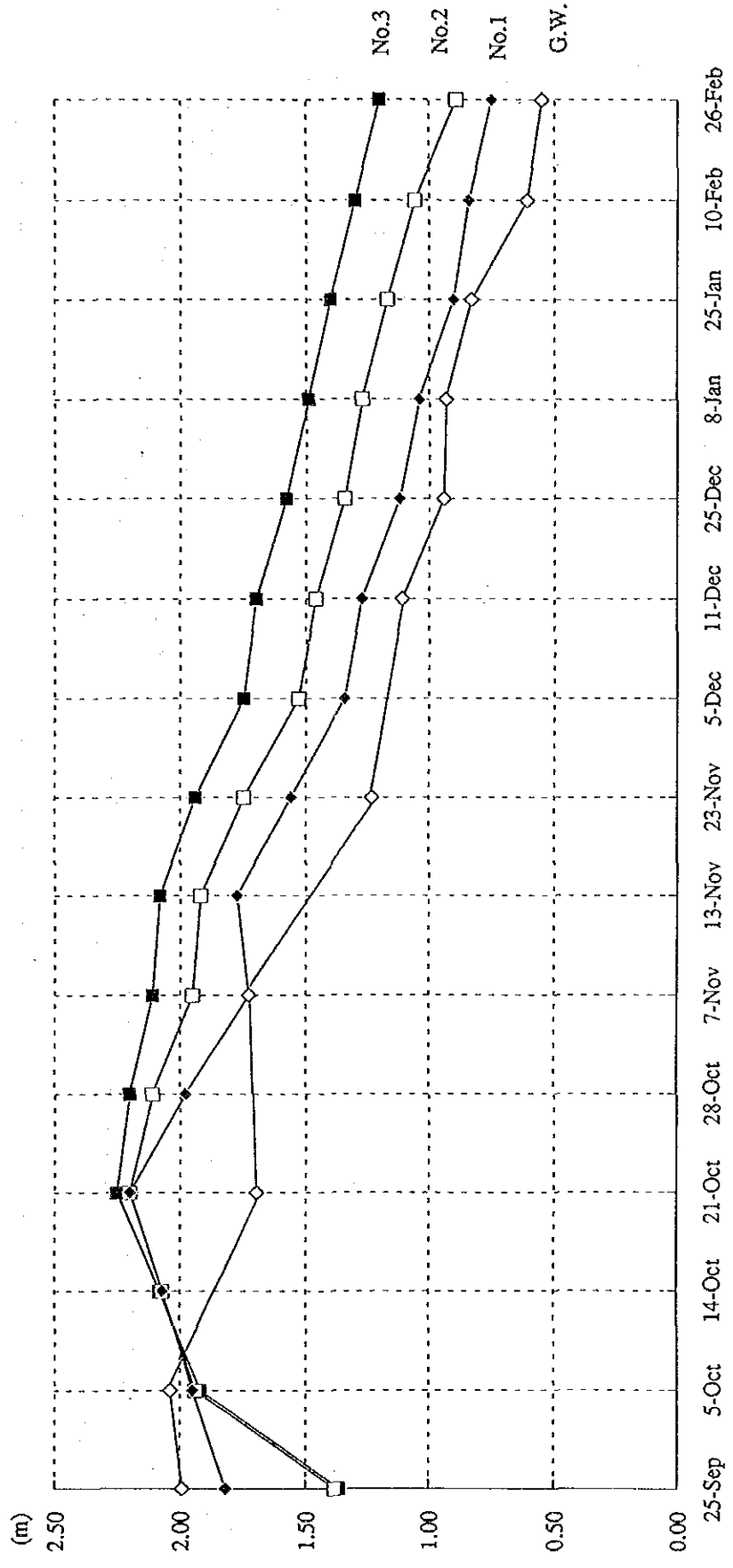
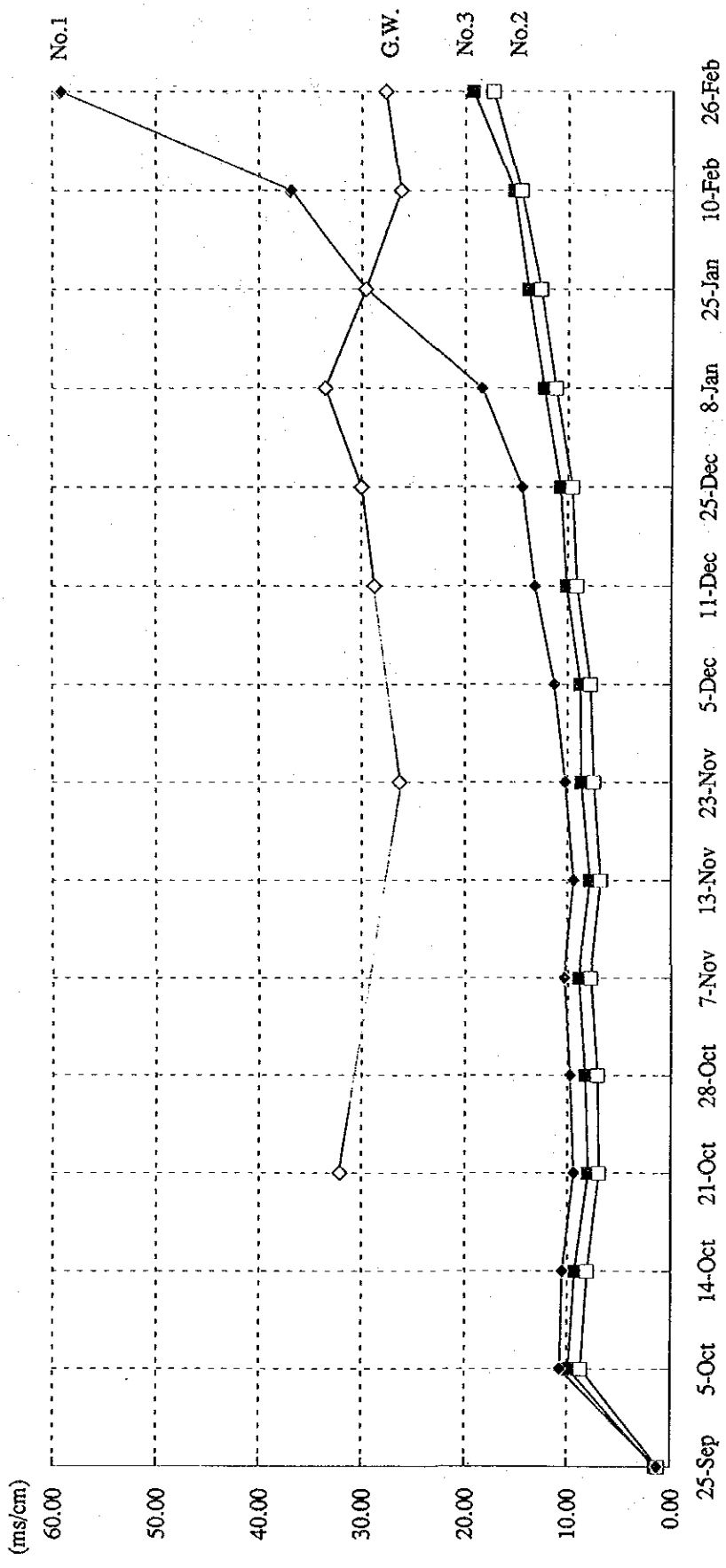


FIGURE H-2 Fluctuation of E.C. Values of Experimental Ponds



H-2 COST ESTIMATE

H-2-1 Summary of Project Cost for Study Area

Table H-4 Project Cost of Annual Investment Plan - Study Area (× 1,000 B)

Year / Cost Item	Total			1st. Year			2nd. Year			3rd. Year		
	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total
1. Construction work												
(1) Irrigation facilities	209,946	357,028	566,974				41,989	71,405	113,394	41,989	71,405	113,394
(2) Drainage facilities	52,850	10,500	63,350				15,100	3,000	18,100	22,650	4,500	27,150
(3) Rural roads	23,726	18,949	42,675							8,897	7,106	16,003
(4) Rural water supply facilities	3,300	7,276	10,576							3,300	7,276	10,576
(5) Reforestation	52,075	-	52,075				10,415	-	10,415	10,415	-	10,415
(6) Social service facilities	25,936	34,749	60,685							25,936	34,749	60,685
Sub-total	367,833	428,502	796,335				67,504	74,405	141,909	113,187	125,036	238,223
2. Equipment	1,742	34,853	36,595				1,742	34,853	36,595			
3. Agricultural extension service	6,453	3,917	10,370	1,556	3,003	4,559	980	183	1,163	980	183	1,163
4. Land acquistion	12,786	-	12,786	2,325	-	2,325	3,487	-	3,487	3,487	-	3,487
5. Project administration	19,112	4,778	23,890				7,644	1,911	9,555	2,867	717	3,584
6. Consulting service	4,048	59,133	63,181	1,654	26,250	27,904	479	6,577	7,056	479	6,577	7,056
Total 1.～6.	411,974	531,183	943,157	5,535	29,253	34,788	81,836	117,929	199,765	121,000	132,513	253,513
7. Physical contingency	41,197	53,118	94,315	553	2,925	3,478	8,184	11,793	19,977	12,100	13,251	25,351
Total 1.～7.	453,171	584,301	1,037,472	6,088	32,178	38,266	90,020	129,722	219,742	133,100	145,764	278,864
8. Price contingency	116,364	100,987	217,351	709	3,381	4,090	15,015	13,906	28,921	29,202	19,998	49,200
Grand Total	569,535	685,288	1,254,823	6,797	35,559	42,356	105,035	143,628	248,663	162,302	165,762	328,064

(continued)

(× 1,000 B)

Cost Item \ Year	4th. Year			5th. Year			6th. Year					
	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total			
1. Construction work												
(1) Irrigation facilities	41,989	71,406	113,395	41,989	71,406	113,395	41,990	71,406	113,396			
(2) Drainage facilities	15,100	3,000	18,100									
(3) Rural roads	8,897	7,106	16,003	5,932	4,737	10,669						
(4) Rural water supply facilities												
(5) Reforestation	10,415	-	10,415	10,415	-	10,415	10,415	-	10,415			
(6) Social service facilities												
Sub-total	76,401	81,512	157,913	58,336	76,143	134,479	52,405	71,406	123,811			
2. Equipment												
3. Agricultural extension service	979	183	1,162	979	183	1,162	979	182	1,161			
4. Land acquistion	3,487	-	3,487									
5. Project administration	2,867	717	3,584	2,867	717	3,584	2,867	716	3,583			
6. Consulting service	479	6,577	7,056	479	6,576	7,055	478	6,576	7,054			
Total 1.～6.	84,213	88,989	173,202	62,661	83,619	146,280	56,729	78,880	135,609			
7. Physical contingency	8,421	8,899	17,320	6,266	8,362	14,628	5,673	7,888	13,561			
Total 1.～7.	92,634	97,888	190,522	68,927	91,981	160,908	62,402	86,768	149,170			
8. Price contingency	25,400	17,766	43,166	22,856	21,459	44,315	23,182	24,477	47,659			
Grand Total	118,034	115,654	233,688	91,783	113,440	205,223	85,584	111,245	196,829			

H-2-2 Cost Breakdown for Study Area

Table H-5 Cost of Irrigation Facilities - Study Area

Description	Unit	Quantity	Unit Rate (B)		Amount (×1,000 B)		
			L/C	F/C	L/C	F/C	Total
1. Yai River Basin(1,083 ha)							
(1) Diversion weirs	nos	6	492,000	524,000	2,952	3,144	6,096
(2) Storage ponds	ha	90.8	578,600	833,900	52,536	75,718	128,254
(3) Intake & regulating structures	nos	34	145,448	255,374	4,945	8,682	13,627
(4) Pumping stations	nos	21	488,307	2,337,721	10,254	49,092	59,346
(5) Head race canals	ha	1,083	8,480	5,070	9,183	5,490	14,673
(6) Secondary canals	ha	1,083	2,895	3,135	3,135	3,395	6,530
(7) Tertiary canals	ha	1,083	5,035	4,700	5,452	5,090	10,542
Sub-total					88,457	150,611	239,068
2. Yang River Basin(783 ha)							
(1) Diversion weirs	nos	6	492,000	524,000	2,952	3,144	6,096
(2) Storage ponds	ha	66.6	578,600	833,900	38,534	55,537	94,071
(3) Intake & regulating structures	nos	25	145,448	255,374	3,636	6,384	10,020
(4) Pumping stations	nos	17	488,307	2,337,721	8,301	39,741	48,042
(5) Head race canals	ha	783	8,480	5,070	6,639	3,969	10,608
(6) Secondary canals	ha	783	2,895	3,135	2,266	2,454	4,720
(7) Tertiary canals	ha	783	5,035	4,700	3,942	3,680	7,622
Sub-total					66,270	114,909	181,179

(continued)

Description	Unit	Quantity	Unit Rate (B)		Amount (1,000 B)		
			L/C	F/C	L/C	F/C	Total
3. Phra Nao River Basin(615 ha)							
(1) Diversion weir	nos	5	492,000	524,000	2,460	2,620	5,080
(2) Storage ponds	ha	48.4	578,600	833,900	28,004	40,360	68,364
(3) Intake & regulating structures	nos	17	145,448	255,374	2,472	4,341	6,813
(4) Pumping stations	nos	12	488,307	2,337,721	5,859	28,052	33,911
(5) Head race canal	ha	615	8,480	5,070	5,215	3,118	8,333
(6) Secondary canal	ha	615	2,895	3,135	1,780	1,928	3,708
(7) Tertiary canals	ha	615	5,035	4,700	3,096	2,890	5,986
Sub-total					48,886	83,309	132,195
4. Existing Pump Area(1,234 ha)							
(1) Tertiary canals construction	ha	1,234	5,035	4,700	6,213	5,799	12,012
(2) Exsting pumps repair (Spare parts)	nos	6	20,000	400,000	120	2,400	2,520
Sub-total					6,333	8,199	14,532
5. Total					209,946	357,028	566,974

Table H-6 Cost of Drainage Facilities - Study Area

Description	Unit	Quantity	Unit Rate (B)		Amount (×1,000 B)		
			L/C	F/C	L/C	F/C	Total
(1) Drainage facilities	ha	5,000	10,570	2,100	52,850	10,500	63,350
Total					52,850	10,500	63,350

Table H-7 Cost of Rural Road - Study Area

Description	Unit	Quantity	Unit Rate (B)		Amount (×1,000 B)		
			L/C	F/C	L/C	F/C	Total
(1) Road construction							
Route No. 1	m	16,000	447	245	7,152	3,920	
Route No. 2	m	12,000	447	245	5,364	2,940	
Route No. 3	m	3,000	541	377	1,623	1,131	
Misc. work	l.s.				1,413	799	
Sub-total					15,552	8,790	24,342
(2) Bridge construction	nos.	3	465,500	306,490	1,396	919	2,315
(3) Road filling and drainage culvets	nos.	75	22,770	26,730	1,707	2,004	3,711
(4) Village road pavement	nos.	60	84,525	120,600	5,071	7,236	12,307
Total					23,726	18,949	42,675

Table H-8 Cost of Reforestation - Study Area

Items	Quantities	Cost/unit (baht/rai)	Total cost (×1,000 baht)
1. Intensive planting survey	59 village	1000.00	59
2. Enrichment planting	2,000 rai (320 ha)	170.40	340
3. Hedgerow intercropping	42,000 rai (6,720 ha)	150.00	6,300
4. Shading/fodder tree planting	46,400 rai (7,420 ha)	850.00	39,440
5. Multistory planting	10,600 rai (1,960 ha)	560.00	5,936
Total			52,075

Table H-9 Cost of Social Service Facilities - Study Area

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
1. Central Market							
(1) Office & Storage	m²	900	1,400	1,400	1,260	1,260	2,520
(2) Market-building	m²	3,200	2,000	2,000	6,400	6,400	12,800
Sub-total					7,660	7,660	15,320
2. Technical Training Center							
(1) Training building	m²	1,100	5,000	5,000	5,500	5,500	11,000
(2) Hendicraft factory	m²	750	2,500	2,500	1,875	1,875	3,750
(3) Food processing factory	m²	750	2,500	2,500	1,875	1,875	3,750
Sub-total					9,250	9,250	18,500
3. Sports & Recreation Facilities							
(1) Pavement	m²	2,400	44	66	105	158	
(2) Related structure	m²	100	1,250	1,250	125	125	
(3) Misc. work					46	56	
Sub-total					276	339	615
4. Equipment/Instruments	l.s.				7,500	17,500	25,000
Transport & Installation	l.s.				1,250	-	1,250
Sub-total					8,750	17,500	26,250
Total					25,936	34,749	60,685

Table H-10 Cost of Agricultural Extension Service - Study Area

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
(1) Personnel cost							
Office manager		7,500 B/month × 12 months × 6 years			540		
Engineer		6,000 B/month × 4 × 12 months × 6 years			1,728		
Agronomist		6,000 B/month × 4 × 12 months × 6 years			1,728		
Clerk		4,500 B/month × 12 months × 6 years			270		
Driver		3,500 B/month × 12 months × 6 years			210		
Sub-total					4,476	-	4,476
(2) Office							
Office building	m^2	75	3,000	3,000	225	225	450
Garage	m^2	150	2,000	2,000	300	300	600
Office supply (10%)					52	52	104
Sub-total					577	577	1,154
(3) Vehicles							
Pick-up (4 ×4)	nos.	4	-	460,000	-	1,840	1,840
Motorcycle (125 cc)	nos.	8	-	25,000	-	200	200
Spare parts						204	204
Sub-total					-	2,244	2,244
(4) Repair & Maintenance							
Repair		2,040,000 × 0.05 ×6 years			61	551	612
Fuel		8.73 B× 15 ℓ × 300 days ×4 nos. ×6 years			753	189	942
Sub-total					814	740	1,554
(5) Miscellaneous (10%)					586	356	942
Total					6,453	3,917	10,370

Table H-11 Land Acquisition Cost - Study Area

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
1. Irrigation Facilities							
(1) Storage pond	ha	251.0	25,000	-	6,275	-	6,275
(2) Head race canal	ha	20.7	25,000	-	517	-	517
(3) Secondary canal	ha	28.7	25,000	-	717	-	717
(4) Tertiary canal	ha	72.2	25,000	-	1,805	-	1,805
Sub-total					9,314		9,314
2. Drainage Facilities							
(1) Interceptor drain	ha	50.0	25,000	-	1,250	-	1,250
(2) Evaporation pond	ha	5.5	25,000	-	137	-	137
(3) Field drain	ha	24.4	25,000	-	610	-	610
Sub-total					1,997		1,997
3. Rural Road							
(1) Route 1&2	ha	16.8	62,500	-	1,050	-	1,050
(2) Route 3	ha	3.6	62,500	-	225	-	225
Sub-total					1,275		1,275
4. Social Service Facilities	ha	1.6	125,000	-	200	-	200
Total					12,786		12,786

Table H-12 Cost of Consulting Service - Study Area

A. Detailed Design		
1. Foreign Currency Portion		
(1) Remuneration		(×1000 Yen)
- Foreign Consultants - 40 M/M		88,000
- Local Consultants - 60 M/M		40,320
(2) Allowance for Foreign Personnel		6,720
(3) Unallocated Contingencies		6,750
	Total (1)	141,790
	(Baht Equivalent:	26,250)
2. Local Currency Portion		(×1000 Baht)
(1) Allowance for Local Personnel		126
(2) Local Communication		300
(3) Local Transportation		600
(4) Salaries for Suppoting Staff		300
(5) Costs for Printing		250
(6) Unallocated Contingencies		78
	Total (2)	1,654
	Total(1)+(2)	27,904
B. Supervision		
1. Foreign Currency Portion		
(1) Remuneration		(×1000 Yen)
- Foreign Consultants - 70 M/M		154,000
- Local Consultants - 5 M/M		3,360
(2) Allowance for Foreign Personnel		11,760
(3) Unallocated Contingencies		8,450
	Total (1)	177,570
	(Baht Equivalent:	32,883)
2. Local Currency Portion		(×1000 Baht)
(1) Allowance for Local Personnel		10
(2) Local Communication		520
(3) Local Transportation		550
(4) Salaries for Supporting Staff		600
(5) Costs for Printing		600
(6) Unallocated Contingencies		114
	Total (2)	2,394
	Total(1)+(2)	35,277

Note: Exchange rate of Baht 1.00 = ¥ 5.40

Table H-13 Operation and Maintenance Cost - Study Area

(1) Personnel cost (× 1,000 B)

Project manager	12,000 B	×		12 months	=	144
Assistant manager	8,000	×	2×	12	=	192
Engineer	6,000	×	4×	12	=	288
Staff (12persons)	50,000	×		12	=	600
						1,224

Pump & gate operator
150 B× 20 days× 56 places× 1 person × 10 months = 1,680

(2) Facilities repair & maintenance

Irrigation	: Pumps(New)	2,200 × 50 × 0.02	=	2,200
	: Pumps(Exist)	11,500 × 0.02	=	230
Rural water	: Pumps & others	3,390 × 0.02	=	67
				2,497

(3) Structures maintenance

Irrigation facilities	456,972 × 0.005	=	2,284
Drainage facilities	63,350 × 0.005	=	316
Rural roads	42,675 × 0.005	=	213
Rural water supply facilities	7,186 × 0.005	=	35
Reforestation	52,075 × 0.005	=	260
Social service facilities	60,685 × 0.005	=	303
			3,411

(4) Fuel (Pumps) 5,145 ℓ/year × 8.73 B × 50 places = 2,245
Electric charge(Exist pumps) 72kw× 1.17 B × 1,250 hrs = 1,055
Electric charge(Rural water pumps) = 44
3,344

(5) Vehicle repair & maintenance

Heavy equipment	12,430	×		0.1	=	1,243
Jeep	550	×		0.1	=	55
Pick up	460	×	6	× 0.1	=	276
Motorcycle	25	×	12	× 0.1	=	30
(fuel)	8.73	×	15 ×300	×7	=	275
	8.73	×	20 ×100	×7	=	122
						2,001

(6) Extension

Salary(7 persons) 39,500 × 12 month = 474

(7) Miscellaneous (5 %) = 731

Total 15,362

H-2-3 Summary of Project Cost for Pilot Area

Table H-14 Project Cost and Annual Investment Plan - Pilot Area (× 1,000 B)

Cost Item \ Year	Total			1st. Year			2nd. Year			3rd. Year		
	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total	L/C	F/C	Total
1. Construction work												
(1) Irrigation facilities	33,955	56,861	90,816				25,467	42,645	68,112	8,488	14,216	22,704
(2) Drainage facilities	8,669	1,723	10,392				8,669	1,723	10,392			
(3) Rural roads	1,494	2,076	3,570							1,494	2,076	3,570
(4) Rural water supply facilities	3,300	7,276	10,576							3,300	7,276	10,576
(5) Reforestation	6,224	-	6,224				3,112	-	3,112	3,112	-	3,112
(6) Social service facilities	22,106	30,919	53,025							22,106	30,919	53,025
Sub-total	75,748	98,855	174,603				37,248	44,368	81,616	38,500	54,487	92,987
2. Equipment	1,742	34,853	36,595				1,742	34,853	36,595			
3. Agricultural extension service	2,533	2,756	5,289	1,229	2,407	3,636	652	175	827	652	174	826
4. Land acquistion	1,784	-	1,784	1,020	-	1,020	764	-	764			
5. Project administration	8,381	2,095	10,476				5,029	1,257	6,286	3,352	838	4,190
6. Consulting service	1,399	20,428	21,827	839	12,257	13,096	280	4,086	4,366	280	4,085	4,365
Total 1. ~ 6.	91,587	158,987	250,574	3,088	14,664	17,752	45,715	84,739	130,454	42,784	59,584	102,368
7. Physical contingency	9,159	15,898	25,057	309	1,466	1,775	4,572	8,474	13,046	4,278	5,958	10,236
Total 1. ~ 7.	100,746	174,885	275,631	3,397	16,130	19,527	50,287	93,213	143,500	47,062	65,542	112,604
8. Price contingency	19,108	20,679	39,787	396	1,695	2,091	8,387	9,992	18,379	10,325	8,992	19,317
Grand Total	119,854	195,564	315,418	3,793	17,825	21,618	58,674	103,205	161,879	57,387	74,534	131,921

H-2-4 Cost Breakdown for Pilot Area

Table H-15 Cost of Irrigation Facilities - Pilot Area

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
1. Upper Area of Yang River(158 ha)							
(1) Diversion weir	nos	1			492	524	1,016
(2) Storage ponds							
A-block	ha	6.3	578,600	833,900	3,645	5,253	
B-block	ha	4.3	578,600	833,900	2,487	3,585	
C-block	ha	5.0	578,600	833,900	2,893	4,169	
Sub-total					9,025	13,007	22,032
(3) Intake & regulating structures	nos	5	145,448	255,374	727	1,276	2,003
(4) Pumping stations	nos	3	488,307	2,337,721	1,464	7,013	8,477
(5) Head race canal							
Canal work	m	1,600	599	287	958	459	
Ckeck gate	nos	1			116	204	
Misc. work	l.s.				107	66	
Sub-total					1,181	729	1,910
(Unit cost per hectare)					(7.47)	(4.61)	(12.08)
(6) Secondary canal							
Canal work	m	3,200	130	142	416	454	
Ckeck gate	nos	17	1,200	1,000	20	17	
Misc. work	l.s.				43	47	
Sub-total					479	518	997
(Unit cost per hectare)					(3.03)	(3.28)	(6.31)
(7) Tertiary canals							
Canal work	m	7,700	90	84	693	646	
Ckeck gate	nos				138	129	
Misc. work	l.s.				831	775	1,606
Sub-total					(5.26)	(4.91)	(10.17)
(Unit cost per hectare)							
Total - 1.					14,199	23,842	38,041

(continued)

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
2. Lower Area of Yang River(166 ha)							
(1) Diversion weir	nos	1			492	524	1,016
(2) Storage ponds							
A-block	ha	7.5	578,600	833,900	4,339	6,254	
B-block	ha	4.7	578,600	833,900	2,719	3,919	
C-block	ha	4.8	578,600	833,900	2,777	4,002	
Sub-total					9,835	14,175	24,010
(3) Intake & regulating structures	nos	5	145,448	255,374	727	1,276	2,003
(4) Pumping stations	nos	3	483,307	2,337,721	1,464	7,013	8,477
(5) Head race canal							
Canal work	m	2,200	599	287	1,317	631	
Ckeck gate	nos	1			116	204	
Misc. work	l.s.				143	83	
Sub-total					1,576	918	2,494
(Unit cost per hectare)					(9.49)	(5.53)	(15.02)
(6) Secondary canal							
Canal work	m	3,100	130	142	403	440	
Ckeck gate	nos	12	1,200	1,000	14	12	
Misc. work	l.s.				41	45	
Sub-total					458	497	955
(Unit cost per hectare)					(2.76)	(2.99)	(5.75)
(7) Tertiary canals							
Canal work	m	7,400	90	84	666	621	
Ckeck gate	nos				133	124	
Misc. work	l.s.				799	745	1,544
Sub-total					(4.81)	(4.49)	(9.30)
(Unit cost per hectare)							
Total - 2.					15,351	25,148	40,499

(continued)

Description	Unit	Quantity	Unit Rate (B)		Amount (×1,000 B)		
			L/C	F/C	L/C	F/C	Total
3. Nakphreecha Area(57 ha)							
(1) Cross Regulater (1.5 m× 1.5 m× 2 nos)	nos	1			232	408	640
(2) Intake & regulating structures	nos	2	145,448	255,374	290	510	800
(3) Storage ponds	nos	4.8	578,600	833,900	2,777	4,002	6,779
(4) Pumping stations	nos	1			488	2,337	2,825
(5) Secondary canal							
Canal work	m	1,700	130	142	221	459	
Ckeck gate	nos	7	1,200	1,000	8	204	
Misc. work	l.s.				22	66	
Sub-total					251	729	1,910
						1)	(12.08)
(6) Tertiary canals							
Canal work	m	3,400	90	84	306	285	
Misc. work	l.s.				61	57	
Sub-total					367	342	709
Total - 3.					4,405	7,871	12,276
4. Total					33,955	56,861	90,816

Table H-16 Cost of Drainage Facilities - Pilot Area (A = 820 ha)

	Description	Unit	Quantity	Unit Rate (B)		Amount (1,000 B)		
				L/C	F/C	L/C	F/C	Total
(1)	Interceptor drain	m	9,600	744	130	7,142	1,248	
	Pipe culvert (ϕ500, ℓ = 12.0m)	nos	19	7,392	6,048	140	114	
	Miscellaneous work	l.s.				728	136	
	Sub-total					8,010	1,498	9,508
(2)	Field drain	m	6,100	51	30	311	183	
	Pipe culvert (ϕ300, ℓ = 10.0m)	nos	12	2,100	1,900	25	22	
	Miscellaneous work	l.s.				33	20	
	Sub-total					369	225	594
(3)	Evaporation pond	nos	5	53,012	-	265	-	
	Miscellaneous work	l.s.				25	-	
	Sub-total					290	-	290
	Total					8,669	1,723	10,392
	(Unit cost per hectare)					(10.57)	(2.10)	(12.67)

Table H-17 Cost of Rural Road - Pilot Area

	Description	Unit	Quantity	Unit Rate (B)		Amount (×1,000 B)		
				L/C	F/C	L/C	F/C	Total
(1)	Road filling and drainage culverts	nos	10	22,770	26,730	227	267	494
(2)	Village road pavement	nos	15	84,525	120,600	1,267	1,809	3,076
	Total							

Table H-18 Cost of Rural Water Supply Facilities - Pilot Area

Description	Unit	Quantity	Unit Rate (B)		Amount (×1,000 B)		
			L/C	F/C	L/C	F/C	Total
1. Facilities for Pa San 1, 2 Villages							
(1) Well (ϕ200, ℓ=30m)	nos	2	92,000	368,000	184	736	920
(2) Pump facilities (ϕ40, 2.2kw)	nos	2	70,000	350,000	140	700	840
(3) Water tank (5 m³)	nos	2	46,000	230,000	92	460	552
Related structures	l.s.				36	184	220
(4) Pipe lines (VPϕ75)	m	2,000	60	120	120	240	360
(5) Valves, GIP pipes, etc.	l.s.				114	464	578
Sub-total					686	2,784	3,470
2. Facilities for Phra Yun and Others							
(1) RC pipe line	m	1,000	1,688	1,382	1,688	1,382	3,070
(2) Pumping station	nos	1			115	100	215
(3) Pump facilities (ϕ50×2.2kw×2)	set unit	1			90	450	540
(4) Water tank (20m³)	set	1			96	480	576
Related structures	l.s.				38	192	230
(5) Purification facilities	unit	1			260	1,300	1,560
(6) Pipe lines (VPϕ75)	m	1,500	60	120	90	180	270
(7) Others (10%)	l.s.				237	408	645
Sub-total					2,614	4,492	7,106
Total					3,300	7,276	10,576

Table H-19 Cost of Reforestation - Pilot Area

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
(1) Intensive planting servey	nos.	15	1,000	-	15	-	15
(2) Seedling cost							
1) Fruits	ha	180	937(150.0 B/rai)-		168	-	168
2) Mulberry	ha	360	3,500(560.0 B/rai)-		1,260	-	1,260
3) Cash crops	ha	500	1,065(170.4 B/rai)-		532	-	532
4) Pasture	ha	800	5,312(850.0 B/rai)-		4,249	-	4,249
Sub-total					6,209	-	6,209
Total					6,224	-	6,224

Table H-20 Cost of Social Service Facilities - Pilot Area

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
1. Central Market							
(1) Office & storage	m²	450	1,400	1,400	630	630	1,260
(2) Market-building	m²	1,600	2,000	2,000	3,200	3,200	6,400
Sub-total					3,830	3,830	7,660
2. Technical Training Center							
(1) Training building	m²	1,100	5,000	5,000	5,500	5,500	11,000
(2) Hendicraft factory	m²	750	2,500	2,500	1,875	1,875	3,750
(3) Food procexxing factory	m²	750	2,500	2,500	1,875	1,875	3,750
Sub-total					9,250	9,250	18,500
3. Sports & Recreation Facilities	l.s.				276	339	615
4. Equipment/Instruments	l.s.				7,500	17,500	25,000
Transport & Installation	l.s.				1,250	-	1,250
Sub-total					8,750	17,500	26,250
Total					22,106	30,919	53,025

Table H-21 Equipment Cost

Description	Unit	Quantity	Unit Rate (B)		Amount (1,000 B)		
			L/C	F/C	L/C	F/C	Total
(1) Construction equipment							
Bulldozer (9 ton)	nos	2	-	1,950,000	-	3,900	
Backhoe (0.35 m³)	nos	2	-	1,900,000	-	3,800	
Truck (8 ton)	nos	3	-	1,200,000	-	3,600	
Spare parts (10%)					-	1,130	
Sub-total						12,430	12,430
(2) Drilling equipment							
Drilling rig	Unit	1	-	9,000,000	-	9,000	
Water tank lorry (7 m³)	Unit	1	-	1,050,000	-	1,050	
Truck (6 ton, 3-t crane)	Unit	2	-	1,100,000	-	2,200	
Truck (2 ton, 1-t crane)	Unit	2	-	520,000	-	1,040	
Submerged pump	Unit	2	-	250,000	-	500	
Diesel generator	Unit	2	-	520,000	-	1,040	
Welder	Unit	1	-	270,000	-	270	
Air compressor	Unit	2	-	900,000	-	1,800	
Spare perts (10%)	l.s.				-	1,690	
Sub-total						18,590	18,590
(3) Vehicles							
Pick-up (4×4)	nos	2	-	460,000	-	920	
Motorcycle (125cc)	nos	5	-	25,000	-	125	
Spare parts (10%)	l.s.				-	104	
Sub-total					-	1,149	1,149
(4) Survey equipment	l.s.				-	600	600
(5) Laboratory equipment	l.s.				-	2,084	2,084
(6) Inland freight (5%)	l.s.				1,742	-	1,742
Total					1,742	34,853	36,595

Table H-22 Cost of Agricultural Extension Service - Pilot Area

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
(1) Personnel cost							
Office manager		7,500 B/month × 12 months × 3 years			270		
Engineer		6,000 B/month × 2 × 12 months × 3 years			432		
Agronomist		6,000 B/month × 2 × 12 months × 3 years			432		
Clerk		4,500 B/month × 12 months × 3 years			162		
Driver		3,500 B/month × 12 months × 3 years			126		
Sub-total					1,422	-	1,422
(2) Office							
Office building	m^2	75	3,000	3,000	225	225	450
Garage	m^2	150	2,000	2,000	300	300	600
Office supply (10%)					52	52	104
Sub-total					577	577	1,154
(3) Vehicles							
Pick-up (4 ×4)	nos.	3	-	460,000	-	1,380	1,380
Motorcycle (125 cc)	nos.	5	-	25,000	-	125	125
Spare parts						150	150
Sub-total					-	1,655	1,655
(4) Repair & Maintenance							
Repair		1,505,000 × 0.05 ×3 years			22	203	225
Fuel		8.73 B× 15 ℓ × 300 days ×3 nos. ×3 years			282	71	353
Sub-total					304	274	578
(5) Miscellaneous (10%)					230	250	480
Total					2,533	2,756	5,289

Table H-23 Land Acquisition Cost - Pilot Area

Description	Unit	Quantity	Unit Rate (B)		Amount (× 1,000 B)		
			L/C	F/C	L/C	F/C	Total
1. Irrigation Facilities							
(1) Storage pond	ha	39.8	25,000	-	995	-	995
(2) Head race canal	ha	2.7	25,000	-	67	-	67
(3) Secondary canal	ha	4.4	25,000	-	110	-	110
(4) Tertiary canal	ha	7.4	25,000	-	185	-	185
Sub-total					1,357		1,357
2. Drainage Facilities							
(1) Interceptor drain	ha	8.2	25,000	-	205	-	205
(2) Evaporation pond	ha	0.9	25,000	-	22	-	22
(3) Field drain	ha	4.0	25,000	-	100	-	100
Sub-total					327		327
3. Social Service Facilities	ha	0.8	125,000	-	100	-	100
Total							1,784

Table H-24 Cost of Consulting Service - Pilot Area

A. Detailed Design		
1. Foreign Currency Portion		(×1000 Yen)
(1) Remuneration		
- Foreign Consultants - 15 M/M		33,000
- Local Consultants - 20 M/M		13,440
(2) Allowance for Foreign Personnel		2,520
	Total (1)	48,960
	(Baht Equivalent:	9,067)
2. Local Currency Portion		(×1000 Baht)
(1) Allowance for Local Personnel		42
(2) Local Communication		105
(3) Local Transportation		210
(4) Salaries for Suppoting Staff		105
(5) Costs for Printing		90
(6) Unallocated Contingencies		20
	Total (2)	572
	Total(1)+(2)	9,639
B. Supervision		
1. Foreign Currency Portion		(×1000 Yen)
(1) Remuneration		
- Foreign Consultants - 25 M/M		55,000
- Local Consultants - 3.2 M/M		2,150
(2) Allowance for Foreign Personnel		4,200
	Total (1)	61,350
	(Baht Equivalent:	11,361)
2. Local Currency Portion		(×1000 Baht)
(1) Allowance for Local Personnel		7
(2) Local Communication		180
(3) Local Transportation		190
(4) Salaries for Supporting Staff		210
(5) Costs for Printing		210
(6) Unallocated Contingencies		30
	Total (2)	827
	Total(1)+(2)	12,188

Note: Exchange rate of Baht 1.00 = ¥ 5.40

Table II-25 Operation and Maintenance Cost - Pilot Area

(1) Personnel cost (×1,000 B)

Project manager	12,000 B	×		12 months	=	144
Assistant manager	8,000 B	×		12	=	96
Engineer	6,000 B	×	2×	12	=	144
Staff (6persons)	25,000 B	×		12	=	300
						684

Pump & gate operator
150 B× 20 days× 7 places × 1 person × 10 months = 210

(2) Facilities repair & maintenance

Irrigation : Pumps	2,200× 7 × 0.02	=	308
Rural water : Pumps & others	3,390× 0.02	=	67
			375

(3) Structures maintenance

Irrigation facilities	75,416 × 0.005	=	377
Drainage facilities	10,392 × 0.005	=	51
Rural roads	3,570 × 0.005	=	17
Rural water supply facilities	7,186 × 0.005	=	35
Reforestation	6,224 × 0.005	=	31
Social service facilities	53,025 × 0.005	=	265
			776

(4) Fuel (Pumps) 5,145 ℓ/year × 8.73 B × 7 places = 314

Electric charge(Pumps) 2.2 kw × 1.17 B × 4 nos. × 12 hrs. × 360 days = 44

358

(5) Equipment repair & maintenance

Heavy equipment	12,430	×		0.1	=	1,243
Jeep	550	×		0.1	=	55
Pick up	460	×	3 ×	0.1	=	138
Motorcycle	25	×	6 ×	0.1	=	15
(fuel)	8.73	×	15 ×300 ×4		=	157
	8.73	×	20 ×100 ×7		=	122
						1,730

(6) Extension

			months		
Salary(5 persons)	27,000	×	12	=	330

(7) Miscellaneous (5%) = 223

Total 4,686

H-2-5 Unit Construction Costs

Table H-26 Unit Costs of Irrigation Canals

Description	Unit	Quantity	Unit Rate (B)		Amount (B)		
			L/C	F/C	L/C	F/C	Total
(1) Head race canal							
Stripping	m3	0.60	3	6	2	4	
Excavation	m3	2.53	4	11	10	28	
Embankment	m3	1.12	9	25	10	28	
Sodding	m2	4.28	11	-	47	-	
Concrete	m3	0.50	1,059	454	530	227	
Total per meter					599	287	886
(2) Secondary canal							
Stripping	m3	0.80	3	6	2	5	
Embankment	m3	2.25	13	36	29	81	
Sodding	m2	4.25	11	-	47	-	
Soil-cement	m3	0.15	348	372	52	56	
Total per meter					130	142	272
(3) Tertiary canal							
Stripping	m3	0.60	3	6	2	4	
Embankment	m3	1.20	13	36	16	43	
Sodding	m2	3.40	11	-	37	-	
Soil-cement	m3	0.10	348	372	35	37	
Total per meter					90	84	174

Table H-27 Unit Cost of Storage Pond

Description	Unit	Quantity	Unit Rate (B)		Amount (B)		
			L/C	F/C	L/C	F/C	Total
(Estimated for the storage surface area of 5.00 ha)							
Stripping	m3	1,116	3	6	3,348	6,696	
Excavation	m3	150,000	4	11	600,000	1,650,000	
Embankment	m3	8,432	9	25	75,888	210,800	
Sodding	m2	5,432	11	-	60,016	-	
Concrete	m3	6,189	348	372	2,153,772	2,302,308	
Total					2,893,024	4,169,804	7,062,828
(per hectare)					(578,600)	(833,900)	(1,412,500)

Table H-28 Unit Cost of Diversion Weir

Description	Unit	Quantity	Unit Rate (B)		Amount (B)		
			L/C	F/C	L/C	F/C	Total
(1) Diversion weir							
Rainforeced concret	m3	135.0	2,009	1,644	271,215	221,940	
Stone lining	m3	30.0	606	67	18,180	2,010	
Miscellaneous work	l.s.				57,879	44,790	
Sub-total					347,274	268,740	616,014
(2) Intake structure							
Rainforeced concret	m3	23.0	2,009	1,644	46,207	37,812	
Gate (1.5×1.5)	nos	1			90,000	210,000	
Miscellaneous work	l.s.				9,241	7,562	
Sub-total					145,448	255,374	400,822
Total					492,722	524,114	1,016,836

Table H-29 Unit Cost of Pumping Station

Description	Unit	Quantity	Unit Rate (B)		Amount (B)		
			L/C	F/C	L/C	F/C	Total
(1) Civil work							
Rainforeced concrete	m3	47.0	2,009	1,644	94,423	77,268	
Miscellaneous work	l.s.				18,884	15,453	
Sub-total					113,307	92,721	206,028
(2) Pump house	m2	36.0	1,250	1,250	45,000	45,000	90,000
(3) Pump facilities incl. pipes, valves, etc. (ϕ200 ×2)	unit	2	165,000	1,100,000	330,000	2,200,000	2,530,000
Total					488,307	2,337,721	2,826,028

Table H-30 Unit Costs of Drainage Facilities

Description	Unit	Quantity	Unit Rate (B)		Amount (B)		
			L/C	F/C	L/C	F/C	Total
(1) Interceptor drain							
Stripping	m3	0.51	3	6	2	3	
Excavation	m3	4.08	4	11	16	45	
Embankment	m3	0.72	78	-	56	-	
Bard (t=2.5cm)	m3	2.0	202	41	404	82	
Log (ϕ125, ℓ = 2.5m)	nos	1.33	200	-	266	-	
Total per meter					744	130	874
(2) Field drain							
Stripping	m3	0.36	3	6	1	2	
Excavation	m3	2.52	4	11	10	28	
Embankment	m3	0.51	78	-	40	-	
Total per meter					51	30	81
(3) Evaporation pond							
Excavation	m3	652	39	-	25,428	-	
Embankment	m3	62	78	-	4,836	-	
Clay soil lining	m3	188	121	-	22,748	-	
Total per one place					53,012	-	53,012

Table H-31 Unit Costs of Rural Road

Description	Unit	Quantity	Unit Rate (B)		Amount (B)		
			L/C	F/C	L/C	F/C	Total
(1) Road construction-type A							
Stripping	m3	2.0	3	6	6	12	
Embankment	m3	8.7	26	36	226	313	
Laterite paving	m3	1.43	182	37	260	52	
Sodding	m2	4.5	11	-	49	-	
Total per meter					541	377	918
(2) Road construction-type B							
Stripping	m3	1.0	3	6	3	6	
Embankment	m3	5.2	26	36	135	187	
Laterite paving	m3	1.43	182	37	260	52	
Sodding	m2	4.5	11	-	49	-	
Total per meter					447	245	692
(3) Bridge							
Rainforced concrete-1	m3	40.0	2,137	1,748	85,480	69,920	
Rainforced concrete-2	m3	100.0	1,863	1,524	186,300	152,400	
Plain concrete	m3	10.0	1,059	454	10,590	4,540	
Masonry	m3	66.0	905	227	59,730	14,982	
Stone lining	m3	50.0	606	67	30,300	3,350	
Miscellaneous work					93,100	61,298	
Total per one place					465,500	306,490	771,990
(4) Road filling & drainage pipe							
Earth filling	m3	500	26	36	13,000	18,000	
Concrete pipe (ϕ600)	m	10	770	630	7,700	6,300	
Miscellaneous work	l.s.				2,070	2,430	
Total per one place					22,770	26,730	49,500
(5) Village road pavement (ℓ = 500m)							
Embankment	m3	600	26	36	15,600	21,600	
Earth cutting	m3	75	39	-	2,925	-	
Asphalt pavement	m2	1,500	44	66	66,000	99,000	
Total per one village					84,525	120,600	205,125

Table H-32 Cost of Multistory Planting

Items	Year (baht/rai)			
	1	2	3	4
1. Trees planting along boarder	80	-	-	-
2. Mango Planting	480	-	-	-
3. Land preparation	400	200	-	-
4. Planting upland rice	100	100	-	-
5. Planting papaya	200	-	-	-
6. Planting mulberry	200	-	-	-
7. Planting chilli	100	-	-	-
8. Fertilizing & maintenance	200	200	200	200

Note: Planting cost include seedlings and labour.

Table H-33 Cost of Shading/fodder tree planting for 100 trees

Items	Year (baht/rai)			
	1	2	3	4
1. Land preparation	400	-	-	-
2. Seedlings	300	-	-	-
3. Planting	150	-	-	-
4. Grass seeds	300	-	-	-
5. Sowing	100	-	-	-
6. Material costs	50	-	-	-
7. Fertilizer for trees	140	-	-	-
8. Fertilizer for grass	140	140	-	-
9. Fire lines preparation	35	-	-	-
10. Maintenance	150	150	150	150

Table H-34 Cost of Hedgerow Intercropping

Items	Year (baht/rai)			
	1	2	3	4
1. Trees along boarder(40 trees)				
- seedlings	100	30	-	-
- labour for planting	40	40	40	400
2. Hedgerow				
- seeds	50	-	-	-
- pruning labour	40	40	40	40
3. Crop area(0.8 rai)				
- land preparation	220	160	160	160
- fertilizer	150	120	100	80
- seeds(c_2 & c_3)	100	100	100	100
- seedlings(c_1 & c_4)	400	-	-	-

Table H-35 Cost of Line Enrichment Coverings 100 rai

Year	Activities	Mandays per 100 rai	Baht @ 40
1.	Selection of area, marking of block and lines	32	1,280
	Clearing of lines	170	6,800
	Digging of planting holes	48	1,920
	Production of planting stock	80	3,200
	Planting and replanting	64	2,560
	Weeding	32	1,280
	Total		17,040
2.	Weed control, climber cutting	48	1,920
3.	Weed control, climber cutting	48	1,920
4.	Weed control, climber cutting	48	1,920
5.	Weed control, climber cutting	48	1,920
6.	Weed control, climber cutting	48	1,920

Table H-36 List of Equipment Costs for Social Service Facilities

Description	Q'ty	Unit cost(Yen)	Total cost(Yen)
1. Technical Training Center			
Video TV Set	5	300,000	1,500,000
Personal Computer	2	500,000	1,000,000
Word Processor	3	200,000	600,000
Copy Machine	1	500,000	500,000
Camera	2	50,000	100,000
Drafter & Tool	5	150,000	750,000
Workshop & Tool	5	60,000	300,000
Van	3	3,000,000	9,000,000
Bike	5	300,000	1,500,000
Tractor	1	5,000,000	5,000,000
Mobile Generator	2	200,000	400,000
Audio-Room (50 seats)	1	2,000,000	2,000,000
Workshop Unit	1	2,000,000	2,000,000
Dormitory (20 beds)	1	1,200,000	1,200,000
Showroom Furniture	1	1,000,000	1,000,000
Office Furniture	1	1,000,000	1,000,000
Air Conditioner	2	400,000	800,000
Electric Fan	10	30,000	300,000
Refrigerator	1	150,000	150,000
Miscellaneous Set	1	5,800,000	5,800,000
Sub-Total			34,900,000

(continued)

Description	Q'ty	Unit cost(Yen)	Total cost(Yen)
2. Handicraft Factory			
Mudmmee Weaving Tool	50	150,000	7,500,000
Sewing Machine	50	150,000	7,500,000
Fiber Setting Tool	50	30,000	1,500,000
Ceiling Fan	10	30,000	300,000
Dryer Fan	5	40,000	200,000
Dyeing Set	2	50,000	100,000
Storage Furniture	1	1,000,000	1,000,000
Tailor's Tool	50	40,000	2,000,000
Washing Basin	10	50,000	500,000
Miscellaneous Set	1	4,700,000	4,700,000
Sub-Total			25,300,000
3. Food Processing Plant			
Boiler	1	4,000,000	4,000,000
Refrigerator & Freezer	1	3,500,000	3,500,000
SS Jacketed Batch	6	700,000	4,200,000
SS Processing Table	6	50,000	300,000
Chopper & Mixer	4	800,000	3,200,000
Sausage Packer	1	1,500,000	1,500,000
Smoking Maker	1	1,500,000	1,500,000
Semi-Auto Filler	4	1,250,000	5,000,000
Incubator Tool	4	700,000	2,800,000
Weighter	2	300,000	600,000
Laboratory Tool	1	2,000,000	2,000,000
Miscellaneous Set	1	5,700,000	5,700,000
Sub-Total			34,300,000
Total			94,500,000

(Baht Equivalent: B 17,500,000)

Table H-37 List of Laboratry Equipment Costs

Description	Q'ty	Unit cost(Yen)	Total cost(Yen)
Wagner pot	100	2,000	200,000
Hand auger	5	100,000	500,000
Soil hardness tester	5	70,000	350,000
Tension meter	10	50,000	500,000
EC meter	5	170,000	850,000
pH meter	5	100,000	500,000
Balance	5	200,000	1,000,000
Ion-exchange water purifier	2	200,000	400,000
Pump	5	50,000	250,000
Rice mill for yield check	1	175,000	175,000
Auto grain-counter	1	900,000	900,000
Thresher for yield check	1	580,000	580,000
Cone penetrometer	1	110,000	110,000
A kit of apparatus for soil analysis	1	1,850,000	1,850,000
Soil-three-phases meter	1	450,000	450,000
Soil-extract shaker	1	500,000	500,000
Self-recording tension meter	2	1,070,000	2,140,000
		Total	11,255,000

(Baht Equivalent: B 2,084,000)

Note: Exchange rate of Baht 1.00= ¥ 5.40

H-2-6 Unit Prices

Table H-38 Unit Prices of Materials

Item	Unit	Rate(Baht)
Sand	cu.m	280
Gravel	cu.m	300
Rip Rap	cu.m	392
Laterite	cu.m	165
Reinforcement Bar	ton	12,000
Cement	50kg	100
Diesel Oil	litre	8.73
Timber (Soft)	cu.m	8,100
Timber (Hard)	cu.m	14,000

Table H-39 Rate of Foreign and Local Currency

Description	F/C	L/C
Cement	60%	40%
Steel bar	70%	30%
Timber	20%	80%
Fuel&Oil	80%	20%
Labour	-	100%
Spare Parts	90%	10%
Gravel	-	100%
Sand	-	100%
Laterite	-	100%
Concrete block	40%	60%
Reinforced concrete pipe	50%	50%

Table H-40 Unit Prices of Construction Works

Description of Works	Unit	L/C	F/C	Total
Reinforced concrete	cu.m	1,863	1,524	3,387
- Light	cu.m	2,009	1,644	3,653
- Medium	cu.m	2,137	1,748	3,885
- Heavy	cu.m	655	280	935
Rough concrete	cu.m	1,059	454	1,513
Fine concrete	cu.m	905	227	1,132
Masonry	cu.m	606	67	673
Riprap	cu.m	379	-	379
Rock	cu.m	324	-	324
Cutting by Excavator	cu.m	4	11	15
— do — (hard)	cu.m	5	14	19
Clearing by bulldozer	cu.m	3	6	9
Compaction by machine (95%)	cu.m	9	25	34
— do — (85%)	cu.m	7	21	28
Laterite grading	cu.m	4	12	16
Cutting by labors	cu.m	39	-	39
Compaction by labors	cu.m	78	-	78
Sodding	sq.m	11	-	11

Table H-41 Escalation Factor

Year	Foreign Currency		Local Currency	
	Annual Inflation * (%)	Escalation Factor	Annual Inflation ** (%)	Escalation Factor
1991	9.04	0.0452	4.5	0.0225
92	1.14	0.0966	4.5	0.0685
93	0.42	0.1051	4.5	0.1166
94	1.64	0.1072	4.5	0.1668
95	3.76	0.1372	4.5	0.2194
96	4.03	0.1815	4.5	0.2742
97	4.71	0.2333	4.5	0.3316
98	3.25	0.2821	4.5	0.3715
99	3.43	0.3249	4.5	0.4541
2000	3.34	0.3698	4.5	0.5195

* G-5 MUV (Manufactures Unit Value) Index, World Bank, Oct. 26, 1990

** Weighted Producer Price Index (Construction Materials 52%, Machinery & Equipment: 48%) between 1983 and 1989 Bank of Thailand, Dec. 1989

APPENDIX I AGRO-SOCIO ECONOMY

CONTENTS

LIST OF TABLES

LUST OF FIGURES

1-1. Socio Agro-Economic Conditions in the Northeast

The Northeast or Korat Plateau, the largest region in the Kingdom of Thailand bounded on the north and east by the Mekong River which forms the common border with the neighouring and traditionally cultural sharing country, on the west by the Phetc Mountain Range with the mountainous region of North Thailand, and on the south-east the war-raged Kampuchea, while on the south-west by the Central Region where a economy is implemented at the moment.

The region contains approximately 17 million people or about one-third of the total population of the whole country which consists of the majority on "Thai Esarn" and many ethmic groups such as Lao-Wieng, Thai Korat, Khmer, Vietnamese and Chinese, mainly dwelling in border areas.

Farming is the main economic activity in the region which 80 percent of the population have been engaged in earning their living up to now.

The region is composed of 3 river-basins, Mekong, Chi and Mun, but due to its topographic features of high plateau of approximately 200 m above sea level and sloping toward its southeast, irrigation from these water resources has not largely applied.

Mekong basin : 5 changwats (Loei, Sakhon Nakhom, Udon Thani, Nong Khai and Nakhon Planom)

Chi basin : 6 changwats (Chaiyaphum, Khou Kaen, Maha Salakham, Roi Et, Kalasin and Yasothon)

Mun basin : 5 changwats (Nakhon Ratchashima, Buri Ram, Surin, Si Saket and Ubon Ratchathani)

Rainfed paddy cultivation, therefore, maintains the main economic activity.

Besides, poor soil characteristics of salinity and an erratic rainfall pattern have contributed to the backward economy of this region causing a low income per capita of approximately 250 US $ compared to an average of approximately 1,000 US $ at national level.

General basic data of the Northeast are as follows.

Total Area	17 Mha
Provinces (Changwats)	18
Population	17 million
Population growth rate	2.37 %
Districts (Tambons)	1981
Mubans (villages)	20,828
Farms	1.840,184
Average farm size	4.5 ha
average household members	6.0 people

Permanent agriculture in the regions is essentially small, predominantly crop-based, mixed-farming with 80 percent of agricultural income obtained from cropping activities. The remainder acres from the sale of livestock and fish, production of silk and charcoal, sale of forest products, etc.

According to I.A. Craig and U. Pisone an variety of cropping systems have been evolved by farmers in response to their local agroecological conditions and family requirements. In 1984, 96 percent of the region has no irrigation and the crop production environment is characterized by rainfall with extremely high annual variability. Staggered planting dates, cultural practices and the crop grown are the most common farmer strategies for dealing with this variability.

Cropping patterns in the region can best be summarized according the five generalized land types: lower paddy, middle paddy, upper paddy, upland and hill land. Most farms are composed of a mixture of two, three of more of these land types in varying proportions depending of their location.

The lower paddy land is bunded and planted to long-duration rice every year in the wet season. Rice seeding nurseries are also generally established on this land type as soon as sufficient water is available. Other crops grown in part of this area include kenaf and a variety of vegetables for home consumption with sale of the surplus in local markets. The major problems on the lower paddy land are occasional flooding of the rice waterlogging of the soil.

The middle paddy is probably the most productive land in the region, as it combines reasonable water control with a reduced risk of flooding. A medium-duration rice crop is produced in the rainy season in most years, sometimes with vegetable, legume or tobacco crops before and/or after the rice.

The upper paddy is also bunded but may be planted to short-duration rice in only three or four years out of ten with a successful harvest occurring even less frequently. This land has the potential for producing one or two upland crops during the rainy season. Farmers will plant rice whenever possible, however, and by the time the decision is made that there will be insufficient rainfall for rice, it is generally too late to plant an upland crop. Weed problems are severe on this land since it often lies fallow for two to three consecutive years allowing weed populations to build up.

The uplands account for 20 to 30 percent of the cultivated land in the Northeast and consist of unbounded fields, often on land reopened from a short bush fallow. The major crops grown on this land in order of importance are: cassava, kenaf, sugarcane, upland rice and legumes such as peanut or mung bean, which are usually grown as monocrops during the rainy season. The major problems here are rapid reduction in soil nutrient levels, selective soil erosion of clay and organic matter, and disease build-up in the continuously cropped areas.

Agriculture in the Northeast therefore, is subjected to two major types of instability: first, production instability caused mainly by climatic variability, and second, price instability for both marketed products and purchase inputs.

The greatest production variability occurs in the wet season rice crop and (reflected in both the area planted and yield per planted areas. Regional production do not give a true picture of this variability. It is not until the lower levels in hierarchy are reached that the real variability facing farmers become apparent.

In cash crops, a further factor of market risk is also introduced. The farm respond similarly with minimal inputs in these crops; they choose export crops which have more stable prices and plant crops with flexible

marketing schedules such as cassava or kenaf and maize which can be sold when prices are higher.

From the above background, the total cropped area in the Northeast is increasing as population pressure causes the farmers to cut the forest and bring it under cultivation. Reforestation is occurring at an alarming rate and currently stands at seven percent per year. Most of the forest clearance is not for permanent agriculture. Farmers are exploiting the initially high organic matter and nutrient levels for two to three years after which the land is abandoned as fertility levels and yields decline. This is adding significantly to the region's problems through increased flooding in the rainy season and reduced river flow in the dry season.

Recent data on agroeconomy of the Northeast are included in following tables.

These information offer a whole picture on this aspect with changes in land use and planted areas, but the aspect of economic depression is still maintained despite of various infrastructures for socio-economic development have been implemented.

FIGURE I-1 CHANGWATS IN THE NORTHEAST

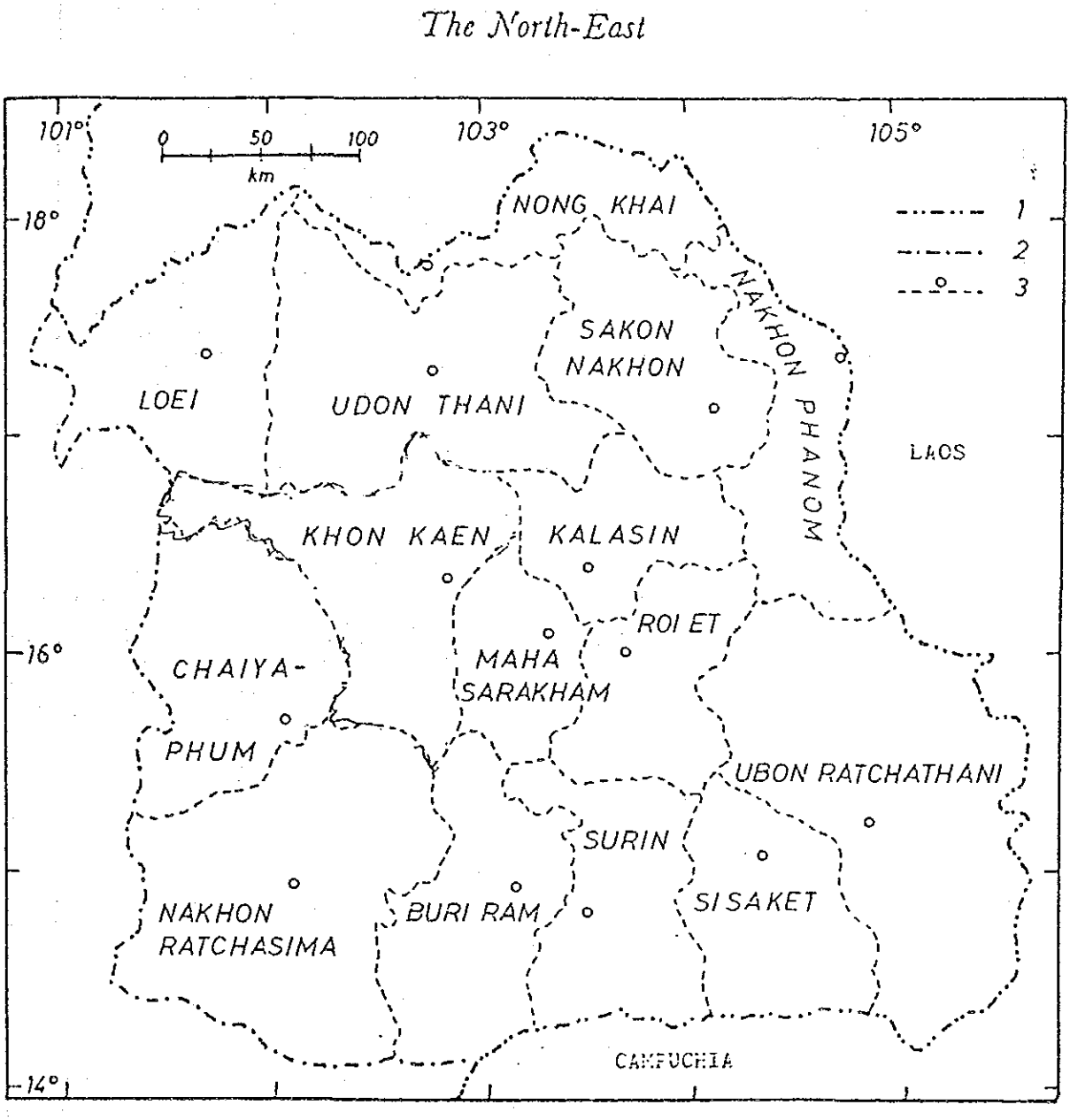


Table I-1 The situation of land use and crop production in the Northeast (1983)

Land Use	Area	Percent of Total Area	Percent Change in Last 5 years
	Mha		
Total area	17	100	Unchanged
Forest land	2.7	16	-35
Farm holding	8.3	49	+ 6
Unclassified	5.9	35	+20
Farm holding	8.3	100	+ 6
Paddy land	5.8	70	+ 5
Field crops	1.7	20	+31
Others	0.8	10	Unchanged
(Irrigated area)	(0.4)	(4.8)	(+44)
Head of cattle	6 million	-	+ 7
No. of pigs	1.1 million	-	+24

Land Use			Production			
Crop	Planted Crop Area	Change in Planted Area 1978-83	Percent of National Production	Mean Yield 1978-83	National Mean Yield 1978-83	Percent of National Average
	ha×103	(%)	(%)	(kg/ha)	(kg/ha)	(%)
Rice	4,260	+9	36	1,200	1,660	73
Cassava	726	+15	59	13,400	13,900	96
Maize	501	+53	22	1,780	1,990	90
Kenaf	217	-31	100	1,040	1,040	100
Sugarcane	104	+124	11	39,800	40,600	98
Peanut	28	+25	19	1.020	1,190	86
Cotton	25	+13	25	1,270	1,150	112
Mumg bean	18	+55	4	664	594	112

(Source: OAE, 1983)

Table I-2 Utilization of Farm Holding Lands in Thailand and Northeast (1988)

(Unit: rais)

Region	Farm holding lands								
	Housing area	Paddy land	Under field crops	Under fruit treess and tree crops	Under vegetable and flowers	Livesock farm area	Idle land	Other land	Total
North-Eastern	1.147.552	38.594.234	13.439.713	1.844.652	414.775	929.274	4.075.260	567.149	60.827.495
Northern	953.948	16.952.374	11.757.104	1.610.600	326.340	1.120.525	1.006.368	293.519	34.020.778
Central Plain	797.262	14.352.675	10.296.603	4.233.185	217.054	2.563.224	902.575	600.307	33.962.885
Southern	444.662	4.292.162	225.832	11.846.389	69.622	149.435	1.700.092	261.304	18.989.498
Whole Kingdom	3.343.424	74.191.445	35.719.252	19.534.826	1.027.791	4.762.458	7.684.292	1.722.279	147.800.656

Utilization of farm holding lands in Northeast by province, 1988

(Unit: rais)

Province	Farm holding lands								
	Housing area	Paddy land	Under field crops	Under fruit treess and tree crops	Under vegetable and flowers	Livesock farm area	Idle land	Other land	Total
Whole Kingdom	3.343.424	74.191.445	35.719.252	19.534.826	1.027.791	4.762.458	7.684.292	1.722.279	147.800.656
Nakhon Phanom	51.634	1.148.896	182.042	44.026	7.037	11.329	169.834	70.263	1.685.061
Sakon Nakhon	56.755	2.085.772	302.160	72.845	14.543	22.209	240.174	93.901	2.888.309
Nong Khai	53.265	1.369.566	676.066	53.554	15.121	9.989	216.101	36.297	2.429.959
Udon Thani	97.727	3.416.635	1.134.154	121.138	10.872	24.018	465.475	32.690	5.302.709
Loei	42.183	533.564	1.535.469	112.603	10.967	8.397	137.738	12.546	2.393.467
Mukdahan	20.324	357.817	138.634	38.394	2.393	27.479	197.548	18.170	800.759
Yasothon	30.785	1.306.366	228.664	93.756	93.756	57.366	358.738	20.912	2.099.401
Ubon Ratchathani	113.671	4.303.444	528.510	105.608	105.608	24.314	1.108.816	39.873	6.235.672
Kalasin	57.973	1.621.635	659.629	62.912	13.775	6.607	161.663	11.402	2.595.596
KhonKaen	77.604	2.659.860	1.048.500	174.342	18.398	21.054	148.420	21.269	4.169.456
Maha Sarakham	59.004	1.984.850	442.593	61.580	9.845	3.062	74.007	29.740	2.664.681
Roi Et	73.698	3.045.357	362.788	49.471	13.353	7.058	111.613	18.974	3.682.312
Buri Ram	75.161	3.315.248	535.206	92.524	12.058	47.583	106.897	25.245	4.209.922
Surin	72.010	3.153.132	244.106	101.195	6.636	26.187	184.555	22.745	3.810.576
Si Sa Ket	66.740	2.697.160	452.588	135.093	32.764	8.324	70.600	6.889	3.470.158
Chaiyaphum	65.239	1.749.682	1.283.154	176.918	14.668	123.098	133.676	10.967	3.557.402
Nakhon Ratchasima	133.779	3.845.300	3.685.441	348.603	32.981	501.200	189.395	95.266	8.832.055
Total	1.147.552	36.594.234	13.439.713	1.844.652	414.775	929.274	4.075.260	567.149	60.827.495

Source: Agricultural Statistics of Thailand Crop Year 1989-1990

1ha= 6.25rais

Table I-3 Types of farm holding lands in Thailand 1988 (Unit: rai)

Region	Farm holding land	(Owned)				(Others)				
		Owner	Mortgaged out (period unspecified)	Mortgaged out (period specified)	Total	Rented	Mortgaged in (period unspecified)	Mortgaged in (period specified)	Free of charge	Total
North-Eastern	60.827.495	54.221.736	902.553	6.831	55.131.120	2.944.799	338.636	1.815	2.411.125	5.696.375
Northern	34.020.778	24.270.319	1.012.881	5.466	25.288.666	5.890.884	112.138	9.022	2.720.068	8.732.112
Central Plain	33.962.885	22.317.934	1.470.570	13.661	23.802.165	8.890.781	54.232	9.725	1.205.982	10.160.720
Southern	18.989.498	17.086.399	158.881	5.293	17.250.573	1.021.585	62.022	0	655.318	1.738.925
Whole Kingdom	147.800.656	117.896.388	3.544.885	31.251	121.472.524	18.748.049	567.028	20.562	6.992.493	26.328.132

Types of farm holding lands in Northeast by province. 1988 (Unit: rais)

Province	Farm holding land	(Owned)				(Others)				
		Owner	Mortgaged out (period unspecified)	Mortgaged out (period specified)	Total	Rented	Mortgaged in (period unspecified)	Mortgaged in (period specified)	Free of charge	Total
Whole Kingdom	147.800.656	117.896.388	3.544.885	31.251						
Nakhon Phanom	1.685.061	1.513.274	62.567	31.251	1.575.841	23.981	-	20.562	84.996	109.220
Sakon Nakhon	2.888.309	2.632.968	49.106	-	2.682.074	134.312	1.140	243	70.783	206.235
Nong Khai	2.429.959	2.285.060	-	-	2.285.060	92.712	-	-	52.187	144.899
Udon Thani	5.302.709	4.793.997	21.980	-	4.815.977	303.654	-	-	183.078	486.732
Loei	2.393.467	2.074.339	182.700	-	2.257.039	74.984	7.353	-	54.091	136.428
Mukdahan	800.759	758.872	-	-	758.872	13.470	-	-	28.417	41.887
Yasothon	2.099.401	1.977.311	-	-	1.977.311	34.302	-	-	87.788	122.090
Ubon Ratchathani	6.235.672	5.766.803	-	3.532	5.770.335	240.289	12.812	-	212.236	465.337
Kalasin	2.595.596	2.397.894	54.592	-	2.452.486	27.505	-	179	115.426	143.110
KhonKaen	4.169.456	3.565.328	12.288	-	3.688.616	106.833	16.400	-	357.607	480.840
Maha Sarakham	2.664.681	2.295.701	144.901	-	2.440.602	62.751	11.077	-	150.251	224.079
Roi Et	3.682.312	3.134.100	101.607	2.871	3.238.578	196.953	12.592	-	234.189	443.734
Buri Ram	4.209.922	3.660.248	13.680	-	3.673.928	252.130	80.324	-	203.540	535.994
Surin	3.810.576	3.246.656	7.254	428	3.254.338	301.006	75.403	1.393	178.436	556.238
Si Sa Ket	3.470.158	3.200.954	7.211	-	3.208.165	128.339	33.930	-	99.724	261.993
Chaiyaphum	3.557.402	3.316.658	4.354	-	3.321.012	95.758	-	-	140.632	236.390
Nakhon Ratchasima	8.832.055	7.601.573	129.313	-	7.730.886	855.820	87.605	-	157.744	1.101.169
Total	60.827.495	54.221.736	902.553	6.831	55.131.120	2.944.799	338.636	1.815	2.411.125	5.696.375

Source: Agricultural Statistics of Thailand Crop Year 1989-1990

1ha= 6.25rais

Table I-4 Farm Size in the Northeast

(Unit: rai)

Basin	Province	Total Land	Farm Holding Land	Number of Farms	Farm Holding per farm
Mekong	Loei	7,140,362	7,393,467	80,771	29.6
	Udon Thani	9,743,368	5,302,709	170,337	29.4
	Sakon Nahkon	6,003,602	2,888,309	108,667	26.6
	Nong Khao	4,582,675	2,429,959	80,819	30.0
	Nakhon Phanom	3,445,418	1,685,061	77,252	21.8
	Sub Total	30,915,425	19,698,505	517,846	27.5
Chi River	Chaiyaphum	7,986,429	3,557,402	133,187	26.7
	Khon Kaen	6,803,744	4,169,456	166,446	25.0
	Maha Sarakhan	3,307,302	2,664,681	104,226	25.5
	Roi Et	5,187,156	3,682,312	156,287	23.6
	Kalasin	4,341,716	2,595,596	103,591	25.0
	Yasothon	2,601,040	2,099,401	66,616	31.5
	Sub Total	30,227,387	18,768,848	730,353	26.7
Mune River	Nakhon Ratchasima	12,808,728	8,832,055	246,863	35.7
	Buri Ram	6,451,178	4,209,922	147,877	28.5
	Surin	5,077,535	3,810,576	146,355	26.0
	Si Sa Ket	5,524,985	3,470,158	141,083	24.6
	Ubon Ratchathani	11,816,211	6,235,672	195,683	31.8
	Sub Total	41,678,637	26,548,383	877,861	29.3
	Total	102,821,450	65,015,736	2,126,060	27.7

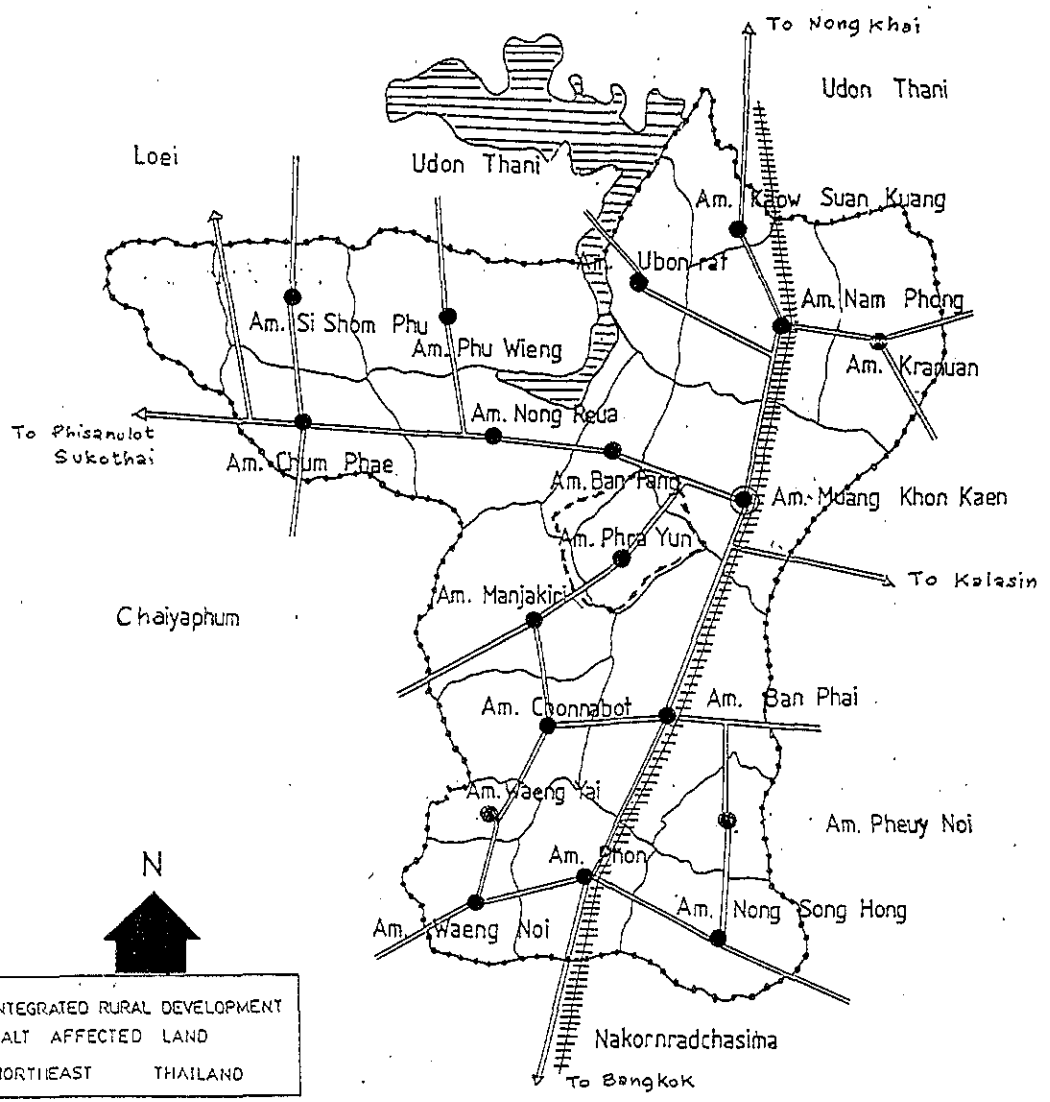
Source: Agricultural Statistics of Thailand Crop Year 1989-1990

Table I - 5 Agricultural Organization in the Northeast

Basin	Province	Number of farms	Agri. Cooperatives		Thrift & Coop. Credit		Registered Agri. Groups			
			No. of Members	%	No. of Members	%	Total No. of Groups	Paddy Lands	Upland Lands	Others
Mekong	Loei	80,771	12,527	15.5	7,608	9.4	42	2	35	5
	Udon Thani	170,337	25,438	14.9	24,536	14.4	113	91	17	5
	Sakon Nahkon	108,667	19,024	17.5	16,971	15.6	29	22	2	5
	Nong Kha	80,819	14,156	17.5	9,320	11.5	40	31	8	1
	Nakhon	77,252	16,835	21.8	7,256	9.4	27	25	0	2
	Sub Total	517,846	87,980	17.0	65,691	12.7	251	171	62	18
Chi River	Chaiyaphum	133,187	18,158	13.6	9,402	7.1	94	64	18	12
	Khon Kaen	166,446	27,214	16.4	25,062	15.1	93	66	10	17
	Maha Sarakhan	104,226	15,863	15.2	11,308	10.8	33	29	0	4
	Roi Et	156,287	20,953	13.4	17,157	11.0	84	83	1	0
	Kalasin	103,591	19,696	19.0	11,581	11.2	64	52	10	2
	Yasothon	66,616	9,587	14.4	6,127	9.2	35	33	2	0
	Sub Total	730,353	111,471	15.3	80,637	11.0	403	327	41	35
Mune River	Nakhon Ratchasima	246,863	48,195	19.5	29,702	12.0	102	72	28	2
	Buri Ram	147,877	18,532	12.5	16,072	10.9	53	49	2	2
	Surin	146,355	27,365	18.7	15,419	10.5	84	82	0	2
	Si Sa Ket	141,083	27,229	19.3	14,107	10.0	87	76	8	3
	Ubon Ratchathani	195,683	33,586	17.2	29,917	15.3	141	131	7	3
	Sub Total	877,861	154,907	17.6	105,217	12.0	467	410	45	12
	Total	2,126,060	354,358	16.7	251,545	11.8	1,121	908	148	65

Source: Agricultural Statistics of Thailand Crop Year, 1989/1990

FIGURE I-2 MAP OF CHANGWAT KHONKAEN



LEGEND

- STUDY AREA
- AMPHOE
- CHANGWAT
- HIGHWAY
- RAIL WAY
- AMPHOE BOUNDARY
- CHANGWAT BOUNDARY

THE INTEGRATED RURAL DEVELOPMENT OF SALT AFFECTED LAND IN NORTHEAST THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE I-3 CHART OF CENTRAL AND LOCAL GOVERNMENTS

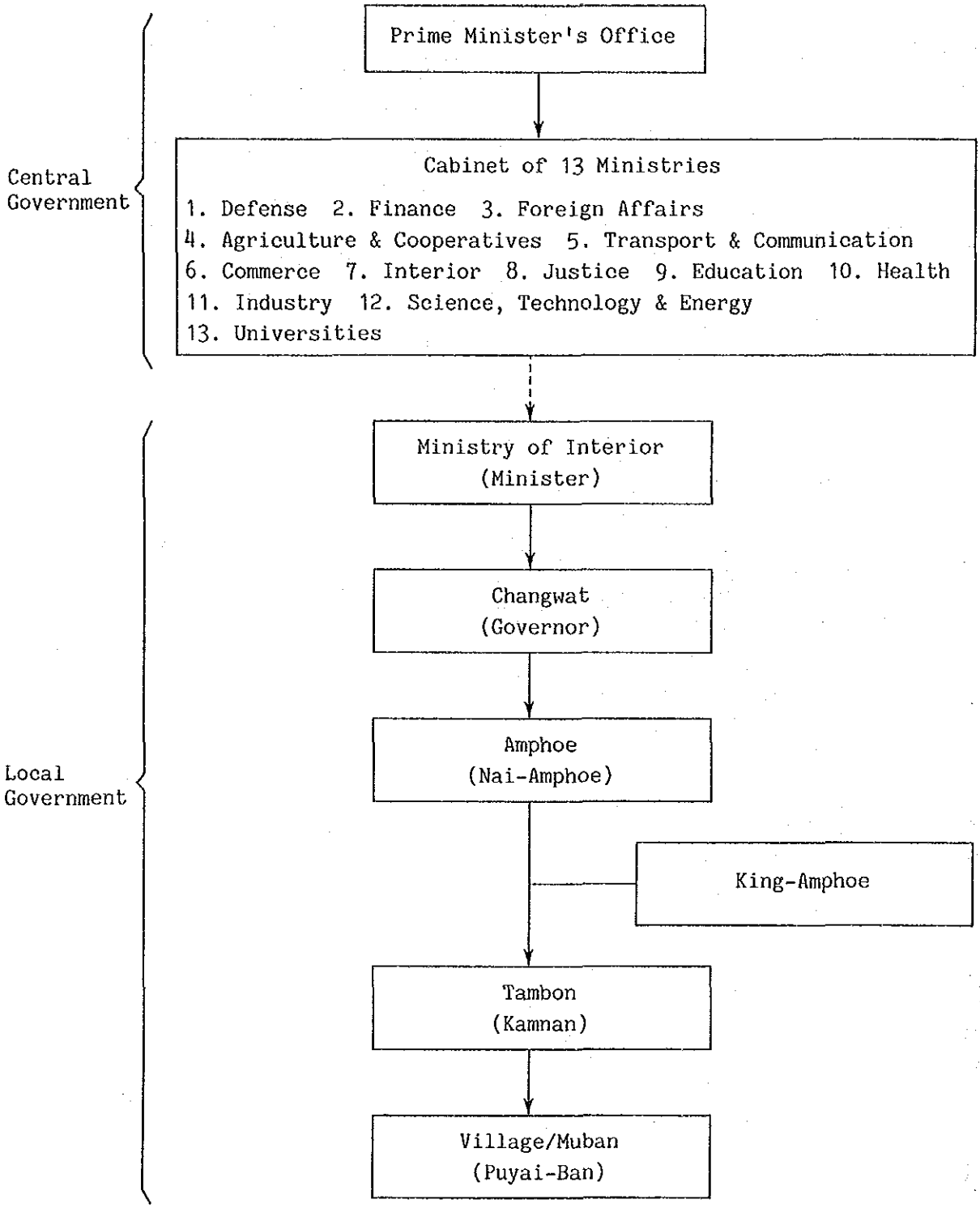
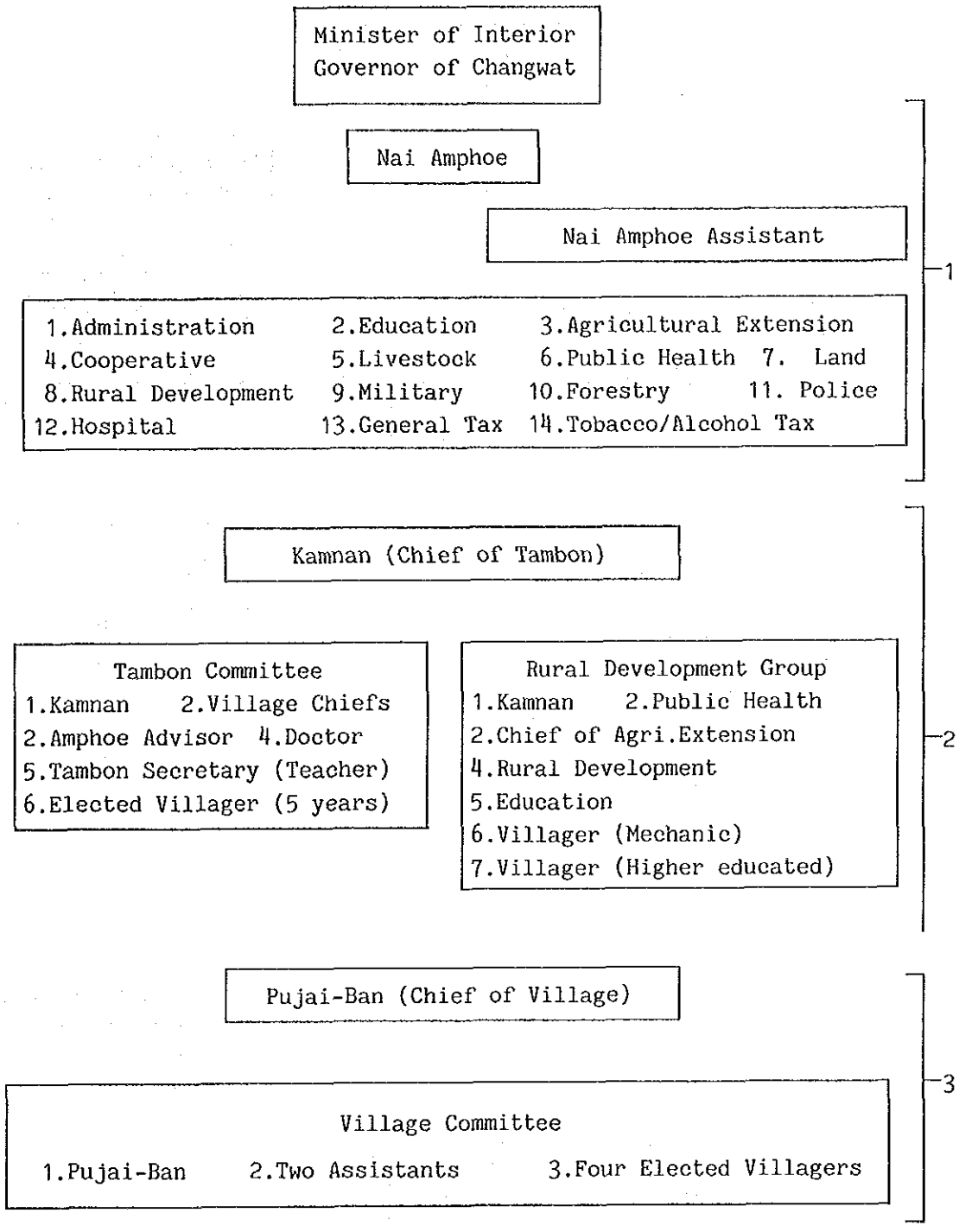


Figure I-4 Government Organization for Rural Development



Note: 1 Amphoe Level Organization
2 Tambon Level Organization
3 Village Level Organization

FIGURE I-5 : Organizational Structure of Rural Development Management

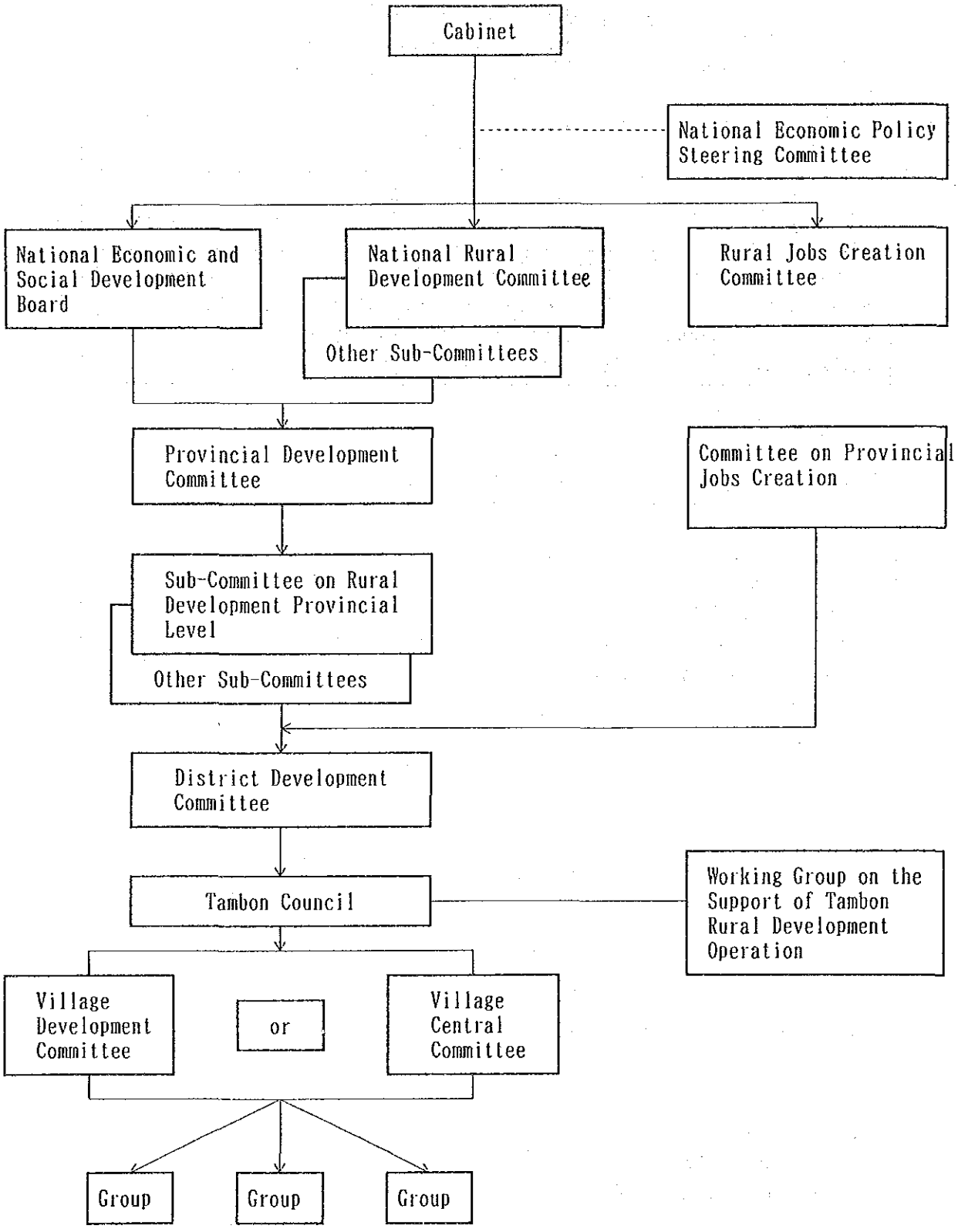


Table I-6 Farming Areas in Changwat Khon Kaen

Unit : Rai

Amphoe	Paddy	Up land crops	Citrus	Vege-tables	Flowers	Total
Muang	288,544	73,054	9,632	3,933	115	375,278
Ban Phai	218,220	135,858	13,411	1,984	-	369,473
Pon	165,081	67,712	391	2,131	-	235,315
Fong Song Hong	185,536	26,523	796	514	-	213,369
Waeng Noi	88,562	19,467	1,892	197	-	110,118
Chonnabot	68,650	32,842	3,870	1,016	18	106,396
Mujakiri	125,180	108,787	3,144	345	-	237,456
Nong Reua	164,580	22,183	4,806	1,833	-	193,402
Phu Wiang	200,117	41,214	8,570	904	-	250,805
Chum Phae	159,000	35,085	2,401	2,245	10	198,741
Si Chom Phu	100,572	77,394	12,319	3,807	50	194,142
Nam Phong	179,241	73,753	1,520	3,068	2	258,584
Kra Nuan	138,770	100,788	4,320	1,469	2	245,347
Ubonral	60,315	108,090	4,510	2,808	-	175,723
Ban Pang	107,583	25,893	5,434	2,858	-	141,764
Phra Yun	75,030	10,210	1,027	708	-	86,975
Kao Suan Kuang	6,321	75,418	6,933	3,670	10	152,352
Waeng Yai	6,009	23,411	2,4309	533	-	92,392
Peuay Noi	39,030	25,477	434	301	-	65,242
Phu Pha Mahn	21,685	23,426	1,758	2,005	-	48,901
Total	2,518,026	1,106,585	90,634	36,325	205	3,751,775

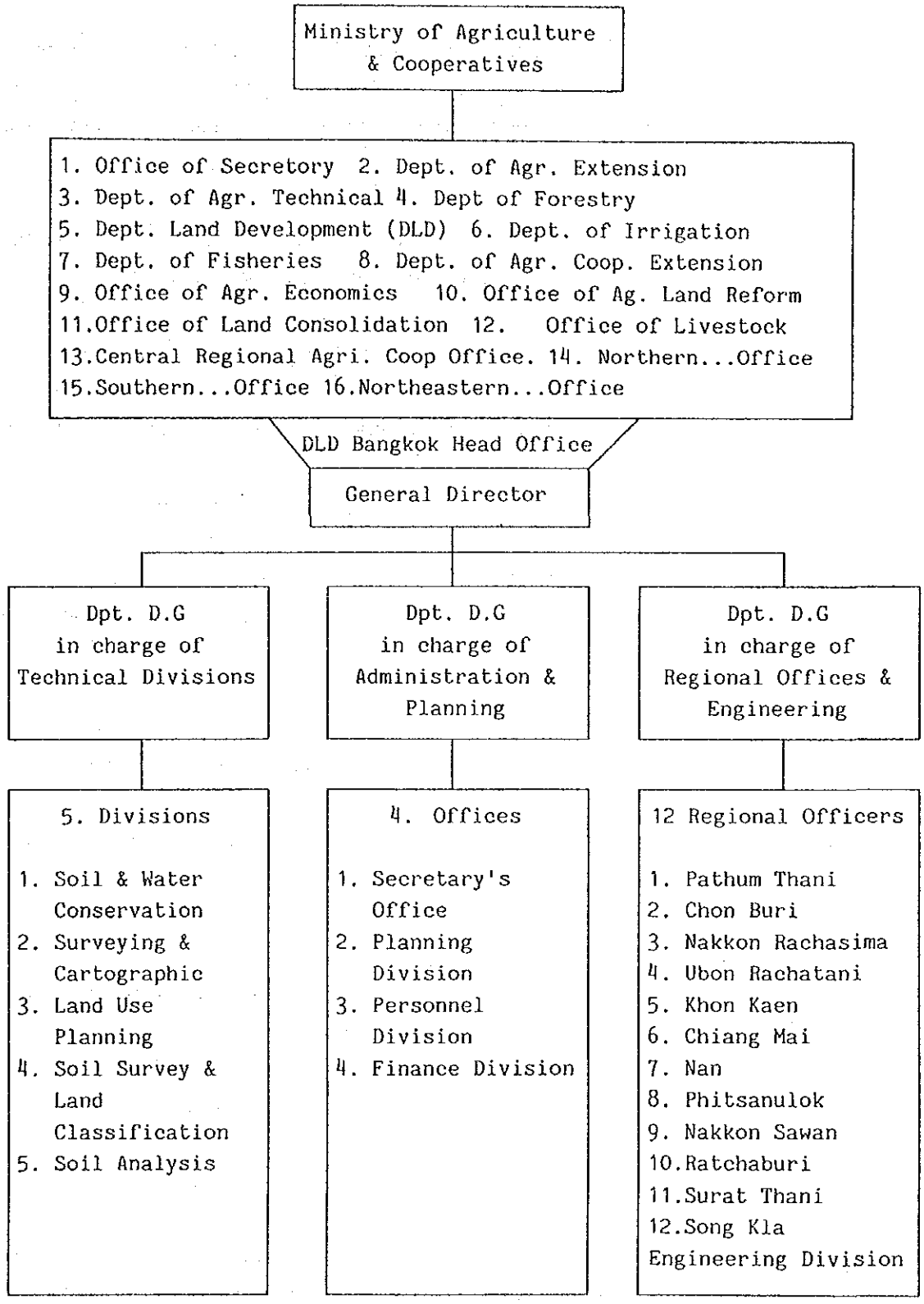
(Source : Marketing Information of Changwat Khon Kaen, 1988. Commercial Office)

Table I-7 Major Economic Crops Production in Khon Kaen, Crop Year 1988/89

Crops	Crop Year 1988/89					
	Area Plants (Rai)	Damage (Rai)	Yield (Kg/Rai)	Production (Ton)	Price (B/Kg)	Value (Million) Baht
1. Paddy						
- Non sticky	314,194	29,945	340	96,483	4.26	411.018
- Sticky	1,436,179	107,406	316	419,901	3.65	1,532.639
2. Second Paddy						
- Non sticky	90,709	-	530	48,290	4.10	197.989
- Sticky	19,567	-	540	10,620	3.62	38.444
(Sub-Total)	(1,860,649)	(137,351)		(575,294)		(2,180.050)
3. Sugar Cane	119,508	-	6,662	796,204	0.41	322.463
4. Cassava	425,889	-	1,872	797,522	0.66	526.365
5. Corn	69,511	-	629	43,704	2.16	94.401
6. Kenaf	98,899	-	184	18,219	4.80	87.451
7. Green Bean	38,247	50	103	3,960	9.64	38.174
8. Peanut	7,065	-	179	1,265	6.25	7.906
9. Soybean	85,764	-	244	20,986	9.15	192.022
10. Silk	35,644	-	-	203	520	105.560
(Sub Total)	880,527	(50)				(1,374.342)
Total	2,741,176	137,401				3,554.392

(Source: Marketing Information of Changwat Khon Kaen, 1988. Commercial Office)

FIGURE I-6 ORGANIZATION - CHART OF DLD



1-2. Green Esarn Programme

The Green Esarn or Esarn-Keew, a five year plan initially endorsed in the Sixth National Five-Year Plan (1986-1991) is promoted as the first step towards achieving the longer term objectives for the Northeast region.

Its strategy is based on the broad concept of regional self sufficiency in basic necessities and the generation of regional exports.

For the long-term objectives over 20 years, the frame is aimed at:

- Improved per capita income levels and a more equitable spread of wealth throughout the Region (alleviation of hardship)
- Ability to support the growing population within the Region.
- Regional self sufficiency in food and basic commodities including fuelwood, which can be produced economically within the Region.
- Export of value added commodities to other parts of Thailand and overseas.

According to the study of the Biwater Study Team to present the Regional Development Strategy the proposed development strategy comprises:

- major expansion of oilseed and protein crops under irrigated condition to enable the Region to satisfy its human and livestock nutritional requirements and to allow the development of and export trade in meat;
- maintained production of cassava in the more arid areas for animal feedstuffs, alcohol, glucose and continued export;
- increased production of fruits and vegetables under irrigated conditions for local consumption and for export as fresh and processed commodities;
- major expansion of fish production to meet local needs.

The Northeast has been considered up to now as possessing of few natural advantages over other regions of Thailand in terms of potential productivity and, therefore, it will be essential for the Government to

lend its support to regional development through preferential incentives, to optimize appropriate land and water use.

Development will require active promotion by the Government to encourage investment by the private sector, and inducements to locate appropriate industries in the North East. The main non-fiscal measures which the Government can adopt will be the provision of liaison services between farmers and industrial consumers, training of extension workers to support farmers in a closely integrated inter-agency network, freer legislation on slaughterhouses and the movement of carcasses, and a major line of credit to support farmers with little or no security.

The infrastructure for agro-industry should be developed, including the provision of basic services. To attract industry, urban centres should be provided with safe and reliable water supplies adequate to cope with rapid urban expansion.

Government could also construct irrigation, processing and packaging facilities and sell or lease them subsequently to the private sector. This would ensure the ordinated development of production and marketing.

The adoption of these policies must be accompanied by a clear demonstration by the Government of its intention to back the private sector with infrastructure support. The basic industrial infrastructure is sound, with good roads, railways and power supplies. The most appropriate and tangible investment that can now be made is in irrigation schemes on the Mekong to bring water from assured supplies into the hardship areas of the Region, notably those on the frontiers of Laos and Kampuchea. This would be consistent with Government policies for investment in these strategic areas.

Preferential incentives can be provided in a variety of through tax and licensing arrangements, aimed at directing significant proportion of Thai and foreign investment to the Region to take advantage of export opportunities for silk, forest products, furniture, fruit and vegetables, alcohol and glucose.

The short term objective is to put in place infrastructural elements of the longer term plan which will stimulate the economy and make other projects possible. Developments should be targetted towards hardship areas possible.

The Table below shows production and consumption of major commodities in the North East in 1987 and 2002.

Table I-8 Production and Consumption in the Northeast in 1987 and 2002

	1987			2002		
	Production	Consum-ption	Shortfall	Production	Consum-ption	Shortfall
	..... 'ooo Tonnes per Annun					
Paddy Rice	7,356	5,544	-	8,712	6,535	-
Protein:						
Fish	54	191	137	62	316	254
Animal	64	68	4	74	113	39
vegetable	32	69	37	40	114	74
Total	150	328	178	176	543	367
Fruit/Vegetables	624	571	-	709	744	35
Edible Vegetable Oil	48	76	28	56	126	70

These is a surplus of rice, fruit and vegetables at present. Other commodities are in deficit. Allowing for more population expansion and a modest rise in production, which occur over the next 10 years without major irrigation development, it is clear that-will be major deficits fish, animal/vegetable protein, vegetable oil, fruit vegetables.

Recently, the Esarn-Keew Programme is not largely publicized as in previous times but the programme is considered on the procedure in which socio-economic measures have been emphasized, based on implemented infrastructures.

Table I-10 Strategy Formulation per Item in Green Esarn Programme

Forestry Woodfuel demand grossly exceeds supply in the region and forest is being cut at a rate of 400,000 rai per year to make up the shortfall. Over nine million rai of additional forest, forest farms and woodlots will be needed. The land must come from cleared land not suitable for agriculture, of which 4.4 million rai is available and from Forest Reserve areas already cultivated, of which 5.16 million rai will be needed. This area should be converted to forest farms and forest villages, using a mix of high yielding local trees and fast growing imported species. The improvement in the availability of fuelwood resulting from the reafforestation programme will take the pressure off Protected Forest and make law enforcement more practical. The option of forest farms will provide security of tenure for the illegal settlers.
Agriculture The land taken for forestry will be the most marginal of all the areas. These will generally be cassava, oilseed and upland rice areas at present. In the case of cassava there are potential local demands for alcohol production and animal feed replacing the declining European market share. Similarly there are unfulfilled local demands for oil seed crops. Rice is presently in surplus so can be reduced in the short term provided farmers have price security on cash crops. In the long term rice production can be increased under irrigation.
Irrigation More irrigation will be necessary to increase regional productivity in order to: - Make up for land placed under forest and woodlot. - Provide additional food for the growing population of which an increasing proportion will be town dwellers. - Provide fodder crops and vegetable protein for livestock. - Allow fruit and vegetable production for export. It is estimated that the equivalent of 300,000 ha of new irrigation will be required by 2002. This can be made up to a limited extent from improvement of existing projects where it is economically sound to do so.
Livestock The present meat protein production is low compared to regional demand and therefore there are opportunities in the local markets. Additionally there is export potential for meat. The possible products are beef, pork, chicken and ducks, though there are some market limitations. Also there is a local demand for dairy products. The production of livestock is important to the strategy because it has close links with other sectors, and creates jobs not only in rearing but in the provision of foodstuffs and in processing and packaging.
Agro-Industry Increased agricultural production will provide the raw materials for agro-industry and this will create job opportunities for people in the urban centres.
Fisheries The shortfall in the supply of fish is most pronounced with a total market opportunity of 316,000 tonnes by 2002. The production may be limited by the available area of small, medium and large scale reservoirs to 43,000 tonnes, but additional opportunity exists in aquaculture at village and farm level.
Water Supply The proposed strategy will target on reduced population density in rainfed areas. Population density, many people will move to the town and provide a labour force for industry. Industry must be attracted to the North East and the availability of raw materials from agriculture may not be sufficient to do this. The Government must therefore ensure that essential services are in place. Water supply will be the main activity in this respect.

(Biwater Study Team)

Table I-9 Items subjected to Green Esarn Programme

Forestry can be extended with advantage. Deep rooted trees can thrive in the climate of the region, and species exist which are appropriate to saline conditions. The widespread extension of forest must be linked to the creation of jobs in the economy, as forest land cannot support a high density of population. The forest products themselves are a source of raw materials, but their ability to create jobs in, for example, paper and pulp industries is limited.
Agriculture should be diversified to include crops with a high potential for local processing or to create local employment. These will include tree crops (fruit, rubber, mulberry, eucalyptus and bamboo) and field crops (soyabean, groundnut, vegetables, fodder). Because of its suitability in marginal areas, cassava should be maintained for export and processing into animal feed, alcohol and glucose.
Irrigated agriculture offers the main opportunity to improve agricultural output. New irrigation schemes must be attached to those storage reservoirs that can be developed economically, without creating major resettlement and environmental problems, or to the only reliable perennial source in the region, the Mekong river, where opportunities exist for major expansion. However it should be recognised that owing to the poor resource endowment of the Region and low commodity prices irrigation projects in the North East are unlikely to yield high returns in purely economic terms but have significant social benefits. If the lack of market opportunities, which has been a problem in the past, can be solved, the existing investment should be fully utilised by increasing the use of the water made available in the Chi Basin.
Fisheries can be developed to improve subsistence level farming, particularly by assisting the spread of fish ponds by the construction of hatcheries to ensure the supply of fish seed for annual restocking, and improving water retention in the ponds. Significant improvements to yields can be made only where water is provided, as the sandy soils retain little moisture.
Flood control programmes do not appear to be justified in general, as the productivity of land is too low to amortize the costs. Where it can be provided as part of an irrigation scheme, it is likely to be justified, and opportunities to control floods should be investigated in multipurpose projects.
Hydropower opportunities exist in the region, but development is seldom complementary to agricultural needs. Where such schemes can be justified on the basis of energy produced, rather than as providers of firm power, they should be developed. The timing of these developments must be determined by the National Generating Plan of EGAT.
Water supplies to rural areas cannot be supported until per capita incomes rise so that they can be paid for, as the present programme for the installation of Ongs (storage jars) satisfies basic human needs. The same argument, if applied to urban centres, may discourage the development of local industries which need assurances that adequate facilities exist. In view of the overall objective to increase industrialization, a positive attitude should be taken to providing urban water supplies in key locations where the ability to recover costs is not immediately apparent, but where development of industry is to be actively encouraged.
Agro-Industry The development of Agro-Industry will require close coordination between the production, processing and marketing sectors and involve both private and public sector participation. The concept would necessitate the production, processing and marketing of those commodities offering comparative advantage within the context of the Region's future development. Possible enterprises would include cassava to animal feed; glucose and alcohol; bamboo, rubber and paper mulberry to pulp and paper, timber, silk fabrics and furniture; crop primary products of fruit, vegetables, bamboo shoots and sweetcorn for export; crop by-products to livestock, which with fodder and feeds generate pork and beef for export and dairy products for internal consumption.

1-3. NESDB Survey on Socio-Economic Conditions at Village Level

Since the task of rural development is an important item notified in the National Plans of the Kingdom of Thailand, the NESDB (National Economic and Social Development Board), the central agency under the Prime Minister's Office in charge of planning national strategies for socio-economic development, has conducted a survey every year at village level for understanding the present living conditions and problems in the whole country, aiming at outlaying countermeasures for these problems though corresponding resolutions from the NRDC (National Rural Development Committee).

Data collected from this annual survey at local level, namely the NRD 2C survey, are subjected to be processed at central level for formulating data-base of each village through 34 related indicators of sectors, namely Basic Items/Structures (10), Production (7), Public Health (9), Water (2), and Knowledge (6).

* Indicators of Basic Items/Structures are as follows;
  1. Ownership document
  2. Electricity
  3. Communication
  4. Rice Mill/Shop
  5. Housing
  6. Wood/Fuel
  7. Job Availability
  8. Draught Animals
  9. Salary Rate
  10. Land Ownership

* Indicators of Production Sector are as follows:
  1. Rice Production
  2. Other Farming Production
  3. Other Professions
  4. Migration for Works
  5. Farming Group
  6. Agricultural Credit Source
  7. Agriculture in Dry Season

* Indicators of Public Health Sector are as follows:
  1. Public Health Service in Village
  2. Public Health Service in Tambon
  3. Sanitation in Family
  4. General Health and Sanitation
  5. Treatment Procedure
  6. Weight of New Born Baby
  7. New Born to 5-year old Children
  8. Vaccine Injection
  9. Family Planning

* Indicators of Water Supply are as follows:
  1. Drinking Water and Domestic Water
  2. Agricultural Water

* Indicators of knowledge are as follows:
  1. Education Level of the Whole Population
  2. Knowledge of Official Persons
  3. Situation for Knowledge-Promotion
  4. Place in Village for Knowledge Promotion
  5. Data and News Service Place
  6. Sports Cultural and Religions Activities

Each indicator will be evaluated by following ranking:
  1. Lower than Average Standard
  2. Average Standard
  3. More than Average Standard

(Average Standard means not fully sufficient but tolerable)

The situation of each village, Tambon, Amphoe, therefore, could be obtained for its corresponding file of every year.

From there data, the Rural Development Committee at central level will approve countermeasures (items, budget etc.) for each Changwat based on requests from local committees of Village, Tambon, Amphoe and Changwat.

Table I-11 NESDB Evaluation for Development of Villages in the Study Area in 1988 (1)

The Notheast Changwat Khon Kaen Amphoe Phra Yun Tambol Ban Ton

Village	Basic Structure										Production							Public Health									Water		Knowledge					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5	6
Development stage N. 1																																		
1. Ban Dong Kao	2	3	1	3	3	3	3	3		1	3	1	1	2	1	3	1	3	1	1	2	3	3	1	3	2	1	1	2	1	1	2	2	3
Development stage N. 2																																		
2. Ban Ton (1)	2	3	3	3	3	3	3	1		1	2		1	1	3	3	3	3	3	3	1	2	1	3	2	3	1	3	3	3	3	3	3	3
3. " Ton (2)	2	3	1	3	3		1	2	2	1	2	3	1	2	1	3	1	3	3	3	2	3	3	3	3	3	1	1	3	3	3	2	3	3
4. " Jod Yai	2	3	2	3	3	3	3	2		3	2	1		2	3	3	1	3	3	1	3	3	3	1	1	1	1	1	2	1	2	3	2	2
5. " Dong Klang	2	3	3	3	3	3	3	3		3	3	1		1	1		1	3	3	1	2	3	1	3	3	1	1	1	3	1	1	3	2	2
6. " Hin Kong	2	3	1	1	3	3	2	3		3	2	3	1	2	1	3	1	1	2	3	3	3	2	3	3	3	1	1	2	2	2	2	2	3
Total 1=	0	0	3	1	0	0	1	2	0	3	0	3	4	2	4	0	5	1	1	3	1	0	2	2	1	2	6	5	0	3	2	0	0	0
2=	6	0	1	0	0	0	1	2	1	0	4	0	0	4	0	0	0	0	1	0	3	1	1	0	1	1	0	0	0	3	2	3	4	2
3=	0	6	2	5	6	5	4	2	0	3	2	2	0	0	2	5	1	5	4	3	2	5	3	4	4	3	0	1	3	2	2	3	2	4

Remark : 3 = *** (More than average standard) 2 = ** (in average standard) 1 = * (Low than average standard)

Evaluation for Development of Villages (2)

The Notheast Changwat Khon Kaen Amphoe Phra Yun Tambol Phra Yun

Village	Basic Structure										Production							Public Health									Water		Knowledge					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5	6
Development stage N. 2																																		
1. Ban Hua Buang	2	3	3	3	3	3	3	2	2	3	1	1	1	2	3	3	1	3	3	3	2	2	3	1	3	2	3	1	2	2	2	2	2	3
2. " Na Lom	2	3	3	3	3	3	3	1	2	3	1		1	2	3	3	1	1	3	1	2	2	3	1	2	1	1	2	3	1	3	3	2	1
3. " Non Bho	2	3	2	3	3	3	3	2		2	2	1	1	2	3	3	1	3	3	3	2	3	1	1	3	3	2	1	3	1	3	3	3	3
4. " Nong Ku	2	3	2	3	3	2	3	2		3	1	1	1	2	2	2	1	3	3	1	2	1	2	1	3	1	1	1	2	2	1	2	2	3
5. " Pha Mho	2	3	3	3	3	3	3	2		2	1	1	1	2	3	3	1	3	3	2	2	2	3	1	3	2	3	1	3	1	3	3	3	3
6. " Hin Harb	2	3	2	3	3	3	3	2	1	3	2	1	1	1	3	3	1	3	3	2	2	2	3	1	3	2	3	1	3	2	2	3	3	3
7. " Kaen Phra Du	2	3	2	2	3	3	3	2	1	3	1	1	1	2	3	3	1	3	3	1	2	3	3	1	3	2	3	1	3	3	1	3	2	3
8. " Pha San (9)	2	3	3	3	3	1	3	2	1	3	1	1	1	2	3	3	1	3	3	1	2	2	3	1	3	1	3	1	2	2	3	2	2	2
9. " Pha San (10)	2	3	3	3	3	3	3	2		3	1	1	1	1	3	3	1	3	3	1	2	3	3	1	3	2	3	1	3	1	1	3	2	2
10. " Phra Yun	2	3	3	3	3	3	3	1	2	3	1		1	2	3	3	1	3	3	3	2	2	3	2	3	3	2	1	3	3	2	3	3	2
Total 1=	0	0	0	0	0	1	0	2	3	0	8	8	10	2	0	0	10	1	0	5	0	1	1	9	0	3	2	9	0	4	3	0	0	1
2=	10	0	4	1	0	1	0	8	3	2	2	0	0	8	1	1	0	0	0	2	10	6	1	1	1	5	2	1	3	4	3	3	6	3
3=	0	10	6	9	10	8	10	0	0	8	0	0	0	0	9	9	0	9	10	3	0	3,	8	0	9	2	6	0	7	2	4	7	4	6

Remark : 3 = *** (More than average standard) 2 = ** (in average standard) 1 = * (Low than average standard)

Evaluation for Development of Villages (3)

The Notheast Changwat Khon Kaen Amphoe Phra Yun Tambol Kham Pom

Village	Basic Structure										Production							Public Health									Water		Knowledge					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5	6
Development stage N.2																																		
1. Ban Kham Pom	2	3	3	2	3	3	3	2		3	3		1	2	1	3	1	3	3	1	1	2	2	3	3	3	1	1	3	2	2	2	2	1
2. " Chan Bung	2	3	3	3	3	3	3	2		3	3		1	2	3	3	1	3	3	3	1	3	3	2	3	3	2	1	2	3	2	2	3	3
3. " Chad	2	3	3	3	3	3	3	3		3	2	1	1	2	1	3	1	3	3	1	2	3	3	3	3	3	1	1	3	1	3	1	2	3
4. " Boe Kae	2	3	3	3	3	3	3	1		2	1	1	1	2	3	3	1	3	3	3	1	3	2	3	3	3	3	1	2	2	1	1	2	3
5. " Nong.Tung Mon	2	3	3	3	3	3	3	2		3	1		1	2	3	3	1	3	3	2	2	2	3	3	3	3	2	1	3	2	3	2	3	2
6. " Boe Tong	2	3	3	3	3	3	3	2	1	2	2	1	1	2	3	3	1	3	3	2	2	3	3	2	3	3	1	1	3	2	2	2	2	3
7. " Po Thong	2	3		1	3	3	3	2		1	1	1		1	1	3	1	1	3	2	2	3	3	3	3	3	1	1	3	1	2	1	3	2
Total 1=	0	0	0	1	0	0	0	1	1	1	3	4	6	1	3	0	7	1	0	2	3	0	0	0	0	0	4	7	0	2	1	3	0	1
2=	7	0	0	1	0	0	0	5	0	2	2	0	0	6	0	0	0	0	0	3	4	2	2	2	0	0	2	0	2	4	4	4	4	2
3=	0	7	6	5	7	7	7	1	0	4	2	0	0	0	4	7	0	6	7	2	0	5	5	5	7	7	1	0	5	1	2	0	3	4

Remark : 3 =***(More than average standard) 2= **(in average standard) 1= *(Low than average standard)

Evaluation for Development of Villages (4)

The Notheast Changwat Khon Kaen Amphoe Phra Yun Tambol Nong Waeng

Village	Basic Structure										Production							Public Health									Water		Knowledge					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5	6
Development stage N.1																																		
1. Nong Waeng	2	3	1	3	3	3	3	2		2	1	1		2	2	2	1	3	3	1	2	2	3	1	3	3	1	3	3	3	2	2	3	2
2. Nong Jik	2	3	1	3	3	3	3	2	2	2	1	1		1	3	3	1	3	3	1	2	2	3	1	3	3	1	1	2	1	1	3	2	2
Development stage N.2																																		
3. NongYhaKaoNok	2	3	2	3	3	3	3	3		3	2	1		2	3	3	1	3	3	1	2	2	3	1	3	3	1	3	3	3	1	2	3	2
4. Non Tun	2	3	2	3	3	3	3	3		3	1	1		1	1	3	1	3	3	2	2	2	3	1	3	3	1	1	3	1	2	2	2	2
5. Nong Pho	2	3	1	3	3	3	3	3		3	2	1	1	2	3	3	2	3	3	1	2	3	3	3	3	3	3	3	2	3	1	2	2	2
Total 1=	0	0	3	0	0	0	0	0	0	0	3	5	1	2	1	0	4	0	0	4	0	0	0	4	0	0	4	2	0	2	3	0	0	0
2=	5	0	2	0	0	0	0	2	1	2	2	0	0	3	1	1	1	0	0	1	5	4	0	0	0	0	0	0	2	0	2	4	3	5
3=	0	5	0	5	5	5	5	3	0	3	0	0	0	0	3	4	0	5	5	0	0	1	5	1	5	5	1	3	3	3	0	1	2	0

Remark : 3= *** (More than average standard) 2= ** (in average standard)1= * (Low than average standard)

Evaluation for Development of Villages (5)

The Notheast Changwat Khon Kaen Amphoe Phra Yun Tambol Phra Bu

Village	Basic Structure										Production							Public Health									Water		Knowledge					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5	6
Development stage N.1																																		
1. Ban Pho Khum Din	2	3	2	2	3	1	1	3		2	2	1	1	2	3	3	1	3	3	3	2	3	3	1	3	3	3	1	3	3	3	2	2	3
2. " Phra Bu	2	1	2	1	3	3	3	2		2	2	1	1	1	3	3	1	2	3	2	2	3	3	1	3	1	2	1	3	1	2	1	3	3
3. " Kham Phom	2	3	3	3	3		3	3	2	3	1		1	1	3	3	1	2	3	3	2	3	3	2	3	1	1	1	2	2	2	1	2	3
4. " Noi Chahn Buang	2	3	3	3	3		3	3		3	2		1	1	1	3	1	2	3	3	2	3	3	3	3	2	1	1	2	2	2	2	2	3
5. " Chard	2	3	3	3	3	3	3	3		3	2		1	2	1	3	1	3	3	3	2	3	3	3	3	1	2	1	3	1	2	1	2	3
6. " Bho Kae	2	3	2	2	3	3	3	3		3	3	2	1	1	3	3	1	2	3	3	2	3	2	3	3	3	1	1	2	2	3	2	1	3
Total 1=	0	1	0	1	0	1	1	0	0	0	1	2	6	4	2	0,	6	0	0	0	0	0	0	2	0	3	3	6	0	2	0	3	1	0
2=	6	0	3	2	0	0	0	1	1	2	4	1	0	2	0	0	0	4	0	1	6	0	1	1	0	1	2	0	3	3	4	3	4	0
3=	0	5	3	3	6	3	5	5	0	4	1	0	0	0	4	6	0	2	6	5	0	6	5	3	6	2	1	0	3	1	2	0	1	6

Remark : 3 = *** (More than average standard) 2 = ** (in average standard) 1 = * (Low than average standard)

Evaluation for Development of Villages (6)

The Northeast Changwat Khon Kaen Amphoe Nanjakiri Tambon Tha Sala

Village	Basic Structure										Production							Public Health									Water		Education					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5	6
1. Ban Sai Kai	1	3	3	3	3	3	3	2	1	3	1		1	3	3	3	1	1	3	2	2	1	3	1	3	3	1	1	3	2	3	2	3	3
2. Ban Tha Sala	1	3	3	3	3	1	3	2		3	2	1	1	1	2	2	1	1	3	1	2	2	3	2	3	3	2	1	3	2	1	2	2	2
3. Ban Non Tun	1	1	3	3	3	3	3	1	1	3	1		1	1	1	3	1	2	3	1	2	3	3	1	3	3	2	1	2	2	2	2	2	3
4. Ban Non Tun	1	1	3	3	3	1	3	2		3	1	1	1	1	1	3	1	1	3	1	2	1	3	1	3	3	1	1	3	1	1	2	2	2
5. Ban Dong Kheng	2	1	3	3	3	1	2	2	1	3	1	1	1	1	2	2	1	1	3	2	2	1	3	3	3	3	2	1	3	3	2	2	3	3
6. Ban Hua Na Neua	1	3	3	3	3	1	3	3	1	3	1	1	1	3	1	2	1	1	3	2	2	1	3	3	3	3	1	1	2	1	1	2	2	3
7. Ban Tha Sawun	2	3	3	3	3	1	3		1	3	1	1	1	3	1	3	1	1	3	2	1	1	3	3	3	3	2	1	3	2	1	2	3	2
8. Ban Non Ngiw	2	1	3	3	3	1	3	2		3	1	1	1	1	2		1	3	3	3	2	3	3	3	3	3	2	1	3	2	1	2	2	3
9. Ban Hua Na Klang	2	1	3	3	3	1	3	3		2	1	1	1	3	3	3	1	3	3	3	2	3	3	3	3	3	3	1	2	2	1	2	2	3
10. Ban Tha Sala	1	3	3	3	3	1	3	1	1	3	1	1	1	1	2	2	1	1	3	3	2	2	3	3	3	3	1	1	3	3	2	1	2	3
Total 1=	6	5	0	0	0	8	0	2	6	0	9	8	10	6	4	0	10	7	0	3	1	5	0	3	0	0	4	10	0	2	6	1	0	0
Total 2=	4	0	0	0	0	0	1	5	0	1	1	0	0	0	4	4	0	1	0	4	9	2	0	1	0	0	5	0	3	6	3	9	7	3
Total 3=	0	5	10	10	10	2	9	2	0	9	0	0	0	4	2	5	0	2	10	3	0	3	10	6	10	10	1	0	7	2	1	0	3	7

Remark : 3= ***(More than average standard) 2= **(In average standard) 1= *(Low than average standard)

Evaluation for Development of Villages (7)

The Northeast Changwat Khon Kaen Amphoe Muang Tambon Don Chang

Village	Basic Structure										Production							Public Health									Water		Education					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5	6
1. Ban Don Chang	2	3	3	3	3	3	3	2	1	3	3	3	1	1	2	2	3	3	3	2	1	2	3	3	2	3	3	3	3	1	2	2	3	3
2. Ban Pha Leuam	2	3	3	3	3	3	3	2		1	2	3	1	2	3	3	1	3	3	2	2	3	3	1	2	3	1	1	3	1	2	2	3	3
3. Ban Pha Sung	2	3	3	3	3	3	3	3	2	3	2	1	1	1	2	2	1	3	3	2	2	2	3	1	3	2	2	2	3	2	1	2	1	2
4. Ban Nong He	2	3	3	3	3	3	3	2	2	3	2	1	3	1	3	3	3	3	3	2	2	3	3	1	2	3	3	3	2	2	2	2	2	3
5. Ban Hua Buang	2	3	3	3	3	3	3	1		3	3	1	1	1	2	2	1	3	3	2	2	3	3	3	3	3	3	1	3	2	1	2	2	3
6. Ban Hua Sa	2	1	3	3	3	3	3	1	2	1	3	1		1	2	2	1	3	3	2	2	1	3	1	2	3	1	1	3	1	1	2	2	3
7. Ban Don Yah Nang	2	3	3	3	3	3	3	2		3	3	1	1	1	2	2	1	3	3	2	2	3	3	1	2	3	2	1	3	1	1	2	2	3
8. Ban Ni Khom	2	3	3	2	3	3	3	1		1	3	1		1	2	2	1	3	3	2	2	1	3	3	3	3	2	1	3	1	1	1	1	3
Total 1=	0	1	0	0	0	0	0	3	1	3	0	6	5	7	0	0	6	0	0	0	1	2	0	5	0	0	2	5	0	5	5	1	2	0
Total 2=	8	0	0	1	0	0	0	4	3	0	3	0	0	1	6	6	0	0	0	8	7	2	0	0	5	1	3	1	1	3	3	7	4	1
Total 3=	0	7	8	7	8	8	8	1	0	5	5	2	1	0	2	2	2	8	8	0	0	4	8	3	3	7	3	2	7	0	0	0	2	7

Remark : 3= ***(More than average standard) 2= **(In average standard) 1= *(Low than average standard)

Evaluation for Development of Villages (8)

The Northeast Changwat Khon Kaen Amphoe Muang Tambon Ban Wah

Village	Basic Structure										Production							Public Health									Water		Education					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	5	6
3. Ban Nong Thum	2	3	3	2	3	3	3	1	2	1	2			2	1	2	1	2	3	1	3	3	3	3	3	1	1	1	3	1	1	2	1	1
6. Ban Thong Lang	2	3	3	3	3		3	2		3	3		1	2	1	3	1	3	3	2	2	2	3	2	2	3	1	1	3	2	1	1	2	2
9. Ban Tao	2	3	3	3	3	3	3	2	1	2	1			1	1	3	1	3	3	2	2	2	3	1	3	3	1	1	3	1	2	2	2	3
Total 1=	0	0	0	0	0	0	0	1	1	1	1	0	1	1	3	0	3	0	0	1	0	0	0	1	0	1	3	3	0	2	2	1	1	1
Total 2=	3	0	0	1	0	0	0	2	1	1	1	0	0	2	0	1	0	1	0	2	2	2	0	1	1	0	0	0	0	1	1	2	2	1
Total 3=	0	3	3	2	3	2	3	0	0	1	1	0	0	0	0	2	0	2	3	0	1	1	3	1	2	2	0	0	3	0	0	0	0	1

Remark : 3= ***(More than average standard) 2= **(In average standard) 1= *(Low than average standard)

Table I-12 Rural Development Budget per Amphoe for Changwat Khon Kaen (1990)

Amphoe	Basic Structure		Production income		Public Health		Water Source		Educaiton		Sub Total	
	No. Sites	Budget (B)	No. Sites	Budget (B)	No. Sites	Budget (B)	No. Sites	Budget (B)	No. Sites	Budget (B)	No. Sites	Budget (B)
Muang	27	14,542,870.00	285	25,637,326.00	29	18,602,250.00	110	62,246,650.00	64	9,762,833.25	515	130,791,929.25
Kranuan	16	1,646,550.00	179	5,791,000.00	107	11,132,785.00	76	18,743,900.00	96	981,050.00	492	38,295,285.00
Chonnabot	13	475,780.00	124	8,364,140.00	48	6,945,000.00	80	28,887,860.00	39	275,975.00	304	44,948,755.00
Chumpae	48	11,767,700.00	179	3,894,797.00	61	10,841,800.00	72	20,887,400.00	83	227,360.00	443	47,619,057.00
Namphong	27	1,398,404.00	250	457,430.00	42	704,000.00	75	23,405,050.00	68	522,300.00	462	26,487,184.00
Banphi	13	5,442,008.00	224	458,500.00	57	2,075,500.00	99	67,732,260.00	90	157,300.00	483	75,865,568.00
Pol	15	2,483,610.00	128	196,540.00	43	463,900.00	58	14,365,000.00	63	71,000.00	307	17,580,050.00
Phuwiang	21	6,765,200.00	209	204,060.00	82	655,900.00	119	26,007,400.00	93	1,053,275.00	524	34,685,835.00
Manjakiri	15	7,365,420.00	157	236,260.00	43	3,600.00	105	23,678,760.00	108	502,300.00	428	31,786,340.00
Sichomphoo	23	566,427.00	122	248,840.00	33	3,195,300.00	40	11,096,600.00	34	94,300.00	252	15,201,467.00
NongReua	23	18,759,500.00	183	7,589,840.00	68	139,500.00	16	19,328,000.00	82	72,300.00	372	45,889,140.00
Nongsonghong	19	11,280,340.00	131	183,940.00	48	12,000.00	53	6,871,400.00	62	72,300.00	313	18,419,980.00
Weangnoi	21	1,625,300.00	124	10,360,220.00	32	0.00	33	15,133,500.00	82	492,300.00	292	27,611,320.00
U-Bolrat	38	7,598,851.00	119	1,455,642.00	33	2,960,000.00	42	3,333,200.00	43	52,300.00	275	15,399,993.00
Ban Fang	14	22,045,500.00	215	158,020.00	38	42,000.00	41	5,926,880.00	45	62,300.00	353	28,234,700.00
Phra Yun	31	156,900.00	71	195,420.00	26	640,000.00	55	10,085,200.00	41	62,300.00	224	101,904,820.00
Waengyai	15	107,900.00	151	145,160.00	48	61,000.00	33	25,018,600.00	47	844,800.00	294	26,177,460.00
Peoynoi	14	1,175,740.00	77	6,192,440.00	30	0.00	22	9,874,300.00	36	52,300.00	179	17,294,780.00
Kaosuankuang	31	1,574,451.00	126	358,720.00	23	16,000.00	40	19,816,300.00	46	78,300.00	266	21,843,771.00
Phoophaman	22	1,023,120.00	107	230,498.00	39	0.00	29	3,348,720.00	41	108,300.00	238	4,710,638.00
Project of Province	5	348,000.00	58	7,020,268.00	42	13,214,909.00	3	1,291,500.00	54	22,878,302.00	162	44,752,979.00
Total	451	118,149,571.00	3,237	79,379,061.00	972	71,705,444.00	1,201	50,784,348.00	1,317	38,423,495.25	7,178	815,501,051.75

(Source : Rural Development Committee : Project Plan 1990)

Table I-13 Project for Rural Development in Amphoe Phra Yun

PLAN \ MINISTRY	Ministry in charge					
	Interior	Agri.	Health	Education	Industry	Total from 5 Ministries
1. Basic Structures	16	11				27 Projects
2. Income Production Increase Plan	8	86			2	96 Projects
3. Health Plan	1		10			11 Projects
4. Water Source Development Plan	7	18	1		1	27 Projects
5. Education Knowledge Promote Plan	13	10	1	21		45 Projects
Total	45 Projects	125 Projects	12 Projects	21 Projects	3 Projects	206 Projects

(Source: Rural Development Committee: Project Plan 1989)

1-4. Basic Socio-Economic Data of the Study Area

1-4-1 General

The study area covers the whole Amphoe Phra Yun in its middle and partly other three Amphoes, Muang (2 Tambon, 11 villages) and Ban Fang (2 Tambon, 4 villages) in the north, and Manja Khiri (1 Tambon, 10 villages) in the south. This study area covers more than 9,500 households with a population of approximately 45,000 inhabitants.

From its short access of less than 30 km to Khon Kaen, the capital city of Northeast region, the study area, therefore, is considered as a suburban area of this city where socio-economic activities including the Green Esarn Programme have been carried out for developing this Northeast region.

1-4-2 Social Aspect

Amphoe Phra Yun, the main administrative unit in the study area, was formulated in 1988. Formerly this area was belonged to Amphoe Muang Khon Kaen. In 1976 it was firstly formed as a King Amphoe.

This Amphoe has 5 Tambons, namely Phra Yun, Kham Pom, Pra Bu, Ban Ton and Non Waeng, in which Tambon Kham Pom was newly formed 2 years ago (since 1 August 1988) by dividing Tambon Pra Bu into 2 Tambons, for proper rural development.

There are 35 Mubans (villages) in Amphoe Phra Yun (Tambon Phra Yun: 11, Tambon Kham Pon: 7, Tambon Pra Bu: 6, Tambon Ban Ton: 6 and Tambon Non Waeng: 5). The total number of Mubans in the study area, therefore, is 60.

The office of Amphoe Phra Yun and main installations such as hospital, post office, agricultural bank, cooperative headquarters are located in Muban Phra Yun in the central of the study area, bordering the national highway Khon Kaen-Manja Khiri.

According to the Amphoe document, social aspects in Amphoe Phra Yun are as follows:

(1) Population

Male	:	Approx. 15,000
Female	:	Approx. 15,000
Total	:	Approx. 30,000

(2) Occupation

Most of local people in Phra Yun are living upon rice cultivation, raising animals and, sometimes, paddy farming mixing with raising animals etc. their second professions are growing mulberry, hamata peas, weaving mats, producing silk worm cocoons and plastic sunshades as sub-incomes.

(3) Education

Primary Schools (22 units)

Number of teachers	:	221
Number of students	:	3,978
(Male : 2,052 Female	:	1,926)

Secondary Schools (2 units)

Number of teachers	:	57
(Male : 34 Female	:	23)
Number of students	:	1,116
(Male : 590 Female	:	526)

(4) Religion

* Church	:	1
* Wat	:	11
Number of monks	:	128
Number of nuns	:	99
Total	:	227

(5) Health care

* Central hospital Doctors	:	1 unit (10 beds)
Nurses and staff	:	2
* Health centers	:	3 units
Health officers	:	9
* Health Coordinators	:	378

Apart form Amphoe Phra Yun, other areas included in the study area cover parts of 3 Amphoes, Muang, Ban Fang and Manja Khiri. These areas has a population of approximately 16,000 inhabitants and cover approximately 170 sq.km, half of the study area, in which approximately 85 % are subjected to agriculture land with paddy as the main crop.

From the NESDB survey, results of socio-economic conditions in the study area are attached.

These data imply the necessity of agricultural water and jobs for off-farm season, which is also the typical and serious problems for the Northeast.

With the restructure of a proper farming system the development of off-farm season, which is also the typical and serious problems for the Northeast.

With the restructure of a proper farming system the development of off-farm sectors is considered very important for employing idle labour-forces and generating incomes in these rural areas in order to make a healthy rural society for the future young generation.

1-4-3 Economic Aspect

Despite of its adjacency to the city of Khon Kaen, the study area is a typical rural area in the Northeast Thailand where most of its population are living upon small-scale farming centering in paddy cultivation with partly upland crops such as cassava, kenaf, mulberry, sugarcane etc.

Expert a limited portion bordering the Chi river is presently subjected to pumping irrigation, almost farm lands in the study area are under rainfed condition by making into small plots for keeping and controlling water.

Due to the particular topo-geographical characteristics of the Korat Plateau, rainfall pattern in the Northeast is very erratic.