APPENDIX K

ENVIRONMENT

Contents

Lists

List of Tables

List of Figures

K.1 General

K.1.1 Present Condition of the National Environment

(1) Recession of Forests

According to the national forests survey in 1960, forested area was approximately 300,000km^2, or 58% of the total national land. It has decreased with an annual average rate of 3% during the 60's and 70's, and 2% during the 80's, respectively. It is about 150,000km^2 or 28% of the national land, at present.

Deforestation in accordance with the concession had been allowed before, but the No-Deforestation Regulation was enforced in 1988 to guard forest from illegal felling in preserved and assigned area. The decreasing rate of forested area is down to 0.3% at present(refer to Table K.1.1).

Over deforestation for commercial needs and diversion to cultivated land caused a recession of forested area. Landless farmers clear it to get cultivated land or the landlords sell it since they are dissatisfied with the caring or preservation of the forest. In many cases, farmers raise cassava or maize (corn) on those lands, but production would decline after several years because of the poor fertility of soil. As a result, the farmers will clear another land.

Royal Forestry Department (RFD) under Ministry of Agriculture and Cooperatives (MOAC) holds forest management including afforestation and forest preservation, and twenty-one branches of RFD and seventy-two of rural forestry offices carry out measures. The Natural Forestry Conservation Law was established in 1964, and it enforces RFD's operation. RFI set 1,200 places or 232,000km^2 of forest as a conservation forest in 1989 including 65,000km^2 of nature conservation area.

National principle on Forestry was stated in 1985 as a foundation of forest management. It classifies forestry into conservation and commercial areas and indicates each area

as 15% and 25% of total national land, respectively.

Other than the natural forestry, afforested area is cared by the government and many enterprises, approximately 7,000km^2 according to RFD's survey in 1989. Eucalyptus, pine and acacia trees are often planted because they grow quickly. However, plants of single or a few varieties can not recover diversified tropical forestry.

(2) Diversification of Species

In terms of diversification of species, Thailand has 4 kinds of important ecosystem.

1) Tropical forest

Tropical forests in Thailand have numerous species and important life resources. One hectare of it includes approximately 200 species of trees and numerous plants. However, as a result of over deforestation because of growth population and extension of agricultural area, forest area had hastily decreased, and a number of species have decreased, varieties of all sorts. A lot of species are endangered at present and some are already extinct.

2) Mangrove forest

Mangrove forests are ranged on the peninsula coast of southern Thailand. They protect estuary and mud shore from erosion or other effect, and they also inhabitat numerous plants and animals. Seventy-five(75) species of mangrove out of 79 species existing in the world are recognized in Thailand. Thirty-five(35) species of mammal, 106 of birds and 25 of reptile live in mangrove forests. Its area was 1,805km^2 according to the survey in 1989, but it has been decreasing because of conversion to agricultural area, mining industry development, housing and industrial development and others. Mangrove forests with the area of 1,320km^2 had been converted for other uses during 14 years from 1975 to 1989, and recession of mangrove forest has been a serious problem in terms of diversification of species.

3) Rivers, lakes and ponds

Thailand has rivers, lakes, marshes, ponds and other bodies of water heavily populated with many living creatures. The number of specie for fresh-water fish only counts about 650. However, freshwater environment has been affected by water resource development, water contamination, over catching of fish, etc.

4) Coral reef

The Coral reef has the second largest number of species second to the tropical forest. One hundred and eight(108) species of fish, 210 of hard coral, many kinds of soft coral, and other little lives live around coral reef in Thailand. At present, 60% of them are damaged or deadly condition, and the reasons are stated as follows.

a) coastal pollution and sand sediment

b) gathering coral and rough fishing

c) indiscriminate fishing around coral reef.

As mentioned above, a number of species are decreasing in Thailand. The reasons for recession of diversification of species are indicated as follows.

1) indiscriminate felling, hunting and fishing

2) destruction of habitat environment

3) illegal trade of wild animals

Indiscriminate felling, hunting and fishing and destruction of habitat environment are related to recession of forested area caused by illegal and over deforestation. Even though the Thai government operated the No-Deforestation Regulation in 1988, habitat environment of coast and lakes have been damaged because of the development, reckless hunting, fishing and felling, and environmental pollution.

(3) Biological Resources

The tropics have the richest biological resources in the world. Ten(10) percent of acknowledged species or 4,253 species out of 41,600 are recognized in Thailand (The Number of Species of Animals in Thailand and the World is shown in Table K.1.2). Trachea plants with 15,000 species, more than 500 species of trees, 1,000 species of orchid and 2,000 species of mushroom are inhabited in Thailand. Although the number of species of insects existing in Thailand is not clear, 10,000 species of beetle, 1,200 species of butterfly, and 200 species of moth are recognized.

The 143 kinds of species are indigenous to Thailand (refer to Table K.1.3). Some of those species are in endangered, and it tells the importance of protection of biological resources.

Lists of the important tree and wildlife species in flood affected area are shown in List K.1.1 and K.1.2.

K.1.2 Environmental Law and Regulation for Agricultural Development and Administration

(1) International Convention

Washington Convention (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and Ramsar Convention (Convention on Wetlands of International Importance especially as Waterfowl Habitat) are two major international environmental conventions related to agricultural development. Thailand joined with the former convention in 1981.

(2) Domestic Law and Regulation

As the domestic regulations for agricultural land development, there are 1) development regulation by National Park Act (established in 1961), 2) regulation on watershed

classification based on the Enhancement and Conservation of National Environmental Quality Act (1992), 3) regulations on forest classification into three classes according to the bylaws of Royal Forestry Department (under Ministry of Agriculture and Cooperatives), 4) The State Irrigation Act(1954), 5) The People Irrigation Act (1941), 6) Land Reform for Agriculture Act (1975), and 7) Agricultural Land Consolidation Act (1974).

As laws for protection of wild life and habitat environment, there are 1) Wild Elephant Conservation Law (established in 1921), 2) Wild Animal Conservation Law (1960) and 3) Wild Life Conservation Law (1991). Especially, 3) forbids collection, gathering and trading of endangered species of fauna and flora in accordance with Washington Convention.

National Park Act was established with the object of conservation of animal species listed in Wild Animal Conservation Law and preservation of natural environment of habitat. At present, 226 places of natural conservation areas and recreation areas are designated, and their area is about 65,000km^2 or 12.7% of total national land.

With the enactment of Enhancement and Conservation of National Environmental Quality Act, National Environmental Board(NEB) and Office of National Environmental Board(ONEB) as NEB's administration office were established, and they have carried enactment of environmental policy, implementation of environmental preservation measure, and establishment of environmental basis (Organization Chart of the National Environmental Board is shown in Figure K.1.1).

Afterwards, the National Environmental Quality Act was established in April, 1992, and at the same time, Ministry of Science, Technology, and Energy changed the title as Ministry of Science, Technology and Environment with three departments under and succeeded to the ONEB's business.

Enhancement and Conservation of National Environmental Quality Act requires submission of Environmental Impact Assessment (EIA) report for the implementation of development

project with certain types and sizes. Details are mentioned in K.3.

1) Three departments for environment

There are three departments for environment in Thailand; 1)Office of Environmental Policy and Planning, 2)Department of Pollution Control, and 3)Department of Environmental Quality Promotion. Duty of each department is as follows.

a) Office of Environmental Policy and Planning

- Design environmental policies in accordance with other national policies and evaluate them to promote environmental preservation.
- Formulation and adjustment of environmental preservation plan according to the Environmental Preservation Law.
- Implementation of survey on natural resources and prepare the profile depending on the situation.
- Adjustment of natural resources management in accordance with environmental preservation plan, national socio-economic plan and development plan from national principle policy and Environmental Preservation Law.
- Indicate guideline for either national and private project which may give negative impact on environment and guide them.
- Preparation of Guideline on International Cooperation related to the environmental preservation.
- Make suggestion and preparation of guideline on applying environmental fund in accordance with Environmental Preservation Law. The duty includes giving publicity to establishment of environmental fund.
- Adjustment of rural environmental preservation project.
- Carry out other duties which belong to the authority of Office of Environmental Policy and Planning.

b) Department of Pollution Control

- State the opinion from the viewpoint of pollution control about measurement policy and plan in accordance with Environmental Preservation Law.

- State the opinion on environmental basis and discharging standard.
- Formulation of environmental management plan for implementation of pollution control.
- Survey and report on pollution according with the problems and condition.
- Organize appropriate system in order to take measurement on water quality, air, noise, and toxic substance.
- Implementation of measures in Environmental Preservation Law as pollution control.
- Receive opinion and application from people who had suffered from the law giving negative impact on environment.
- Carry out other duties which belong to the authority of Department of Pollution Control.

c) Department of Environmental Quality Promotion

- Giving publicity to environmental activities to let public aware of environmental preservation.
- Publication and public relation of data to promote environmental preservation.
- Promote environmental education
- Carry out other duties which belong to the authority of Department of Environmental Quality Promotion.

2) Watershed Classification

Watershed Classification Project was accomplished by the Thai government to clear land-use planning including watershed management. It is considered as the initial step to conserve watershed ecosystem by wise use of natural resources. It also mitigate environmental problem. The government set the National Committee on Watershed Classification, and promulgated so-called "Watershed Classification Regulation" through the cabinet. First, it was enforced for the Ping-Wang River Basin in 1985, and for other rivers after that.

This regulation is based on the five stable parameters, i.e. slope, elevation, landform, soil and geology. Followings are the brief description of Watershed Classification (WSC).

a) Land Use Assignment

WSC 1: Protected or Conservation Forest and Headwater Source :

This class is divided into 2 subclasses;

WSC 1A: includes areas of protected forest and headwater source area, usually located at high elevation on very steep slopes. These areas must be protected permanently.

WSC 1B: denotes similar physical and environmental features as WSC 1A, but some parts of this area have already been cleared for agricultural use by villagers. These areas require special soil conservation and protection measures and should be reforested.

WSC 2: Commercial Forest :

This class comprises areas of protected and/or commercial (mainly commercial) forest. These areas are mostly located at higher elevation on steep slopes. Landform is less erosive than WSC 1. Areas may be used for agroforestry.

WSC 3: Fruit-tree Plantation :

This class covers upland areas with steep slopes and less erosive landform. These areas are usually used for fruit tree plantation or certain agricultural crops, and may be used for commercial forest, agroforestry, and grazing. However, soil conservation measures are required for their uses.

WSC 4: Upland farming :

This class has land with gentle slopes covered with crops, fruit trees, and grazing, but it requires soil conservation measures.

WSC 5: Lowland Farming :

This class lies between gentle slopes and flat areas, used for paddy field or other agricultural uses with few restriction.

Results of watershed classification by each region in Thailand are shown in Table K.1.4.

b) On-site Resources Utilization and Management Practices

Regarding second activity of watershed management, the government also simultaneously developed a set of resource utilization and management practices for each operating unit within each major watershed class. The recommendations for land use practices in each watershed class are as follows;

In WSC 1A:

- No forest product is permitted by any case. It must be strictly kept permanently as headwater source.
- Forest protection activity is the first priority of the government on these areas.
- Immediate reforestation program must be undertaken by the government on the abandoned shifting areas.
- Areas converted into permanent settlement (but classified as 1A due to unidentified by LANDSAT) must be strictly supervised and/or controlled by the government.

in WSC 1B:

- Areas converted into agricultural land must be practiced in accordance with the national economic, social and environmental policies.
- Those areas which have been developed for recreation and resorts should be

harmoniously decorated to keep ecological balance and natural scenarios.

- Reforestation on denuded areas especially those where are unsuitable for agriculture or any other proposes should be immediately undertaken by the concerned agencies.
- Erosion control measures should be practiced on the areas subjected to road construction and mining by the responsible agencies.

- Permission can be made for the unavoidable projects which are very essential to the national economy and security, but the EIS must be prepared by agencies concerned and the project has to be approved by the National Environmental Board.

In WSC 2:

- Forestry and mining activities can be regularly allowed but should be closely and strictly supervised and controlled by the concerned government agencies.
- Agricultural practices are strictly prohibited.
- Immediate reforestation program must be conducted by agencies concerned.

In WSC 3:

- Land utilization for forestry, mining, agriculture and others can be permitted, but soil and water conservation measures are strictly requested.
- Areas with soil depth greater than 50 cm are recommended for fruit-tree and orchard or economic plantation or permanent cash crops, but appropriate soil and water conservation practices are needed.
- Areas having soil shallower than 50 cm should be devoted for reforestation and/or range management.

In WSC 4:

- Forestry, mining and other land-use activities are regularly allowed with close supervision of the government.
- Areas with slope in the range of 18-25 % and soil depth less than 50 cm are recommended for fruit-tree plantation and forestry. Those areas having slope

between 6-18 % should be used for agronomic crops with the application of suitable soil conservation measures.

In WSC 5:

- All kinds of land use practices can be generally allowed.
- Areas with soil depth less than 50 cm are recommended for agronomic crops, private woodlot, fruit-trees, and ranges or recreational propose.
- Areas having soil deeper than 50 cm should be employed as paddy field and agronomy production.
- Lands with high potential of agricultural production should be avoided for industrial development.

For the second activities concerning watershed management based on the Watershed Classification Project in Thailand, only extensive programs of resource management were proposed in the regulation. The detail or intensive approaches were not seriously mentioned.

Watershed management classification maps in Ban Na San and Lan Saka are shown in Figure K.1.2 and K.1.3, respectively.

Besides the above classification, some zoning was also designated by the Forestry Department for future land utilization, namely Zone C for conservation, Zone A for agriculture, and Zone E for economic use. Three zones and national park zone in Ban Na San and Lan Saka are shown in Figure K.1.4 and K.1.5.

Table K.1.1 Forest Land by Region (1961 - 1991)

Unit : million rai

Region / Year	Northeastern		Northern		Central		Southern		Whole Kingdom	
	Area	Decrease	Area	Decrease	Area	Decrease	Area	Decrease	Area	Decrease
1961	44.3 (41.98)		72.7 (68.58)		35.5 (54.66)		18.5 (41.85)		171.0 (53.32)	
1967	38.0 (36.00)	6.3	71.8 (67.73)	0.9	29.9 (46.04)	5.6	15.0 (33.93)	3.5	154.7 (48.25)	16.3
1972	32.7 (30.32)	5.3	71.1 (67.07)	0.7	25.3 (38.96)	4.6	12.1 (27.37)	2.9	141.2 (44.02)	13.5
1977	22.7 (21.51)	10.0	61.6 (58.11)	9.5	20.6 (31.72)	4.7	11.8 (26.69)	0.3	116.7 (36.39)	24.5
1982	16.2 (15.35)	6.5	54.9 (51.79)	6.7	16.6 (25.56)	4.0	10.3 (23.30)	1.5	98.0 (30.56)	18.7
1987	15.2 (14.40)	1.0	51.0 (48.11)	3.9	15.8 (24.33)	0.8	9.3 (21.04)	1.0	91.3 (28.47)	6.7
1988	14.8 (04.02)	0.4	50.3 (47.45)	0.7	15.7 (24.17)	0.1	9.14 (20.68)	0.16	89.94 (28.03)	1.36
1989	14.7 (13.93)	0.1	50.1 (47.26)	0.2	15.6 (24.02)	0.1	9.12 (20.63)	0.02	89.52 (27.94)	0.42
1990	14.2 (13.45)	0.5	49.2 (46.41)	0.9	15.4 (23.71)	0.2	8.7 (19.68)	0.42	87.5 (27.28)	2.02
1991	13.6 (12.89)	0.6	48.2 (45.47)	1.0	15.2 (23.40)	0.2	8.4 (19.00)	0.3	85.4 (26.63)	2.1
Region area	105.53 (100)		106.03 (100)		64.94 (100)		44.20 (100)		320.70 (100)	
Total Forest Area Losses		30.7		24.5		20.3		10.1		84.2

Source : The Royal Forestry Department
Note : Figures in parenthesis represent percentages

Table K.1.2 The Number of Species of Animals in Thailand and the World

Animals	Number of Species in Thailand	Number of Species in the World
Fresh-water fish	650	20,000*
Sea-water fish	2,000	
Amphibian	107	2,500
Reptile	298	6,000
Bird	916	8,600
Mammal	282	4,500
Total	4,253	41,600

Note : *Total number of fresh and sea water fish
Source : Scientific Department of Thailand
UNCED Country Report of Thailand, 1992

Table K.1.3 Indigenous Species to Thailand

Animals	Number
Fresh-water fish	70
Sea-water fish	50
Amphibian	13
Reptile	31
Bird	2
Mammal	8
Total	143

Source : Scientific Department of Thailand
UNCED Country Report of Thailand, 1992

Table K.1.4 Results of River Basin Quality Classification
(Completed by 1989)

Region	Basin Name	Total Area (km^2)	Class 1A		Class 1B		Class 2		Class 3		Class 4		Class 5		Reservoir Area	
			Area (km^2)	% of Basin	Area (km^2)	% of Basin	Area (km^2)	% of Basin	Area (km^2)	% of Basin	Area (km^2)	% of Basin	Area (km^2)	% of Basin	Area (km^2)	% of Basin
North	Ping, Wang	47,468.38	16,040.75	33.79	893.61	1.88	6,746.89	14.21	4,689.22	9.88	4,758.53	10.02	14,089.95	29.68	249.43	0.53
	Yom, Nan	58,516.87	11,370.65	19.43	303.72	0.52	9,570.67	16.36	6,690.70	11.43	5,577.04	9.53	24,820.09	42.42	184.00	0.31
	Subtotal	105,985.25	27,411.40	25.86	1,197.33	1.13	16,317.56	15.40	11,379.92	10.74	10,335.57	9.75	38,910.04	36.71	433.43	0.41
Northeast	Mun	68,725.40	1,353.75	1.97	296.45	0.43	615.80	0.90	1,391.53	2.02	13,531.28	19.69	51,295.10	74.64	241.49	0.35
	Chi	49,896.69	4,965.24	9.95	322.26	0.65	1,321.99	2.65	1,457.24	2.92	11,815.88	23.68	27,260.47	54.63	2,753.61	5.52
	Subtotal	118,622.09	6,318.99	5.33	618.71	0.52	1,937.79	1.63	2,848.77	2.40	25,347.16	21.37	78,555.57	66.22	2,995.10	2.52
South	Basin in the South	77,013.00	10,189.00	13.23	717.00	0.93	8,672.00	11.26	7,973.00	10.35	12,902.00	16.75	34,310.00	44.55	229.00	0.30
			1,337[1/]	1.74	684[2/]	0.89										
East	Basin in the East	36,458.73	2,314.19	6.35	96.00	0.26	1,881.00	5.16	3,007.31	8.25	8,940.74	24.52	20,202.02	55.41	17.47	0.05

Source : Department of Environment Quality Promotion
1/ Class 1A with para rubber tree
2/ Class 1B with para rubber tree

Figure K.1.1 Organization Chart of the National Enviromental Board

Figure K.1.2 Watershed Management Classification Map in Ban Na San

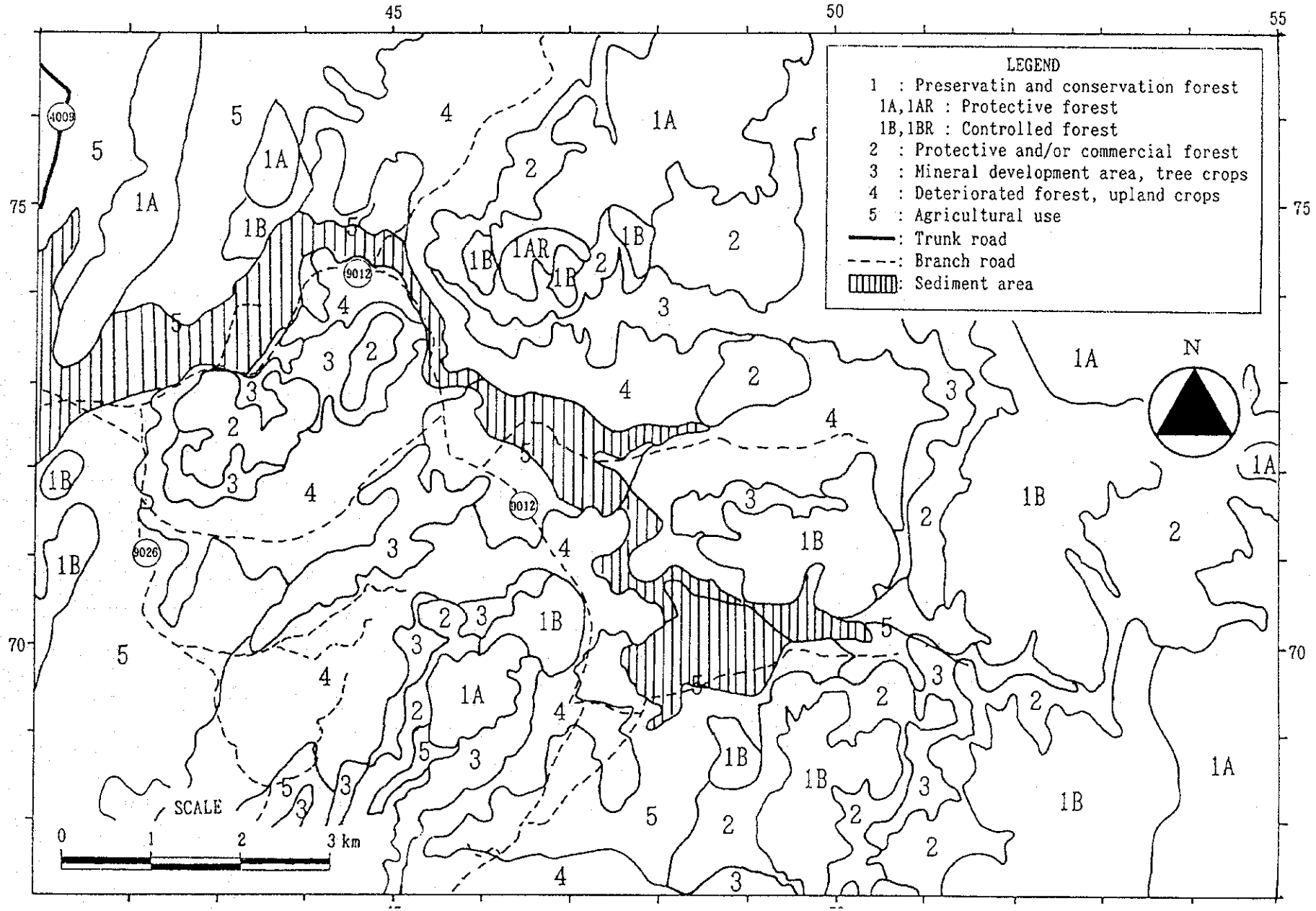


Figure K.1.3 Watershed Management Classification Map in LanSaka

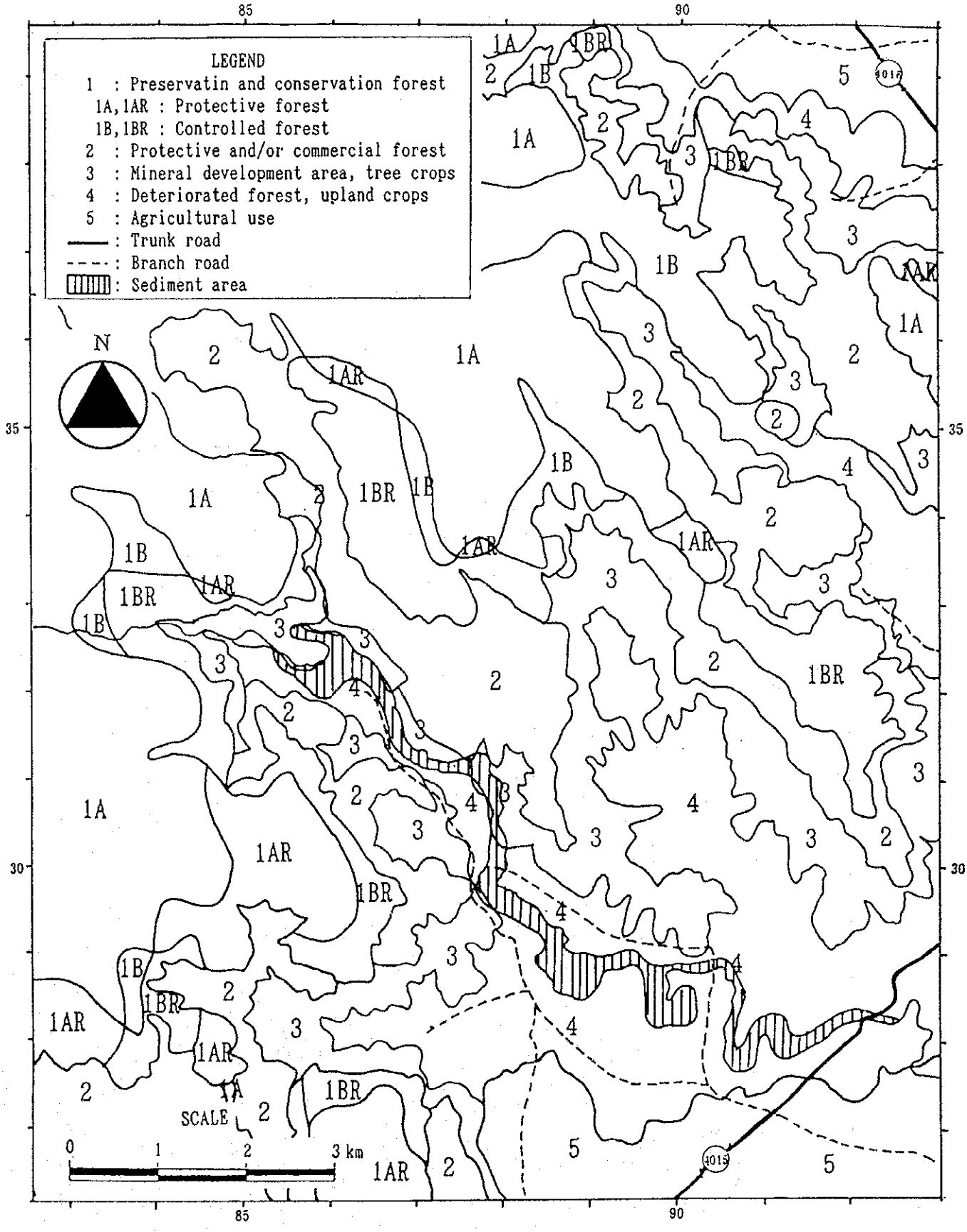
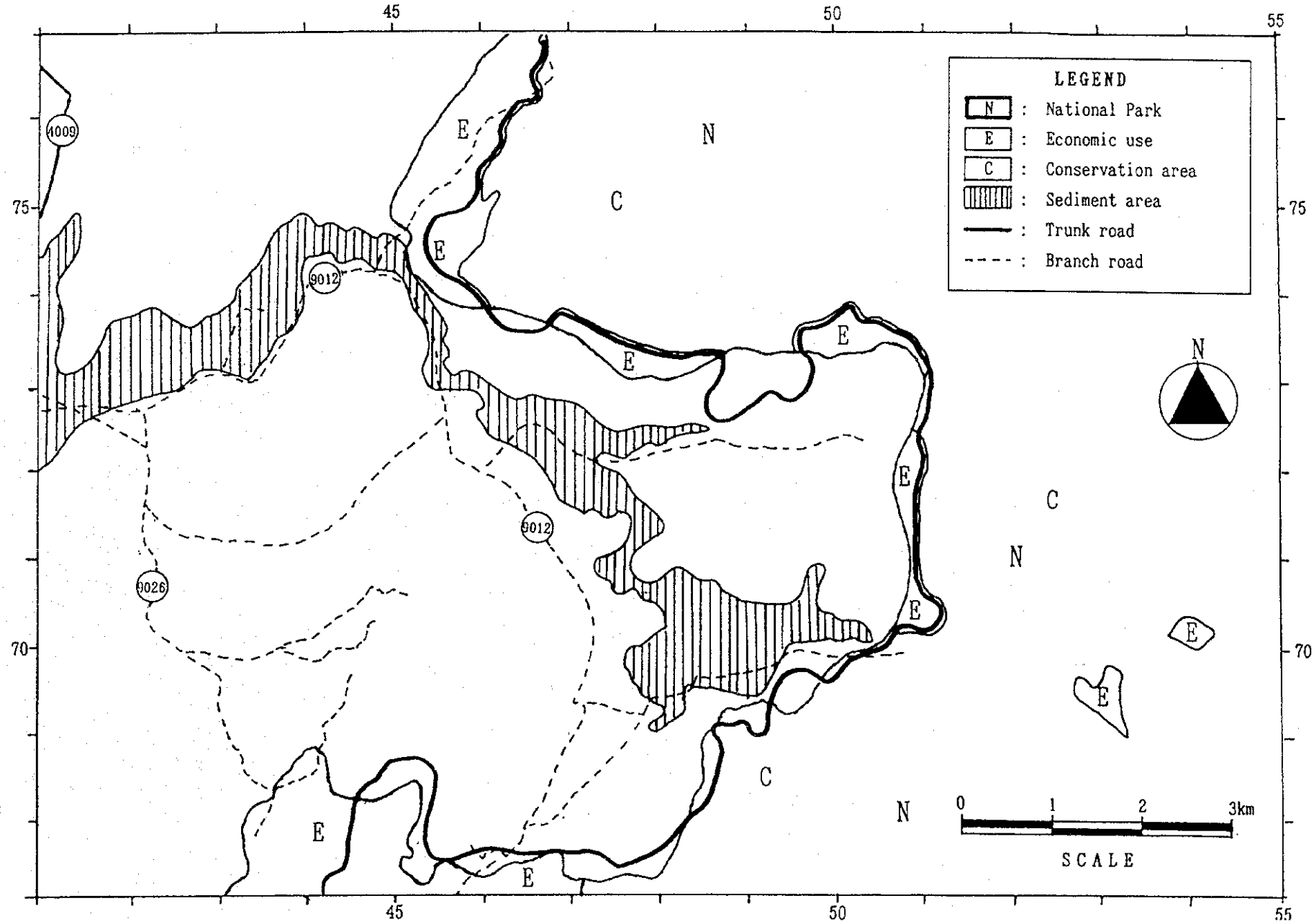
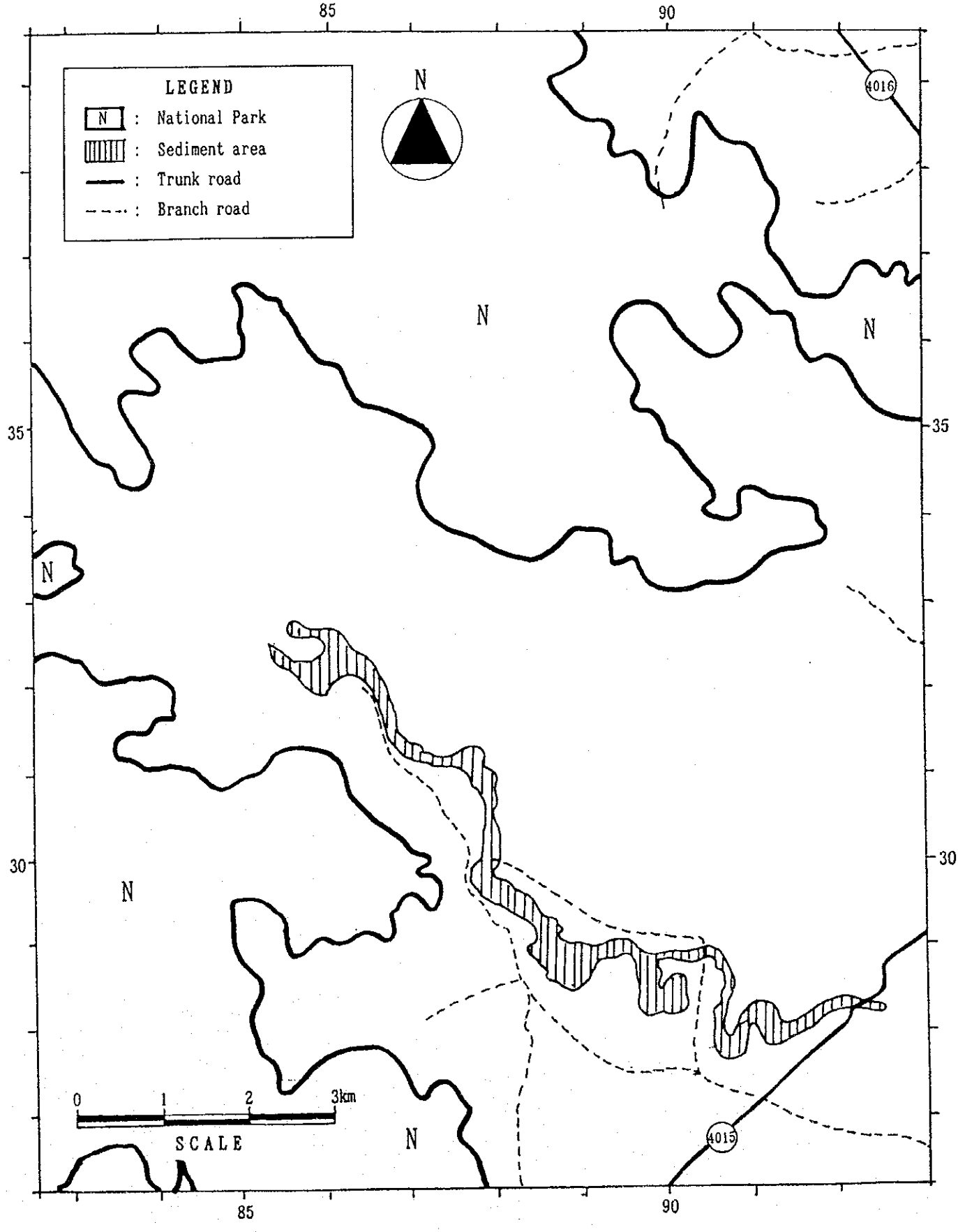


Figure K.1.4 Land Classification in Ban Na San by the Forestry Department



igure K.1.5 Land Classification in Lan Saka by the Forestry Department



List K.1.1 Important Tree Species

1. Azdirachta indiea var. siamensis Vanlenton
2. Atonia maerophylla Wall
3. Aquilaria malaccensis Lamk
4. Artocarpus lanceifulius Roxb.
5. Amisoptera species
6. Adina codiforia Hood. f.
7. Alstonia scholaris R. Br.
8. Cassia fistula Linn.
9. Chukrasia velutina Wight + Arn.
10. Calophyllum pulcherrimum Wall.
11. Cotylelo bius melanoxylon Pierre.
12. Cinnamomum parthenoxylon Nees.
13. Dipterocarpus alatus Roxb.
14. Dipterocarpus costatus Gaertn. f.
15. Durio mansoni Bakh.
16. Fagraea fragrans Roxb.
17. Hopea minutiflora Fischer.
18. Hopea lalifolia Syming.
19. Hopea ordorata Roxb.
20. Hopea pierrei Hance.
21. Intsia bakeri Prain.
22. Litsea grandis Hook. f.
23. Michelia champaca Linn.
24. Mesua ferren Linn.
25. Pakia timoriana Merr., syn.
26. Parashorea stellata Kurz.
27. Pterygota arata R. Br.
28. Shorea gratissima Dyer.
29. Shorea roxburghii Bakh.
30. Tarrietia javanica Blume. syn.
31. Toona ciliata Miq.

List K.1.2 Important Wildlife in the Area

Bird Species

1. Great Hornbill (Buceros bicornis)
2. Green Peafowl (Pavo muticus)
3. Great Argus (Argusianus argus)
4. Gold-whiskered Barbel (Megalaima chysopogon)
5. Greater Flameback (Chuysocolaptes lucidus)
6. Pheasant (Lophura spp.)
7. Red Turtle-Drove (Streptopelia chiensis)
8. Spotted Drove (Streptopelia chinensis)
9. Red-whiskered Bulbul (Pyenonotus jocosus)
10. Thicck-billed Pigeon (Treron curvirostra)

Mammal species

1. Wild Elephant (Elephas maseimus)
2. Gaun (Bos gaurus)
3. Banteng (Bosjavanicus)
4. Sambar Deer (Cervus unicolor)
5. Barking Deer (Muntiacus muntjuk)
6. Brow-antlered Deer (Cervus eldi)
7. Asian or Malayan Tapir (Tapirus indicus)
8. Common Wild Pig (Sus serofa)
9. Mouse Deer (Tsagalus napu)
10. Asiatic Blade Bear (Selenaretos thibetanus)
11. White-hundred Gibbon (Hylobates lar)
12. Crestless Himalayan Porcupine (Hystrise hodosoni)
13. Pig-Tailed Macaque (Macaca nemestrina)
14. Squirrel (Callaseiusus finlayson)
15. Tiger (Pantera tigris)
16. Leopard (Pantera tigris)
17. Clouded leopard (Neofilis nebolusa)

K.2 Initial Environmental Examination (IEE)

Thailand has recently developed wide range of environmental regulations, and environmental issue has becoming an important factor when the project or activity is planned. In addition to that, necessity of environmental impact estimation and assessment are mentioned in Environmental Assessment Guideline prepared by JICA.

Therefore, environmental research in and around the study area had conducted through preparatory study and master plan study.

K.2.1 Preliminary Environmental Survey

Preliminary Environmental Survey was conducted through preparatory study. The results for is was shown in two checklists; initial screening and initial scoping.

(1) Initial Screening

The object of this initial screening is to clear environmental items to be concerned. Listed items used in this screening operation are as follows.

1) Social Environment

- Socio-economic issues

  Living condition, economic activities, community, customary practices of inhabitants in and around the area.

- Health and sanitary issues

  Health condition of related inhabitants, and spreading epidemic diseases

- Historic cite, cultural assets, and scenery

  Area with historic, archeological, scientific assets, or special social value.

2) Natural Environment

- Biological and ecological issues

  Area with valuable species and ecology

- Soil and land resources

  Land devastation, soil erosion, and soil contamination

- Hydrology, water quality, etc.

  Negative impact on hydrological regime of river, lake, swamp and groundwater, and air

Results of initial screening in flood affected area is shown in Table K.2.1.

(2) Initial Scoping

As seen in Table K.2.1, there are some categories which require further examination and overall evaluation. As a second step, initial scoping was conducted to understand those categories comprehensively and environmental impact in and around general study area. Each items are evaluated with rank A through D depending on the significance of environmental impact and evaluation base is also explained. Results are shown in Table K.2.2.

K.2.2 Initial Environmental Examination (IEE)

As seen in Table K.2.2, there is no environmental categories which would be significantly affected by this project. However, some of them might be inducted to worse condition, and also a preliminary environmental survey was carried out for all of flood affected area. Therefore, Initial Environmental Examination (IEE) was carried out for master plan study areas; Ban Na San and Lan Saka. Results for each area are shown in Table K.2.3 and K.2.4.

Table K.2.1 Checklist for Initial Screening

Environmental Issues	Potential Significant Environmental Impact (When the proposed project is implemented, does the following occur?)	Evaluation		
		Yes	No	Unknown
I. Social Environment				
1. Socio-economic Issues The Project Significantly affects socio-economic activities in and around the Project site, such as daily human life, economic activities, transportation, community, institution, and customary practices.	1. Planned residential settlement		○	
	2. Involuntary resettlement		○	
	3. Substantial changes in way of life		○	
	4. Conflict among communities or people		○	
	5. Impacts on native people		○	
	6. Population increase		○	
	7. Drastic change in population composition		○	
	8. Changes in bases of economic activities	○		
	9. Occupational change and loss of job opportunity		○	
	10. Increase in income disparities		○	
	11. Adjustment and regulation of water or fishing (riparian) rights	○		
	12. Changes in social and instructional structures	○		
	13. Changes in existing institutions and customs		○	
2. Health and Sanitary Issues The Project significantly affects hygiene in and around the Project area or induces water related diseases.	1. Increased use of agrochemicals		○	
	2. Outbreak of endemic diseases		○	
	3. Spreading of epidemic diseases (schistosomiasis, malaria, onchocerciasis, elephantiasis)		○	
	4. Residual toxicity of agrochemicals		○	
	5. Increase in domestic and other human wastes		○	
3. Cultural Asset Issues Some historically, culturally, aesthetically or scientifically important assets may be located in the Project site.	1. Impairment of historic remains and cultural assets		○	
	2. Damage to aesthetic sites		○	
II. Natural Environment				
4. Biological and Ecological Issues Some habitats for rare species or ecologically fragile areas are located in the Project or surrounding areas.	1. Changes in vegetation	○		
	2. Negative impacts on important or indigenous fauna and flora (extinction of or decrease in species)		○	
	3. Degradation of ecosystem with biological diversity		○	
	4. Proliferation of exotic and/or hazardous species		○	
	5. Destruction of wetlands and peatlands	○		
	6. Encroachment into tropical rain-forests and wildlands		○	
	7. Destruction of degradation of mangrove forests		○	
	8. Degradation of coral reef		○	
5. Soil and Land Resources The Project significantly induces land devastation, soil erosion, soil contamination, etc..	1. Soil erosion		○	
	2. Soil salinization		○	
	3. Degradation of soil fertility		○	
	4. Soil contamination by agrochemicals and others		○	
	5. Devastation or desertification of land		○	
	6. Devastation of hinterland		○	
	7. Ground subsidence		○	
6. Hydrology and Air and Water Quality The Project significantly affects hydrological regime of river, lake and swamp, groundwater hydrology and air or water quality.	1. Changes in surface water hydrology	○		
	2. Changes in groundwater hydrology	○		
	3. Inundation and flood		○	
	4. Sedimentation		○	
	5. Riverbed degradation	○		
	6. Impediment of inland navigation		○	
	7. Water contamination and deterioration of water quality		○	
	8. Water eutrophication		○	
	9. Salt water intrusion		○	
	10. Changes in temperature of water		○	
	11. Air pollution		○	
7. Landscape and Mining Resources The Project significantly affects landscape or mining resources.	1. Damage to landscape		○	
	2. Impediment of mining resources exploitation		○	
Overall Evaluation		○		

Table K.2.2 Checklist for Initial Scoping

Category of Environmental Impact	Evaluation A	B	C	D	Evaluation base
I. Social Environment					
1. Socio-economic Issues					
(1) Social Issues			○		No resettlement plan
1. Planned residential settlement			○		Not applicable
2. Involuntary resettlement			○		Not applicable
3. Substantial changes in way of life			○		The project may be limited inside the community
4. Conflict among communities or people			○		The project may not involve the native people
5. Impacts on native people					
6. Others					
(2) Demographic issues			○		Not applicable
1. Population increase			○		Not applicable
2. Drastic change in population composition					
3. Others					
(3) Economic Activities			○		Not applicable
1. Changes in bases of economic activities			○		Not applicable
2. Occupational change and loss of job opportunity			○		Not applicable
3. Increase in income disparities					
4. Others					
(4) Institutional and Custom Related Issues			○		No fishing or water rights in the areas
1. Adjustment and regulation of water or fishing (riparian) rights			○		Not applicable
2. Changes in social and instructional structures			○		Not applicable
3. Changes in existing institutions and customs					
4. Others					
2. Health and Sanitary Issues		○			The horticulture requires more agro-chemicals use
1. Increased use of agrochemicals			○		Not applicable
2. Outbreak of endemic diseases			○		Not applicable
3. Spreading of epidemic diseases		○			The horticulture requires more agro-chemicals use
4. Residual toxicity of agrochemicals			○		
5. Increase in domestic and other human wastes					
6. Others					
3. Cultural Asset Issues			○		Not applicable
1. Impairment of historic remains and cultural assets			○		Not applicable
2. Damage to aesthetic sites					
3. Others					
II. Natural Environment					
4. Biological and Ecological Issues		○			Vegetation is changed substantially with the develo
1. Changes in vegetation			○		Not applicable
2. Negative impacts on important or indigenous fauna and flora			○		Not applicable
3. Degradation of ecosystem with biological diversity			○		Not applicable
4. Proliferation of exotic and/or hazardous species			○		No wetland and peatland is in the areas
5. Destruction of wetlands and peatlands			○		Not applicable
6. Encroachment into tropical rain-forests and wildlands			○		No mangrove forest in the areas
7. Destruction of degradation of mangrove forests			○		Not applicable
8. Degradation of coral reef					
9. Others					
5. Soil and Land Resources					
(1) Soil Resources			○		Not applicable
1. Soil erosion			○		Not applicable
2. Soil salinization			○		Not applicable
3. Degradation of soil fertility		○			By agrochemical use
4. Soil contamination by agrochemicals and others					
5. Others					
(2) Land Resources			○		Not applicable
1. Devastation or desertification of land			○		Not applicable
2. Devastation of hinterland			○		Not applicable
3. Ground subsidence					
4. Others					
6. Hydrology and Air and water Quality					
(1) Hydrology		○			Irrig. and Drain. development may change hydrology
1. Changes in surface water hydrology		○			Irrig. and drain. development may change hydrology
2. Changes in groundwater hydrology			○		Not applicable
3. Inundation and flood			○		Sedimentation shall be prevented by the project
4. Sedimentation			○		Sedimentation shall be prevented by the project
5. Riverbed degradation			○		Not applicable
6. Impediment of inland navigation					
7. Others					
(2) Water Quality and Temperature			○		By agrochemical use
1. Water contamination and deterioration of water quality			○		Not applicable
2. Water eutrophication			○		Not applicable
3. Salt water intrusion			○		Not applicable
4. Changes in temperature of water					
5. Others					
(3) Atmosphere			○		Not applicable
1. Air pollution					
2. Others					
7. Landscape and Mining Resources			○		No valuable landscape
1. Damage to landscape			○		No mining resources
2. Impediment of mining resources exploitation					
3. Others					

Note : A = significant environmental impact is unquestionably inducted by the Project
B = significant environmental impact is likely to be inducted by the Project
C = There is no environmental impact.
D = Not known or there likely to be no impact

Table K.2.3

Initial Environmental Examination for Basic Development Plan (Ban Na San)

Environmental Issues	Forecasted Damages to Environment	IEE			
		No Impact	Significant Impact		
			Small	Moderate	Major
A. Environmental Effects due to Project Location					
1. Encroachment into forests	Loss of precious natural resources			○	
2. Impediment to movement wildlife, cattle and people.	Impairment of wildlife and disruption of local socio-economic activities		○		
3. Impairment of historical/cultural monuments, buildings and values	Loss of precious values	○			
4. Conflicts in water supply rights	Inadequate socio-economy	○			
5. Regional flooding/drainage hazards			○		
B. Problems from Oversights in Planning and Design					
1. Watershed erosion	Project benefits impaired			○	
2. Downstream water quality problems	Impairment of downstream beneficial uses	○			
3. Suitability of water supply quality for irrigation	Project benefits impaired	○			
4. Adequacy of drainage planning	Project benefits impaired	○			
5. Land tenure problems	Project benefits impaired		○		
6. Farmer credit limitations	Project benefits impaired		○		
7. Feasibility of agricultural cooperatives	Project benefits impaired			○	
8. Feasibility of water users associations	Project benefits impaired		○		
9. Disruption of existing farmer cooperative systems	Project benefits impaired			○	
10. Use of agricultural chemicals	Project benefits impaired, damages to downstream water quality	○			
11. Selection of pesticides	Project benefits impaired, environmental contamination	○			
12. Land use conflicts	Project benefits impaired, local conflicts		○		
13. Inequities in water distribution	Project benefits impaired, local conflicts	○			
14. Canal maintenance	Project benefits impaired		○		
15. Passageways	Loss of wildlife, disruption of local socio-economic activities	○			
16. Scouring hazards	Project benefits impaired	○			
C. Elements of Successful Economic-cum-Environmental Land Clearance					
1. Reliable estimate of agricultural productivity of lands to be cleared	Hazard to economic viability of project		○		
2. Consistency with national forest conservation policy	Long-term loss in national economy and welfare		○		
3. Appropriate sizing and location of area to be cleared	Disturbance to natural forest areas		○		
4. Optimal clearing methods and procedures	Serious hazards of project benefit and efficiency			○	
5. Optimal post-clearing operations	Serious hazards of project benefit and efficiency		○		
6. Sound agroforestry considerations	Loss of opportunity to enhance project benefits and appropriateness		○		
7. Roads/careful planning and construction	Hazards of soil loss and of encroachment into forests	○			
8. Consideration for use of degraded/unused lands	Loss of oppurtunity to enhance project by use of more suitable land	○			
D. Considerations for Land Clearing in Upland Forests					
1. Changes in water hydrology	Adverse effect on quantity of water supply for downstream users			○	
2. Adverse impacts on water quality	Hazard to water quality for new settlers and downstream users		○		
3. Impact on soil fertility causing erosion and sedimentation	Reduce of land capability		○		
4. Effect on aquatic biology and fisheries	Reduced aquatic productivity in downstream areas		○		
5. Impact on wildlife population and its impact on agricultural productivity	Loss of valuable wildlife		○		
6. Impact on forest resource use to regional and national development plans	Reduced socio-economic values			○	
7. Availability of water supply to new settlers and downstream users	Disruption in the water supply in quantity and quality	○			
8. Flooding hazards	Increased flood discharge and changes of water way		○		
9. Land use changes	Loss of socio-economic and ecological valuables and other land values			○	
10. Socioeconomic impacts	Social conflicts between existing communities and new settlers, loss of traditional utilized forest products and land uses			○	
11. Effects on human health	Adverse effect on public health		○		
E. Monitoring					
1. During construction stage to ensure contractor's compliance	Damages by construction contractor likely not to observe environmental conditions		○		
2. Post-clearance stage to project form experience gained	Damages by operating personal likely not to manage project at optimal level		○		
F. Problems During Construction Stage					
1. Erosion control	Loss of soil, damage to downstream water quality		○		
2. Other construction stage hazards	Adverse environmental effects		○		
3. Monitoring during construction	Without this, serious adverse effects may occur			○	
G. Problems stemming from Deficiencies in Operations					
1. Inadequate O&M	Loss in project efficiency		○		
2. Adverse soil modifications	Loss in project efficiency		○		
3. Fertilizer runoff hazards	Damages to project and to downstream water quality		○		
4. Operations monitoring	Operation efficiency is not lively			○	
5. Aquaculture water supply	Serious aquaculture losses	○			
H. Realization of Enhancement Potentials					
1. Community water supply in service area	Unrealization of valuable socio-economic benefit		○		
2. Aquaculture in service area	Unrealization of valuable socio-economic benefit	○			
I. Overall Environmental Review Criteria					
1. Unwarranted losses in precious resources	Long-term natural environmental and economic losses	○			
2. Unwarranted accelerated use of resources for short-term gains	Long-term natural environmental and economic losses		○		
3. Adverse effects on national energy exchange situation	Adverse effects on natural economics	○			
4. Unwarranted hazards to endangered species	Long-term environmental loss		○		
5. Undesirable population migration to urban sector	Accelerations of urban socio economic problems	○			
6. Increase in affluent/poor income gap	Accelerations of natural socio-economic imbalance		○		

Table K.2.4

Initial Environmental Examination for Basic Development Plan (Lan Saka)

Environmental Issues	Forecasted Damages to Environment	IEE: No Impact	IEE: Significant Impact – Small	IEE: Significant Impact – Moderate	IEE: Significant Impact – Major
A. Environmental Effects due to Project Location					
1. Encroachment into forests	Loss of precious natural resources			○	
2. Impediment to movement wildlife, cattle and people	Impairment of wildlife and disruption of local socio-economic activities		○		
3. Impairment of historical/cultural monuments, buildings and values	Loss of precious values	○			
4. Conflicts in water supply rights	Inadequate socio-economy	○			
5. Regional flooding/drainage hazards				○	
B. Problems from Oversights in Planning and Design					
1. Watershed erosion	Project benefits impaired			○	
2. Downstream water quality problems	Impairment of downstream beneficial uses		○		
3. Suitability of water supply quality for irrigation	Project benefits impaired	○			
4. Adequacy of drainage planning	Project benefits impaired		○		
5. Land tenure problems	Project benefits impaired		○		
6. Farmer credit limitations	Project benefits impaired		○		
7. Feasibility of agricultural cooperatives	Project benefits impaired			○	
8. Feasibility of water users associations	Project benefits impaired		○		
9. Disruption of existing farmer cooperative systems	Project benefits impaired			○	
10. Use of agricultural chemicals	Project benefits impaired, damages to downstream water quality	○			
11. Selection of pesticides	Project benefits impaired, environmental contamination	○			
12. Land use conflicts	Project benefits impaired, local conflicts		○		
13. Inequities in water distribution	Project benefits impaired, local conflicts	○			
14. Canal maintenance	Project benefits impaired			○	
15. Passageways	Loss of wildlife, disruption of local socio-economic activities	○			
16. Scouring hazards	Project benefits impaired	○			
C. Elements of Successful Economic-cum-Environmental Land Clearance					
1. Reliable estimate of agricultural productivity of lands to be cleared	Hazard to economic viability of project		○		
2. Consistency with national forest conservation policy	Long-term loss in national economy and welfare		○		
3. Appropriate sizing and location of area to be cleared	Disturbance to natural forest areas		○		
4. Optimal clearing methods and procedures	Serious hazards of project benefit and efficiency			○	
5. Optimal post-clearing operations	Serious hazards of project benefit and efficiency		○		
6. Sound agroforestry considerations	Loss of opportunity to enhance project benefits and appropriateness		○		
7. Roads/careful planning and construction	Hazards of soil loss and of encroachment into forests	○			
8. Consideration for use of degraded/unused lands	Loss of oppurtunity to enhance project by use of more suitable land	○			
D. Considerations for Land Clearing in Upland Forests					
1. Changes in water hydrology	Adverse effect on quantity of water supply for downstream users			○	
2. Adverse impacts on water quality	Hazard to water quality for new settlers and downstream users		○		
3. Impact on soil fertility causing erosion and sedimentation	Reduce of land capability		○		
4. Effect on aquatic biology and fisheries	Reduced aquatic productivity in downstream areas		○		
5. Impact on wildlife population and its impact on agricultural productivity	Loss of valuable wildlife		○		
6. Impact on forest resource use to regional and national development plans	Reduced socio-economic values			○	
7. Availability of water supply to new settlers and downstream users	Disruption in the water supply in quantity and quality	○			
8. Flooding hazards	Increased flood discharge and changes of water way			○	
9. Land use changes	Loss of socio-economic and ecological valuables and other land values			○	
10. Socioeconomic impacts	Social conflicts between existing communities and new settlers, loss of traditional utilized forest products and land uses			○	
11. Effects on human health	Adverse effect on public health		○		
E. Monitoring					
1. During construction stage to ensure contractor's compliance	Damages by construction contractor likely not to observe environmental conditions		○		
2. Post-clearance stage to project form experience gained	Damages by operating personal likely not to manage project at optimal level		○		
F. Problems During Construction Stage					
1. Erosion control	Loss of soil, damage to downstream water quality		○		
2. Other construction stage hazards	Adverse environmental effects		○		
3. Monitoring during construction	Without this, serious adverse effects may occur			○	
G. Problems stemming from Deficiencies in Operations					
1. Inadequate O&M	Loss in project efficiency		○		
2. Adverse soil modifications	Loss in project efficiency		○		
3. Fertilizer runoff hazards	Damages to project and to downstream water quality		○		
4. Operations monitoring	Operation efficiency is not lively			○	
5. Aquaculture water supply	Serious aquaculture losses	○			
H. Realization of Enhancement Potentials					
1. Community water supply in service area	Unrealization of valuable socio-economic benefit		○		
2. Aquaculture in service area	Unrealization of valuable socio-economic benefit	○			
I. Overall Environmental Review Criteria					
1. Unwarranted losses in precious resources	Long-term natural environmental and economic losses	○			
2. Unwarranted accelerated use of resources for short-term gains	Long-term natural environmental and economic losses		○		
3. Adverse effects on national energy exchange situation	Adverse effects on natural economics	○			
4. Unwarranted hazards to endangered species	Long-term environmental loss		○		
5. Undesirable population migration to urban sector	Accelerations of urban socio economic problems	○			
6. Increase in affluent/poor income gap	Accelerations of natural socio-economic imbalance		○		

K.3 Environmental Impact Assessment (EIA)

One of the regulations in Environmental Preservation Law determines that "Environmental Impact Assessment (EIA) report has to be submitted to the Office of Environmental Policy and Planning (OEPP) under Ministry of Science, Technology and Environment to get permission for implementation of certain kind of new or extension development project".

When the planned project is a prescribed type or size, the developer has to prepare EIA report before the project implementation and submit it to the governmental ministry/office which supervise the project, and its supervising ministry/office submit the report to OEPP and has to get permission of the project (refer to Figures K.3.1 and K.3.2).

The projects which need submission of EIA report are shown in Table K.3.1 and K.3.2.

The items which should be included in EIA report are prescribed, and it requires summary report and main report. Details are as follows.

(1) Report Content

1) Summary report contains
   - Type and size of the project including concerned project's activities.
   - The location of the project including figure, project map and map of environmentally affected area with the scale of 1:50,000 or suitable scale.
   - selection of the project location and project implementation methodology including reason and determination of selection.
   - The importance of environmental impact assessment report including measures of environmental impact protection and solution, and monitoring program according to the form of so-pho 1.

2) Main report contains

- Introduction : objective and the project, reason of the project implementation, objective of the report preparing, outline and methodology of the study.
- Project detail : General features of the project such as type, size and location. Determination of the project location, methodology of the project implementation including reason and detail. Project activities including project location map with the scale of 1:50,000 or suitable scale. Project scheme and activities.
- Present environemnt : report detail environmental resources and various valuations including map of the project area, and environmental impact in the area in short and long term such as general environmental features of the project including figure of physical ersources, bio-physical resources, human use value and life quality.
- Expected impact by the project : assess direct and indirect environmental impact by the project according to the present environment including natural classification on available and unavailabre rehabilitation.
- The environemntal impact protection and solution measures and compensation : explain the detail of protection and solution of expected impact by the project, and if they can not be avoided, the compensation plan should be proposed.
- Measures of environemtanl impact monitoring : should propose suitable measures of environmental impact monitoring on technical and operation method for project monitoring and evaluation after implementation.

(2) Proposed Attachment Paper

1) Summary report = 15 copies
2) Main report = 5 copies
3) First and second cover of the environmental impact assessment report in accordance with the form of so-pho 2.

4) Certificate paper of report preparing and name list of reporter in accordance with the form of so-pho 3.

5) Copy of approval for personnel who take a right to prepare the environmental impact assessment.

Table K.3.1 Proclamation for Types and Sizes of Projects Required Environmental Impact Assessment

Notification of Types and Sizes of Projects or Activities Requiring EIA Reports and Measures for the Prevention of and Remedy for the adverse Effects on the Environmental Quality.

Items	Types of Project or Activities	Sizes
1	Dam or Reservoir	storage volume of 100 million cubic meters (MCM) or more or storage surface area of 15km2 or more.
2	Irrigation	irrigated area of 80,000 rais (12,800 hectares) or more.
3	Commercial Airport	all sizes.
4	Hotel or Resort Facilities environmentally sensitive areas such as areas adjacent to rivers coastal areas, lakes or beaches or in the vicinity of national parks or historical parks.	80 rooms or more.
5	Mass Transit System and Expressway as defined by the Mass Transit System and Expressway Act or projects similar to expressway or rail type mass transit system.	all sizes.
6	Mining as defined by the Mineral Act.	all sizes.
7	Industrial Estate as defined by the Industrial Estate Authority of Thailand Act, or project similar to Industrial Estate.	all sizes.
8	Commercial Port and Harbor	With capacity for vessels of 500 ton-gross or more.
9	Thermal Power Plant	capacity of 10 MW. or more.

Table K.3.1 (2)

Items	Types of Project or Activities	Sizes
10	Industries	
	(1) Petrochemical Industry	using raw materials which is produced from oil refinery and/or natural gas separation with production capacity of 100 tons/day or more.
	(2) Oil Refinery	all sizes.
	(3) Natural Gas Separation of Processing	all sizes.
	(4) Chlor-Alkaline Industry requiring NaCl as raw material for production Na2CO2, NaOH, HCl, Cl2 NaOCl and Bleaching Power	production capacity of each or combined products of 100 tons/day or more.
	(5) Irons and/or Steel Industry.	production capacity of 100 tons/day or more (production capacity calculated by using production capacity of furnace in ton/hour multiply by 24 hours.
	(6) Cement Industry	all sizes.
	(7) Smelting Industry other than Iron and Steel	production capacity of 50 tons/day or more.
	(8) Pulp Industry	production capacity of 50 tons/day or more.
11	All projects in watershed area classified as 1 B by the Cabinet Resolution.	all sizes.

Table K.3.2 Proclamation for Types and Sizes of Projects Required Environmental Impact Assessment (No. 2)

Items	Types of Project or Activities	Sizes
1	Coastal reclamation	All sizes
2	Building in areas adjacent to rivers coastal areas, lakes or beaches or in the vicinity of national parks or historical parks	Building 1. 23.00 meter height or more 2. Total area of all floors or area of any floor in the same building is 10,000 square meters or more
3	Residential condominium as defined by Condominium Act	80 Units or more
4	Land appropriate (or housing development)	Number of Land plot is 500 plots or more or Total land area is more than 100 rais 16 hectare)
5	Hospital which located	5.1 30 beds or more
	1) In area adjacant to rivers coastal areas lakes beaches	5.2 60 beds or more
	2) In area other than 1)	
6	Pesticide Industry or industry producing active ingredient by chemical process	all sizes
7	Chemical fertilizer industry using chemical process in production	all sizes
8	Highway or road a defined by highway act passing through following area 1) Wildlife Sanctuaries and Wildlife Non-Hunting areas as defined by Wildlife Conservation and Protect ion 2) National Parks as defined by National Park Act 3) Watershed class 2 as approved by the cabinet 4) Mangrove forests designated as the National Forest Preserves 5) Coastal area within 50 meters from the maximum sea level	all projects which equivalent to or above the minimum standard of rural highway including roadbed expansion

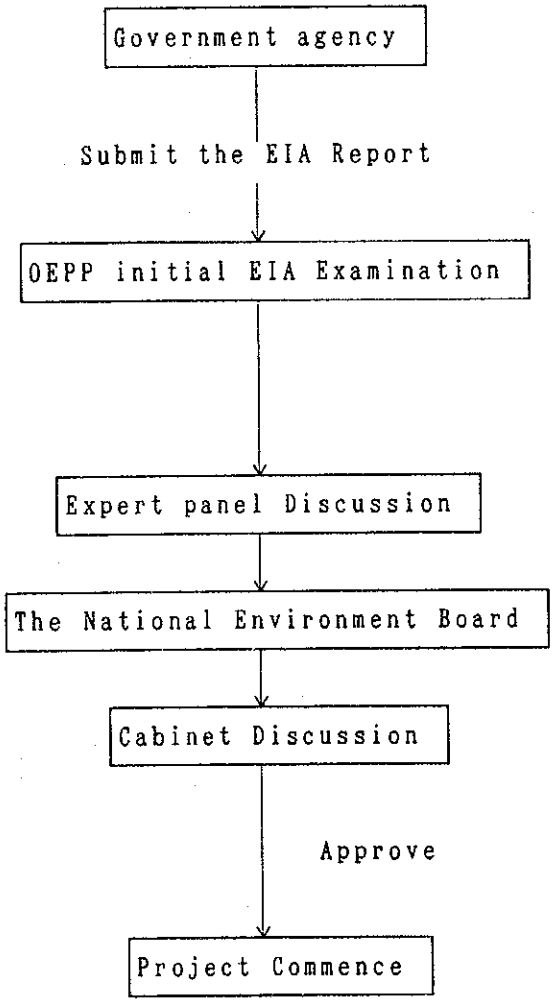


Figure K.3.1 Procedure for EIA for Government Project

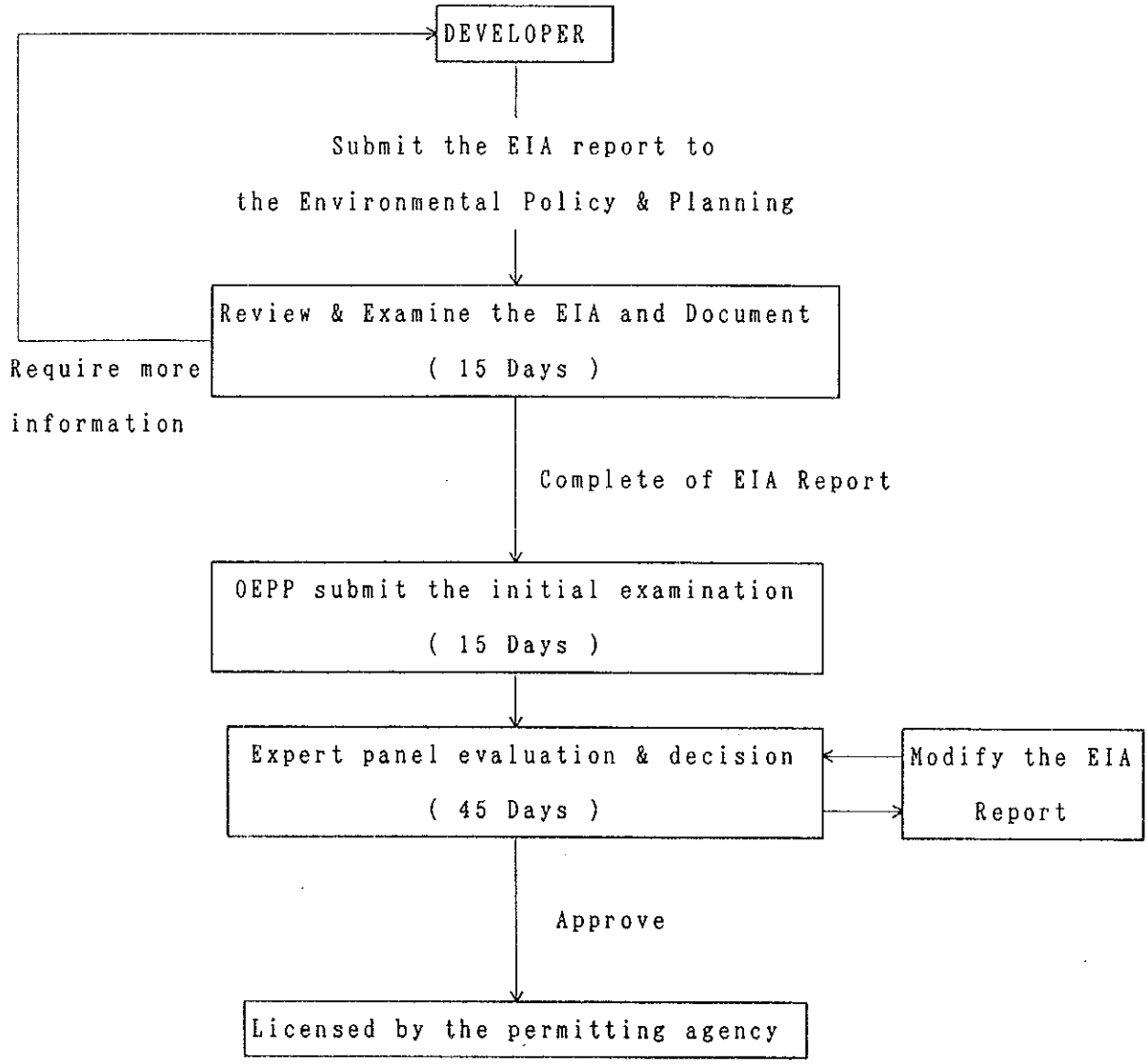


Figure K.3.2 Procedure for EIA for Private Sector Project

APPENDIX L

FIELD TEST

Contents

LIST OF TABLES AND CONTENTS

Tables

Figures

L.1. INTRODUCTION

In Thailand, the Surat Thani and Nakhon Si Thammarat are well known fruit producing provinces. But after flood disaster in 1988 the fruit growers lost many productive areas. Because farmlands were covered with sediment of about 100 cm depth. This sedimentation is an obstacle to plantation of trees.

In order to find the most suitable method for improving the deposited materials and planting fruit trees on them, field tests were conducted in flood affected areas. Test plots were prepared in Ban Na San and Lan Saka districts, at expense of JICA Study Team and cooperation of Department of Land Development(DLD). DLD was requested to procure land for the tests.

L.2. FIELD TEST IN BAN NA SAN

L.2.1. Location of the Test Plots

The test plots were on Nai Toum Usong Nern, Ban Huy Hun, Moo 4 and Tambon Perm Poon Sap, with total area of 3 Rai.

L.2.2. Objectives of the Test

i) To compare the various soil improvement techniques and introduce the most suitable one for fruit tree plantation

ii) To find the most reliable technique for growing fruit trees on the improved land

iii) To establish a demonstration plot in the area.

L.2.3. Field Test

Lands in selected areas were cleared and leveled. Beds with 10 meters width, 50 m length and 0.3 m height were prepared. Rambutan (Rongrian variety) of 9 months old and 60 cm height were selected and used as test plants. They were planted at 10 meters spacing, under four treatments-

1, Trees were directly planted on sediment

2, Transported soil was put on top of the sediment, then trees were planted on this soil

3, Replacement of sediment with transported soil- Pits with size of 1x1x1 m were dug on sediment, the materials were removed and replaced with transported soil

4, Exchange of sediment with lower original soil- Pits were dug, original soil removed and exchanged with sediment. So the original soil was put on top and planted with trees.

Layout of field test is shown in Figure L.2.3-1.

Sixty Rambutan trees were planted in November 13, 1994, with 12 replications. They were irrigated at one day interval with low head sprinkler.
Prior to planting, soil samples from each bed were taken and analyzed for their chemical properties.

L.2.4. Observation and Data Collection

During the Study of JICA Team, once a month following growth parameters were recorded.

Height of plants was measured from ground level to their top-most part.

Spread of plants was measured in two directions, North-South and East-West.

Number of new shoot and leaf appeared on plants was recorded.

Girth of plants was measured at a point about 15 cm above the bud union. The point was marked, so all the measurement were taken at the same place.

L.2.5. RESULTS AND DISCUSSION

1) Soils

Result of soil analysis is presented in Table L.2.5-1.
The pH values of soils ranged between 5.23 and 5.65. Average pH value for deposited soils (sediment) was 5.36, for transported soils 5.42 and for original soils 5.54. This indicated that the deposited and transported soils are strongly acid and original soil is moderately acid.

Percentage of organic matter content of soils ranged from 0.52 to 1.14%. Average organic matter content of three transported soils was 1.05%.

Phosphorus content of the soils ranged between 1 and 23 mg/kg. Original soil had the lowest P content(1 mg/kg).

Potassium content of soils, ranged between 65 and 180 mg/kg. The transported soils had the highest K content.

In general, the soils in their natural condition had favorable physical and chemical condition for growth of most plants.

2) Plants

Monthly recorded data for plant growth are summarized in Tables L.2.5-2 to L.2.5-6.

Results of data analysis are presented in Figures L.2.5-2 to L.2.5-5.

Plant height under all the treatments increased, but with the treatment 4 this increment was more significant.

Spread of plants under treatment 4 was the largest, followed by that of treatments 1 and 3 respectively.

Plants under treatment 4 had the highest leaf number, followed by treatments 1 and 3 respectively.

Girth of plants under treatment 4 was the largest, followed by treatments 1 and 3 respectively.

Overall result of the test suggests that the treatment 4, exchange of flood deposited sediment with lower original soil, is a suitable method for improving the flood affected lands.

Beneficial effect of this treatment can be partly attributed to the factors mentioned below :

Moderate acidity(pH about 5.5)- under such pH value nutrients become more available to plants.

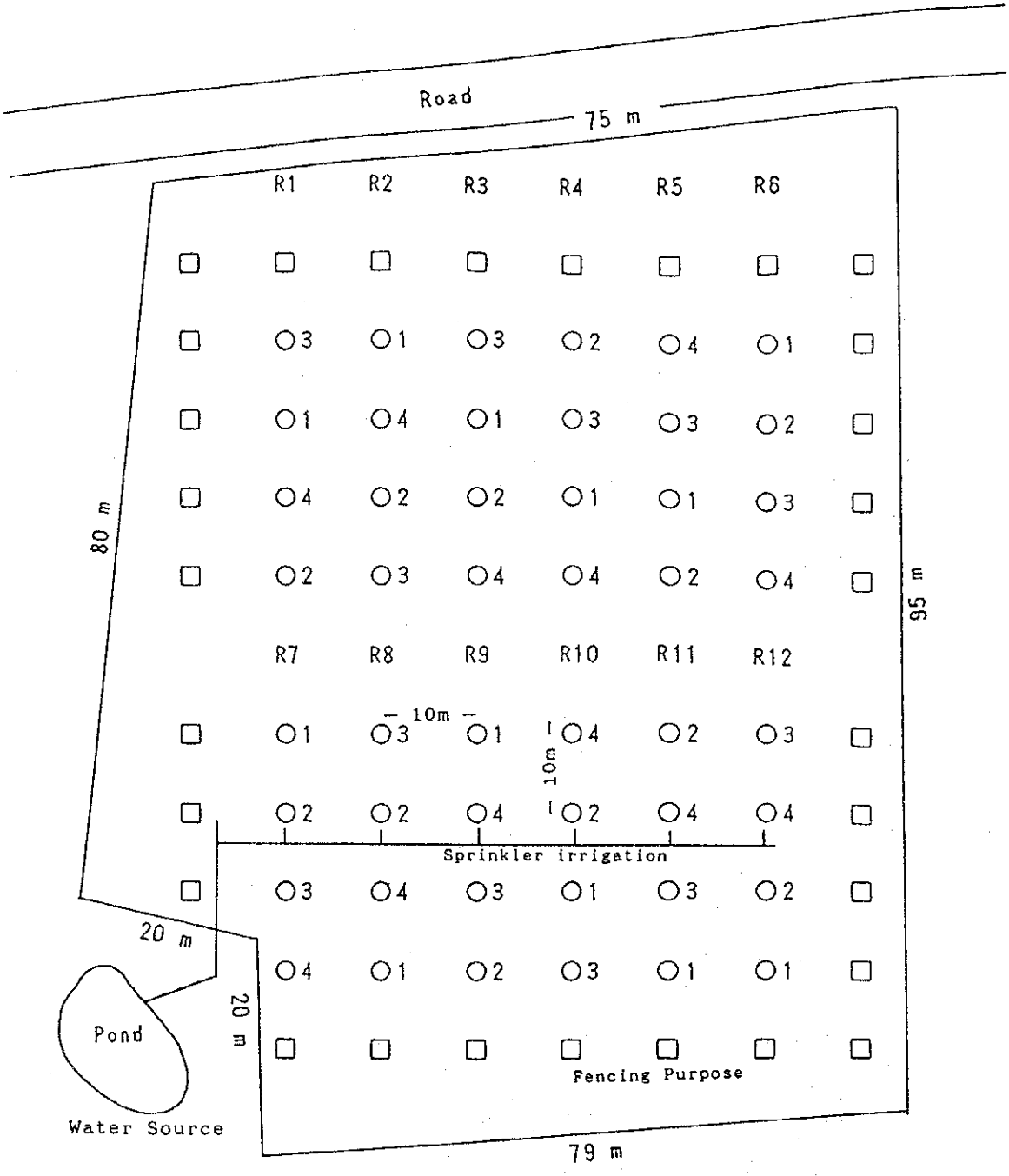
Adoptability of plant to the soil- Rambutan trees have been grown in original soil for years, so they are well adopted to its ecosystem.
The transported soil and flood deposited sediments are not familiar to native plants.

The original soil contain macro and micro-organisms which are well adopted to the local condition. They resume their usual activity after the flood.
Activities of these organisms enhance the plant growth.

Shortcoming of This Test

Accuracy and reliability of recorded data were low to fair. This could be partly due to large number of replications, and short interval of data recording.
Data were recorded at one month interval. Within one month there may not be significant changes in plant parts(Girth).

Six, even three replications could serve the purpose and ensure higher accuracy.



Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

Fig. L.2.3-1 Layout of the Field Test at Ban Na San

Table L.2.5-1 Result of Soil Analysis

Sample Number	pH	% Organic matter	P (mg/kg)	K (mg/kg)	Remarks
1 Sediment	5.26	0.92	23	130	a*
3 Sediment	5.34	0.52	14	90	a*
5 Sediment	5.50	1.02	13	112	a*
6 Clayey soil	5.48	1.13	13	180	b*
8 Clayey soil	5.23	0.90	9	150	b*
10 Clayey soil	5.56	1.13	12	170	b*
11 Original soil	5.65	0.78	1	130	C*
13 Original soil	5.47	1.14	1	65	C*
15 Original soil	5.50	0.87	1	140	C*

a* : Materials(sediment) deposited by Flood.
b* : Clayey soil transported from outside the Study Area.
c* : Soil of the Study Area covered by flood sediments.

Table L.2.5-2 Monthly Recorded Data for Plant Height

Unit: Cm

October 1994

	Treatments			
	1	2	3	4
	84.0	65.0	64.0	56.0
	60.0	61.0	72.0	60.0
	71.0	79.0	85.0	62.0
	81.0	77.0	87.0	82.0
	80.0	60.0	66.0	64.0
R	74.0	62.0	70.0	70.0
	67.0	70.0	76.0	72.0
	98.0	73.0	69.0	66.0
	64.0	61.0	74.0	65.0
	63.0	65.0	69.0	65.0
	65.0	76.0	64.0	61.0
	78.0	70.0	48.0	70.0
Average	73.7	68.2	70.3	66.0

November 1994

	Treatments			
	1	2	3	4
	84.0	65.0	65.0	57.0
	65.0	62.0	76.0	61.0
	79.0	83.0	85.0	62.0
	81.0	77.0	87.0	82.0
	82.0	61.0	69.0	64.0
R	74.0	62.0	71.0	71.0
	70.0	72.0	80.0	75.0
	103.0	74.0	70.0	66.0
	64.0	61.0	74.0	66.0
	66.0	67.0	69.0	65.0
	65.0	78.0	68.0	62.0
	79.0	71.0	50.0	72.0
Average	76.0	69.4	72.0	66.9

December 1994

	Treatments			
	1	2	3	4
	81.0	39.0	61.0	53.0
	71.0	61.0	60.0	60.0
	72.0	74.0	90.0	70.0
	76.0	62.0	75.0	74.0
	84.0	49.0	52.0	61.0
R	75.0	57.0	65.0	66.0
	87.0	68.0	49.0	66.0
	60.0	70.0	75.0	84.0
	66.0	38.0	94.0	64.0
	66.0	56.0	81.0	64.0
	97.0	73.0	67.0	67.0
	65.0	63.0	64.0	82.0
Average	75.0	59.1	69.4	67.6

January 1995

	Treatments			
	1	2	3	4
	91.0	63.0	82.0	68.0
	87.0	70.0	38.0	63.0
	73.0	68.0	65.0	70.0
	64.0	68.0	81.0	78.0
	86.0	59.0	65.0	67.0
R	86.0	67.0	66.0	68.0
	110.0	71.0	83.0	97.0
	68.0	67.0	83.0	92.0
	76.0	74.0	74.0	72.0
	85.0	75.0	99.0	83.0
	110.0	95.0	67.0	68.0
	79.0	76.0	70.0	91.0
Average	84.5	71.1	72.7	76.4

Treatments:
1, Planting the trees on the sediment
2, Put transorted soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

Table L.2.5-2 Cont'd

February 1995

	Treatments			
	1	2	3	4
	104.0	76.0	83.0	76.0
	96.0	71.0	46.0	62.0
	74.0	70.0	77.0	72.0
	70.0	74.0		90.0
	87.0	63.0	67.9	70.0
R	85.6		69.0	92.0
	96.0	86.0	83.0	98.0
	69.0	76.0	90.0	108.0
	90.0	80.0	76.0	88.0
	78.0	76.0	99.0	84.0
	120.0	95.5	67.5	70.0
	65.0	82.0	90.0	104.0
Average	86.2	70.8	70.7	84.5

March 1995

	Treatments			
	1	2	3	4
	105.0	85.0	102.0	83.0
	107.0	74.0	53.0	76.0
	76.0	70.0	83.0	86.0
	70.0	84.0	26.0	100.0
	93.0	60.0	73.0	72.0
R	98.0	35.0		98.0
	110.0	98.0	87.0	104.0
	69.0	85.0	92.0	117.0
	90.0	85.0	87.0	97.0
	83.0	82.0	107.0	84.0
	127.0	96.0	73.0	76.0
	99.0	98.0	97.0	106.0
Average	93.9	79.3	73.3	91.6

April 1995

	Treatments			
	1	2	3	4
	117.0	93.0	103.0	106.0
	120.0	89.0	64.0	96.0
	97.0	80.0	93.0	99.0
	79.0	86.0		112.0
	101.0		78.0	73.0
R	100.0	42.0	74.0	99.0
	120.0	102.0	90.0	120.0
	69.0	102.0	93.0	124.0
	114.0	100.0	102.0	109.0
	87.0	94.0	118.0	102.0
	133.0	98.0	94.0	90.0
	105.0	107.0		120.0
Average	103.5	82.8	75.8	104.2

May 1995

	Treatments			
	1	2	3	4
	124.0	98.0	120.0	116.0
	128.0	94.0	71.0	100.0
	111.0	95.0	104.0	115.0
	85.0	94.0		120.0
	106.0		84.0	79.0
R	85.6		69.0	92.0
	96.0	86.0	83.0	98.0
	69.0	76.0	90.0	108.0
	90.0	80.0	76.0	88.0
	78.0	76.0	99.0	84.0
		96.0	73.0	76.0
	99.0	98.0	97.0	106.0
Average	97.4	89.3	87.8	98.5

Treatments:
1, Planting the trees on the sediment
2, Put transorted soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

Table L.2.5-3 Monthly Recorded Data for Spread of Plant

Unit: Cm

October 1994

		Treatments							
		1		2		3		4	
		N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
		49.0	37.0	34.0	44.0	28.0	32.0	27.0	44.0
		25.0	23.0	35.0	32.0	36.0	46.0	25.0	28.0
		40.0	42.0	38.0	31.0	41.0	37.0	30.0	47.0
		39.0	31.0	38.0	41.0	32.0	35.0	40.0	41.0
		34.0	39.0	38.0	35.0	30.0	37.0	35.0	38.0
		30.0	40.0	27.0	28.0	38.0	31.0	42.0	26.0
	R	40.0	35.0	26.0	38.0	28.0	26.0	34.0	37.0
		40.0	42.0	50.0	55.0	37.0	37.0	32.0	32.0
		33.0	35.0	27.0	27.0	36.0	35.0	35.0	30.0
		28.0	38.0	38.0	45.0	34.0	36.0	33.0	42.0
		34.0	44.0	36.0	38.0	44.0	40.0	40.0	49.0
		35.0	36.0	36.0	40.0	32.0	32.0	30.0	30.0
Average		35.6	36.8	35.3	37.8	34.7	35.3	33.6	37.0

November 1994

		Treatments							
		1		2		3		4	
		N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
		49.0	37.0	39.0	45.0	36.0	32.0	32.0	44.0
		35.0	34.0	30.0	36.0	40.0	46.0	31.0	33.0
		43.0	45.0	42.0	35.0	45.0	39.0	32.0	44.0
		42.0	36.0	39.0	42.0	32.0	45.0	41.0	44.0
		35.0	39.0	39.0	35.0	33.0	38.0	40.0	42.0
	R	31.0	40.0	29.0	33.0	40.0	38.0	45.0	32.0
		50.0	40.0	36.0	42.0	36.0	31.0	37.0	40.0
		41.0	43.0	54.0	55.0	44.0	38.0	34.0	32.0
		34.0	35.0	32.0	33.0	35.0	34.0	38.0	35.0
		29.0	38.0	39.0	46.0	36.0	38.0	34.0	42.0
		34.0	44.0	36.0	40.0	44.0	41.0	45.0	49.0
		35.0	39.0	36.0	41.0	33.0	35.0	35.0	34.0
Average		38.2	39.2	37.6	40.3	37.8	37.9	37.0	39.3

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.
N-S, North-South direction. E-W, East-West direction.

Table L.2.5-3 Cont'd

December 1994

		Treatments							
		1		2		3		4	
		N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
		31.2	34.0	39.3	43.0	33.3	33.4	33.0	26.0
		41.2	37.0	31.7	39.0	33.0	21.0	34.4	38.0
		39.0	50.5	42.7	26.0	41.6	28.0	25.5	45.2
		44.0	33.0	32.0	42.6	36.0	40.0	33.2	43.0
		34.6	32.3	32.0	32.0	28.0	28.0	34.5	37.0
	R	40.0	43.0	34.0	30.5	40.4	35.2	50.4	35.0
		38.0	42.0	46.0	38.0	34.0	38.2	39.0	40.0
		31.6	30.0	29.0	46.0	34.2	34.0	44.0	47.0
		26.0	40.5	39.0	44.0	38.0	45.0	37.6	38.0
		36.0	34.0	33.0	36.0	31.0	30.0	40.2	41.0
		40.0	44.0	55.0	48.3	46.0	32.0	30.0	35.0
		51.3	40.0	38.1	48.2	39.6	43.0	38.0	38.2
Average		37.7	38.4	37.7	39.5	36.3	34.0	36.7	38.6

January 1995

		Treatments							
		1		2		3		4	
		N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
		31.0	30.0	39.4	40.0	37.0	39.0	34.0	36.5
		40.5	32.5	35.7	36.6	28.0	31.5	45.0	37.0
		30.0	28.0	36.0	28.0	32.0	29.0	25.5	45.2
		36.0	31.0	37.0	34.0	27.0	33.0	34.0	45.0
		33.5	28.0	16.5	17.0	26.0	17.5	22.0	29.0
		44.0	44.7	16.0	20.0	46.0	41.0	36.0	50.8
		30.0	38.2	34.5	31.4	38.0	40.2	33.0	58.2
		30.0	26.0	37.0	36.0	29.6	27.5	43.0	54.0
		31.0	40.5	29.2	34.0	38.0	45.0	38.0	33.0
		31.2	33.0	34.0	36.0	35.6	38.0	41.0	38.0
		41.0	54.0	48.0	57.0	46.0	32.0	30.0	36.0
		55.5	46.0	37.5	45.5	45.0	40.0	45.0	38.2
Average		36.1	36.0	33.4	34.6	35.7	34.5	35.5	41.7

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.
N-S, North-South direction E-W, East-West direction.

Table L.2.5-3 Cont'd

February 1995

	Treatments							
	1		2		3		4	
	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
	36.0	39.0	32.0	32.0	43.0	39.0	38.0	51.0
	41.2	43.0	48.0	43.0	40.0	50.0	46.0	42.0
	38.0	43.0	35.0	34.0	40.0	44.0	44.0	34.0
	36.0	32.0	40.0	43.0			39.0	46.0
	31.0	20.0	25.0	23.0	26.0	23.0	25.0	29.0
R	46.0	48.0			48.0	45.0	37.0	58.0
	37.0	34.0	38.0	41.0	45.0	36.0	34.0	36.0
	50.0	33.0	38.0	41.0	30.0	30.0	53.0	60.0
	37.0	47.0	38.0	38.0	40.0	48.0	43.0	44.0
	35.0	30.0	30.0	40.0	46.0	50.0	48.0	38.0
	48.0	46.0	52.0	20.0	43.0	49.0	43.0	33.0
	56.0	38.0	32.0	42.0	41.0	42.0	36.0	46.0
Average	40.9	37.8	34.0	33.1	36.8	38.0	40.5	43.1

March 1995

	Treatments							
	1		2		3		4	
	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
	36.0	40.0	35.0	48.0	43.0	40.0	43.0	40.0
	52.0	54.0	60.0	63.0	62.0	62.0	54.0	48.0
	50.0	54.0	38.0	35.0	43.0	49.0	56.0	44.0
	34.0	36.0	42.0	50.0	42.0	56.0	39.0	52.0
	31.0	20.0	26.0	23.0	46.0	30.0	34.0	32.0
R	46.0	48.0	29.0	23.0	40.0	54.0	34.0	44.0
	38.0	34.0	30.0	32.0	48.0	44.0	53.0	40.0
	40.0	45.0	56.0	50.0	45.0	34.0	67.0	85.0
	67.0	57.0	54.0	48.0	54.0	48.0	54.0	45.0
	51.0	40.0	40.0	35.0	40.0	50.0	55.0	38.0
	45.0	58.0	56.0	30.0	45.0	36.0	40.0	24.0
	55.0	40.0	57.0	48.0	40.0	54.0	53.0	42.0
Average	45.4	43.8	43.6	40.4	45.7	46.4	48.5	44.5

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.
N-S, North-South direction. E-W, East-West direction.

Table L.2.5-3 Cont'd

April 1995

	Treatments							
	1		2		3		4	
	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
	45.0	47.0	57.0	44.0	56.0	54.0	72.0	75.0
	66.0	57.0	68.0	60.0	68.0	69.0	77.0	69.0
	60.0	54.0	44.0	47.0	62.0	41.0	50.0	55.0
	40.0	36.0	44.0	54.0			46.0	47.0
	33.0	34.0			46.0	43.0	36.0	40.0
	49.0	58.0	30.0	27.0	53.0	46.0	41.0	35.0
R	48.0	42.0	42.0	37.0	57.0	44.0	64.0	63.0
	46.0	60.0	50.0	64.0	45.0	48.0	67.0	92.0
	68.0	62.0	56.0	52.0	52.0	60.0	56.0	50.0
	48.0	40.0	40.0	42.0	44.0	46.0	48.0	43.0
	55.0	60.0	28.0	25.0	53.0	49.0	47.0	41.0
	57.0	50.0	51.0	50.0			54.0	44.0
Average	51.3	50.0	42.5	41.8	44.7	41.7	54.8	54.5

May 1995

	Treatments							
	1		2		3		4	
	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
	48.0	49.0	57.6	44.8	60.0	54.0	79.0	76.0
	70.0	61.0	68.0	62.0	68.0	69.0	78.0	74.0
	60.6	34.0	43.0	47.8	62.9	40.0	50.2	55.4
	44.0	37.0	48.0	54.0			46.0	48.0
	33.0	36.0			46.0	43.0	46.0	40.0
	46.0	48.0			48.0	43.0	37.0	58.0
	37.0	34.0	38.0	41.0	45.0	36.0	34.0	36.0
	50.0	33.0	38.0	41.0	30.0	30.0	53.0	60.0
	37.0	47.0	38.0	38.1	40.0	48.0	43.0	44.0
	35.0	30.0	30.0	40.0	46.0	50.0	48.0	38.0
			56.0	30.0	45.0	36.0	40.0	24.0
Average	55.0	40.0	57.0	48.0	40.0	54.0	53.0	42.0

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.
N-S, North-South direction. E-W, East-West direction.

Table L.2.5-4 Monthly Recorded Data for Number of Leaf of Rambutan Plants

October 1994

	Treatments			
	1	2	3	4
	No data available			

November 1994

	Treatments			
	1	2	3	4
	No data available			

December 1994

	Treatments			
	1	2	3	4
	16.0	11.0	16.0	16.0
	19.0	16.0	17.0	15.0
	12.0	11.0	10.0	14.0
	10.0	11.0	31.0	14.0
R	10.0	8.0	8.0	11.0
	11.0	14.0	9.0	14.0
	21.0	13.0	16.0	16.0
	12.0	13.0	11.0	15.0
	12.0	13.0	10.0	16.0
	14.0	14.0	22.0	16.0
	16.0	22.0	14.0	19.0
	15.0	12.0	13.0	15.0
Average	14.0	13.2	14.8	15.1

January 1995

	Treatments			
	1	2	3	4
	14.0	14.0	20.0	20.0
	17.0	24.0	12.0	23.0
	28.0	13.0	14.0	14.0
	12.0	14.0	13.0	18.0
	13.0	11.0	9.0	11.0
	18.0	6.0	15.0	14.0
	14.0	16.0	16.0	20.0
	11.0	13.0	12.0	20.0
	16.0	12.0	10.0	16.0
	8.0	18.0	23.0	21.0
	22.0	23.0	14.0	22.0
	20.0	11.0	16.0	16.0
	16.1	14.6	14.5	17.9

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

Table L.2.5-4 Cont'd

February 1995

	Treatments			
	1	2	3	4
	12.0	14.0	24.0	26.0
	18.0	24.0	26.0	23.0
	48.0	14.0	17.0	19.0
	13.0	21.0	3.0	13.0
	11.0	15.0	9.0	14.0
R	18.0		15.0	16.0
	16.0	15.0	13.0	24.0
	12.0	19.0	22.0	33.0
	21.0	15.0	16.0	17.0
	7.0	14.0	24.0	22.0
	34.0	20.0	12.0	13.0
	17.0	15.0	21.0	19.0
Average	18.9	15.5	16.8	19.9

March 1995

	Treatments			
	1	2	3	4
	17.0	16.0	27.0	26.0
	22.0	38.0	32.0	38.0
	28.0	15.0	19.0	19.0
	20.0	21.0	6.0	22.0
	16.0	18.0	19.0	16.0
	21.0	8.0	25.0	15.0
	11.0	17.0	14.0	22.0
	13.0	18.0	23.0	33.0
	49.0	21.0	21.0	27.0
	15.0	16.0	20.0	20.0
	34.0	29.0	23.0	13.0
	37.0	22.0	19.0	29.0
	23.6	19.9	20.7	23.3

April 1995

	Treatments			
	1	2	3	4
	33.0	17.0	53.0	48.0
	33.0	75.0	56.0	56.0
	32.0	18.0	19.0	26.0
	22.0	24.0		24.0
	20.0		30.0	31.0
R	34.0	11.0	38.0	16.0
	19.0	20.0	18.0	22.0
	22.0	34.0	35.0	36.0
	49.0	24.0	24.0	31.0
	16.0	26.0	22.0	26.0
	28.0	20.0	35.0	24.0
	44.0	24.0	26.0	29.0
Average	29.3	24.4	29.7	30.8

May 1995

	Treatments			
	1	2	3	4
	38.0	22.0	56.0	43.0
	38.0	81.0	59.0	61.0
	36.0	23.0	24.0	29.0
	28.0	26.0		28.0
	24.0		36.0	35.0
	18.0		15.0	16.0
	16.0	15.0	13.0	24.0
	12.0	19.0	22.0	33.0
	21.0	15.0	16.0	17.0
	7.0	14.0	24.0	22.0
		29.0	23.0	13.0
	37.0	22.0	19.0	29.0
	25.0	26.6	27.9	29.2

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

Table L.2.5-5 Monthly Recorded Data for Number of Shoot of Rambutan Plants

October 1994

	Treatments			
	1	2	3	4
	9.0	7.0	9.0	9.0
	10.0	9.0	11.0	7.0
	7.0	9.0	10.0	8.0
	10.0	10.0	7.0	10.0
	14.0	9.0	9.0	9.0
R	8.0	10.0	10.0	9.0
	11.0	7.0	7.0	8.0
	11.0	13.0	12.0	13.0
	7.0	10.0	10.0	11.0
	7.0	8.0	8.0	11.0
	13.0	13.0	8.0	8.0
	12.0	10.0	8.0	15.0
Average	9.9	9.6	9.1	9.8

November 1994

	Treatments			
	1	2	3	4
	10.0	7.0	9.0	9.0
	12.0	10.0	12.0	7.0
	7.0	9.0	12.0	8.0
	10.0	10.0	9.0	10.0
	14.0	9.0	9.0	9.0
R	8.0	10.0	10.0	9.0
	11.0	7.0	8.0	8.0
	11.0	13.0	12.0	13.0
	10.0	10.0	10.0	11.0
	7.0	8.0	10.0	11.0
	13.0	13.0	10.0	10.0
	14.0	10.0	10.0	15.0
Average	10.6	9.7	10.1	10.0

December 1994

Treatments			
1	2	3	4

No data available

January 1995

Treatments			
1	2	3	4

No data available

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

Table L.2.5-5 Cont'd

February 1995

Treatments			
1	2	3	4

No data available

March 1995

Treatments			
1	2	3	4

No data available

April 1995

Treatments			
1	2	3	4

No data available

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

Table L.2.5-6 Monthly Recorded Data for Girth of Rambutan Plants

Unit: Cm

	October 1994				November 1994			
	Treatments				Treatments			
	1	2	3	4	1	2	3	4
R	3.2	2.2	3.4	2.5	3.2	2.2	3.4	2.5
	3.4	2.8	3.1	2.5	3.4	2.8	3.1	2.5
	2.8	2.5	3.4	2.8	2.9	2.9	3.4	2.8
	3.7	2.7	3.0	2.4	3.7	2.7	3.0	2.6
	3.2	2.2	2.6	2.2	3.2	2.2	2.6	2.2
	2.8	2.5	3.0	2.5	2.8	2.5	3.0	2.5
	3.0	3.0	3.1	2.7	3.0	3.0	3.1	2.7
	4.0	3.5	3.1	3.0	4.0	3.5	3.1	3.0
	3.4	3.2	3.2	3.7	3.6	3.2	3.2	3.7
	2.8	2.6	2.8	2.7	2.8	2.6	2.8	2.7
	2.5	3.0	3.4	3.5	2.5	3.0	3.4	3.5
	3.5	3.0	2.2	3.0	3.5	3.0	2.2	3.0
Average	3.2	2.8	3.0	2.8	3.2	2.8	3.0	2.8

	December 1994				January 1995			
	Treatments				Treatments			
	1	2	3	4	1	2	3	4
R	2.6	2.2	3.2	2.3	2.8	2.4	3.3	2.4
	3.1	2.9	2.5	2.5	3.2	2.9	2.6	2.6
	2.8	2.8	3.0	2.4	2.9	2.0	2.0	2.4
	3.2	2.4	2.7	2.4	2.1	2.0	3.1	2.5
	2.8	2.0	2.9	2.4	2.9	2.0	2.9	2.4
	2.5	2.3	2.3	2.6	3.1	2.5	2.1	2.6
	2.8	2.6	2.3	2.7	3.0	2.6	2.4	2.9
	2.2	2.5	2.6	2.8	2.4	2.0	2.6	2.8
	2.4	2.5	2.3	2.9	2.5	2.5	2.3	2.9
	3.4	2.3	3.4	2.3	3.6	2.3	3.4	2.4
	3.6	3.0	2.0	2.8	3.6	3.0	2.0	2.8
	2.8	2.8	2.4	3.2	2.9	3.0	2.4	3.2
Average	2.9	2.5	2.6	2.6	2.9	2.4	2.6	2.7

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

Table L.2.5-6 Cont'd

	February 1995				March 1995			
	Treatments				Treatments			
	1	2	3	4	1	2	3	4
R	2.9	2.7	3.6	3.2	2.9	2.7	3.6	3.2
	3.6	2.9	2.7	3.0	4.0	3.6	3.1	3.3
	3.2	2.6	2.9	3.0	3.4	2.6	3.4	3.3
	2.4	3.0		2.8	3.0	3.1	3.1	3.0
	3.0	2.3	2.9	2.8	3.2	2.5		2.8
	3.3		3.0	3.0	3.5			3.1
	3.3	2.8	2.9	3.1	3.4	3.3	3.1	3.6
	2.4	2.6	3.0	3.5	3.0	3.5	3.4	4.1
	2.7	2.6	2.6	2.9	3.1	3.1	3.1	3.6
	3.6	2.6	3.5	2.9	3.6	3.0	3.7	3.1
	3.6	3.1	3.0	2.9	4.0	3.4	3.3	3.4
	3.1	3.2	3.2	3.2	3.5	3.4	3.3	3.7
Average	3.1	2.5	2.8	3.0	3.4	2.9	2.8	3.4

	April 1995				May 1995			
	Treatments				Treatments			
	1	2	3	4	1	2	3	4
R	3.5	3.3	4.7	4.4	4.1	3.8	5.2	4.8
	4.5	4.5	3.2	3.9	4.9	5.0	3.7	4.2
	3.8	2.9	3.1	4.0	4.3	3.6	3.9	4.5
	3.0	3.3		3.4	3.5	3.7		3.9
	3.2		3.2	2.8	3.6		3.7	3.3
	3.6	3.2	3.9	3.1	3.3		3.0	3.0
	3.4	3.4	3.3	4.3	3.3	2.8	2.9	3.1
	3.1	4.1	3.7	4.8	2.4	2.6	3.0	3.5
	3.9	3.1	3.5	3.7	2.7	2.6	2.6	2.9
	3.9	3.5	3.9	3.2	3.6	2.6	3.5	2.9
	4.5	3.5	3.7	3.2		3.4	3.3	3.4
	4.0	3.4	3.5	4.3	3.5	3.4	3.3	3.7
Average	3.7	3.2	3.3	3.8	3.6	3.4	3.5	3.6

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediment with lower original soil.
R, Replications.

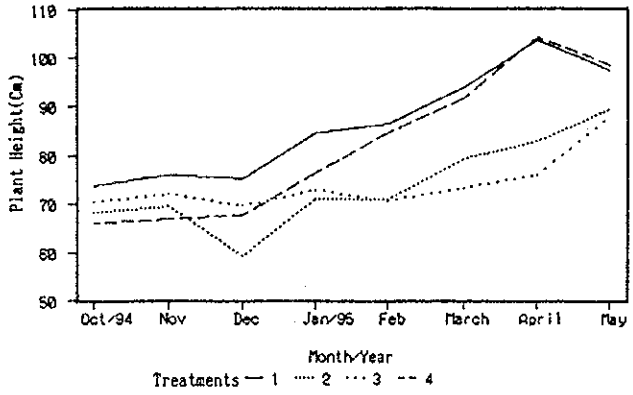


Fig. L.2.5-2 Monthly Changes in Height of Rambutan Plants

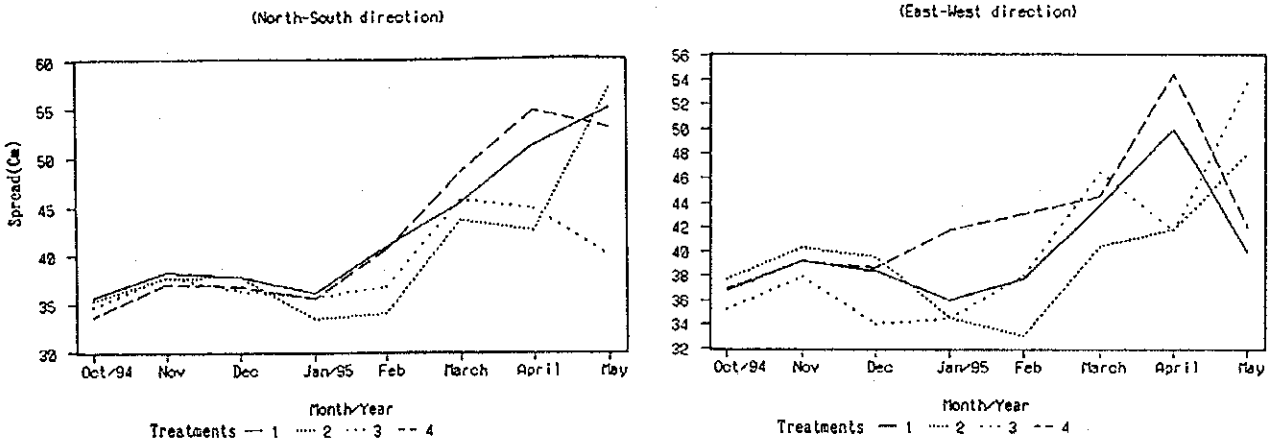


Fig. L.2.5-3 Monthly Changes in Spread of Rambutan Plants

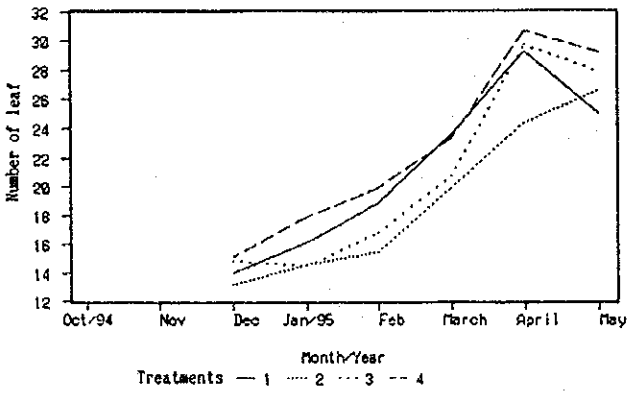


Fig. L.2.5-4 Monthly Changes in Number of Leaf of Rambutan Plants

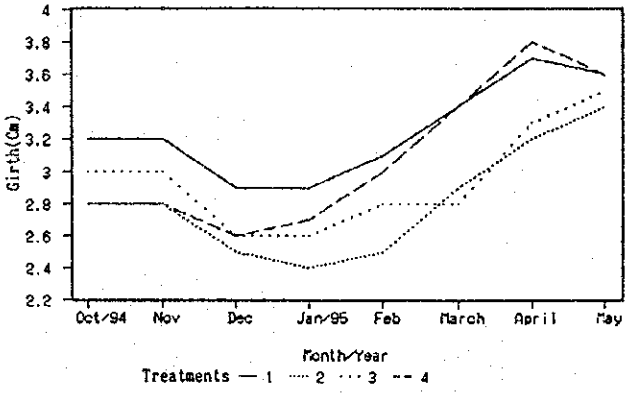


Fig. L.2.5-5 Monthly Changes in Girth of Rambutan Plants

Treatments :
1, Planting the trees on sediment
2, Put transported soil on top of the sediment
3, Replace the sediment with transported soil
4, Exchange the sediments with lower original soil.

L.3. FIELD TEST AT LAN SAKA

L.3.1 Background

Lan Saka is one of the area suffered from 1988 flood. The flood caused heavy damage to fruit trees, particularly in low lands along the Tha Di river. Under present condition, these lands are subjected to annual flood.

The field test was carried out at Wat Chan, Tambon Kam Loan, Amphoe Lan Saka, with total area of 3 Rai.

L.3.2 Objectives of the test

To compare the growth and development of Rambutan, Mangosteen, and young Coconut

To find out the most suitable farming technique for protecting the low-lying areas from flood hazard.

To establish a demonstration plot in the flood hazard area.

L.3.3 Land and Bed Preparation

Selected land was cleared and leveled. Nine-bed with 4m width, 50m length and 1.25m height were made. Pits with 2m width, 2m length and 1m depth, and 10m intervals were dug in the beds. Sediment was taken away and pits were refilled with a mixture of transported soil and compost(1:1 ratio), added with 200g rock phosphate and planted on October 1, 1994.

Before planting, soil samples from the beds were collected and analyzed for their chemical properties.

There were three treatments, each having three replications of five randomly distributed plants :

Treatment 1, Planting of Rambutan- 9 months old, 60cm height.

Treatment 2, Planting of Mangosteen- 3 years old, 1m height.

Treatment 3, Planting of young Coconut- Nam Hom variety with 3 months age, 50cm height and 3-5 fronds.

The tests were carried out under common framing practices.

Layout and Sketch of Test Plot are shown in Fig. L.3.3-1(a-b).

L.3.4 Observation and data collection

Once a month, the following growth parameters were recorded:

Height of plants was measured from ground level to their top-most part.

Spread of plant was measured in two directions- N-S and E-W.

Number of new shoots appeared on Rambutan and Mangosteen, and number of new fronds on Coconut plants were recorded.

Girth of Rambutan plants was measured at 15cm above union bud, for Mangosteen and coconut at 15 and 50cm above ground level.

All measurement were done at the same painted point.

L.3.5 Results of the Test

Results of soil analysis are same as those presented in Table L.2.5-1 of this Appendix.

Monthly recorded data for plants growth are summarized in Tables L.3.5-1 to L.3.5-6.

Results of the data analysis for plants growth are shown in Figures L.3.5-1 to L.3.5-4.

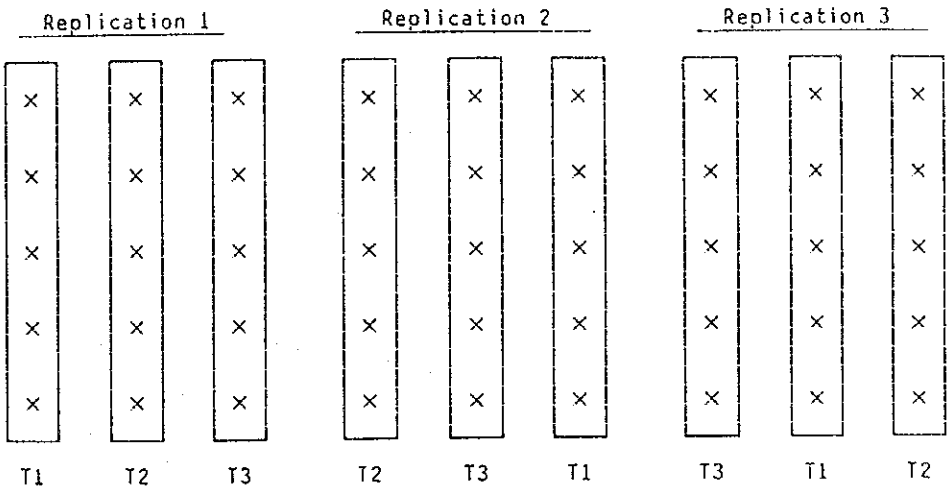
Overall height of Coconut plant was more significant than that of other plants.

The Coconut plant had the largest spread in both North-South and East-West directions.

The Rambutan plant produced largest number of leaf, followed by Mangosteen and Coconut plants respectively.

From observation and overall results obtained so far, it can be realized that the planting of Coconut trees is the suitable technique for protecting the low-lying areas against flood.

(a)



T1 ; Treatment of Rambutan
T2 ; Treatment of Mangosteen
T3 ; Treatment of Young coconut

; Raising Bed

(b)

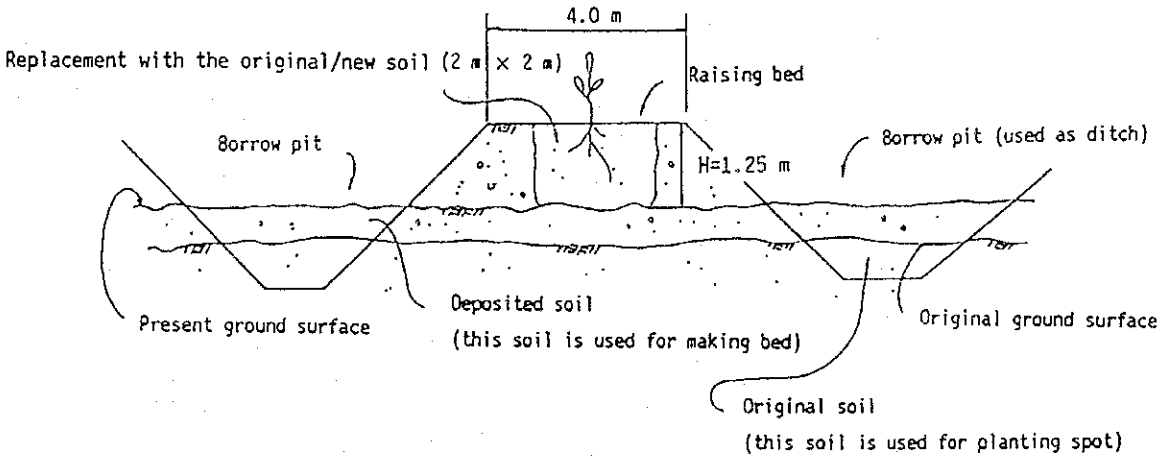


Fig. L.3.3-1 Layout(a) and Sketch(b) of Test Plot at Lan Saka

Table L.3.5-1 Monthly Recorded Data for Whole Plant Height

Unit: Cm

October 1994

	Rambutan			Mangossteen			Young Coconut		
	Bed replication			Bed replication			Bed replication		
	1	2	3	1	2	3	1	2	3
	71.0	50.0	49.0	77.0	70.0	81.0	89.0	67.0	78.0
	76.0	44.0	52.0	66.0	72.0	68.0	84.0	89.0	83.0
PR	68.0	51.0	64.0	69.0	72.0	71.0	81.0	69.0	48.0
	41.0	47.0	51.0	68.0	68.0	71.0	56.0	63.0	38.0
	56.0	54.0	74.0	69.0	95.0	71.0	44.0	84.0	53.0
Average	62.4	49.2	58.0	69.8	75.4	72.4	70.8	74.4	60.0

November 1994

	1	2	3	1	2	3	1	2	3
	74.0	58.0	52.0	79.0	74.0	85.0	94.0	73.0	82.0
	76.0	45.0	54.0	66.0	75.0	71.0	87.0	101.0	89.0
PR	70.0	52.0	65.0	71.0	72.0	75.0	90.0	88.0	55.0
	49.0	60.0	54.0	68.0	74.0	73.0	69.0	75.0	39.0
	57.0	55.0	80.0	69.0	98.0	76.0	54.0	86.0	68.0
Average	65.2	54.0	61.0	70.6	78.6	76.0	78.8	84.6	66.6

December 1994

	1	2	3	1	2	3	1	2	3
	83.0	59.0	54.0	79.0	79.0	88.0	94.0	76.0	87.0
	77.0	46.0	57.0	68.0	76.0	71.0	92.0	108.0	91.0
PR	71.0	53.0	65.0	76.0	73.0	77.0	92.0	82.0	63.0
	56.0	64.0	58.0	69.0	78.0	74.0	80.0	81.0	48.0
	59.0	57.0	84.0		99.0	78.0	59.0	93.0	68.0
Average	69.2	55.8	63.6	58.4	81.0	77.6	83.4	88.0	71.4

PR, Plant Replications.

Table L.3.5.-1 Cont'd

January 1995

	Rambutan			Mangosteen			Young Coconut		
	Bed Replication			Bed Replication			Bed Replication		
	1	2	3	1	2	3	1	2	3
	91.0	77.0	74.0	99.0	92.0	108.0	91.0	78.0	82.0
	82.0	67.0	74.0	83.0	84.0	90.0	93.0	107.0	87.0
PR	102.0	63.0	63.0	101.0	85.0	95.0	82.0	82.0	64.0
	77.0	83.0	87.0	80.0	97.0	98.0	82.0	83.0	51.0
	68.0	62.0	85.0		113.0	96.0	62.0	91.0	69.0
Average	84.0	70.4	76.6	90.75	94.2	97.4	82.0	88.2	70.6

February 1995

	1	2	3	1	2	3	1	2	3
	91.0		84.0	96.0	88.0	108.0	91.0	74.0	75.0
	81.0	78.0	75.0	77.0	78.0	89.0	90.0	108.0	85.0
PR	101.0	69.0	65.0	101.0	98.0	95.0	91.0	87.0	75.0
	92.0	85.0	90.0	71.0	96.0	97.0	84.0	81.0	56.0
	76.0		86.0		107.0	93.0	61.0	87.0	63.0
Average	88.2	77.3	80.0	86.3	93.4	96.4	83.4	87.4	70.8

March 1995

	1	2	3	1	2	3	1	2	3
	104.0	63.0	71.0	91.0	91.0	108.0	98.0	83.0	93.0
	43.0	52.0	41.0	77.0	77.0	89.0	86.0	107.0	84.0
PR	114.0	72.0	91.0	99.0	98.0	94.0	85.0	81.0	75.0
	87.0		34.0	79.0	91.0	97.0	89.0	90.0	67.0
	78.0				107.0	95.0	61.0	89.0	69.0
Average	85.2	62.3	59.3	69.2	92.8	96.6	83.8	90.0	77.6

PR, Plant Replications.

Table L.3.5.-1 Cont'd

April 1995

	Rambutan			Mangosteen			Young Coconut		
	Bed Replication			Bed Replication			Bed Replication		
	1	2	3	1	2	3	1	2	3
PR	120.0			92.0	92.0	67.0	114.0	101.0	121.0
	49.0	73.0		74.0	78.0		113.0	131.0	93.0
		67.0			101.0		98.0	104.0	108.0
	89.0	93.0		75.0	89.0		95.0	105.0	77.0
	71.0		43.0		106.0	95.0	63.0	81.0	76.0
Average	82.3	77.7	43.0	80.3	93.2	81.0	96.6	104.4	95.0

May 1995

	1	2	3	1	2	3	1	2	3
PR	128.0			95.0	94.0		129.0	118.0	134.0
	44.0	73.0			76.0		117.0	145.0	92.0
		59.0					114.0	112.0	123.0
	89.0	92.0		79.0	94.0		103.0	108.0	85.0
			42.0			84.0	63.0	83.0	91.0
Average	87.0	74.7	42.0	87.0	88.0	84.0	105.2	113.2	105.0

June 1995

	1	2	3	1	2	3	1	2	3
PR	116.0	87.0	78.0	88.0	65.0	56.0	145.0	130.0	149.0
	89.0	86.0	88.0	61.0	56.0	58.0	126.0	154.0	103.0
	83.0	73.0	82.0	58.0	62.0	63.0	114.0	125.0	139.0
	101.0	91.0	79.0	69.0	58.0	71.0	101.0	126.0	88.0
	77.0	94.0	74.0	54.0	65.0	66.0	71.0	74.0	99.0
Average	93.2	86.2	80.2	66.0	61.2	62.8	111.4	121.8	115.6

PR, Plant Replications.

Table L.3.5-2 Monthly Recorded Data for Trunk Height

Unit: Cm

October 1994

	Rambutn			Mangosteen			Young Coconut		
	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
PR	50.0	51.0	43.0	64.0	68.0	79.0	23.0	20.0	20.0
	65.0	36.0	48.0	60.0	63.0	67.0	25.0	23.0	19.0
	55.0	42.0	55.0	63.0	62.0	70.0	20.0	20.0	16.0
	30.0	42.0	34.0	59.0	64.0	68.0	19.0	22.0	11.0
	45.0	47.0	65.0	50.0	83.0	69.0	16.0	20.0	17.0
Average	49.0	43.6	49.0	59.2	68.0	70.6	20.6	21.0	16.6

November

	1	2	3	1	2	3	1	2	3
PR	53.0	52.0	44.0	65.0	68.0	80.0	26.0	22.0	20.0
	68.0	38.0	52.0	67.0	63.0	67.0	26.0	25.0	22.0
	62.0	48.0	57.0	66.0	65.0	70.0	27.0	21.0	16.0
	42.0	53.0	36.0	59.0	68.0	69.0	20.0	22.0	12.0
	46.0	50.0	70.0	50.0	83.0	71.0	16.0	20.0	19.0
Average	54.2	48.2	51.8	61.4	69.4	71.4	23.0	22.0	17.8

December 1994

	1	2	3	1	2	3	1	2	3
PR	69.0	54.0	46.0	75.0	68.0	81.0	29.0	22.0	21.0
	71.0	39.0	54.0	66.0	65.0	70.0	26.0	25.0	26.0
	64.0	49.0	57.0	75.0	68.0	75.0	31.0	21.0	17.0
	44.0	53.0	39.0	63.0	77.0	69.0	24.0	23.0	13.0
	52.0	50.0	69.0		92.0	76.0	16.0	20.0	19.0
Average	60.0	49.0	53.0	55.8	74.0	74.2	25.2	22.2	19.2

PR, Plant Replications.

Table L.3.5-2 Cont'd

January 1995

	Rambutan			Mangosteen			Young Coconut		
	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
	69.0	58.0	58.0	78.0	75.0	90.0	26.0	21.0	24.0
	76.0	56.0	58.0	67.0	67.0	70.0	31.0	28.0	26.0
PR	79.0	51.0	56.0	77.0	82.0	78.0	29.0	23.0	19.0
	67.0	65.0	72.0	65.0	79.0	78.0	24.0	26.0	13.0
	52.0	50.0	68.0		95.0	79.0	15.0	28.0	22.0
Average	68.6	56	62.4	71.75	79.6	79	25.0	25.2	20.8

February 1995

	1	2	3	1	2	3	1	2	3
	76.0		71.0	75.0	74.0	91.0	23.0	23.0	24.0
	72.0	57.0	59.0	64.0	70.0	70.0	30.0	28.0	26.0
PR	98.0	51.0	61.0	76.0	88.0	77.0	30.0	22.0	16.0
	76.0	67.0	73.0	59.0	77.0	78.0	26.0	23.0	12.0
	62.0		65.0		89.0	88.0	16.0	28.0	18.0
Average	76.8	58.3	65.8	68.5	79.6	80.8	25.0	24.8	19.2

March 1995

	1	2	3	1	2	3	1	2	3
	94.0			80.0	80.0	91.0	24.0	24.0	25.0
	39.0	63.0	59.0	66.0	69.0	70.0	25.0	28.0	23.0
PR	101.0	52.0	33.0	77.0	87.0	76.0	28.0	22.0	23.0
	73.0	72.0	77.0	58.0	83.0	78.0	21.0	22.0	18.0
	66.0		28.0		89.0	78.0	19.0	25.0	19.0
Average	74.6	62.3	49.3	56.2	81.6	78.6	23.4	24.2	21.6

PR, Plant Replications.

Table L.3.5-2 Cont'd

April 1995

	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
	103.0			81.0	83.0	53.0	49.0	42.0	42.0
	33.0	65.0		62.0	69.0		46.0	42.0	36.0
PR		56.0			92.0		39.0	41.0	37.0
	75.0	79.0		59.0	81.0		28.0	39.0	22.0
	63.0		31.0		91.0	81.0	24.0	22.0	22.0
Average	68.5	66.7	31.0	67.3	83.2	67.0	37.2	37.2	31.8

May 1995

	1	2	3	1	2	3	1	2	3
	104.0			84.0	86.0		41.0	41.0	43.0
	35.0	64.0			69.0		34.0	52.0	33.0
PR		56.0					32.0	41.0	42.0
	76.0	81.0		63.0	83.0		27.0	39.0	22.0
			34.0			69.0	21.0	19.0	32.0
Average	71.7	67.0	34.0	73.5	79.3	69.0	31.0	38.4	34.4

June 1995

	1	2	3	1	2	3	1	2	3
	95.0	69.0	67.0	84.0	47.0	44.0	46.0	42.0	43.0
	72.0	65.0	72.0	43.0	43.0	43.0	43.0	52.0	32.0
PR	64.0	71.0	66.0	37.0	49.0	47.0	37.0	42.0	46.0
	83.0	81.0	62.0	63.0	43.0	53.0	34.0	44.0	29.0
	63.0	72.0	61.0	35.0	46.0	46.0	20.0	23.0	32.0
Average	75.4	71.6	65.6	52.4	45.6	46.6	36.0	40.6	36.4

PR, Plant Replications.

Table L.3.5-3 Monthly Recorded Data for Spread of Plants

Unit: Cm

October 1994

Rambutan

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	43.0		35.0		36.0		38.0		33.0		41.0	
	41.0		45.0		31.0		25.0		36.0		38.0	
PR	46.0		44.0		46.0		37.0		23.0		29.0	
	50.0		46.0		34.0		39.0		40.0		32.0	
	32.0		39.0		36.0		33.0		34.0		38.0	
Average	42.4		41.8		36.6		34.4		33.2		35.6	

Mangosteen

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	43.0		48.0		40.0		51.0		39.0		45.0	
	42.0		43.0		41.0		37.0		28.0		46.0	
PR	41.0		45.0		34.0		51.0		43.0		45.0	
	35.0		47.0		45.0		40.0		39.0		46.0	
	42.0		41.0		44.0		57.0		46.0		34.0	
Average	40.6		44.8		40.8		47.2		39.0		43.2	

Young Coconut

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	48.0		63.0		51.0		40.0		38.0		34.0	
	19.0		56.0		44.0		41.0		43.0		66.0	
PR	38.0		53.0		63.0		59.0		32.0		23.0	
	41.0		36.0		16.0		41.0		17.0		21.0	
	11.0		36.0		65.0		61.0		46.0		32.0	
Average	31.4		48.8		47.8		48.4		35.2		35.2	

November 1994

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	50.0		40.0		36.0		40.0		36.0		43.0	
	44.0		46.0		32.0		33.0		38.0		41.0	
PR	46.0		48.0		47.0		39.0		32.0		31.0	
	52.0		49.0		40.0		40.0		44.0		34.0	
	32.0		39.0		37.0		35.0		35.0		39.0	
Average	44.8		44.4		38.4		37.4		37.0		37.6	

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	45.0		43.0		40.0		56.0		42.0		45.0	
	45.0		41.0		45.0		37.0		33.0		45.0	
PR	41.0		53.0		41.0		45.0		51.0		44.0	
	38.0		43.0		45.0		43.0		41.0		47.0	
	45.0		47.0		44.0		55.0		48.0		38.0	
Average	42.8		45.4		43.0		47.2		43.0		43.8	

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	53.0		67.0		51.0		42.0		40.0		52.0	
	19.0		63.0		39.0		44.0		32.0		68.0	
PR	36.0		41.0		45.0		67.0		33.0		26.0	
	51.0		58.0		44.0		22.0		33.0		29.0	
	25.0		34.0		24.0		58.0		46.0		40.0	
Average	36.8		52.6		40.6		46.6		36.8		43.0	

December 1994

Rambutan

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	52.0		45.0		38.0		41.0		42.0		47.0	
	46.0		44.0		35.0		41.0		42.0		41.0	
PR	54.0		57.0		51.0		35.0		31.0		46.0	
	53.0		52.0		41.0		43.0		43.0		42.0	
	53.0		41.0		39.0		35.0		41.0		39.0	
Average	51.6		47.8		40.8		39.0		39.8		43.0	

Mangosteen

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	56.0		39.0		44.0		56.0		47.0		43.0	
	56.0		42.0		55.0		49.0		42.0		49.0	
PR	42.0		54.0		64.0		53.0		49.0		46.0	
	38.0		48.0		45.0		51.0		38.0		45.0	
					45.0		57.0		43.0		31.0	
Average	38.4		36.6		50.6		53.2		43.8		42.8	

Young Coconut

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	99.0		59.0		44.0		62.0		54.0		49.0	
	59.0		74.0		39.0		62.0		43.0		71.0	
PR	51.0		68.0		66.0		71.0		41.0		44.0	
	61.0		67.0		63.0		37.0		38.0		34.0	
	21.0		61.0		52.0		61.0		57.0		54.0	
Average	58.2		65.8		52.8		58.6		46.6		50.4	

January 1995

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	51.0		49.0		36.0		44.0		35.0		46.0	
	28.0		45.0		37.0		43.0		41.0		46.0	
PR	51.0		46.0		49.0		41.0		41.0		45.0	
	45.0		51.0		53.0		54.0		47.0		44.0	
	34.0		39.0		30.0		26.0		34.0		36.0	
Average	41.8		46.0		41.0		41.6		39.6		43.4	

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	79.0		61.0		40.0		51.0		44.0		49.0	
	51.0		45.0		63.0		59.0		46.0		57.0	
PR	53.0		60.0		61.0		56.0		53.0		50.0	
	46.0		59.0		47.0		49.0		39.0		37.0	
					68.0		73.0		71.0		39.0	
Average	57.3		56.3		55.8		57.6		50.6		46.4	

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	99.0		74.0		56.0		53.0		64.0		56.0	
	71.0		73.0		73.0		69.0		61.0		82.0	
PR	57.0		68.0		56.0		65.0		49.0		52.0	
	57.0		79.0		59.0		68.0		41.0		42.0	
	32.0		67.0		72.0		78.0		54.0		42.0	
Average	71.0		73.5		63.2		66.6		53.8		54.8	

February 1995

Rambutan

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	54.0		53.0						33.0		42.0	
	22.0		34.0		34.0		39.0		28.0		52.0	
PR	58.0		51.0		52.0		45.0		45.0		36.0	
	49.0		56.0		43.0		46.0		54.0		46.0	
	47.0		46.0						31.0		34.0	
Average	46.0		48.0		43.0		43.3		38.2		42.0	

Mangosteen

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	72.0		54.0		44.0		65.0		41.0		62.0	
	47.0		51.0		66.0		52.0		53.0		54.0	
PR	56.0		67.0		58.0		69.0		56.0		42.0	
	47.0		49.0		44.0		53.0		52.0		57.0	
					52.0		78.0		65.0		38.0	
Average	55.5		55.3		52.8		63.4		53.4		50.6	

Young Coconut

	Bed Replications 1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	99.0		74.0		66.0		57.0		58.0		62.0	
	78.0		86.0		78.0		71.0		72.0		78.0	
PR	64.0		79.0		56.0		79.0		63.0		61.0	
	65.0		93.0		60.0		76.0		49.0		55.0	
	39.0		71.0		68.0		75.0		56.0		59.0	
Average	69.0		80.6		65.6		71.6		59.6		63.0	

March 1995

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	65.0		56.0						23.0		39.0	
	27.0		26.0		37.0		42.0		22.0		20.0	
PR	49.0		54.0		57.0		46.0		49.0		38.0	
	55.0		49.0		46.0		54.0		21.0		36.0	
	34.0		46.0									
Average	46.0		46.2		46.7		47.3		28.8		33.3	

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	54.0		42.0		53.0		64.0		29.0		61.0	
	41.0		38.0		54.0		41.0		41.0		59.0	
PR	44.0		48.0		69.0		63.0		61.0		37.0	
	48.0		53.0		48.0		64.0		55.0		51.0	
					69.0		81.0		59.0		35.0	
Average	46.8		45.3		58.6		62.6		49.0		48.6	

	1				2				3			
	N-S		E-W		N-S		E-W		N-S		E-W	
	114.0		76.0		61.0		67.0		66.0		64.0	
	95.0		86.0		91.0		64.0		76.0		73.0	
PR	59.0		98.0		56.0		91.0		58.0		61.0	
	67.0		78.0		71.0		76.0		47.0		53.0	
	38.0		72.0		42.0		69.0		63.0		74.0	
Average	74.6		82.0		64.2		73.4		62.0		65.0	

PR, Plant Replications.
N-S, North-South direction.
E-W, East-West direction.

Table L.3.5-3

Cont'd

April 1995

	Rambutan						Mangosteen						Young Coconut					
	Bed Replications						Bed Replications						Bed Replications					
	1		2		3		1		2		3		1		2		3	
	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
PR	43.0	46.0					58.0	47.0	45.0	53.0	26.0	47.0	103.0	94.0	74.0	69.0	30.0	79.0
	33.0	27.0	32.0	28.0			36.0	29.0	49.0	46.0			112.0	103.0	98.0	82.0	69.0	71.0
			54.0	43.0					49.0	74.0			71.0	88.0	76.0	81.0	78.0	84.0
	59.0	32.0	57.0	51.0			37.0	52.0	45.0	46.0			65.0	82.0	79.0	83.0	56.0	63.0
	17.0	12.0			29.0	36.0			37.0	46.0	38.0	34.0	39.0	51.0	58.0	67.0	63.0	71.0
Average	38.0	29.3	47.7	40.7	29.0	36.0	43.7	42.7	45.0	53.0	32.0	40.5	78.0	83.6	77.0	76.4	59.2	69.6

May 1995

	1		2		3		1		2		3		1		2		3	
	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
PR	35.0	44.0					69.0	53.0	48.0	63.0			86.0	91.0	83.0	78.0	96.0	88.0
	29.0	27.0	33.0	29.0					39.0	31.0			92.0	91.0	102.0	84.0	62.0	69.0
			38.0	32.0									83.0	104.0	85.0	97.0	87.0	82.0
	42.0	31.0	61.0	63.0			47.0	41.0	47.0	42.0			75.0	98.0	96.0	87.0	73.0	64.0
					27.0	29.0					34.0	43.0	42.0	48.0	41.0	64.0	74.0	65.0
Average	35.3	34.0	44.0	41.3	27.0	29.0	58.0	47.0	44.7	45.3	34.0	43.0	75.6	86.4	81.4	82.0	78.4	73.6

June 1995

	1		2		3		1		2		3		1		2		3	
	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W
PR	43.0	48.0	48.0	43.0	34.0	37.0	73.0	58.0	34.0	33.0	41.0	33.0	84.0	92.0	96.0	87.0	114.0	103.0
	46.0	51.0	47.0	39.0	43.0	47.0	32.0	34.0	46.0	39.0	39.0	42.0	102.0	88.0	127.0	114.0	64.0	78.0
	49.0	51.0	36.0	44.0	49.0	47.0	38.0	39.0	34.0	45.0	42.0	38.0	82.0	76.0	86.0	103.0	105.0	88.0
	56.0	52.0	57.0	68.0	48.0	44.0	32.0	43.0	41.0	35.0	44.0	37.0	76.0	108.0	95.0	91.0	74.0	51.0
	42.0	39.0	48.0	44.0	37.0	35.0	38.0	44.0	42.0	39.0	39.0	33.0	43.0	45.0	44.0	53.0	66.0	67.0
Average	47.2	48.2	47.2	47.6	42.2	42.0	42.6	43.6	39.4	38.2	41.0	36.6	77.4	81.8	89.6	89.6	84.6	77.4

PR, Plant Replications.
N-S, North-South direction.
E-W, East-West direction.

Table L.3.5-4 Monthly Recorded Data for Number of Leaf

October 1994

	Rambutan			Mangosteen			Young Coconut		
	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
	43.0	30.0	29.0	25.0	27.0	23.0	5.0	3.0	3.0
	21.0	16.0	32.0	26.0	27.0	24.0	3.0	5.0	4.0
PR	39.0	39.0	18.0	21.0	28.0	30.0	4.0	3.0	3.0
	27.0	37.0	37.0	26.0	26.0	26.0	4.0	4.0	3.0
	33.0	30.0	30.0	22.0	27.0	22.0	3.0	5.0	4.0
Average	32.6	30.4	29.2	24.0	27.0	25.0	3.8	4.0	3.4

November 1994

	1	2	3	1	2	3	1	2	3
	25.0	22.0	30.0	25.0	25.0	28.0	5.0	4.0	4.0
	20.0	12.0	32.0	25.0	27.0	30.0	4.0	5.0	5.0
PR	36.0	34.0	8.0	25.0	25.0	36.0	5.0	4.0	4.0
	26.0	37.0	28.0	22.0	30.0	34.0	5.0	4.0	4.0
	21.0	30.0	23.0	22.0	30.0	27.0	4.0	5.0	5.0
Average	25.6	27.0	24.2	23.8	27.4	31.0	4.6	4.4	4.4

December 1994

	1	2	3	1	2	3	1	2	3
	37.0	38.0	50.0	22.0	26.0	28.0	6.0	5.0	4.0
	44.0	43.0	32.0	34.0	37.0	26.0	4.0	6.0	5.0
PR	65.0	56.0	28.0	21.0	34.0	32.0	5.0	4.0	5.0
	65.0	58.0	60.0	19.0	26.0	28.0	5.0	5.0	5.0
	39.0	56.0	60.0		29.0	24.0	5.0	6.0	5.0
Average	50.0	50.2	46.0	19.2	30.4	27.6	5.0	5.2	4.8

PR, Plant Replications.

Table L.3.5-4 Cont'd

January 1995

	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
	73.0	63.0	54.0	28.0	27.0	24.0	6.0	6.0	5.0
	36.0	62.0	65.0	31.0	35.0	36.0	5.0	7.0	6.0
PR	76.0	74.0	43.0	27.0	38.0	40.0	6.0	6.0	6.0
	81.0	88.0	104.0	27.0	40.0	30.0	5.0	7.0	6.0
	47.0	29.0	54.0		43.0	35.0	5.0	6.0	6.0
Average	62.6	63.2	64	28.25	36.6	33	5.4	6.4	5.8

Febraury 1995

	1	2	3	1	2	3	1	2	3
	72.0		75.0	29.0	37.0	33.0	7.0	6.0	6.0
	77.0	60.0	49.0	30.0	34.0	33.0	6.0	7.0	6.0
PR	74.0	109.0	59.0	25.0	45.0	38.0	6.0	6.0	6.0
	170.0	143.0	90.0	27.0	40.0	34.0	6.0	7.0	5.0
	78.0		45.0		36.0	31.0	5.0	6.0	6.0
Average	94.2	104.0	63.6	27.8	38.4	33.8	6.0	6.4	5.8

March 1995

	1	2	3	1	2	3	1	2	3
	83.0			32.0	32.0	16.0	6.0	8.0	6.0
	56.0	60.0	31.0	27.0	14.0	18.0	7.0	8.0	6.0
PR	79.0	102.0	23.0	16.0	32.0	16.0	8.0	6.0	7.0
	162.0	167.0	27.0	16.0	40.0	16.0	6.0	7.0	5.0
	49.0		31.0		23.0	18.0	6.0	7.0	7.0
Average	85.8	109.7	28.0	18.2	28.2	16.8	6.6	7.2	6.2

PR, Plant Replications.

Table L.3.5-4

April 1995

	Rambutan			Mangosteen			Young Coconut		
	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
PR	93.0			34.0	22.0	6.0	5.0	6.0	7.0
	49.0	35.0		20.0	11.0		6.0	9.0	3.0
		80.0			44.0		6.0	7.0	6.0
	64.0	160.0		11.0	29.0		5.0	6.0	4.0
	32.0		51.0		18.0	13.0	4.0	6.0	5.0
Average	59.5	91.7	51.0	21.7	24.8	9.5	5.2	6.8	5.0

May 1995

	1	2	3	1	2	3	1	2	3
PR	26.0			32.0	40.0		4.0	7.0	6.0
	36.0	27.0			14.0		6.0	9.0	4.0
		18.0					6.0	7.0	6.0
	37.0	11.0		14.0	24.0		7.0	7.0	4.0
			21.0			15.0	5.0	5.0	5.0
Average	33.0	18.7	21.0	23.0	26.0	15.0	5.6	7.0	5.0

June 1995

	1	2	3	1	2	3	1	2	3
PR	110.0	114.0	100.0	36.0	17.0	15.0	5.0	5.0	6.0
	120.0	88.0	114.0	25.0	12.0	21.0	4.0	7.0	3.0
	96.0	164.0	138.0	20.0	18.0	17.0	4.0	8.0	6.0
	154.0	43.0	110.0	13.0	14.0	35.0	4.0	6.0	3.0
	102.0	98.0	55.0	19.0	26.0	24.0	5.0	6.0	3.0
Average	116.4	101.4	103.4	22.6	17.4	22.4	4.4	6.4	4.2

PR, Plant Replications.

Table L.3.5-5 Monthly Recorded Data for Number of Shoot

October 1994

	Rambutan			Mangosteen			Young Coconut		
	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
PR	No data available		15.0		8.0	6.0	2.0	2.0	2.0
						6.0	1.0	1.0	2.0
						6.0	1.0	2.0	2.0
					6.0	6.0	1.0	1.0	2.0
					6.0	6.0	2.0	1.0	2.0
Average					6.7	6.0	1.4	1.4	2.0

November 1994

	1	2	3	1	2	3	1	2	3
PR	21.0	21.0	46.0		8.0		1.0		
	30.0	31.0		10.0	8.0			1.0	
	40.0	32.0	10.0		10.0				1.0
	45.0	39.0	37.0					1.0	1.0
	19.0	28.0	38.0					1.0	1.0
Average	31.0	30.2	32.8	10.0	8.7		1.0	1.0	1.0

December 1994

	1	2	3	1	2	3	1	2	3
PR	37.0	38.0		10.0			1.0	1.0	1.0
			18.0			10.0	1.0	1.0	1.0
		12.0	13.0	8.0		10.0	1.0	1.0	1.0
				10.0	14.0		1.0	1.0	1.0
	24.0				14.0	12.0			1.0
Average	30.5	25.0	15.5	9.3	14.0	10.7	1.0	1.0	1.0

PR, Plant Replications.

Table L.3.5-5 Cont'd

January 1995

	Rambutan			Mangosteen			Young Coconut		
	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
PR	No data available			8.0	14.0		1.0		1.0
							1.0		1.0
				4.0			1.0		1.0
					8.0		1.0		1.0
	23.0						1.0	1.0	1.0
Average	23.0			6.0	11.0		1.0	1.0	1.0

Febraury 1995

	1	2	3	1	2	3	1	2	3
PR	64.0			12.0	6.0		1.0	1.0	1.0
	31.0	81.0		14.0	2.0		1.0	1.0	1.0
	77.0	23.0	10.0				1.0	1.0	1.0
		69.0			12.0		1.0	1.0	1.0
			39.0			2.0	1.0		1.0
Average	57.3	57.7	24.5	13.0	6.7	2.0	1.0	1.0	1.0

March 1995

	1	2	3	1	2	3	1	2	3
PR							1.0		1.0
							1.0		1.0
		96.0	6.0	10.0			1.0	1.0	1.0
							1.0	1.0	1.0
	47.0					2.0		1.0	1.0
Average	47.0	96.0	6.0	10.0		2.0	1.0	1.0	1.0

PR, Plant Replications.

Table L.3.5-5

April 1995

	Rambutan			Mangosteen			Young Coconut		
	Bed Replications			Bed Replications			Bed Replications		
	1	2	3	1	2	3	1	2	3
PR	No data available			16.0	18.0		1.0	1.0	1.0
				12.0	8.0		1.0	1.0	1.0
							1.0	1.0	1.0
	28.0			14.0			1.0	1.0	1.0
							1.0	1.0	1.0
Average	28.0			14.0	13.0		1.0	1.0	1.0

May 1995

	1	2	3	1	2	3	1	2	3
PR	87.0			16.0	2.0		1.0	1.0	1.0
	68.0	96.0					1.0	1.0	1.0
		66.0					1.0		1.0
	5.0	138.0		14.0	22.0		1.0	1.0	1.0
			28.0					1.0	1.0
Average	53.3	100.0	28.0	15.0	12.0		1.0	1.0	1.0

June 1995

	1	2	3	1	2	3	1	2	3
PR		2.0	15.0	22.0	6.0	6.0	1.0	1.0	1.0
		14.0	8.0		6.0	4.0	1.0	1.0	1.0
					6.0		1.0	1.0	1.0
			10.0	15.0			1.0	1.0	1.0
			7.0				1.0	1.0	1.0
Average		8.0	10.0	18.5	6.0	5.0	1.0	1.0	1.0

PR, Plant Replications.

Table L.3.5-6 Monthly Recorded Data for Girth of Plants

Unit: Cm

October 1994

	Rambutan Bed Replication			Mangosteen Bed Replication			Young Coconut Bed Replication		
	1	2	3	1	2	3	1	2	3
	1.5	1.9	1.6	3.2	3.3	3.0	No data		
	2.0	1.8	2.0	2.8	2.8	2.7	Available		
PR	2.0	2.2	2.1	3.0	3.2	2.6			
	2.0	2.0	1.6	3.0	2.9	2.8			
	2.5	2.4	2.6	2.8	2.9	2.5			
Average	2.0	2.1	2.0	3.0	3.0	2.7			

November 1994

	1	2	3	1	2	3	1	2	3
	2.0	2.2	1.9	3.4	3.2	3.0	No data		
	2.5	2.4	2.2	2.8	3.0	2.8	Available		
PR	2.5	2.2	2.2	3.3	3.2	3.2			
	2.2	2.5	1.8	3.5	3.4	3.2			
	2.5	2.5	2.9	3.2	2.8	2.8			
Average	2.3	2.4	2.2	3.2	3.1	3.0			

December 1994

	1	2	3	1	2	3	1	2	3
	2.5	2.2	2.2	3.6	3.4	3.5	No data		
	2.5	2.7	2.7	2.9	3.0	2.8	Available		
PR	2.6	2.7	2.2	3.0	3.2	3.2			
	2.5	3.0	2.6	3.2	3.5	3.6			
	2.6	2.5	3.1		3.2	2.8			
Average	2.5	2.6	2.6	3.2	3.3	3.2			

PR, Plant Replications.

Table L.3.5-6 Cont'd

January 1995

	Rambutan Bed Replication			Mangosteen Bed Replication			Young Coconut Bed Replication		
	1	2	3	1	2	3	1	2	3
	2.8	2.5	2.6	3.8	3.4	3.4	No data		
	2.6	3.0	2.8	3.3	3.1	3.2	Available		
PR	3.1	2.9	2.5	3.3	3.3	3.4			
	3.0	3.2	3.0	3.4	3.2	3.4			
	2.8	2.6	3.2		3.3	3.3			
Average	2.9	2.8	2.8	3.4	3.3	3.3			

February 1995

	1	2	3	1	2	3	1	2	3
	3.3		2.6	3.7	3.5	3.8	12.9	12.6	10.4
	2.5	3.2	2.6	3.5	3.6	3.8	12.6	12.1	11.2
PR	3.9	3.7	2.4	3.9	3.4	3.6	12.2	12.4	11.2
	3.2	3.6	3.7	3.8	3.5	3.8	12.2	12.8	13.2
	2.9		3.2		3.6	3.9	9.8	11.1	10.6
Average	3.2	3.5	2.9	3.7	3.5	3.8	11.9	12.2	11.3

March 1995

	1	2	3	1	2	3	1	2	3
	3.9			4.1	3.4	3.4	14.2	13.6	13.4
	2.8	3.6	2.8	3.4	3.3	3.6	13.7	14.2	12.1
PR	3.9	3.8	2.4	3.6	3.5	3.7	13.2	13.7	14.4
	3.8	3.2	3.4	3.8	3.6	3.5	14.6	17.0	12.9
	3.2		3.2		3.8	3.4	9.2	10.6	11.4
Average	3.5	3.5	3.0	3.7	3.5	3.5	13.0	13.8	12.8

PR, Plant Replications.

Table L.3.5-6

April 1995

	Rambutan Bed Replication			Mangosteen Bed Replication			Young Coconut Bed Replication		
	1	2	3	1	2	3	1	2	3
	3.8			4.2	3.5	4.2	17.4	16.5	13.3
	2.6	3.0		3.8	3.4		15.6	16.0	12.2
PR		3.6			3.8		15.2	15.7	14.6
	4.0	3.8		4.4	3.6		13.8	14.7	15.4
	3.4		3.6		3.8	3.5	12.0	11.6	12.2
Average	3.5	3.5	3.6	4.1	3.6	3.9	14.8	14.9	13.5

May 1995

	1	2	3	1	2	3	1	2	3
	4.0			4.5	3.8		16.4	19.0	15.6
	2.6	3.4			3.4		17.8	19.4	14.4
PR		3.8					15.7	17.7	19.2
	4.1	3.9		4.4	4.0		14.8	17.6	17.6
			3.1				9.8	12.2	14.4
Average	3.6	3.7	3.1	4.5	3.7		14.9	17.2	16.2

June 1995

	1	2	3	1	2	3	1	2	3
	3.9	3.2	2.9	4.1	2.4	2.9	22.6	19.3	16.3
	3.3	3.2	2.9	2.6	2.4	2.7	18.7	18.2	14.1
PR	2.6	3.3	3.4	2.6	2.4	3.4	16.4	16.4	19.7
	4.2	4	3.2	4.1	2.6	2.6	14.2	20.7	14.4
	2.6	2.9	2.3	3.1	2.4	2.6	10.6	12.8	11.8
Average	3.32	3.32	2.94	3.3	2.44	2.84	16.5	17.4	15.2

PR, Plant Replications.

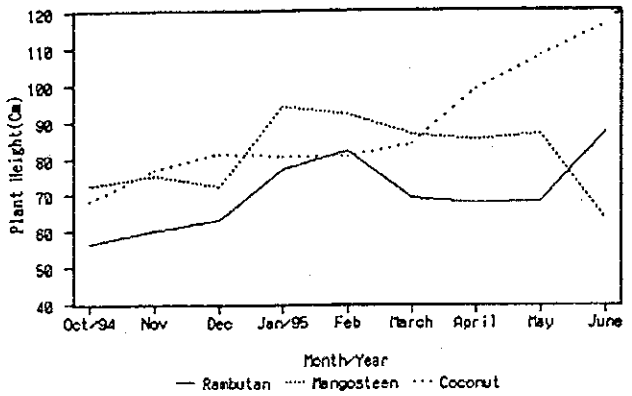


Fig. L.3.5-1 Monthly Changes in Height of Plants

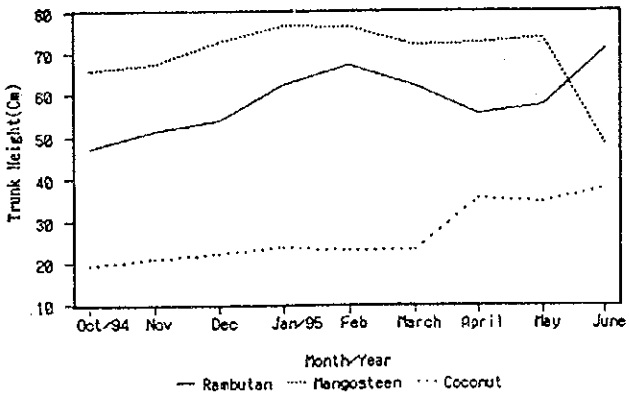


Fig. L.3.5-2 Monthly Changes in Height of Trunk

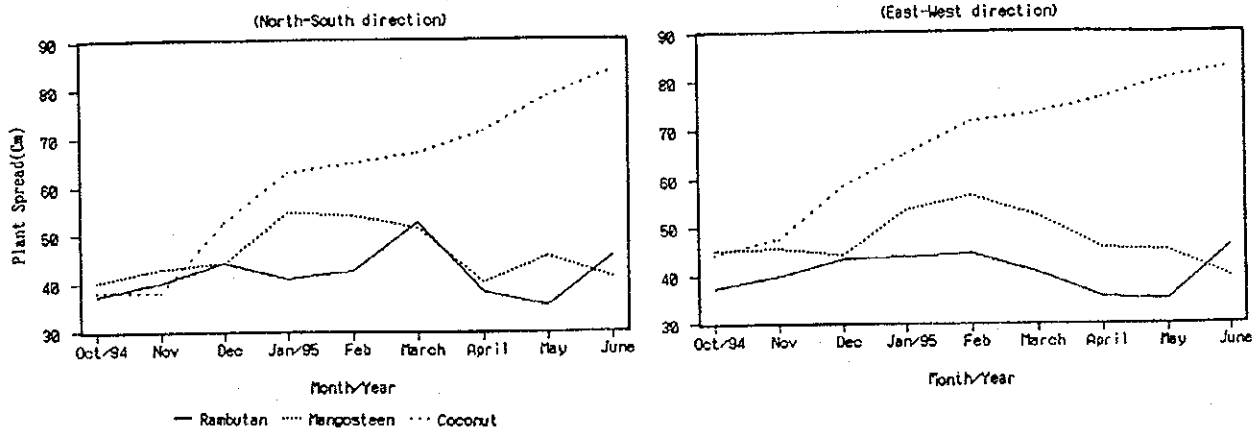


Fig. L.3.5-3 Monthly Changes in Spread of Plants

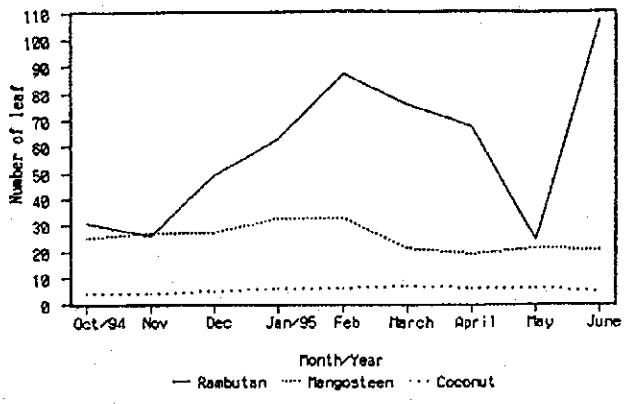


Fig. L.3.5-4 Monthly Changes in Number of leaf of Plants

Note and Suggestions

According to the initial plan, the tests will be continued until fruiting stage of the trees, to accumulate sufficient data and information, then draw a concrete conclusion.

To assure the accuracy of further measurement and data recording works, the following points are suggested :

1) Measurement and data recording to be done at longer intervals, preferably 3 months, to reduce chances of error.

2) Measurement to be done with tools of higher accuracy.

3) Observation and measurement to be carried out by the same technician throughout the test. With this, abnormalities and damage to plants are recognized faster and easier.

4) During the interval, some sediments may be accumulated around the plants. This should not cause any error in measurement of plant height.

APPENDIX M

COST ESTIMATION

Contents

Implementation Cost - Ban Na San Feasibility Study Area - Case-1

Unit: x1,000Bts

Description	(1st year)		(2nd year)		(3rd year)		(4th year)		(5th year)		(6th year)		(7th year)		(8th year)		Total	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Construction Cost																		
- Drainage Improvement			1,310	10,951	1,310	10,951											2,619	21,902
- Irrigation Improvement						5,560												5,560
- Land Improvement			162	91	162	91											324	182
- Soil Improvement				1,258		1,258												2,516
- Farm Road Improvement			21	99	21	99											43	198
- Agricultural Supporting Service			1,920														1,920	
Sub-total			3,413	12,399	1,493	17,959											4,906	30,358
																		35,264
2. Project Administration	855	348	52	348	52	348											959	1,044
																		2,003
3. Consulting Service (10% of 1.)		3,526																
- Detail Design (40% of 3.)		1,411																1,411
- Construction Supervision (60% of 3.)				1,058		1,058												2,116
Sub-total		1,411		1,058		1,058												3,526
																		3,526
4. Agricultural Supporting Activity	87	1,680	87	1,680	87	1,680	87	1,680									348	6,720
																		7,068
Sub-total = Σ(1-4)	942	3,439	3,552	15,485	1,632	21,045	87	1,680									6,213	41,649
																		47,862
5. Physical Contigency Σ(1-4)*10%	94	344	355	1,549	163	2,105	9	168									621	4,165
																		4,786
Sub-total = Σ(1-5)	1,036	3,782	3,907	17,034	1,795	23,150	96	1,848									6,835	45,814
																		52,649
6. Price Escalation	52	348	300	2,405	186	4,457	13	455									552	7,664
																		8,215
GRAND TOTAL	1,089	4,131	4,208	19,439	1,982	27,607	108	2,303									7,388	53,479
		5,219		23,646		29,588		2,411										60,865

Table- 1. Implementation cost - Ban Na San F/S area, Case-1.

Implementation Cost - Ban Na San Feasibility Study Area - Case-2

Unit: x1,000Bts

Description	(1st year)		(2nd year)		(3rd year)		(4th year)		(5th year)		(6th year)		(7th year)		(8th year)		Total	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Construction Cost																		
- Drainage Improvement			867	5,571	867	6,571											1,734	13,142
- Irrigation Improvement						4,347												4,347
- Land Improvement			128	76	128	76											256	152
- Soil Improvement				1,129		1,129												2,257
- Farm Road Improvement			21	99	21	99											43	198
- Agricultural Supporting Service			1,920														1,920	
Sub-total			2,936	7,874	1,016	12,221											3,952	20,095
																		24,047
2. Project Administration	855	348	52	348	52	348											959	1,044
																		2,003
3. Consulting Service (10% of 1.)		2,405																
- Detail Design (40% of 3.)		962																962
- Construction Supervision (60% of 3.)				1,058		1,058												2,116
Sub-total		962		1,058		1,058												3,078
																		3,078
4. Agricultural Supporting Activity	87	1,680	87	1,680	87	1,680	87	1,680									348	6,720
																		7,068
Sub-total = Σ(1-4)	942	2,990	3,075	10,960	1,155	15,307	87	1,680									5,259	30,937
																		36,196
5. Physical Contigency Σ(1-4)*10%	94	299	308	1,096	116	1,531	9	168									526	3,094
																		3,620
Sub-total = Σ(1-5)	1,036	3,289	3,383	12,056	1,271	16,838	96	1,848									5,785	34,031
																		39,316
6. Price Escalation	52	303	260	1,702	132	3,242	13	455									457	5,701
																		6,158
GRAND TOTAL	1,089	3,592	3,643	13,758	1,402	20,079	108	2,303									6,242	39,732
		4,680		17,401		21,482		2,411										45,974

	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9
Price escalation rate	0.03	0.09	0.08	0.14	0.10	0.19	0.13	0.25	0.16	0.30	0.19	0.36	0.22	0.42	0.25	0.49

Implementation Cost - Lan Saka Possibility Study Area - Case-1

Unit: x1,000Bts

Description	(1st year)		(2nd year)		(3rd year)		(4th year)		(5th year)		(6th year)		(7th year)		(8th year)		Total	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Construction Cost																		
- Drainage Improvement			3,260	27,901	3,260	27,901	3,260	27,901									9,780	83,702
- Irrigation Improvement								3,451										3,451
- Land Improvement					303	197	303	197									607	395
- Soil Improvement					80	1,032	80	1,032									161	2,064
- Farm Road Improvement					83	214	83	214									166	428
- Fish pond					332	329	332	329									664	658
- Agricultural Supporting Service			1,920														1,920	
Sub-total			5,180	27,901	4,058	29,673	4,058	33,124									13,296	90,697
																		103,993
2. Project Administration	855	348	52	348	52	348											959	1,044
																		2,003
3. Consulting Service (10% of 1.)		10,399																
- Detail Design (40% of 3.)		4,160																4,160
- Construction Supervision (60% of 3.)				1,058		1,058												2,116
Sub-total		4,160		1,058		1,058												6,276
																		6,276
4. Agricultural Supporting Activity	87	1,344	87	1,344	87	1,344	87	1,344	87	1,344							435	6,720
																		7,155
Sub-total = Σ(1-4)	942	5,852	5,319	30,650	4,197	32,423	4,145	34,468	87	1,344							14,690	104,737
																		119,427
5. Physical Contigency Σ(1-4)*10%	94	585	532	3,065	420	3,242	415	3,447	9	134							1,469	10,474
																		11,943
Sub-total = Σ(1-5)	1,036	6,437	5,851	33,716	4,617	35,665	4,560	37,915	96	1,478							16,159	115,211
																		131,370
6. Price Escalation	52	592	450	4,759	479	6,866	599	9,334	15	447							1,596	21,999
																		23,595
GRAND TOTAL	1,089	7,029	6,301	38,475	5,096	42,531	5,159	47,248	111	1,925							17,755	137,209
		8,118		44,776		47,627		52,407		2,036								154,965

Table- 3. Implementation cost - Lan Saka F/S area, Case-1.

Implementation Cost - Lan Saka Possibility Study Area - Case-2

Unit: x1,000Bts

Description	(1st year)		(2nd year)		(3rd year)		(4th year)		(5th year)		(6th year)		(7th year)		(8th year)		Total	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Construction Cost																		
- Drainage Improvement			1,782	14,465	1,782	14,465	1,782	14,465									5,347	43,396
- Irrigation Improvement								2,518										2,518
- Land Improvement					135	94	135	94									269	188
- Soil Improvement					92	742	92	742									184	1,484
- Farm Road Improvement					83	214	83	214									166	428
- Fish pond					332	329	332	329									664	658
- Agricultural Supporting Service			1,920														1,920	
Sub-total			3,702	14,465	2,424	15,844	2,424	18,362									8,550	48,672
																		57,222
2. Project Administration	855	348	52	348	52	348											959	1,044
																		2,003
3. Consulting Service (10% of 1.)		5,722																
- Detail Design (40% of 3.)		2,289																2,289
- Construction Supervision (60% of 3.)				1,058		1,058												2,116
Sub-total		2,289		1,058		1,058												4,405
																		4,405
4. Agricultural Supporting Activity	87	1,344	87	1,344	87	1,344	87	1,344	87	1,344							435	6,720
																		7,155
Sub-total = Σ(1-4)	942	3,981	3,841	17,215	2,563	18,594	2,511	19,706	87	1,344							9,944	60,841
																		70,784
5. Physical Contigency Σ(1-4)*10%	94	398	384	1,722	256	1,859	251	1,971	9	134							994	6,084
																		7,078
Sub-total = Σ(1-5)	1,036	4,379	4,226	18,937	2,819	20,453	2,762	21,677	96	1,478							10,938	66,925
																		77,863
6. Price Escalation	52	403	325	2,673	293	3,938	363	5,337	15	447							1,048	12,797
																		13,845
GRAND TOTAL	1,089	4,782	4,551	21,610	3,111	24,391	3,125	27,014	111	1,925							11,986	79,722
		5,871		26,161		27,503		30,138		2,036								91,708

Table- 4. Implementation cost - Lan Saka F/S area, Case-2.

Implementation Cost - Lan Saka Feasibility Study Area - Case-3

Unit: x1,000Bts

Description	(1st year)		(2nd year)		(3rd year)		(4th year)		(5th year)		(6th year)		(7th year)		(8th year)		Total	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Construction Cost																		
- Drainage Improvement			2,189	18,387	2,189	18,387	2,189	18,387									6,567	55,162
- Irrigation Improvement								2,986										2,986
- Land Improvement					304	198	304	198									608	396
- Soil Improvement					80	912	80	912									161	1,823
- Farm Road Improvement					83	214	83	214									165	428
- Fish pond					332	329	332	329									664	658
- Agricultural Supporting Service			1,920														1,920	
Sub-total			4,109	18,387	2,988	20,040	2,988	23,025									10,084	61,452
																		71,536
2. Project Administration	855	348	52	348	52	348											959	1,044
																		2,003
3. Consulting Service (10% of 1.)		7,154																
- Detail Design (40% of 3.)		2,861																2,861
- Construction Supervision (60% of 3.)				1,058		1,058												2,116
Sub-total		2,861		1,058		1,058												4,977
																		4,977
4. Agricultural Supporting Activity	87	1,344	87	1,344	87	1,344	87	1,344	87	1,344							435	6,720
																		7,155
Sub-total = Σ(1-4)	942	4,553	4,248	21,137	3,127	22,790	3,075	24,369	87	1,344							11,478	74,193
																		85,672
5. Physical Contigency Σ(1-4)*10%	94	455	425	2,114	313	2,279	307	2,437	9	134							1,148	7,419
																		8,567
Sub-total = Σ(1-5)	1,036	5,009	4,673	23,251	3,439	25,069	3,382	26,806	96	1,478							12,626	81,613
																		94,239
6. Price Escalation	52	461	359	3,282	357	4,826	444	6,599	15	447							1,229	15,615
																		18,844
GRAND TOTAL	1,089	5,470	5,032	26,533	3,796	29,895	3,827	33,405	111	1,925							13,855	97,228
		6,558		31,565		33,691		37,232		2,036								111,083

Table- 5. Implementation cost - Lan Saka F/S area, Case-3.

Implementation Cost - Lan Saka Feasibility Study Area - Case-4

Unit: x1,000Bts

Description	(1st year)		(2nd year)		(3rd year)		(4th year)		(5th year)		(6th year)		(7th year)		(8th year)		Total	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1. Construction Cost																		
- Drainage Improvement			711	4,952	711	4,952	711	4,952									2,134	14,856
- Irrigation Improvement								2,053										2,053
- Land Improvement					135	94	135	94									269	188
- Soil Improvement					92	654	92	654									184	1,309
- Farm Road Improvement					83	214	83	214									165	428
- Fish pond					332	329	332	329									664	658
- Agricultural Supporting Service			1,920														1,920	
Sub-total			2,631	4,952	1,353	6,243	1,353	6,297									5,337	19,492
																		24,829
2. Project Administration	855	348	52	348	52	348											959	1,044
																		2,003
3. Consulting Service (10% of 1.)		2,483																
- Detail Design (40% of 3.)		993																993
- Construction Supervision (60% of 3.)				1,058		1,058												2,116
Sub-total		993		1,058		1,058												3,109
																		3,109
4. Agricultural Supporting Activity	87	1,344	87	1,344	87	1,344	87	1,344	87	1,344							435	6,720
																		7,155
Sub-total = Σ(1-4)	942	2,685	2,770	7,702	1,492	8,993	1,440	9,641	87	1,344							6,731	30,365
																		37,095
5. Physical Contigency Σ(1-4)*10%	94	269	277	770	149	899	144	964	9	134							673	3,036
																		3,710
Sub-total = Σ(1-5)	1,036	2,954	3,048	8,472	1,641	9,892	1,583	10,605	96	1,478							7,404	33,401
																		40,805
6. Price Escalation	52	272	234	1,196	170	1,904	208	2,611	15	447							680	6,430
																		7,110
GRAND TOTAL	1,089	3,225	3,282	9,668	1,811	11,797	1,792	13,215	111	1,925							8,084	39,831
		4,314		12,950		13,608		15,007		2,036								47,915

Table- 6. Implementation cost - Lan Saka F/S area, Case-4.

Cost of the respective works

Unit: Baths

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Dike x1,000st											
Ban Na San F/S area											
Case-A, Complete dike construction	1			16,221	921	333	268	409	16,489	1,663	18,152
Case-B, Semi dike construction	1			9,402	538	191	153	234	9,555	963	10,518
Lan Saka F/S area	1										
Case-A, Upstream, Complete dike construction	1			22,151	1,338	541	435	664	22,586	2,543	25,129
Case-C, Downstream, Polder dike construction	1			41,180	2,340	1,050	844	1,288	42,024	4,678	46,702
Case-D, Downstream, Semi dike construction	1			10,142	658	230	185	282	10,327	1,171	11,497
Drainage canal											
Type-I	(m)			116.4		7.8	6.0	9.0	122.4	16.9	139.2
Type-II	(m)			171.5		15.0	12.3	18.3	183.7	34.3	218.0
Type-III	(m)			269.2		35.9	27.6	41.2	296.8	77.2	374.0
Type-IV	(m)			375.0		63.8	49.1	73.3	424.1	137.1	561.2
Type-V	(m)			489.5		99.7	76.7	114.5	566.1	214.2	780.4
Drop structure											
Type-I	1			13,777	8,436	124	108	143	13,885	8,703	22,588
Type-II	1			24,156	14,830	258	221	297	24,377	15,384	39,761
Type-III	1			43,157	26,170	615	510	708	43,667	27,493	71,160
Check structure											
Type-I	1			25,464	28,580	2,237	2,365	2,129	28,028	32,948	60,974
Type-II	1			39,334	44,603	2,780	3,192	2,643	42,526	50,028	92,552
Type-III	1			64,111	78,915	3,374	3,969	3,216	67,980	85,505	153,484
Pipe crossing structure											
Type-I	1			7,601	4,512	316	328	340	7,930	5,168	13,098
Type-II	1			13,284	7,849	523	537	586	13,822	8,957	22,779
Type-III	1			19,268	11,486	828	766	932	20,034	13,238	33,272
Type-IV	1			30,961	19,444	1,100	1,052	1,221	32,013	21,765	53,778
Farm road											
Type-I	(m)			155.2		17.7	14.2	21.7	179.4	39.3	218.8
Type-II	(m)			120.4		12.6	10.1	15.5	130.6	28.0	158.6
Type-III, repair work	(m)			39.6		2.8	2.3	3.5	41.9	6.3	48.2
Bridge repair											
Repair work	1			120,962	87,164	881	718	1,014	121,580	89,060	210,640
Irrigation improvement											
Pipeline installation (manual)	(ha)			50,000					50,000		50,000
Water lifting pump	1			75,000					75,000		75,000
Shallow well	1			4,000					4,000		4,000
Flexible hose	(ha)			12,500					12,500		12,500
Land improvement											
Land clearing (Ban Na San)	(ha)					162	2,193	286	2,193	448	2,641
Land clearing (Lan Saka)	(ha)					464	6,264	818	6,264	1,282	7,546
Land grading	(ha)			850		3,200	2,500	3,900	3,150	7,100	10,250
Rubble/trash exclusion/removal	(ha)			2,600					2,600		2,600
Stumping	(ha)					2,545	2,047	3,122	2,047	5,667	7,714
Stump exclusion	(ha)					2,240	1,801	2,745	1,801	4,985	6,786
Bamboo planting	(m)			100					100		100
Fish pond	1			8,330	7,500	1,182	1,184	1,417	10,014	10,099	20,112

Table- 7. Unit cost table of the respective work.

Cost of Ban Na San F/S area, Case-A (complete dike) & Case-B (Semi-dike)

Unit: x1,000 Bts

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Drainage improvement											
1. Dike											
1.1. Case-A, Complete dike construction	2,200			16,221	921	333	268	409	16,489	1,663	18,152
1.2. Case-B, Semi dike construction	1,150			9,402	538	191	153	234	9,555	963	10,518
2. Drainage canal											
2.1. Type-I	1,175			136.7		9.2	7.1	10.6	143.8	19.8	163.6
2.2. Type-II	870			149.2		13.9	10.7	15.9	159.9	29.8	189.7
Sub-total of 2.	2,045			285.9		23.1	17.8	26.5	303.7	49.6	353.3
3.Appurtenant structures											
3.1.Drop structure											
3.1.1. Type-I	7			96.4	59.1	0.9	0.8	1.0	97.2	60.9	158.1
3.1.2. Type-II	4			96.6	59.3	1.0	0.9	1.2	97.5	61.5	159.0
3.1.3. Type-III	5			215.8	130.8	3.1	2.5	3.5	218.3	137.5	355.8
Sub-total of 3.1.	16			408.8	249.2	5.0	4.2	5.7	413.0	259.9	673.0
3.2.Check structure											
Type-I	1			25.5	28.6	2.2	2.6	2.1	28.0	32.9	61.0
3.3.Pipe crossing structure											
3.3.1. Type-I	2			15.2	9.0	0.6	0.7	0.7	15.9	10.3	26.2
3.3.2. Type-III	1			19.3	11.5	0.8	0.8	0.9	20.0	13.2	33.3
3.3.3. Type-IV	2			61.9	36.9	2.2	2.1	2.4	64.0	43.5	107.6
Sub-total of 3.3.	5			96.4	59.4	3.7	3.5	4.1	99.9	67.1	167.0
Sub-total of 3.				530.7	337.2	10.9	10.3	11.9	541.0	360.0	901.0
Total of 1.1. 2. 3. Case-A				17,038	1,258	367	296	447	17,334	2,073	19,407
Total of 1.2. 2. 3. Case-B				10,219	875	225	181	272	10,400	1,372	11,773
Road improvement											
Type-II	1,200			144.5		15.1	12.2	18.5	156.7	33.6	190.3
Irrigation improvement											
Case-A, Pipeline installation (manual)	35.2			1,760					1,760		1,760
Water lifting pump	35.2			2,640					2,640		2,640
Sub-total for Case-A				4,400					4,400		4,400
Case-B, Pipeline installation (manual)	27.5			1,376					1,376		1,376
Water lifting pump	27.5			2,064					2,064		2,064
Sub-total for Case-B				3,440					3,440		3,440
Land improvement											
Case-A, Land clearing (Ban Na San)	15.2					2	33	4	33	7	40
Land grading	35.2			23		113	88	137	111	250	361
Sub-total for Case-A				23		115	121	142	144	257	401
Case-B, Land clearing (Ban Na San)	15.2					2	33	4	33	7	40
Land grading	27.5			19		88	69	107	87	195	282
Sub-total for Case-B				19		91	102	112	120	202	322

Table- 8. Cost of improvement works, Ban Na San F/S area, Case-A & B.

Cost of Lan Saka F/S area (UPSTREAM & DOWNSTREAM), Case-A, B, C & D

Unit: x1,000 Rs

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Drainage improvement											
1. Dike											
1.1. Case-A, Complete dike	2,000			22,151	1,338	541	435	664	22,586	2,543	25,129
1.2. Case-B, no dike	2,000			200					200		200
1.3. Case-C, Complete dike	3,000			41,180	2,340	1,050	844	1,288	42,024	4,678	46,702
1.4. Case-D, Semi dike	1,000			10,142	658	230	185	282	10,327	1,171	11,497
2. Drainage canal											
2.1. Type-I	600			69.8		4.7	3.6	5.4	73.4	10.1	83.5
2.2. Type-II	625			107.2		10.0	7.7	11.4	114.8	21.4	136.3
2.3. Type-IV	1,300			487.5		83.0	63.8	95.2	551.3	178.2	729.5
Sub-total of 2.	2,525			664.5		97.6	75.0	112.1	739.6	209.7	949.3
3.Appurtenant structures											
3.1.Drop structure											
3.1.1. Type-I	7			96.4	59.1	0.9	0.8	1.0	97.2	60.9	158.1
3.1.2. Type-II	1			24.2	14.8	0.3	0.2	0.3	24.4	15.4	39.8
Sub-total of 3.1.	8			120.6	73.9	1.1	1.0	1.3	121.6	76.3	197.9
3.2.Check structure											
3.2.1. Type-I	1			25.5	28.6	2.2	2.6	2.1	28.0	32.9	61.0
3.2.2. Type-III	1			64.1	78.9	3.4	3.9	3.2	68.0	85.5	153.5
Sub-total of 3.2.	2			89.6	107.5	5.6	6.4	5.3	96.0	118.5	214.5
3.3.Pipe crossing structure											
3.3.1. Type-I	11			83.6	49.6	3.5	3.6	3.7	87.2	56.9	144.1
3.3.2. Type-II	1			13.3	7.8	0.5	0.5	0.6	13.8	9.0	22.8
3.3.3. Type-III	2			38.5	23.0	1.6	1.5	1.9	40.1	26.5	66.5
3.3.4. Type-IV	1			31.0	19.4	1.1	1.1	1.2	32.0	21.8	53.8
Sub-total of 3.3	15			166.4	99.9	6.7	6.7	7.4	173.1	114.0	287.2
Sub-total of 3.				376.6	281.3	13.5	14.1	14.1	390.7	308.8	699.5
Road improvement											
Type-II (m)	1100			132.5		13.8	11.1	17.0	144	31	174
Road repair, Type III (m)	1,750			69		5	4	6	73	11	84
Bridge repair	1			121	87	1	1	1	122	89	211
Irrigation improvement											
Case-1, Pipeline installation (manual) (ha)	40.5			2,024					2,024		2,024
Water lifting pump	7.0			525					525		525
Shallow well	7.0			28					28		28
Flexible hose (ha)	12.3			154					154		154
Case-2, Pipeline installation (manual) (ha)	28.8			1,440					1,440		1,440
Water lifting pump	7.0			525					525		525
Shallow well	7.0			28					28		28
Flexible hose (ha)											
Case-3, Pipeline installation (manual) (ha)	33.1			1,656					1,656		1,656
Water lifting pump	7.0			525					525		525
Shallow well	7.0			28					28		28
Flexible hose (ha)	12.3			154					154		154
Case-4, Pipeline installation (manual) (ha)	21.4			1,072					1,072		1,072
Water lifting pump	7.0			525					525		525
Shallow well	7.0			28					28		28
Flexible hose (ha)											
Land improvement											
Case-1, Land clearing (Lan Saka) (ha)	20.6					10	129	17	129	26	156
Land grading (ha)	12.3			8		39	31	48	39	87	126
Rubble/trash removal(ha)	20.6			13		66	52	80	65	147	212
Stumping (ha)	20.6					53	42	64	42	117	159
Stump exclusion (ha)	20.6					46	37	57	37	103	140
Case-2, Land clearing (Lan Saka)(ha)	11.2					5	70	9	70	14	85
Land grading (ha)											
Rubble/trash removal(ha)	11.2			7		36	28	44	35	80	115
Stumping (ha)	11.2					29	23	35	23	63	86
Stump exclusion (ha)	11.2					25	20	31	20	56	76
Case-3, Land clearing (Lan Saka) (ha)	20.7					10	130	17	130	27	156
Land grading (ha)	12.3			8		39	31	48	39	87	126
Rubble/trash removal(ha)	20.7			13		66	52	81	65	147	212
Stumping (ha)	20.7					53	42	65	42	117	160
Stump exclusion (ha)	20.7					46	37	57	37	103	140
Case-4, Land clearing (Lan Saka) (ha)	11.2					5	70	9	70	14	85
Land grading (ha)											
Rubble/trash removal(ha)	11.2			7		36	28	44	35	80	115
Stumping (ha)	11.2					29	23	35	23	63	86
Stump exclusion (ha)	11.2					25	20	31	20	56	76
Fish pond, Case-1, 2, 3 & 4	52			459	390	61	62	74	521	525	1,046

Cost of Ban Na San F/S area, Case-A (Complete dike), Case-1

Unit: x1,000 Bts

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
1. Drainage improvement											
1.1. Dike (m)	2,200			16,221	921	333	258	409	16,489	1,663	18,152
1.2. Drainage canal (m)	2,045			286		23	18	27	304	50	353
1.3. Appurtenant structure				531	337	11	10	12	541	360	901
①=Sub-total				17,038	1,258	367	286	447	17,334	2,073	19,407
②=O&M and benefit (17% of sub-total)				2,896	214	62	50	76	2,947	352	3,299
③=Tax, etc. (8% of ①+②)				1,395	118	34	28	42	1,422	194	1,616
Total				21,329	1,590	464	374	565	21,903	2,619	24,322
2. Irrigation improvement											
2.1. Pipeline installation (ha)	35.2			1,760					1,760		1,760
2.2. Water lifting pump (ha)	35.2			2,640					2,640		2,640
①=Sub-total				4,400					4,400		4,400
②=O&M and benefit (17% of sub-total)				748					748		748
③=Tax, etc. (8% of ①+②)				412					412		412
Total				5,560					5,560		5,560
3. Land improvement											
3.1. Land clearing (ha)	15.2					2.5	33.3	4.3	33.3	6.8	40.1
3.2. Land grading (ha)	35.2			22.9		112.6	88.0	137.3	110.9	249.9	360.8
①=Sub-total				22.9		115.1	121.3	141.6	144.2	256.7	400.9
②=O&M and benefit (17% of sub-total)				3.9		19.6	20.6	24.1	24.5	43.6	68.2
③=Tax, etc. (8% of ①+②)				2.1		10.3	11.4	13.3	13.5	24.0	37.5
Total				28.9		145.4	153.3	179.0	182.2	324.4	506.6
4. Soil improvement				1,991					1,991		1,991
①=Sub-total				1,991					1,991		1,991
②=O&M and benefit (17% of sub-total)				338					338		338
③=Tax, etc. (8% of ①+②)				186					186		186
Total				2,516					2,516		2,516
5. Farm road improvement											
5.1. Road construction (m)	1,200			145		13	12	19	157	34	190
5.2. Road repair (m)											
5.3. Bridge repair											
①=Sub-total				145		13	12	19	157	34	190
②=O&M and benefit (17% of sub-total)				25		3	2	3	27	6	32
③=Tax, etc. (8% of ①+②)				14		1	1	2	15	3	18
Total				183		19	15	23	198	43	240
6. Agricultural supporting service											
6.1. Equipment & materials					1,920					1,920	1,920
Total				29,816	3,510	629	543	768	30,359	4,906	35,265

Table-10. Construction cost for Ban Na San F/S area, Case-A.

Cost of Ban Na San F/S area, Case-B (Semi-dike construction), Case-2

Unit: x1,000 Bts

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
1. Drainage improvement											
1.1. Dike (m)	1,150			9,402	538	191	153	234	9,555	963	10,518
1.2. Drainage canal (m)	2,045			286		23	18	27	304	50	353
1.3. Appurtenant structure				531	337	11	10	12	541	360	901
①=Sub-total				10,219	875	225	181	272	10,400	1,372	11,773
②=O&M and benefit (17% of sub-total)				1,737	149	38	31	46	1,768	233	2,001
③=Tax, etc. (8% of ①+②)				956	82	21	17	25	973	128	1,102
Total				12,912	1,106	284	229	344	13,142	1,734	14,876
2. Irrigation improvement											
2.1. Pipeline installation (ha)	27.5			1,376					1,376		1,376
2.2. Water lifting pump (ha)	27.5			2,064					2,064		2,064
①=Sub-total				3,440					3,440		3,440
②=O&M and benefit (17% of sub-total)				585					585		585
③=Tax, etc. (8% of ①+②)				322					322		322
Total				4,347					4,347		4,347
3. Land improvement											
3.1. Land clearing (ha)	15.2					2.5	33.3	4.3	33.3	6.8	40.1
3.2. Land grading (ha)	27.5			17.9		88.1	68.8	107.3	86.7	195.4	282.1
①=Sub-total				17.9		90.5	102.1	111.7	120.0	202.2	322.2
②=O&M and benefit (17% of sub-total)				3.0		15.4	17.4	19.0	20.4	34.4	54.8
③=Tax, etc. (8% of ①+②)				1.7		8.5	9.6	10.5	11.2	18.9	30.2
Total				22.6		114.4	129.1	141.1	151.7	255.5	407.2
4. Soil improvement				1,736					1,736		1,736
①=Sub-total				1,736					1,736		1,736
②=O&M and benefit (17% of sub-total)				304					304		304
③=Tax, etc. (8% of ①+②)				167					167		167
Total				2,257					2,257		2,257
5. Farm road improvement											
5.1. Road construction (m)	1,200			145		13	12	19	157	34	190
5.2. Road repair (m)											
5.3. Bridge repair											
①=Sub-total				145		13	12	19	157	34	190
②=O&M and benefit (17% of sub-total)				25		3	2	3	27	6	32
③=Tax, etc. (8% of ①+②)				14		1	1	2	15	3	18
Total				183		19	15	23	198	43	240
6. Agricultural supporting service											
6.1. Equipment & materials					1,920					1,920	1,920
Total				19,722	3,026	417	374	509	20,095	3,952	24,047

Table-11. Construction cost for Ban Na San F/S area, Case-B.

Cost of Lan Saka F/S area, Case-A + Case-C (Complete dike construction), Case-1

Unit: x1,000 Bts

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
1. Drainage improvement											
1.1. Dike (m)	5,000			63,331	3,678	1,591	1,280	1,952	65,110	7,221	72,331
1.2. Drainage canal (m)	2,525			665		98	75	112	740	210	949
1.3. Appurtenant structure				377	281	13	14	14	391	309	700
①=Sub-total				64,872	3,959	1,702	1,369	2,078	66,241	7,740	73,980
②=O&M and benefit (17% of sub-total)				11,028	673	289	233	353	11,261	1,316	12,577
③=Tax, etc. (6% of ①+②)				6,072	371	159	128	195	6,200	724	6,925
Total				81,972	5,003	2,150	1,730	2,626	83,702	9,780	93,481
2. Irrigation improvement											
2.1. Pipeline installation (ha)	40.5			2,024					2,024		2,024
2.2. Water lifting pump	7.0			525					525		525
2.3. Shallow well	7.0			28					28		28
2.4. Flexible hose (ha)	12.3			154					154		154
①=Sub-total				2,731					2,731		2,731
②=O&M and benefit (17% of sub-total)				464					464		464
③=Tax, etc. (6% of ①+②)				256					256		256
Total				3,451					3,451		3,451
3. Land improvement											
3.1. Land clearing (ha)	20.6					9.6	129.3	16.9	129.3	26.5	155.7
3.2. Land grading (ha)	12.3			8.0		39.4	30.8	48.0	38.8	87.5	126.3
3.3. Bubble exclusion (ha)	20.6			13.4		66.0	51.6	80.5	65.0	146.5	211.8
3.4. Stumping (ha)	20.6					52.5	42.3	64.4	42.3	117.0	159.2
3.5. Stump exclusion (ha)	20.6					46.2	37.2	56.7	37.2	102.9	140.1
①=Sub-total				21.4		213.8	291.1	266.5	312.5	480.3	792.9
②=O&M and benefit (17% of sub-total)				3.6		36.3	49.5	45.3	53.1	81.7	134.8
③=Tax, etc. (6% of ①+②)				2.0		20.0	27.2	24.9	29.3	45.0	74.2
Total				27.1		270.2	367.8	336.8	394.9	606.9	1,001.9
4. Soil improvement				1,588		58	45	69	1,634	127	1,761
①=Sub-total				1,588		58	45	69	1,634	127	1,761
②=O&M and benefit (17% of sub-total)				270		10	8	12	278	22	299
③=Tax, etc. (6% of ①+②)				149		5	4	6	153	12	165
Total				2,007		74	57	87	2,064	161	2,225
5. Farm road improvement											
5.1. Road construction (m)	1,100			132		14	11	17	144	31	174
5.2. Road repair (m)	1,750			69		5	4	6	73	11	84
5.3. Bridge repair	1			121	87	1	1	1	122	89	211
①=Sub-total				323	87	20	16	24	338	131	469
②=O&M and benefit (17% of sub-total)				55	15	3	3	4	58	22	80
③=Tax, etc. (6% of ①+②)				30	8	2	1	2	32	12	44
Total				408	110	25	20	30	428	165	593
6. Fish pond	52			459	390	61	62	74	521	525	1,046
①=Sub-total				459	390	61	62	74	521	525	1,046
②=O&M and benefit (17% of sub-total)				78	66	10	10	13	89	89	178
③=Tax, etc. (6% of ①+②)				43	37	6	6	7	49	49	98
Total				580	493	78	78	93	658	664	1,322
7. Agricultural supporting service											
7.1. Equipment & materials					1,920					1,920	1,920
Total				88,445	7,526	2,597	2,253	3,173	90,697	13,296	103,993

Table-12. Construction cost for Lan Saka F/S area, Case A+C, Case-1.

Cost of Lan Saka F/S area, Case-A (Dike) + Case-D (Semi), Case-2

Unit: x1,000 Bts

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
1. Drainage improvement											
1.1. Dike (m)	3,000			32,593	1,996	771	620	946	33,213	3,713	36,926
1.2. Drainage canal (m)	2,525			665		98	75	112	740	210	949
1.3. Appurtenant structure				377	281	13	14	14	391	309	700
①=Sub-total				33,634	2,277	882	709	1,072	34,343	4,232	38,575
②=O&M and benefit (17% of sub-total)				5,718	387	150	121	182	5,838	719	6,558
③=Tax, etc. (6% of ①+②)				3,148	213	83	66	100	3,215	396	3,611
Total				42,500	2,877	1,115	897	1,355	43,396	5,347	48,744
2. Irrigation improvement											
2.1. Pipeline installation (ha)	28.8			1,440					1,440		1,440
2.2. Water lifting pump	7.0			525					525		525
2.3. Shallow well	7.0			28					28		28
2.4. Flexible hose (ha)											
①=Sub-total				1,993					1,993		1,993
②=O&M and benefit (17% of sub-total)				339					339		339
③=Tax, etc. (6% of ①+②)				187					187		187
Total				2,518					2,518		2,518
3. Land improvement											
3.1. Land clearing (ha)	11.2					5.2	70.2	9.2	79.2	14.4	84.6
3.2. Land grading (ha)											
3.3. Bubble exclusion (ha)	11.2			7.3		35.8	28.0	43.7	35.3	79.5	114.8
3.4. Stumping (ha)	11.2					28.5	22.9	35.0	22.9	63.5	86.4
3.5. Stump exclusion (ha)	11.2					25.1	20.2	30.7	20.2	55.8	76.0
①=Sub-total				7.3		94.6	141.3	118.6	148.5	213.2	361.7
②=O&M and benefit (17% of sub-total)				1.2		16.1	24.0	20.2	25.3	36.2	61.5
③=Tax, etc. (6% of ①+②)				0.7		8.9	13.2	11.1	13.9	20.0	33.9
Total				9.2		119.6	178.5	149.8	187.7	269.4	457.1
4. Soil improvement				1,122		67	52	78	1,174	145	1,320
①=Sub-total				1,122		67	52	78	1,174	145	1,320
②=O&M and benefit (17% of sub-total)				191		11	9	13	200	25	224
③=Tax, etc. (6% of ①+②)				105		6	5	7	110	14	124
Total				1,418		85	66	99	1,484	184	1,668
5. Farm road improvement											
5.1. Road construction (m)	1,100			132		14	11	17	144	31	174
5.2. Road repair (m)	1,750			69		5	4	6	73	11	84
5.3. Bridge repair	1			121	87	1	1	1	122	89	211
①=Sub-total				323	87	20	16	24	338	131	469
②=O&M and benefit (17% of sub-total)				55	15	3	3	4	58	22	80
③=Tax, etc. (6% of ①+②)				30	8	2	1	2	32	12	44
Total				408	110	25	20	30	428	165	593
6. Fish pond	52			459	390	61	62	74	521	525	1,046
①=Sub-total				459	390	61	62	74	521	525	1,046
②=O&M and benefit (17% of sub-total)				78	66	10	10	13	89	89	178
③=Tax, etc. (6% of ①+②)				43	37	6	6	7	49	49	98
Total				580	493	78	78	93	658	664	1,322
7. Agricultural supporting service											
7.1. Equipment & materials					1,920					1,920	1,920
Total				47,433	5,400	1,421	1,239	1,728	48,672	8,550	57,222

Table-13. Construction cost for Lan Saka F/S area, Case A+D, Case-2.

Cost of Lan Saka F/S area, Case-B (No dike) + Case-C (polder), Case-3

Unit: x1,000 Bts

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
1. Drainage improvement											
1.1. Dike (m)	3,000			41,680	2,340	1,050	844	1,288	42,524	4,678	47,202
1.2. Drainage canal (m)	2,525			665		98	75	112	740	210	949
1.3. Appurtenant structure				377	281	13	14	14	391	309	700
①=Sub-total				42,721	2,622	1,161	934	1,414	43,654	5,197	48,851
②=O&M and benefit (17% of sub-total)				7,263	446	197	159	240	7,421	883	8,305
③=Tax, etc. (8% of ①+②)				3,999	245	109	87	132	4,086	486	4,572
Total				53,982	3,313	1,467	1,180	1,787	55,162	6,567	61,728
2. Irrigation improvement											
2.1. Pipeline installation (ha)	33.1			1,656					1,656		1,656
2.2. Water lifting pump	7.0			525					525		525
2.3. Shallow well	7.0			28					28		28
2.4. Flexible hose (ha)	12.3			154					154		154
①=Sub-total				2,363					2,363		2,363
②=O&M and benefit (17% of sub-total)				402					402		402
③=Tax, etc. (8% of ①+②)				221					221		221
Total				2,986					2,986		2,986
3. Land improvement											
3.1. Land clearing (ha)	29.7					9.6	129.7	16.9	129.7	26.5	156.2
3.2. Land grading (ha)	12.3			8.0		39.4	30.8	48.0	38.7	87.3	126.1
3.3. Bubble exclusion (ha)	20.7			13.5		66.2	51.8	80.7	65.2	147.0	212.2
3.4. Stumping (ha)	20.7					52.7	42.4	64.6	42.4	117.3	159.7
3.5. Stump exclusion (ha)	20.7					46.4	37.3	56.8	37.3	103.2	140.5
①=Sub-total				21.5		214.3	291.8	267.1	313.3	481.3	794.6
②=O&M and benefit (17% of sub-total)				3.6		36.4	49.6	45.4	53.3	81.8	135.1
③=Tax, etc. (8% of ①+②)				2.0		20.1	27.3	25.0	29.3	45.1	74.4
Total				27.1		270.7	368.7	337.5	395.8	608.2	1,004.1
4. Soil improvement				1,398		58	45	69	1,443	127	1,570
①=Sub-total				1,398		58	45	69	1,443	127	1,570
②=O&M and benefit (17% of sub-total)				238		10	8	12	245	22	267
③=Tax, etc. (8% of ①+②)				131		5	4	6	135	12	147
Total				1,766		74	57	87	1,823	161	1,984
5. Farm road improvement											
5.1. Road construction (m)	1,100			132		14	11	17	144	31	174
5.2. Road repair (m)	1,750			69		5	4	6	73	11	84
5.3. Bridge repair	1			121	87	1	1	1	122	89	211
①=Sub-total				323	87	20	16	24	338	131	469
②=O&M and benefit (17% of sub-total)				55	15	3	3	4	58	22	80
③=Tax, etc. (8% of ①+②)				30	8	2	1	2	32	12	44
Total				408	110	25	20	30	428	165	593
6. Fish pond	52			459	390	61	62	74	521	525	1,046
①=Sub-total				459	390	61	62	74	521	525	1,046
②=O&M and benefit (17% of sub-total)				78	66	10	10	13	89	89	178
③=Tax, etc. (8% of ①+②)				43	37	6	6	7	49	49	98
Total				580	493	78	78	93	658	664	1,322
7. Agricultural supporting service											
7.1. Equipment & materials					1,920					1,920	1,920
Total				59,748	5,836	1,914	1,704	2,335	61,452	10,084	71,536

Table-14. Construction cost for Lan Saka F/S area, Case B+C, Case-3.

Cost of Lan Saka F/S area, Case-B (No dike) + Case-D (Semi-dike), Case-4

Unit: x1,000 Bts

Description	Unit	Labour & materials				Machinery cost			Total cost		
		Unit cost		Implement cost		Depre	Implement cost				
		L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
1. Drainage improvement											
1.1. Dike (m)	1,000			10,442	658	230	185	282	10,627	1,171	11,797
1.2. Drainage canal (m)	2,525			665		98	75	112	740	210	949
1.3. Appurtenant structure				377	281	13	14	14	391	309	700
①=Sub-total				11,483	939	341	274	409	11,757	1,689	13,446
②=O&M and benefit (17% of sub-total)				1,952	160	58	47	69	1,999	287	2,286
③=Tax, etc. (8% of ①+②)				1,075	88	32	26	38	1,100	158	1,259
Total				14,510	1,187	431	347	516	14,856	2,134	16,991
2. Irrigation improvement											
2.1. Pipeline installation (ha)	21.4			1,072					1,072		1,072
2.2. Water lifting pump	7.0			525					525		525
2.3. Shallow well	7.0			28					28		28
2.4. Flexible hose (ha)											
①=Sub-total				1,625					1,625		1,625
②=O&M and benefit (17% of sub-total)				276					276		276
③=Tax, etc. (8% of ①+②)				152					152		152
Total				2,053					2,053		2,053
3. Land improvement											
3.1. Land clearing (ha)	11.2					5.2	70.2	9.2	70.2	14.4	84.5
3.2. Land grading (ha)											
3.3. Bubble exclusion (ha)	11.2			7.3		35.8	28.0	43.7	35.3	79.5	114.8
3.4. Stumping (ha)	11.2					28.5	22.9	35.0	22.9	63.5	86.4
3.5. Stump exclusion (ha)	11.2					25.1	20.2	30.7	20.2	55.8	76.0
①=Sub-total				7.3		94.6	141.3	118.6	148.5	213.2	361.7
②=O&M and benefit (17% of sub-total)				1.2		16.1	24.0	20.2	25.3	36.2	61.5
③=Tax, etc. (8% of ①+②)				0.7		8.9	13.2	11.1	13.9	20.0	33.9
Total				9.2		119.6	178.5	149.8	187.7	269.4	457.1
4. Soil improvement				984		67	52	78	1,036	145	1,181
①=Sub-total				984		67	52	78	1,036	145	1,181
②=O&M and benefit (17% of sub-total)				167		11	9	13	176	25	201
③=Tax, etc. (8% of ①+②)				92		6	5	7	97	14	111
Total				1,243		85	66	99	1,309	184	1,493
5. Farm road improvement											
5.1. Road construction (m)	1,100			132		14	11	17	144	31	174
5.2. Road repair (m)	1,750			69		5	4	6	73	11	84
5.3. Bridge repair	1			121	87	1	1	1	122	89	211
①=Sub-total				323	87	20	16	24	338	131	469
②=O&M and benefit (17% of sub-total)				55	15	3	3	4	58	22	80
③=Tax, etc. (8% of ①+②)				30	8	2	1	2	32	12	44
Total				408	110	25	20	30	428	165	593
6. Fish pond	52			459	390	61	62	74	521	525	1,046
①=Sub-total				459	390	61	62	74	521	525	1,046
②=O&M and benefit (17% of sub-total)				78	66	10	10	13	89	89	178
③=Tax, etc. (8% of ①+②)				43	37	6	6	7	49	49	98
Total				580	493	78	78	93	658	664	1,322
7. Agricultural supporting service											
7.1. Equipment & materials					1,920					1,920	1,920
Total				18,803	3,710	738	689	889	19,492	5,337	24,828

Table-15. Construction cost for Lan Saka F/S area, Case B+D, Case-4.

Unit Cost of Implementation Works - DIKE (Ban Na San F/S area)

Unit:x1,000 Bts

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
◇Complete dike construction												
Gabion	m3	8,293	1750		14,513					14,513		14,513
Excavation M= 19,954 * 0.9	m3	17,959					110	89	136	89	246	335
(Bulldoze 11t) L= 19,954 * 0.1	m3	1,995	65		130					130		130
Base trim M= 4,429 * 0.9	m3	3,986					16	13	20	13	37	50
L= 4,429 * 0.1	m3	443	13		6					6		6
Fill & compact M= 31,360 * 0.9	m3	28,224					206	166	253	166	459	625
L= 31,360 * 0.1	m3	3,136	13		41					41		41
Filling material	m3	6,977	89		621					621		621
Slope trim	m2	13,485	13		175					175		175
Sodding	m2	21,977	30		659					659		659
Material (laterite)	m3	849	90	4	76	3				76	3	80
Geotextile	m2	15,822		58		918					918	918
Total cost			2,063	62	16,221	921	333	268	409	16,489	1,663	18,152
◇Semi dike construction												
Gabion	m3	4,559	1750		7,978					7,978		7,978
Excavation M= 8,275 * 0.9	m3	7,448					46	37	56	37	102	139
(Bulldoze 11t) L= 8,275 * 0.1	m3	828	65		54					54		54
Base trim M= 2,781 * 0.9	m3	2,503					10	8	13	8	23	31
L= 2,781 * 0.1	m3	278	13		4					4		4
Fill & compact M= 20,442 * 0.9	m3	18,398					134	108	165	108	300	408
L= 20,442 * 0.1	m3	2,044	13		27					27		27
Filling material	m3	9,386	89		835					835		835
Slope trim	m2	7,841	13		102					102		102
Sodding	m2	12,133	30		364					364		364
Material (laterite)	m3	429	90	4	39	2				39	2	40
Geotextile	m2	9,250		58		537					537	537
Total cost			2,063	62	9,402	538	191	153	234	9,555	963	10,518

Note : M=Machinery, L=Labour

Table-16. Cost of dike, Ban Na San F/S area, Case-A & B.

Unit Cost of Implementation Works - DIKE (Lan Saka F/S area)

Unit:x1,000 Bts

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
◇ Upstream, Complete dike construction												
Gabion	m3	9,997	1,380		13,796					13,796		13,796
Excavation M= 10,100 * 0.9	m3	9,090					56	45	69	45	125	170
(Bulldoze 11t) L= 10,100 * 0.1	m3	1,010	65		66					66		66
Base trim M= 8,080 * 0.9	m3	7,272					30	24	37	24	67	91
L= 8,080 * 0.1	m3	808	13		11					11		11
Fill & compact M= 69,169 * 0.9	m3	62,252					455	366	558	366	1,013	1,380
L= 69,169 * 0.1	m3	6,917	13		90					90		90
Filling material	m3	50,989	139		7,087					7,087		7,087
Slope trim	m2	15,599	13		203					203		203
Sodding	m2	26,324	30		790					790		790
Material (laterite)	m3	780	140	4	109	3				109	3	112
Geotextile	m2	23,013		58		1,335					1,335	1,335
Total cost			1,793	62	22,151	1,338	541	435	664	22,586	2,543	25,129
◇ Downstream, Polder dike construction												
Gabion	m3	16,468	1,380		22,726					22,726		22,726
Excavation M= 12,144 * 0.9	m3	10,930					67	54	83	54	150	204
(Bulldoze 11t) L= 12,144 * 0.1	m3	1,214	65		79					79		79
Base trim M= 13,451 * 0.9	m3	12,106					50	40	61	40	111	152
L= 13,451 * 0.1	m3	1,345	13		17					17		17
Fill & compact M=141,742 * 0.9	m3	127,568					933	750	1,144	750	2,077	2,827
L=141,742 * 0.1	m3	14,174	13		184					184		184
Filling material	m3	116,147	139		16,144					16,144		16,144
Slope trim	m2	31,760	13		413					413		413
Sodding	m2	48,260	30		1,448					1,448		1,448
Material (laterite)	m3	1,200	140	4	168	5				168	5	173
Geotextile	m2	40,267		58		2,335					2,335	2,335
Total cost			1,793	62	41,180	2,340	1,050	844	1,288	42,024	4,678	46,702

Note : M=Machinery, L=Labour

Table-17. Cost of dike, Lan Saka F/S area, Case-A & C.

Unit Cost of Implementation Works - DIKE (Lan Saka F/S area)

Unit:x1,000 Bts

Description		Unit	Quantity	Labour & materials				Machinery cost			Total cost		
				Unit cost		Implement cost		Depre	Implement cost				
				L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
◇ Downstream, Semi dike construction													
Gabion		m3	4,606	1,380		6,356					6,356		6,356
Excavation	M= 3,522 * 0.9	m3	3,170					19	16	24	16	43	59
(Bulldoze 11t)	L= 3,522 * 0.1	m3	352	65		23					23		23
Base trim	M= 3,439 * 0.9	m3	3,095					13	10	16	10	28	39
	L= 3,439 * 0.1	m3	344	13		4					4		4
Fill & compact	M= 30,075 * 0.9	m3	27,068					198	159	243	159	441	600
	L= 30,075 * 0.1	m3	3,008	13		39					39		39
Filling material		m3	23,114	139		3,213					3,213		3,213
Slope trim		m2	7,401	13		96					96		96
Sodding		m2	12,076	30		362					362		362
Material (laterite)		m3	340	140	4	48	1				48	1	49
Geotextile		m2	11,322		58		657					657	657
Total cost				1,793	62	10,142	658	230	185	282	10,327	1,171	11,497

Note : M=Machinery, L=Labour

Table-18. Cost of dike, Lan Saka F/S area, Case-D.

Total volume of fill, cut, gabion and sodding (Complete dike protection).

Station No.	Distance from down-stream	Interval distance (m)	Average height of dike (m)	G1 (m3)	G2 (m3)	C1 (m3)	C2 (m3)	T1 (m3)	F1 (m3)	F2 (m3)	T2 (m2)	S1 (m2)	L1 (m3)	Geo-textile (m2)
X347'	14,297	210.0	2.29	420	219	2,187	183	263	952	630	990	1,830	84	918
X347	14,507	532.0	2.65	1,064	711	5,864	407	657	2,353	1,596	2,485	4,613	213	2,900
X352	15,039	508.0	3.23	1,016	913	5,128	168	978	5,369	1,524	3,112	5,144	203	3,627
X357	15,547	494.0	3.91	988	1,163	3,246		1,366	8,854	1,482	3,944	5,920	198	4,537
X362	16,041	302.0	4.40	604	829	2,070		920	5,912	906	2,383	3,591	121	3,207
X365	16,343	154.0	2.20	154	211	702		246	1,550	231	572	880	31	632
X365'	16,497													
Total		2,200		4,246	4,047	19,196	757	4,429	24,991	6,369	13,485	21,977	849	15,822
					8,293		19,954			31,360				

Volume of work of an interval = average volume of end stations * interval distance
X347' & X365' : Lower and upper end of dike along Khlong Chawang.

Table-19. Volume of fill, cut, gabion, etc, Ban Na San F/S area, Case-A.

Total volume of fill, cut, gabion and sodding (Semi-dike protection).

Station No.	Distance from down-stream	Interval distance (m)	Average height of dike (m)	G1 (m3)	G2 (m3)	C1 (m3)	C2 (m3)	T1 (m3)	F1 (m3)	F2 (m3)	T2 (m2)	S1 (m2)	L1 (m3)	Geo-textile (m2)
X347'	14,307	200.0	2.29	400	208	2,082	174	250	906	600	942	1,742	80	874
X347"	14,507		2.65											
X352	15,039		3.23											
X357	15,547	494.0	3.91	988	1,163	3,246		1,366	8,854	1,482	3,944	5,920	198	4,537
X362	16,041	302.0	4.40	604	829	2,070		920	5,912	906	2,383	3,591	121	3,207
X365	16,343	154.0	2.20	154	211	702		246	1,550	231	572	880	31	632
X365'	16,497													
Total		1,150		2,146	2,413	8,101	174	2,781	17,223	3,219	7,841	12,133	429	9,250
					4,559		8,275			20,442				

Volume of work of an interval = average volume of end stations * interval distance
X347' : Lower end of dike at marsh land (downstream of X347)
X347" : Upper end of dike at marsh land.
X357 & X365' : Lower and upper end of dike along Khlong Chawang.

Table -20. Volume of fill, cut, gabion, etc, Ban Na San F/S area, Case-8.

Volume of work at station X347 to X365

Station No.	River bed elevation (m)	Freeboard (m)	Design water level (m)	Ground elevation Front (m)	Ground elevation Back (m)	G1 (m2)	G2 (m2)	C1 (m2)	C2 (m2)	T1 (m2)	F1 (m2)	F2 (m2)	T2 (m2)	S1 (m2)	L1 (m3)
X347	75.48	77.77	76.77	77.35	77.02	2.0	1.0	10.4	0.9	1.3	4.5	3.0	4.7	8.7	0.4
X352	80.86	83.88	82.88	83.32	83.16	2.0	1.6	11.6	0.7	1.2	4.3	3.0	4.6	8.6	0.4
X357	87.27	90.70	89.70	88.83	88.87	2.0	2.0	8.6		2.6	16.8	3.0	7.6	11.6	0.4
X362	90.90	95.30	94.30	93.50	93.20	2.0	2.7	4.6		2.9	19.0	3.0	8.3	12.3	0.4
X365	94.86	99.26	98.26	96.87	97.50	2.0	2.7	9.1		3.2	20.1	3.0	7.4	11.4	0.4

G1=Gabion (1m*3m*0.5m)=1.0m(depth or 2 layers of 0.5m)*1m(width)*2(location)=2m2
G2=Gabion (1m*3m*0.3m)=0.3m(thickness)*slope length of submerged bank
C1=cut volume for gabion G1+G2 (m2)
C2=cut volume of slope above berm/gabion (m2)
T1=Foundation trimming for embankment/fill (m2), to a depth of 0.2m
F1=Fill/banking volume of embankment (m2), volume of T1 included.
F2=Filling excavation for gabion (m2)
T2=Slope trimming (m2)
S1=Sodding for bank erosion protection (m2)
L1=Laterite for road pavement (thickness=0.2m, width=2m) (m3)

Table-21. Volume of work at each station, Ban Na San F/S area.

Total volume of fill, cut, gabion and sodding (UPSTREAM REGION)

Station No.	Distance from down-stream	Interval distance (m)	Average height of dike (m)	G1 (m3)	G2 (m3)	C1 (m3)	C2 (m3)	T1 (m3)	F1 (m3)	F2 (m3)	T2 (m)	S1 (m)	L1 (m2)	Geo-textile (m2)
X115'	11,100													
		400.0	4.87	800	1,331	1,506		1,810	11,104	1,200	2,984	5,184	160	4,805
X115	11,500													
		500.0	4.87	1,000	1,565	3,279		2,235	19,658	1,500	4,585	7,335	200	6,014
X120	12,000													
		500.0	4.90	1,000	1,573	3,431		2,045	17,331	1,500	4,033	6,783	200	6,043
X125	12,500													
		500.0	4.69	1,000	1,488	1,726		1,988	13,910	1,500	3,636	6,386	200	5,732
X130	13,000													
		100	2.23	100	140	159		202	1,317	150	362	637	20	419
X130'	13,100													
Total		2,000		3,900	6,097	10,100		8,080	63,319	5,850	15,599	26,324	780	23,013
					9,997			18,179		69,169				

Volume of work of an interval = average volume of end stations * interval distance

Table-22. Volume of fill, cut, gabion, etc, Lan Saka F/S area, Case-A.

Total volume of fill, cut, gabion and sodding (POLDER, RING DIKE)

Station No.	Distance from down-stream	Interval distance (m)	Average height of dike (m)	G1 (m3)	G2 (m3)	C1 (m3)	C2 (m3)	T1 (m3)	F1 (m3)	F2 (m3)	T2 (m)	S1 (m)	L1 (m2)	Geo-textile (m2)
RIGHT CHANNEL														
X95'	9,450													
		50	5.77	100	193	196		265	3,280	150	675	950	20	734
X95	9,500													
		500.0	5.46	1,000	1,803	1,926		2,553	30,106	1,500	6,476	9,226	200	6,887
X100	10,000													
		500.0	5.21	1,000	1,698	2,024		2,295	23,785	1,500	5,783	8,533	200	6,502
X105	10,500													
		500.0	5.31	1,000	1,741	2,181		1,915	14,306	1,500	4,033	6,783	200	6,658
X110	11,000													
		200.0	5.37	400	666	753		805	5,552	600	1,492	2,592	80	2,699
X110'	11,200													
Total		1,750		3,500	6,101	7,081		7,833	77,029	5,250	18,459	28,084	700	23,480
					9,601			14,914		82,279				
LEFT CHANNEL														
X95'	9,450													
		50	5.77	100	193	196		265	3,280	150	675	950	20	734
X95	9,500													
		360.0	5.46	720	1,298	1,386		1,838	21,676	1,080	4,663	6,643	144	4,959
X100	9,860													
		360.0	5.21	720	1,223	1,457		1,652	17,125	1,080	4,164	6,144	144	4,682
X105	10,220													
		360.0	5.31	720	1,253	1,571		1,379	10,300	1,080	2,904	4,884	144	4,794
X110	10,580													
		120.0	5.37	240	399	452		483	3,331	360	895	1,555	48	1,619
X110'	10,700													
Total		1,250		2,500	4,367	5,063		5,618	55,713	3,750	13,301	20,176	500	16,787
					6,867			10,680		59,463				

Volume of work of an interval = average volume of end stations * interval distance

Table-23. Volume of fill, cut, gabion, etc, Lan Saka F/S area, Case-C.

Total volume of fill, cut, gabion and sodding (SEMI-RING DIKE)

Station No.	Distance from down-stream	Interval distance (m)	Average height of dike (m)	G1 (m3)	G2 (m3)	C1 (m3)	C2 (m3)	T1 (m3)	F1 (m3)	F2 (m3)	T2 (m)	S1 (m)	L1 (m2)	Geo-textile (m2)
LEFT CHANNEL														
X105'	10,400	100.0	5.25	200	340	405		459	4,757	300	1,157	1,707	40	1,314
X105	10,500	500.0	5.31	1,000	1,741	2,181		1,915	14,306	1,500	4,033	6,783	200	6,658
X110	11,000	120.0	5.37	240	399	452		483	3,331	360	895	1,555	48	1,619
X110'	11,120													
RIGHT CHANNEL														
X110'	10,700	130	5.31	260	426	484		582	5,131	390	1,316	2,031	52	1,731
X105'	10,830													
Total		850		1,700	2,906	3,522		3,439	27,525	2,550	7,401	12,076	340	11,322
					4,606			6,961		30,075				

Volume of work of an interval = average volume of end stations * interval distance

Table-24. Volume of fill, cut, gabion, etc, Lan Saka F/S area, Case-D.

Volume of work at station X95 to X130

Station No.	River bed elevation (m)	Freeboard (m)	Design water level (m)	Ground elevation Front (m)	Ground elevation Back (m)	G1 (m2)	G2 (m2)	C1 (m2)	C2 (m2)	T1 (m2)	F1 (m2)	F2 (m2)	T2 (m)	S1 (m)	L1 (m2)
X95	28.67	34.44	33.44	30.67	30.43	2.0	3.9	3.9		5.3	65.6	3.0	13.5	19.0	0.4
X100	29.80	34.98	33.96	31.48	31.36	2.0	3.4	3.8		4.9	54.8	3.0	12.4	17.9	0.4
X105	30.33	35.58	34.58	32.58	32.60	2.0	3.4	4.3		4.3	40.3	3.0	10.7	16.2	0.4
X110	31.25	36.62	35.62	33.61	35.62	2.0	3.5	4.4		3.4	16.9	3.0	5.4	10.9	0.4
X115	32.7	37.57	36.57	33.48	35.04	2.0	3.1	3.1		4.7	38.8	3.0	9.5	15.0	0.4
X120	33.78	38.66	37.66	35.09	36.39	2.0	3.1	10.0		4.3	40.0	3.0	8.8	14.3	0.4
X125	34.58	39.49	38.49	36.09	37.78	2.0	3.2	3.7		3.9	29.3	3.0	7.3	12.8	0.4
X130	35.75	40.21	39.21	36.58	38.53	2.0	2.8	3.2		4.0	26.3	3.0	7.2	12.7	0.4

G1=Gabion (1m*3m*0.5m)=1.0m(depth or 2 layers of 0.5m)*1m(width)*2(location)=2m2
G2=Gabion (1m*3m*0.3m)=0.3m(thickness)*slope length of submerged bank
C1=cut volume for gabion G1+G2 (m2)
C2=cut volume of slope above berm/gabion (m2)
T1=Foundation trimming for embankment/fill (m2), to a depth of 0.2m
F1=Fill/banking volume of embankment (m2), volume of T1 included.
F2=Filling excavation for gabion (m2)
T2=Slope trimming (m)
S1=Sodding for bank erosion protection (m)
L1=Laterite for road pavement (thickness=0.2m, width=2m) (m2)

Table-25. Volume of work at each station, Lan Saka F/S area.

Unit Cost of Implementation Works – OPEN CHANNEL

Unit: Baths/m

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Open channel												
◇Type-I B=H=0.7m,L=2.8m												
Excavation M=1.23 * 0.9	m3	1.11					7.85	6.03	9.01	6.0	16.9	22.9
(Back hoe 0.6m3) L=1.23 * 0.1	m3	0.12	65		8.00					8.0		8.0
Trimming 2.52	m	2.52	13		32.76					32.8		32.8
Sodding 2.52	m	2.52	30		75.60					75.6		75.6
Total cost					116.36		7.85	6.03	9.01	122.4	16.9	139.2
◇Type-II B=H=1.0m,L=4.0m												
Excavation M= 2.5 * 0.9	m3	2.25					15.95	12.26	18.32	12.3	34.3	46.5
(Back hoe 0.6m3) L= 2.5 * 0.1	m3	0.25	65		16.25					16.3		16.3
Trimming 3.61	m	3.61	13		46.93					46.9		46.9
Sodding 3.61	m	3.61	30		108.30					108.3		108.3
Total cost					171.48		15.95	12.26	18.32	183.7	34.3	218.0
◇Type-III B=H=1.5m,L=6.0m												
Excavation M=5.63 * 0.9	m3	5.07					35.93	27.62	41.25	27.6	77.2	104.8
(Back hoe 0.6m3) L=5.63 * 0.1	m3	0.56	65		36.60					36.6		36.6
Trimming 5.41	m	5.41	13		70.33					70.3		70.3
Sodding 5.41	m	5.41	30		162.30					162.3		162.3
Total cost					269.23		35.93	27.62	41.25	296.8	77.2	374.0
◇Type-IV B=H=2.0m,L=8.0m												
Excavation M=10.0 * 0.9	m3	9.00					63.81	49.05	73.26	49.1	137.1	186.1
(Back hoe 0.6m3) L=10.0 * 0.1	m3	1.00	65		65.00					65.0		65.0
Trimming 7.21	m	7.21	13		93.73					93.7		93.7
Sodding 7.21	m	7.21	30		216.30					216.3		216.3
Total cost					375.03		63.81	49.05	73.26	424.1	137.1	561.2
◇Type-V B=H=2.5m,L=10.0m												
Excavation M=15.6 * 0.9	m3	14.07					99.74	76.67	114.51	76.7	214.2	290.9
(Back hoe 0.6m3) L=15.6 * 0.1	m3	1.56	65		101.60					101.6		101.6
Trimming 9.02	m	9.02	13		117.26					117.3		117.3
Sodding 9.02	m	9.02	30		270.60					270.6		270.6
Total cost					489.46		99.74	76.67	114.51	566.1	214.2	780.4

Note : M=Machinery, L=Labour B = bottom width, H= depth, I:i=1:1.5

Table-26. Cost of standard type drainage canal.

Unit Cost of Implementation Works – DROP STRUCTURE

Unit: Baths

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Drop structure												
◇Type-I B1=H1=H2=0.7m,B2=2.2m,L=2.0m												
Excavation M=16.5 * 0.8	m3	13.2					94	72	107	72	201	273
(Back hoe 0.6m3) L=16.5 * 0.2	m3	3.3	65		215					215		215
Refill M= 5.1 * 0.8	m3	4.1					29	22	33	22	62	84
(see below) L= 5.0 * 0.2	m3	1.0	26		26		1	14	2	40	4	43
Reinforced concrete 5.1	m3	5.1	2,457	1,638	12,531	8,354				12,531	8,354	20,885
Riprap (mortar) 1.4	m3	1.4	529	59	741	83				741	83	823
Foundation 0.84	m3	0.8	316		265					265		265
Total cost					13,777	8,436	124	108	143	13,885	8,703	22,588
◇Type-II B1=H1=H2=1.0m,B2=3.1m,L=2.5m												
Excavation M=36.0 * 0.8	m3	28.8					204	157	234	157	439	596
(Back hoe 0.6m3) L=36.0 * 0.2	m3	7.2	65		468					468		468
Refill M= 9.0 * 0.8	m3	7.2					51	39	59	39	110	149
(see below) L= 9.0 * 0.2	m3	1.8	26		47		2	25	4	71	6	78
Reinforced concrete 8.99	m3	9.0	2,457	1,638	22,081	14,721				22,081	14,721	36,802
Riprap (mortar) 1.84	m3	1.8	529	59	975	109				975	109	1,084
Foundation 1.85	m3	1.9	316		585					585		585
Total cost					24,156	14,830	258	221	297	24,377	15,384	39,761
◇Type-III B1=H1=H2=1.5m,B2=5.1m,L=3.0m												
Excavation M=93.3 * 0.8	m3	74.6					529	407	608	407	1,137	1,544
(Back hoe 0.6m3) L=93.3 * 0.2	m3	18.7	65		1,213					1,213		1,213
Refill M=14.5 * 0.8	m3	11.6					82	63	94	63	177	240
(see below) L=14.5 * 0.2	m3	2.9	26		75		4	40	6	115	10	125
Reinforced concrete 15.9	m3	15.9	2,457	1,638	39,010	26,007				39,010	26,007	65,016
Riprap (mortar) 2.76	m3	2.8	529	59	1,462	163				1,462	163	1,625
Foundation 4.42	m3	4.4	316		1,397					1,397		1,397
Total cost					43,157	26,170	615	510	708	43,667	27,493	71,160

Note : M=Machinery, L=Labour Foundation : crushed stone foundation
B1 & B2 = width at before & after drop, H1 & H2 = Water depth at before & after drop, L = Length of drop
Labour part of refill work uses back hoe (0.6m3) and soil compactor 90kg/tamper/rammer

Table-27. Cost of standard type drop structure.

Unit Cost of Implementation Works – CHECK STRUCTURE (1/2)

Unit: Baths

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Check gate structure												
◇Type-I												
Excavation M=1.69 * 0.9 * 1	m3	1.52					10.8	8.3	12.4	8	23	31
(Back hoe 0.6m3) L=1.69 * 0.1 * 1	m3	0.17	65		11					11		11
Refill M=0.48 * 0.8 * 1	m3	0.38					2.7	2.1	3.1	2	6	8
(Back hoe 0.6m3) L=0.48 * 0.2 * 1	m3	0.10	26		2		0.1	1.3	0.2	4	0	4
Reinforced concrete 3.78 * 1 * 1	m3	3.78	2,457	1,638	9,287	6,192				9,287	6,192	15,479
Riprap (mortar) 3.22 * 1 * 1	m3	3.22	529	59	1,703	190				1,703	190	1,893
Gate 1 * 1 * 1	set	1.00	4,500	12,600	4,500	12,600				4,500	12,600	17,100
Pipeline 1 * 1 * 1	m	20	374	350	7,480	7,000	2,020	2,320	1,920	9,800	10,940	20,740
Foundation 0.52 * 1 * 1	m3	0.52	316		164					164		164
Sub-total					23,149	25,982	2033.6	2331.7	1935.7	25,480	29,951	55,431
Miscellaneous 10% of sub-total					2,315	2,598	203.4	233.2	193.6	2,548	2,995	5,543
Total cost					25,464	28,580	2237.0	2564.9	2129.3	28,028	32,946	60,974
◇Type-II												
Excavation M=1.84 * 0.9 * 1	m3	1.66										
(Back hoe 0.6m3) L=1.84 * 0.1 * 1	m3	0.18	65		12					12		12
Refill M= 1.7 * 0.8 * 1	m3	1.36										
(Back hoe 0.6m3) L= 1.7 * 0.2 * 1	m3	0.34	26		9		2.4	1.9	2.8	11	5	16
Reinforced concrete 4.9 * 1 * 1	m3	4.90	2,457	1,638	12,039	8,026				12,039	8,026	20,066
Riprap (mortar) 4.61 * 1 * 1	m3	4.61	529	59	2,439	272				2,439	272	2,711
Gate 1 * 1 * 1	set	1.00	9,000	21,000	9,000	21,000				9,000	21,000	30,000
Pipeline 1 * 1 * 1	m	25	479	450	11,975	11,250	2,525	2,900	2,400	14,875	16,175	31,050
Foundation 0.9 * 1 * 1	m3	0.90	316		284					284		284
Sub-total					35,758	40,548	2527.4	2901.9	2402.8	38,660	45,478	84,138
Miscellaneous 10% of sub-total					3,576	4,055	252.7	290.2	240.3	3,866	4,548	8,414
Total cost					39,334	44,603	2780.2	3192.0	2643.0	42,526	50,026	92,552

Note : M=Machinery, L=Labour Foundation = crushed stone foundation

Unit Cost of Implementation Works – CHECK STRUCTURE (2/2)

Unit: Baths

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Check gate structure												
◇Type-III												
Excavation M=2.76 * 0.9 * 1	m3	2.49					17.6	13.6	20.2	14	38	51
(Back hoe 0.6m3) L=2.76 * 0.1 * 1	m3	0.28	65		18					18		18
Refill M=3.32 * 0.8 * 1	m3	2.65					18.8	14.5	21.6	14	40	55
(Back hoe 0.6m3) L=3.32 * 0.2 * 1	m3	0.66	26		17		0.9	9.1	1.5	26	2	29
Reinforced concrete 6.92 * 1 * 1	m3	6.92	2,457	1,638	17,000	11,333				17,000	11,333	28,333
Riprap (mortar) 6.91 * 1 * 1	m3	6.91	529	59	3,655	408				3,655	408	4,063
Gate 1 * 1 * 1	set	1.00	18,000	42,000	18,000	42,000				18,000	42,000	60,000
Pipeline 1 * 1 * 1	m	30	636	600	19,080	18,000	3,030	3,480	2,880	22,560	23,910	46,470
Foundation 1.62 * 1 * 1	m3	1.62	316		512					512		512
Sub-total					58,282	71,741	3,067	3,517	2,923	61,800	77,732	139,531
Miscellaneous 10% of sub-total					5,828	7,174	307	352	292	6,180	7,773	13,953
Total cost					64,111	78,915	3,374	3,869	3,216	67,980	85,505	153,484

Note : M=Machinery, L=Labour Foundation = crushed stone foundation

Table-28. Cost of standard type drainage check gate structure.

Unit Cost of Implementation Works – PIPE CROSSING STRUCTURE (1/2)

Unit: Baths

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Pipe crossing structure												
◇Type-I φ=600,B1=0.7m,B2=1.0,Q=0.3m3/s												
Excavation M=17.1 * 0.9	m3	15.4					109	84	125	84	234	318
(Back hoe 0.6m3) L=17.1 * 0.1	m3	1.7	65		111					111		111
Refill M=14.4 * 0.8	m3	11.5					71	57	87	57	158	215
(see below) L=14.4 * 0.2	m3	2.9	26		75		4	39	6	114	10	124
Reinforced concrete1.86	m3	1.9	1,946	1,297	3,620	2,412				3,620	2,412	6,032
Riprap 2.76	m3	2.8	500		1,380					1,380		1,380
RC pipe 6	m	6.0	350	350	2,100	2,100	132	148	122	2,248	2,354	4,602
Foundation 1.0	m3	1.0	316		316					316		316
Total cost					7,601	4,512	316	328	340	7,930	5,168	13,098
◇Type-II φ=800,B1=1.4m,B2=1.5,Q=0.6m3/s												
Excavation M=35.0 * 0.9	m3	31.5					223	172	256	172	480	652
(Back hoe 0.6m3) L=35.0 * 0.1	m3	3.5	65		228					228		228
Refill M=29.3 * 0.8	m3	23.4					144	116	177	116	321	436
(see below) L=29.3 * 0.2	m3	5.9	26		152		8	80	13	232	20	253
Reinforced concrete3.97	m3	4.0	1,946	1,297	7,726	5,149				7,726	5,149	12,875
Riprap 4.2	m3	4.2	500		2,100					2,100		2,100
RC pipe 6	m	6.0	450	450	2,700	2,700	148	170	140	2,870	2,987	5,857
Foundation 1.2	m3	1.2	316		379					379		379
Total cost					13,284	7,849	523	537	586	13,822	8,957	22,779
◇Type-III φ=1000,B1=1.6m,B2=2.0,Q=1.0m3/s												
Excavation M=58.4 * 0.9	m3	52.6					373	286	428	286	800	1,087
(Back hoe 0.6m3) L=58.4 * 0.1	m3	5.8	65		380					380		380
Refill M=49.2 * 0.9	m3	44.3					272	219	334	219	607	826
(see below) L=49.2 * 0.1	m3	4.9	26		128		6	67	11	195	17	213
Reinforced concrete6.08	m3	6.1	1,946	1,297	11,832	7,886				11,832	7,886	19,717
Riprap 5.52	m3	5.5	500		2,760					2,760		2,760
RC pipe 6	m	6.0	600	600	3,600	3,600	169	193	159	3,793	3,928	7,721
Foundation 1.8	m3	1.8	316		569					569		569
Total cost					19,268	11,486	820	766	932	20,034	13,238	33,272

Note : M=Machinery, L=Labour B1 & B2 = width and length at pipe inlet (entrance)
Refill work uses backhoe (0.6m3) and soil compactor/tamper/rammer Foundation = Crushed stone foundation

Unit Cost of Implementation Works – PIPE CROSSING STRUCTURE (2/2)

Unit: Baths

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Pipe crossing structure												
◇Type-IV φ=1000*2,B1=3.1m,B2=2.0,Q=2.0m3/s												
Excavation M=71.6 * 0.9	m3	64.4					457	351	525	351	981	1,333
(Back hoe 0.6m3) L=71.6 * 0.1	m3	7.2	65		465					465		465
Refill M=54.0 * 0.9	m3	48.6					299	241	367	241	666	906
(see below) L=54.0 * 0.1	m3	5.4	26		140		7	74	12	214	19	233
Reinforced concrete9.44	m3	9.4	1,946	1,297	18,370	12,244				18,370	12,244	30,614
Riprap 7.2	m3	7.2	500		3,600					3,600		3,600
RC pipe 12	m	12.0	600	600	7,200	7,200	337	386	318	7,586	7,855	15,442
Foundation 3.8	m3	3.8	316		1,185					1,185		1,185
Total cost					30,961	19,444	1,100	1,052	1,221	32,013	21,765	53,778

Note : M=Machinery, L=Labour B1 & B2 = width and length at entrance
Refill work uses backhoe (0.6m3) and soil compactor/tamper/rammer Foundation = Crushed stone foundation

Table-29. Cost of standard type pipe crossing structure.

Unit Cost of Implementation Works – FARM ROAD

Unit: Baths/m

Description	Unit	Quantity	Labour & materials: Unit cost L.C.	Labour & materials: Unit cost F.C.	Labour & materials: Implement cost L.C.	Labour & materials: Implement cost F.C.	Machinery cost: Depre F.C.	Machinery cost: Implement cost L.C.	Machinery cost: Implement cost F.C.	Total cost L.C.	Total cost F.C.	Total cost Total
Farm road												
◇Type-I b=3.0m, h=0.5m										87.5		87.5
Banking material 1.75	m3	1.75	50		87.5							
Levelling/compaction 1.75	m3	1.75					12.8	10.3	15.7	10.3	28.5	38.8
Laterite 0.33	m3	0.33	180		59.4					59.4		59.4
Levelling/compaction 0.33	m3	0.33					2.4	1.9	3.0	1.9	5.4	7.3
Subbase trimming 0.40	m3	0.40					2.5	2.0	3.0	2.0	5.5	7.5
Trimming 1.41	m2	1.41	13		18.33					18.3		18.3
Total cost					165.2		17.7	14.2	21.7	179.4	39.3	218.8
◇Type-II b=2.0m, h=0.5m										62.5		62.5
Banking material 1.25	m3	1.25	50		62.5							
Levelling/compaction 1.25	m3	1.25					9.1	7.4	11.2	7.4	20.4	27.7
Laterite 0.22	m3	0.22	180		39.6					39.6		39.6
Levelling/compaction 0.22	m3	0.22					1.6	1.3	2.0	1.3	3.6	4.9
Subbase trimming 0.30	m3	0.30					1.8	1.5	2.3	1.5	4.1	5.6
Trimming 1.41	m2	1.41	13		18.33					18.3		18.3
Total cost					120.4		12.6	10.1	15.5	130.6	28.0	158.6
◇Type-III Existing b=2.0m, h=0.0m										39.6		39.6
Laterite 0.22	m3	0.22	180		39.6							
Levelling/compaction 0.22	m3	0.22					1.6	1.3	2.0	1.3	3.6	4.9
Subbase trimming 0.20	m3	0.20					1.2	1.0	1.5	1.0	2.7	3.7
Total cost					39.6		2.8	2.3	3.5	41.9	6.3	48.2

Note : M=Machinery, L=Labour
Type-I b=3.0m, h=0.5m, i=1.0
Type-II b=2.0m, h=0.5m, i=1.0
Type-III Existing b=2.0m
b=top width, h=height, i=1(vertical):i(horizontal) Laterite h=0.1m, b=road width, loss=0.1, Subbase trimming depth=0.1m
Levelling/compaction by bulldozer (11t) Subbase trimming by bulldozer 11t (see cut and banking)

Table-30. Cost of standard type farm road.

Unit Cost of Implementation Works – BRIDGE REPAIR WORK

Unit: Baths

Description	Unit	Quantity	Labour & materials: Unit cost L.C.	Labour & materials: Unit cost F.C.	Labour & materials: Implement cost L.C.	Labour & materials: Implement cost F.C.	Machinery cost: Depre F.C.	Machinery cost: Implement cost L.C.	Machinery cost: Implement cost F.C.	Total cost L.C.	Total cost F.C.	Total cost Total
Bridge repair work												
Excavation M= 126 * 0.8 * 1	m3	100.80					714.7	549.4	820.5	549	1,535	2,085
(Back hoe 0.6m3) L= 126 * 0.2 * 1	m3	25.20	65		1,638					1,638		1,638
Refill M=14.6 * 0.8 * 1	m3	11.68					82.8	63.7	95.1	64	178	242
(Back hoe 0.6m3) L=14.6 * 0.2 * 1	m3	2.92	26		76		3.8	40.0	6.4	116	10	126
Reinforced concrete 28.4 * 1 * 1	m3	28.42	2,457	1,638	69,828	46,552				69,828	46,552	116,380
Riprap (mortar) 32 * 1 * 1	m3	32.00	529	59	16,928	1,888				16,928	1,888	18,816
Guard rail (pipe) 40 * 1 * 1	m	40.00	513	770	20,520	30,800				20,520	30,800	51,320
Foundation 2.8 * 1 * 1	m3	2.80	316		885					885		885
Sub-total					109,875	79,240	801	653	922	110,528	80,963	191,491
Miscellaneous 10% of sub-total					10,987	7,924	80	65	92	11,053	8,096	19,149
Total cost					120,862	87,164	881	718	1,014	121,580	89,060	210,640

Note : M=Machinery, L=Labour Foundation = crushed stone foundation
Guard rail (pipe GP-CP-28)

Table-31. Cost of standard type bridge repair work.

Unit Cost of Implementation Works - PIPE LINE INSTALLATION

Unit: Baths/m or 20m

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Pipe line												
◇φ=300 Manual installation												
Pipe (10 pipes/day) 20	m	20.0	225	225	4,500	4,500				4,500	4,500	9,000
Pipe connecting 1.5%					68	68				68	68	135
Skilled labour /20m 2.7	p/day	2.70	150		405					405		405
Unskilled labour /20m 3.4	p/day	3.40	130		442					442		442
Total /20m					5,415	4,568				5,415	4,568	9,982
Total cost per meter					271	228				271	228	499
◇φ=600 2.43m/pipe												
Pipe (12.7 pipe/day) 30.9	m	30.9	350	350	10,815	10,815				10,815	10,815	21,630
Skilled labour 2	p/day	2.0	150		300					300		300
Unskilled labour 3.5	p/day	3.5	130		455					455		455
Truck crane 3t 4.7	m/hr	4.7					3,122	3,587	2,951	3,587	6,074	9,661
Total /day					11,570	10,815	3,122	3,587	2,951	15,157	16,889	32,046
Total cost per meter					374	350	101	116	96	491	547	1,037
◇φ=800 2.43m/pipe												
Pipe (11.1 pipe/day) 26.9	m	26.9	450	450	12,105	12,105				12,105	12,105	24,210
Steeplejack 1	p/day	1.0	180		180					180		180
Skilled labour 1	p/day	1.0	150		150					150		150
Unskilled labour 3.5	p/day	3.5	130		455					455		455
Truck crane 3t 4.1	m/hr	4.1					2,713	3,121	2,570	3,121	5,283	8,404
Total /day					12,890	12,105	2,713	3,121	2,570	16,011	17,388	33,399
Total cost per meter					479	450	101	116	96	595	646	1,242
◇φ=1000 2.43m/pipe												
Pipe (9.8 pipe/day) 23.8	m	23.8	600	600	14,280	14,280				14,280	14,280	28,560
Steeplejack 1	p/day	1.0	180		180					180		180
Skilled labour 1.5	p/day	1.5	150		225					225		225
Unskilled labour 3.5	p/day	3.5	130		455					455		455
Truck crane 3t 3.6	m/hr	3.6					2,408	2,759	2,273	2,759	4,681	7,440
Total /day					15,140	14,280	2,408	2,759	2,273	17,899	18,961	36,860
Total cost per meter					636	600	101	116	96	752	797	1,549

Note : M=Machinery, L=Labour p/day : person(s)/day

Table-32. Cost of standard type pipe line installation.

Unit Cost of Implementation Works - FISH POND

Unit: Baths

Description	Unit	Quantity	Labour & materials				Machinery cost			Total cost		
			Unit cost		Implement cost		Depre	Implement cost				
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total
Fish pond												
Excavation M= 100 * 0.8 * 1	m3	80.00					567.2	436.0	651.2	436	1,218	1,654
(Back hoe 0.6m3) L= 100 * 0.2 * 1	m3	20.00	65		1,300					1,300		1,300
Refill M= 100 * 0.8 * 1	m3	80.00					584.8	470.4	717.6	470	1,302	1,773
(Bulldozer 11t) L= 100 * 0.2 * 1	m3	20.00	26		520		26.0	274.0	44.0	794	70	864
R.C. pipe 300mm 10 * 1 * 1	1	10.00	271	228	2,710	2,280				2,710	2,280	4,990
Gate 0.5m*0.5m	1				4,300	5,220	3.75	3.2	4.3	4,303	5,228	9,531
Total cost					8,830	7,500	1,182	1,184	1,417	10,014	10,099	20,112

Note : M=Machinery, L=Labour

Table-33. Cost of standard type ridge.

Unit Cost of Implementation Works – RAISED RIDGE (1/2)

Unit: Baths/m

Description	Unit	Quantity	Labour & materials: Unit cost L.C.	Labour & materials: Unit cost F.C.	Labour & materials: Implement cost L.C.	Labour & materials: Implement cost F.C.	Machinery cost: Depre F.C.	Machinery cost: Implement cost L.C.	Machinery cost: Implement cost F.C.	Total cost L.C.	Total cost F.C.	Total cost Total
Ridge												
◇Type-I h=0.5m 16 trees/rai							2,047	1,647	2,513	1,647	4,559	6,207
Excavation M= 2.6 * 160 * 0.8	m3	332.8								5,408		5,408
(Bulldozer 11t) L= 2.6 * 160 * 0.2	m3	83.2	65		5,408		2,152	1,731	2,641	1,731	4,793	6,524
Fill/compaction M= 2.3 * 160 * 0.8	m3	294.4								1,914		1,914
(Bulldozer 11t) L= 2.3 * 160 * 0.2	m3	73.6	26		1,914					9,755		9,755
Trimming 4.69 * 160	m2	750.4	13		9,755					8,194		8,194
Sodding 5.69 * 160 * 0.3	m2	273.1	30		8,194							
Total cost					25,270		4,199	3,378	5,153	28,649	9,352	38,001
◇Type-II h=0.75m 13.9 trees/rai							2,619	2,108	3,216	2,108	5,835	7,943
Excavation M=3.83 * 139 * 0.8	m3	425.9								6,921		6,921
(Bulldozer 11t) L=3.83 * 139 * 0.2	m3	106.5	65		6,921		2,991	2,406	3,671	2,406	6,662	9,068
Fill/compaction M=3.68 * 139 * 0.8	m3	409.2								2,660		2,660
(Bulldozer 11t) L=3.68 * 139 * 0.2	m3	102.3	26		2,660					11,005		11,005
Trimming 6.09 * 139	m2	846.5	13		11,005					8,870		8,870
Sodding 7.09 * 139 * 0.3	m2	295.7	30		8,870							
Total cost					29,455		5,611	4,514	6,886	33,969	12,497	46,466
◇Type-III h=1.0m 13.3 trees/rai							3,177	2,557	3,900	2,557	7,077	9,635
Excavation M=5.25 * 123 * 0.8	m3	516.6								8,395		8,395
(Bulldozer 11t) L=5.25 * 123 * 0.2	m3	129.2	65		8,395		3,740	3,009	4,590	3,009	8,330	11,339
Fill/compaction M=5.20 * 123 * 0.8	m3	511.7								3,326		3,326
(Bulldozer 11t) L=5.20 * 123 * 0.2	m3	127.9	26		3,326					12,488		12,488
Trimming 7.81 * 123	m2	960.6	13		12,488					9,753		9,753
Sodding 8.81 * 123 * 0.3	m2	325.1	30		9,753							
Total cost					33,962		6,917	5,566	8,490	39,527	15,408	54,935

Note : M=Machinery, L=Labour
Type-I h=0.50m Cut(d=1.0m, b=1.40m,i=1.2), Fill/banking (h=0.50m,b=4.0m,i=1.2), Length of ridge=160m
Type-II h=0.75m Cut(d=1.2m, b=1.75m,i=1.2), Fill/banking (h=0.75m,b=4.0m,i=1.2), Length of ridge=139m
Type-III h=1.00m Cut(d=1.5m, b=1.70m,i=1.2), Fill/banking (h=1.00m,b=4.0m,i=1.2), Length of ridge=123m
d=depth, h=height, b=bottom (cut) or top (fill/banking) width, i=1(vertical):i(horizontal)

Unit Cost of Implementation Works – RAISED RIDGE (Circular) (2/2)

Unit: Baths/tree

Description	Unit	Quantity	Labour & materials: Unit cost L.C.	Labour & materials: Unit cost F.C.	Labour & materials: Implement cost L.C.	Labour & materials: Implement cost F.C.	Machinery cost: Depre F.C.	Machinery cost: Implement cost L.C.	Machinery cost: Implement cost F.C.	Total cost Baths/tree L.C.	Total cost Baths/tree F.C.	Total cost Baths/tree Total
Circular ridge												
◇Type-IV h=0.5m per tree							43	33	49	33	91	124
Excavation M= 7.5 * 1 * 0.8	m3	6.0								98		98
(Backhoe) L= 7.5 * 1 * 0.2	m3	1.5	65		98		38	31	47	31	85	115
Fill/compaction M= 6.5 * 1 * 0.8	m3	5.2								34		34
(Bulldozer 11t) L= 6.5 * 1 * 0.2	m3	1.3	26		34					245		245
Trimming 18.84 * 1	m2	18.8	13		245					188		188
Sodding 6.28 * 1 * 1	m2	6.3	30		188							
Total cost					565		81	63	95	628	176	804

Note : M=Machinery, L=Labour

Table-34. Cost of standard type fish pond.

Unit cost of work involving machine

Description	Unit Cost						
	Capacity ⑮	Unit	Deprec. F.C. ③/⑮	F.C. ⑰/⑮	L.C. ⑱/⑮	Total	Remarks
☐Cut and Banking							
- Bulldozer 11t L=10 m	45.5	m3/hr	6.15	7.55	4.95	18.65	Baht/m3
L=30 m	30.2	//	9.27	11.37	7.45	28.10	//
L=60 m	20.0	//	14.00	17.17	11.26	42.43	//
- Scraper 26 t L=100 m	85.3	//	10.55	12.33	6.59	29.47	//
L=200 m	54.5	//	16.51	19.30	10.32	46.13	//
- Backhoe 0.6 m3 90°	42.3	//	7.09	8.14	5.45	20.69	//
- Tractor shovel 1.3 m3	38.0	//	10.79	11.61	7.47	29.87	//
- Dragline 0.8 m3 90°	45.3	//	9.05	9.74	6.26	25.05	//
☐Transportation							
- Dump truck 6t L= 1.0 km	8.7	//	10.34	15.88	12.64	38.86	//
L= 2.0 km	7.0	//	12.86	19.73	15.71	48.30	//
L= 5.0 km	4.5	//	20.00	30.69	24.44	75.13	//
L=10.0 km	2.8	//	32.14	49.33	39.28	120.75	//
L=30.0 km	1.1	//	81.82	125.56	99.98	307.36	//
☐Leveling for embankment							
- Bulldozer 11t	67.8	//	4.13	5.07	3.32	12.52	//
☐Compaction for embankmant							//
- Bulldozer 11 t	88.2	//	3.17	3.89	2.55	9.62	//
☐Leveling/Compaction							//
- Bulldozer 11 t	38.3	//	7.31	8.97	5.88	22.16	//
- Soil compactor 90kg	3.33	//	1.33	2.20	13.68	17.22	//
☐Land clearing							
- Weed cutter (Ban Na San)	123.1	m2/h	162	286	2,193	2,642	Baht/ha
(Lan Saka)	43.1	//	464	818	6,264	7,545	//
☐Stumping							
- Rake dozer (Ban Na San)	2,000	m2/h	1,400	1,717	1,126	4,243	Baht/ha
(Lan Saka)	1,100	//	2,545	3,122	2,047	7,714	//
Stumps exclusion							
- Rake dozer (Ban Na San)	5,000	m2/h	560	687	450	1,697	Baht/ha
(Lan Saka)	1,250	//	2,240	2,748	1,801	6,789	//
☐Plowing							
- Tractor 9-10t 90HP	4,880	m2/h	533	600	425	1,557	Baht/ha
☐Land grading							
- Bulldozer 11 t	885	m2/h	3,164	3,881	2,544	9,588	Baht/ha
☐Pipeline installation							
- Truck crane 3t ϕ=600	4.7	m/h	21.5	20.32	24.7	66.5	Baht/m
ϕ=800	4.1	//	24.6	23.30	28.3	76.2	//
ϕ=1000	3.6	//	28.1	26.53	32.2	86.8	//

⑮=based on Japanese standard. See capacity table estimated for machinery.

Table-35. Unit cost of work involving machinery.

Purchase, running and O&M cost of machinery

Description	Purchase Price (x1000 Baht) ①	Life span (hr) ②	Depreciation F.C. (Baht/hr) ③	Repair cost Rate ④	Parts F.C. (Baht/hr) ⑤	Labour L.C. (Baht/hr) ⑥	Fuel (l/hr) ⑦	$ Bath/l F.C. (Baht/hr) ⑧	L.C. (Baht/hr) ⑨	Operation and Labour Driver (man/hr) ⑩	Labour (man/hr) ⑪	Others (man/hr) ⑫	Total L.C. (Baht/hr) ⑬	Administrative cost Rate ⑭	Tools F.C. (Baht/hr) ⑮	Labour L.C. (Baht/hr) ⑯	Total F.C. (Baht/hr) ⑰	Total L.C. (Baht/hr) ⑱
Bulldozer 11t	2,500	10,000	230.0	0.65	145.6	36.4	13.0	99.8	25.0	0.174	0.087		65.8	0.07	98.0	98.0	343.4	225.1
Carry-all Scraper 26t	9,000	10,000	900.0	0.65	468.0	117.0	35.0	268.8	67.2	0.157	0.084		63.2	0.07	315.0	315.0	1,051.3	362.4
Backhoe 0.6 m3	3,000	10,000	300.0	0.55	132.0	33.0	14.0	107.5	26.9	0.174	0.087		65.8	0.07	105.0	105.0	344.5	230.7
Tractor Shovel 1.3m3	4,100	10,000	410.0	0.65	213.2	53.3	11.0	84.5	21.1	0.174	0.087		65.8	0.07	143.5	143.5	441.2	283.7
Dragline	4,100	10,000	410.0	0.65	213.2	53.3	11.0	84.5	21.1	0.174	0.087		65.8	0.07	143.5	143.5	441.2	283.7
Pile Driver	1,300	10,000	130.0	0.65	67.6	16.9	11.0	84.5	21.1	0.143	0.571	0.429	209.2	0.07	45.5	45.5	197.6	292.7
Dump Truck 6t	900	10,000	90.0	0.80	43.2	10.8	6.5	49.9	12.5	0.139			41.7	0.10	46.0	46.0	138.1	110.0
Weed Cutter	9	4,500	2.0	0.45	0.7	0.2	0.3	2.3	0.6			0.143	25.7	0.05	0.5	0.5	3.5	27.0
Motor Grader 2.5m	2,200	10,000	220.0	0.50	88.0	22.0	7.5	57.6	14.4	0.167	0.087		63.7	0.07	77.0	77.0	222.6	177.1
Tired Roller 11t	720	10,000	72.0	0.50	28.8	7.2	5.7	43.8	10.9	0.167	0.087		63.7	0.07	23.2	23.2	97.8	107.0
Vibrating Roller 3.5t	1,400	10,000	140.0	0.50	56.0	14.0	2.5	19.2	4.8	0.208			62.4	0.07	49.0	49.0	124.2	130.2
Tractor 9-10t 90HP	2,600	10,000	260.0	0.60	124.8	31.2	10.0	76.8	19.2	0.174	0.087		65.8	0.07	91.0	91.0	292.6	207.2
Soil Compactor 90kg	20	4,500	4.4	0.45	1.8	0.4	0.6	4.6	1.2	0.143			42.9	0.05	1.1	1.1	7.3	45.6
Truck Crane 3t	1,010	10,000	101.0	0.45	36.4	9.1	3.1	23.8	6.0	0.173	0.087		65.5	0.07	35.4	35.4	95.5	115.9
Portable Conc. Mixer	31	10,000	3.1	0.70	1.7	0.4	-			0.143			42.9	0.05	0.8	0.8	2.5	44.1

①=①*1000bath/②
⑤=③*④*0.8
⑥=③*④*0.2
⑧=8(bath/litre)*⑦*1.2*0.8
⑨=9(bath/litre)*⑦*1.2*0.2
⑬=(⑩*250bath/day+⑪*130bath/day+⑫*150bath/day)*1.2
⑮=③*⑭*10(Life span)*0.5
⑯=③*⑭*10(Life span)*0.5
⑰=⑤+⑧+⑮
⑱=⑪*⑫+⑬+⑯

①:Market price in Thailand
②:Thailand (310) standard
④:Japanese standard

Table-36. Purchase, running and O & M cost of machinery.

◎ Buildozer

▲ <Excavation> Q=(60*q*f*E)/Cm Cm=0.027*L+0.79

f=	1	Coefficient
E=	0.6	Efficiency
q=	1.34 m3	11ton

L(m)	Cm(min)	Q(m3/hr)
10	1.06	45.5
30	1.60	30.2
60	2.41	20.0

▲ <Levelling + compaction> Q=Q1*Q2/(Q1+Q2)

Q= 38.3 m3/hr

<Levelling> Q1=10*E*(A*D+B)

A=	11	11ton	
B=	8	11ton	
D(m)=	0.3	0.15≦D≦0.35	D:Depth
E=	0.6	Efficiency	

Q1= 67.8 m3/hr

<Compaction> Q2=V*W*D*E/N

V(m/hr)=	3,500	11ton	
W(m)=	0.7	11ton	
D(m)=	0.3	Depth	
E=	0.6	Efficiency	
N=	5		

Q2= 88.2 m3/hr

◎ Scraper Q=(60*q*f*E)/Cm Cm=0.0162*L+1.25

<Excavation>

f=	1	Coefficient		
E=	0.6	Efficiency		
q=	6.8 m3	q=qo*K	K=	0.85
			qo(m3)=	8.00 (26ton)

L(m)	Cm(min)	Q(m3/hr)
100	2.87	85.3
200	4.49	54.5
300	6.11	40.1

◎ Backhoe Q=(3600*q*f*E)/Cm

<Excavation>

f=	1	Coefficient		
E=	0.6	Efficiency		
q=	0.6 m3	q=qo*K	K=	0.98
			qo(m3)=	0.60 m3

swing(°)	Cm(s)	Q(m3/hr)
45	28	45.4
90	30	42.3
135	32	39.7
180	35	36.3

◎ Tractor shovel Q=(3600*q*f*E)/Cm

<Excavation & loading>

f=	1	Coefficient		
E=	0.5	Efficiency		
q=	0.9 m3	q=qo*K	K=	0.73
			qo(m3)=	1.30 m3

L(m)	Cm(min)	Q(m3/hr)	
<8m	45.00	38.0	
8	45.92	37.2	8～50m

◎ Dragline Q=(3600*q*f*E)/Cm

<Excavation & unloading>

f=	1	Coefficient		
E=	0.5	Efficiency		
q=	0.7 m3	q=qo*K	K=	0.88
			qo(m3)=	0.80 m3

swing(°)	Cm(s)	Q(m3/hr)
45	25	50.7
90	28	45.3
135	31	40.9
180	34	37.3

◎ Clamshell Q=(3600*q*f*E)/Cm

<Excavation & unloading>

f=	1	Coefficient		
E=	0.5	Efficiency		
q=	0.5 m3	q=qo*K	K=	0.8
			qo(m3)=	0.6 m3

swing(°)	Cm(s)	Q(m3/hr)
45	33	26.2
90	36	24.0
135	39	22.2
180	42	20.6

◎ Dump truck Q=(60*q*f*E)/Cm Cm=αL+β

<Transportation>

f=	1	Coefficient		
E=	0.9	Efficiency		
q=	3.3 m3	q=T/W	T=	6 ton
			W(t/m3)=	1.8 m3
			α=	4.8
			β=	16

L(m)	Cm(min)	Q(m3/hr)
1,000	20.80	8.7
2,000	25.60	7.0
5,000	40.00	4.5
10,000	64.00	2.8
30,000	160.00	1.1

Table-37. Capacity of machinery.

Unit Cost of Implementation Works

Unit: Baths

Description	Unit	Quantity	Labour & materials cost				Machinery cost			Total cost			Remarks
			Unit cost		Implement cost		Depre	Implement cost					
			L.C.	F.C.	L.C.	F.C.	F.C.	L.C.	F.C.	L.C.	F.C.	Total	
Manual excavation													
Common labour	p/m3	0.5	130		65					65		65	/m3
Manual refilling													
Common labour & compaction	p/m3	0.2	130		26					26		26	
Soil compactor 90kg	set	1.0					1.3	13.7	2.2	14	4	17	
Total cost					26		1.3	13.7	2.2	40	4	43	/m3
Manual slope trimming													
Common labour	p/m2	0.1	130		13					13		13	/m2
Manual sodding													
Material	m2	1.0	15		15					15		15	
Miscellaneous = 10% of materials					2					2		2	
Common labour	p/m2	0.1	130		13					13		13	
Total cost					30					30		30	/m2
Manual banking (laterilte on road)													
Material - Ban Na San (trucked in)	m3	1.0	50		50					50		50	
Material - Lan Saka (trucked in)	m3	1.0	100		100					100		100	
Common labour & compaction	p/m3	0.2	130		26					26		26	
Soil compactor 90kg	set	1.0					1.3	13.7	2.2	14	4	17	
Total cost - Ban Na San					76		1.3	13.7	2.2	90	4	93	/m3
Total cost - Lan Saka					126		1.3	13.7	2.2	140	4	143	/m3
Manual banking (simple structure)													
Material - Ban Na San (trucked in)	m3	1.0	50		50					50		50	
Material - Lan Saka (trucked in)	m3	1.0	100		100					100		100	
Common labour & compaction	p/m3	0.3	130		39					39		39	
Total cost - Ban Na San					89					89		89	/m3
Total cost - Lan Saka					139					139		139	/m3
Land clearing/mowing													
Weed cutter - Ban Na San	ha	1.0					162	2,193	286	2,193	448	2,641	/ha
Weed cutter - Lan Saka	ha	1.0					464	6,264	818	6,264	1,282	7,546	/ha
Heaping & igniting/burning													
Ban Na San 1 person/10a*10	ha	10.0	130		1,300					1,300		1,300	/ha
Lan Saka 2.5persons/10a*10	ha	25.0	130		3,250					3,250		3,250	/ha
Rubble/trash exclusion/removal													
Ban Na San	p	15.0	130		1,950					1,950		1,950	/ha
Lan Saka	p	20.0	130		2,600					2,600		2,600	/ha
Gravel exclusion/removal													
Ban Na San	p	10.0	130		1,300					1,300		1,300	/ha
Lan Saka	p	8.0	130		1,040					1,040		1,040	/ha
Stumping (rakedozer)													
Ban Na San	ha	1.0					1,400	1,126	1,717	1,126	3,117	4,243	/ha
Lan Saka	ha	1.0					2,545	2,047	3,122	2,047	5,667	7,714	/ha
Stump exclusion (rakedozer)													
Ban Na San	ha	1.0					560	450	687	450	1,247	1,697	/ha
Lan Saka	ha	1.0					2,240	1,801	2,748	1,801	4,988	6,789	/ha
Land grading													
Bulldozer 11t	ha	1.0					3,200	2,500	3,900	2,500	7,100	9,600	
Common labour	p/ha	5.0	130		650					650		650	
Total cost					650		3,200	2,500	3,900	3,150	7,100	10,250	/ha
Plowing													
Tractor 9-10t 90HP	ha	1.0					533	425	600	425	1,133	1,558	/ha
Crushed stone foundation (structure)													
Material	m3	1.0	250		250					250		250	
Miscellaneous = 10% of materials					25					25		25	
Skilled labour	p/m3	0.1	150		15					15		15	
Common labour	p/m3	0.2	130		26					26		26	
Total cost					316					316		316	/m3
Bamboo planting													
Labour cost	p	2	120		240					240		240	
Labour cost (50 trees/2 persons)	t	50	240		5					5		5	
Seedling	t	1	25		25					25		25	
Manure	t	1	20		20					20		20	
Total cost per tree	t	1	50		50					50		50	
per m (2 trees/m)	m	2	50		100					100		100	

p : person(s) or person(s)/day, t : tree(s) or per tree

Table-38. Unit cost of light machinery and manual works.

Cost of materials & labour and currency appropriation

Materials	Units	Surat Thani (Baht)	Nakhon Si Thammarat (Baht)	Cost for F/S	Appropriation L.C. (%)	Appropriation F.C. (%)	Unit cost L.C. (Baht)	Unit cost F.C. (Baht)	Remarks
Sand	m3	90	110	110	100		110		
Gravel	m3	250	240	250	100		250		
Laterite	m3	110	180	180	100		180		
Soft timber	m3			9,000	100		9,000		
Sod	m2			15	100		15		
Clayey soil (road banking)	m3	50	50	50	100		50		
Clayey soil (soil improvement)	m3								
Ban Na San		50	100	50	100		50		
Lan Saka				100	100		100		
Cement	20kg	92.5	93.0	93.0	30	70	27.9	65.1	
Steel bar	kg	13.86	14.59	14.59	10	90	1.5	13.1	
Flat bar	kg			17	10	90	1.7	15.3	
Fuel(diesel, gasoline, lubricant oil)	litre			8	50	50	4	4	
Spare parts					10	90			
Reinforced Concrete									
- Light	m3	3,158	3,243	3,243	60	40	1,946	1,297	
- Medium	m3	3,566	3,669	3,669	60	40	2,201	1,468	
- Heavy	m3	3,974	4,095	4,095	60	40	2,457	1,638	
Lean Concrete	m3	1,054	1,069	1,069	70	30	748	321	
Riprap	m3	500	436	500	100		500		
Riprap with mortar	m3	588	526	588	90	10	529	59	
Loose stone	m3	326	271	326	100		326		
Geotextile	m2			58		100		58	
Guard rail	m			1,283	40	60	513	770	
RC pipe	m								
ϕ300	m			450	50	50	225	225	
ϕ500	m			650	50	50	325	325	
ϕ600	m			700	50	50	350	350	
ϕ700	m			800	50	50	400	400	
ϕ800	m			900	50	50	450	450	
ϕ900	m			1,000	50	50	500	500	
ϕ1000	m			1,200	50	50	600	600	
Labour									
Unskilled labour	day	130	130	130	100		130		
Skilled labour	day	150	150	150	100		150		
Foreman	day	250	300	300	100		300		
Carpenter	day	150	180	180	100		180		
Concrete worker	day	150	190	190	100		190		
Steel worker	day	130	190	190	100		190		
Stone worker (mason)	day	130		130	100		130		
Operator (heavy machine)	day	250	250	250	100		250		
Driver (general)	day	200	200	200	100		200		
Mechanic	day	250		250	100		250		
Master mechanic	day	300		300	100		300		
Electrician	day	150	150	150	100		150		
Driller	day	150		150	100		150		
Guard/watchman	day	200	200	200	100		200		
Steelejack	day	180	180	180	100		180		
Surveyer	day	250		250	100		250		
Slide gate 1.3*0.55 (0.72m2)	set	18,000	18,000	18,000	30	70	5,400	12,600	
1.8*0.85 (1.53m2)	set	30,000	30,000	30,000	30	70	9,000	21,000	
2.7*1.35 (3.65m2)	set	60,000	60,000	60,000	30	70	18,000	42,000	

Table-39. Cost of materials & labour and currency appropriation.

Table-40 Supporting Survice Project Cost

1. Facilities and Equipment (F.C.) Unit: Bath

Description	Unit Cost	Ban Na San		Lan Saka	
		Quantity	Amount	Quantity	Amount
Machine and Vehicle					
Pick-up 2200cc	610,000	1	610,000	1	610,000
Station Wagon 2200cc	770,000	1	770,000	1	770,000
Motorcycle 100cc	55,000	2	110,000	2	110,000
Hand Sprayer	30,000	1	30,000	1	30,000
Sub Total	1,465,000		1,520,000		1,520,000
Others			400,000		400,000
Total			1,920,000		1,920,000

2. Personnel Cost

Experts	Unit Cost Baht/Month	Ban Na San (4-year)		Lan Saka (5-year)	
		Quantity (M/M)	Amount	Quantity	Amount
Experts					
Soil	120,000	10	1,200,000	10	1,200,000
Agriculture	120,000	10	1,200,000	10	1,200,000
Irrigation/Drainage	120,000	10	1,200,000	10	1,200,000
Agro-Economy	120,000	10	1,200,000	10	1,200,000
Sub Total	480,000	40	4,800,000	40	4,800,000
Local Staff					
Assistant	20,000	48	960,000	48	960,000
Driver	20,000	48	960,000	48	960,000
Sub Total	40,000	96	1,920,000	96	1,920,000
Total	520,000	136	6,720,000	136	6,720,000

3. Operation/Maintenance Cost

1) Annual Repair and Maintenance of Equipment (F.C.)

Purchase Price/Life Time(10 years) x 0.05

(Ban Na San) 1,520,000/10 x 0.05 = 7,600
(Lan Saka) 1,520,000/10 x 0.05 = 7,600

2) Annual Fuel and Oil (F.C.)

(Ban Na San) 8.0 Baht/liter x 10 liter/day x 200 days x 5 = 80,000
(Lan Saka) 8.0 Baht/liter x 10 liter/day x 200 days x 5 = 80,000

Accordingly, total repair and maintenance cost for project period is estimated as follows :

Description	Ban Na San (4-year)		Lan Saka (5-year)	
	F.C.	L.C.	F.C.	L.C.
1) Repair/Maintenance	30,400		38,000	
2) Fuel/Oil	320,000		400,000	
Total	350,400		438,000	

Table-41 Administration Cost

1. Salary(L.C.)

Section	Annual Salary	Ban Na San		Lan Saka	
		Quantity	Amount	Quantity	Amount
Administration					
Chief	120,000				
Accountant	72,000	1	72,000	1	72,000
Assist-accountant	60,000				
Typist	48,000	1	48,000	1	48,000
Clerk	48,000				
Project Management					
Manager	120,000	1	120,000	1	120,000
Assist-manager	120,000				
Secretary	48,000				
Clerk	48,000				
Engineering					
Chief	120,000				
Civil Engineer	108,000				
Technical	96,000				
Surveyor	108,000	1	108,000	1	108,000
Mechanical Support					
Driver(Vehicles)	72,000				
Operator(Heavy-Machines)	84,000				
Securitary	48,000				
Total	1,320,000	4	348,000	4	348,000

2. Equipment for Supervision of Construction (F.C.)

Description	Unit Cost (F.C.)	Ban Na San		Lan Saka	
		Quantity	Amount	Quantity	Amount
Pick-up	610,000	1	610,000	1	610,000
Swamp Bulldozer 13t	3,000,000				
Bulldozer 11t	2,500,000				
Motorcycle	55,000	2	110,000	2	110,000
Walkie-Talkie	15000	3	45,000	3	45,000
Personal Computer	150000				
Sub Total		6	765,000	6	765,000
Miscellaneous (5%)			38,250		38,250
Total			803,250		803,250

3. Operation Cost

1) Annual Repair and Maintenance of Equipment (F.C.)

Purchase Price/Life Time(10 years) x 0.05

(Ban Na San) 803,000/10 x 0.05 = 4,015
(Lan Saka) 803,000/10 x 0.05 = 4,015

2) Annual Fuel and Oil (F.C.)

(Ban Na San) 8.0 Baht/liter x 10 liter/day x 200 days x 3 = 48,000
(Lan Saka) 8.0 Baht/liter x 10 liter/day x 200 days x 3 = 48,000

Accordingly, total operation cost is estimated as follows :

Description	Ban Na San (3-year)		Lan Saka (3-year)	
	F.C.	L.C.	F.C.	L.C.
1) Repair and Maintenance of Equipment	12,045		12,045	
2) Fuel and Oil	144,000		144,000	
Total	156,045		156,045	

Table-42 Annual Operation/Maintenance Cost

1. Personnel Cost

Description/Section	Ban Na San			Lan Saka		
	1	2	3	1	2	3
Manager	1			1		
Administration		1			1	
Machine Management						
Engineering			1			
Agricultural Service						1
Total	1	1	1	1	1	1

Description/Section	Annual Salary	Ban Na San		Lan Saka	
		Quantity	Amount	Quantity	Amount
1 Officer	108,000	1	108,000	1	108,000
2 Permanent Employee	84,000	1	84,000	1	84,000
3 Temporary Employee	60,000	1	60,000	1	60,000
Total		3	252,000	3	252,000

2. Repair and Maintenance of Equipment and Machine

Description	Purchase Price	Ban Na San		Lan Saka	
		Quantity	Amount	Quantity	Amount
Pick-up	610,000	1	610,000	1	610,000
Tractor	760,000	1	760,000	1	760,000
Hand Sprayer	30,000	1	30,000	1	30,000
Motorcycle	55,000	1	55,000	1	55,000
Total	1,455,000	4	1,455,000	4	1,455,000
Repair/Maintenance Cost			7275		7275

Remark : Repair/Maintenance Cost = (purchase Price/10 years) x 0.05

3. Fuel and Oil Cost

(Ban Na San) 8.0 Baht/liter X 10 liter/day x 200 days x 2 = 32,000
(Lan Saka) 8.0 Baht/liter X 10 liter/day x 200 days x 2 = 32,000

4. Administration and Others (10% of salaries and Wages)

(Ban Na San) 252,000 x 0.10 = 25,200
(Lan Saka) 252,000 x 0.10 = 25,200

5. Annual Operation/Maintenance Cost

(1) Ban Na San

Unit: 1000 Baht

Items	Case-1	Case-2
1- L.C. Personnel Cost		
- Personnel	252	252
- Administration	25	25
- Repair of facilities *1	390	217
Materials for facilities*2	35	24
2- F.C.	32	32
Total	734	550

(2) Lan SaKa

Unit: 1000 Baht

Items	Case-1	Case-2	Case-3	Case-4
1- L.C. Personnel Cost				
- Personnel	252	252	252	252
- Administration	25	25	25	25
- Repair of facilities *1	930	515	644	224
Materials for facilities*2	103	57	71	24
2- F.C.	32	32	32	32
Total	1,342	881	1,024	557

*1 = Construction Cost * 0.01 x 0.9
*2 = Construction Cost * 0.01 x 0.1