4-4 Irrigation Facilities

(1) General

The major problems relevant to the irrigation system in the project area (8,840 km^2) are as follows;

- Almost all cultivation areas of upland, vegetable and tree crops are rainfed only due to poor water resources development.
- Depending mainly on rainfed cultivation, the farmers have little knowledge or experience in water resources development or irrigation methods.
- The area has a comparatively rich rainfall compared with other regions. However, 80% of the annual precipitation in the area occurs in the rainy season, therefore, even in Chanthaburi which has the highest amount of rainfall, water shortages occur in the dry season.
- The function of existing reservoirs and natural streams is decaying with the accumulation of sedimentation caused by land erosion, particularly in the area planted with cassava in Rayong and Chonburi provinces.

Taking into account the background mentioned above and the undulating topography, establishment of an irrigation system with small reservoirs is prerequisite to complete the system of agricultural production in the project area.

(2) Irrigation method

1) Crops

Considering the marketability of crops and the topography, irrigation for upland and tree crops should be promoted with high priority.

In case of introducing an irrigation system to the project area, it is very important to obtain stable water resources such as reservoir and/or groundwater. However, sufficient water resources for irrigation will be limited by the following;

- Maximum height of dam to be constructed by DLD shall be less than 6.0 m from the original ground surface.
- Area required for coustruction must be kept to a minimum in order to acquire farmer's agreement.
- Dam with large storage capacity will not be constructed owing to the undulating topography and highly permeable ground.
- Groundwater will be limited because the area is covered with granite which has poor water holding capacity.
- Limitation of water resources indicates that water cost of small irrigation systems is higher than that of large ones.

Therefore, the construction plan for the irrigation facilities in the project area is considered to be for beneficial crops such as fruit trees, vegetables, etc. as actually being introduced in the field.

2) Irrigation method

The irrigation method for field crops is mainly classified as follows ;

i) Surface irrigation
(Border irrigation, Contour ditch irrigation, Furrow irrigation, Perforated pipe irrigation, etc.)

ii) Spray irrigation
(Sprinkler irrigation, Drip irrigation, etc.)

iii) Sub-surface irrigation
(Open canal irrigation, Pipeline irrigation)

Selection of the irrigation method shall be made taking into account the various factors such as field and climatic conditions, irrigation efficiency, construction cost, operation and maintenance methods, etc. (Comparison of each irrigation method is shown in Table 3.3-5 and 3.3-6 of Vol. IV Appendix for B/P).

Considering field conditions of the project area and cost of storage water, irrigation methods for upland and tree crops shall be employed as follows.

- Water shall be taken from the pond by methods such as gravity flow through outlets for the down-stream area and pumping up for the up-stream area,

- Relationship between basic intake rate and irrigation method is generally as follows;

Infiltration	Basic Intake Rate	Irrigation Method
Large	More than 75 mm/hr	Spray irrigation
Medium	50 - 75 mm/hr	Spray or surface irrigation
Small	Less than 50 mm/hr	Surface irrigation

According to the results of the infiltration test conducted in the field, there were some places with small intake rates, however, most of the soil texture of each pilot area is sandy.

Therefore,

- Perforated pipe irrigation
- Sprinkler irrigation
- Spot drip irrigation

will be adaptable but such surface irrigation as border, contour ditch and furrow irrigation will not be suitable due to the high amount of water consumption.

- From the economical point of view, in case of comparatively large ponds (more than 100,000 cu.m pond capacity) a pump station will be planned but in other cases, utilization of portable pumps is more applicable.

(3) Irrigation water requirement

Considering the cost and limited amount of water, only tree crops especially fruit trees and vegetables will be irrigated and upland crops presently planted under rainfed conditions such as cassava, sugarcane and pineapple are not considered to be irrigated.

Diversion water requirement is estimated taking into account crop consumptive use, rainfall, water losses (field losses, conveyance and operation losses), etc.

The diversion water requirement for fruit trees which will be introduced was estimated based on 1/2 year minimum rainfall as shown in Table 4.4-2 under the following conditions.

1) Crop consumptive use

Crop consumptive use was estimated by applying the modified Penman Method taking into account the data obtained in the field. (Refer to Table 4.4-1)

Crop	Crop Factor	Water Consumption (mm) Maximum per day	Average per day	Per year
Mango	0.6	2.5 ~ 3.4	2.0 ~ 2.8	739 ~ 1,019
Durian	0.7	2.9 ~ 4.0	2.4 ~ 3.3	862 ~ 1,189

2) Effective rainfall

Efective rainfall for upland crops is considered to be the rainfall amount retained as total readily available moisture (TRAM) in the effective root zone. The rainfall beyond the said rainfall amount will flow out from the cultivated area. TRAM for fruit trees was assummed according to the soil texture as follows;

Soil Texture	Available Water Holding Capacity (%)	Effective soil layer (cm)	TRAM (mm)
- Sandy loam	11	120	73
- Loamy sand ~ sandy loam	7 ~ 11	120	60
- Clay loam ~ Silty clay	14 ~ 17	120	100

3) Irrigation efficiency

The irrigation efficiency is dependent on field, water conveyance and operation conditions. In order to use the valuable water effectively, spot irrigation method with pipe-line system which

is one of the minimum water loss methods shall be adopted. An irrigation efficiency of 0.75 will be expected.

Crop	Irrigation method	Irrigation Efficiency Ef	Ec	Eo	E
- Paddy land	Surface	0.70	0.90	0.90	0.57
- Up land	Surface	0.55	0.90	0.90	0.45
	Spray	0.70	0.95	1.00	0.67
	Spot	0.80	0.95	1.00	0.76

4) Other conditions

Irrigation interval;

Although the irrigation interval for upland crops is normally assummed as TRAM divided by maximum water consumption, taking into account optimum phenomena of water absorption of root and practical irrigation in the field, a half month interval is applied.

Rainfall;

Taking into account characteristics of trees such as ability to withstand drought, minimum 1/2 year probability rainfall is employed.

Table 4.4-2 indicates that in the dry season, 400 ~ 600 mm of irrigation water for fruit trees is required, while in the rainy season Chanthaburi province has almost enough water for growing but other provinces require 120 ~ 170 mm water.

Table 4.4-1 Crop Consumptive Use

Province	ETo 1)	Crop	Crop Factor	Growing Period	Average Water Consumption	
					Per Day	Per Year
	(mm/Year)				(mm)	(mm)
Chachaoengsao	1,569	Mango	0.6	Year round	2.6 (3.2 ~ 2.0)	941
/ Chonburi		Durian	0.7	〃	3.0 (3.8 ~ 2.4)	1,098
Rayong	1,699	Mango	0.6	〃	2.8 (3.4 ~ 2.2)	1,019
		Durian	0.7	〃	3.3 (4.0 ~ 2.5)	1,189
Chanthaburi	1,232	Mango	0.6	〃	2.0 (2.5 ~ 1.7)	739
		Durian	0.7	〃	2.4 (2.9 ~ 2.0)	862

1) ETo ; Evapotranspiration

Table 4.4-2 Diversion Water Requirement

Pilot Area	Crop	Annual Rainfall	Effective Rainfall	Water Consumption	Diversion Water Consumption	
					Dry	Rainy
		(mm)	(mm)	(mm)	(mm)	(mm)
CS – NO.3	Mango	1,514.8	436.5	941.0	546.3	126.4
CN – NO.8	Durian	1,174.9	535.8	1,099.4	580.8	170.8
RY – NO.2	Durian	1,421.3	650.1	1,189.5	588.2	130.9
CT – NO. 2	Durian	2,225.4	481.3	864.5	446.7	64.2

Note;

(1) Rainfall is 1/2 year minimum rainfall

(2) Relationship between pilot area and gaging station is

Pilot Area	Gaging Station
CS – NO.3	CS – 03052
CN – NO.8	CN – 09042
RY – NO.2	RY – 48022
CT – NO. 2	CT – 06081

(4) Irrigation facilities

Presently, the project area (8,840 km²) is under rainfed cultivation except for a certain area as aforementioned. In case that the soil conservation measures are introduced to the project area according to the characteristic of each province, about 530 km² of irrigable area for upland crops will be possible by constructing 212 MCM of reservoir capacity as shown in Table 4.4-3.

Table 4.4-3 Development Plan for the Project Area

Province	Area	Plan	Rate [1]	Acreage	Required Water Resources [2]
	(km²)		(%)	(km²)	(1000 m³)
Chachoengsao	2,200	II	6	132	52,800
Chonburi	3,041	II	6	182	72,800
Rayong	2,634	II	6	158	63,200
Chanthaburi	965	II	6	58	23,200
Total	8,840			530	212,000

Note;

1) ; Irrigation rate for each plan (refer to Table 3.2.3-1 in Vol. Ⅲ)

2) ; 4,000 m³/ha of required pond capacity for irrigable area is applied (refer to Table 3.2.3-1 in Vol. Ⅲ)

4-5 Supporting Measures

(1) Infrastructural background for rural development

1) Rural area and population in the study area

The area and population in the provinces are;

Rural area	:	18,641.2 km²	Population	1,360,508
Municipal area	:	313.7 km²	Population	281,000
Sanitary area	:	649.1 km²	Population	499,667

According to the above data, the rural area covers 95% of the whole study area and 64% of the whole population are residing there.

2) Target areas for rural development in the study area

In the Sixth NESD Plan which is the key governmental policy for rural development, target areas are determined in accordance with problems and needs, 1) Backward area, 2) Middle-level area and 3) Progressive area. Within the three areas, backward area and middle-level area are the target areas for rural development by the government. The number of the said three kinds of areas in the study area is as follows;

Backward area	:	403 villages
Middle-level area	:	1,002 villages
Progressive area	:	692 villages

3) The status of rural development in the Sixth NESD Plan

i) The Sixth Economic and Social Development Plan

The Sixth NESD Plan has a direction for development up to 1991 that includes 2 overall targets, 3 main strategies and 10 working programs as follows :

- Two targets

a) Set up economic growth target at an average of more than 5 % year.

b) Developing human quality to enable progress in social development and to create peace and fairness in society.

- Three strategies

a) Increase efficiency and capability in country development including human resources development, science and technology, and natural resources development.

b) Increase efficiency, improve quality in production, marketing , technology and reduce production costs to be able to better compete with other countries.

c) Promote the income distribution and wider distribution of development and distribution of development benefits to the region and rural areas, especially the low income groups.

- Ten working programs

a) Economic and financial stabililzation program

b) Program to develop human resources, society and culture

c) Natural resources development and environmental management program

d) Science and technology development program

e) Program to improve management and review the government's role in the development process

f) State enterprises development program

g) Program to develop production, marketing and employment generation system

h) Basic service development program

i) Urban and specific zones development program

j) Rural development program

ii) Rural development program in the Sixth NESD plan

- Objectives:

To improve the quality of life of the poor population who live in rural areas and have missed out on development benefits in order to produce more community self-reliance and to enable the population to adjust themselves properly to the changing economic and social environment.

- Strategies:

a) Emphasize on the target area specified by the provinces.

This is to completely solve the remaining problems left over from the Fifth plan, by using the area, social and economic conditions as the development criteria, based on the real problems and needs of the population.

b) Lift up the living standard of rural population covering the backward, middle-level and progressive areas.

The government sector should concentrate on the backward and middle-level areas, while encouraging the private sector to invest more in the progressive areas.

c) Adjust the rural development management mechanisms to unite every sector and become more integrated, cooperate in solving basic problems of the rural community, increasing the production income by using the appropriate technology.

d) Promote the role of rural people's organizations and the population in making decisions and solving their own problems and the community's as well as encourage them to be able to help themselves.

- Development program:

The development programs can be divided into 3 categories as follows;

a) The rural development program under the government sector and popular participation. The six ministries who are responsible for this program are the Ministry of Agriculture and Cooperatives, Education, Public Health, Industry, Commerce and Interior.

b) The rural development programs to be implemented by the private sector and the people's association's such as the rural job creation program, the quality of life

improvement program, the rural development fund program and other development programs.

c) Other rural development administration supplementary programs such as training and supervision in rural development planning, monitoring and evaluation program, and so on.

(2) Existing social infrastructure in the study area

1) Structure of the settlement in the study area

As the result of the field investigation, it can be said that the structure of the settlement in the rural area is a typical scatter type.

2) Roads and transportation

There are many principal and provincial highways, whose total length in the 4 provinces is about 2,209 km. The road density is 113 m/km^2 and many standard roads connect residential areas conveniently within the study area as well as branch off towards the neighbouring towns. The Eastern Seabord area is already covered by an extensive road network, including an expressway to Bangkok Metropolis. There are also 226 km of railroad passing through Chachoengsao, Nakhon Nayok and Prachinburi.

The other 143 km railway line from Chachoengsao, down the western fringe of the Eastern seabord to Sattahip passing Si Racha and Laem Chabang, is under construction. There is also a commercial sea-port at Sattahip. In addition, U-Tapao has been converted from a military base to a commercial airport and in Thamai district, Chanthaburi, there is a commercial airport, also.

3) Rural motorization

Under such road conditions, rural motorization has been progressing remarkably, one out of ten households owns a pick-up truck and one out of four households owns a motorcycle.

4) Water supply

There are few large water resources in the study area compared with other regions. The use of water for agriculture, industry and domestic purposes has been relying on the existing small reservoirs

and/or groundwater in specific areas.

Besides, the geological structure of the foundation is granite stone which cannot store water and causes a lack of groundwater especially in the seaboard area. As far as drinking and domestic water in the study area are concerned, 52% of the total number of villages are under the worst conditions.

5) Rural electrification

According to the data from the PEA, the electrified rate of the total number of villages in the study area as of 1987 is more than 80%.

Nearly 20% of the households have been left from electrification because of the structure of their settlement, scatter type.

6) Communication

i) Postal service

In fiscal year 1987, the number of post offices, special post offices and mailboxes in the study area are 47, 4, and 965, respectively.

The communication Authority of Thailand has a criterion of post office establishment, one post office shall cover 30,000 ~ 50,000 inhabitants and/or 50 ~ 200 km^2 in area.

When comparing the existing number of post offices with the criterion, an existing post office covers about 33,000 persons and 300 km^2 which coincides with the criterion. There is a future plan to establish another two post offices in Chonburi province to meet the further demand of the Eastern Seaboard area.

ii) Telephone

At present, there are 64 telephone exchanges in the study area. Telephone Organization of Thailand (TOT) has a criterion of telephone exchange establishment, viz., one telephone exchange shall be installed in tambons which have a population of more than 5,000.

Public telephones have not been installed in the rural area, so government and public offices and factories such as large enterprises have been using radiophones.

According to the TOT's schedule, telephone lines will be increased from the existing 35,300 lines to 57,248 lines and another two telephone exchanges in Chonburi province in order to meet with Eastern Seabord Development in the near future.

7) Education

The education system in Thailand adopted the 6-3-3 school year system ten years ago.

The point at issue on this matter may be elementary schools, whose criteria for establishment are; 1) number of pupils must not be less than 20 per each grade, 2) the area of the school must not be less than 6 rai (0.96 ha), and 3) the new school must be at least 6 km away from any existing school. According to the fundamental data of the Sixth NESD Plan, 969 villages (47.2%) in the study area have an elementary school and most of the children attend school on foot or by bus.

8) Public health

As the result of the Fifth NESD Plan's emphasis on this matter in rural development under which continuous efforts have been made by government, 288 district hospitals were constructed and sub-district health offices established in all target areas on a national scale.

Despite such progress during the period of the Fifth Plan, both the adults and children in many villages are still afflicted with malaria and other diseases and the infant mortality rate is still relatively high.

There are lots of farmhouses which have no lavatory and colon bacilli were detected from the shallow well water they consume every day. Sanitary conditions surrounding rural people still have much room for improvement.

Criteria for establishment of public health centers are; 1) population of more than 3,000, 2) 2 rai (0.32 ha) of land must be provided without any conditions, 3) there are no existing health services, 4) it must not be located in the same sub-dictrict of a district hospital and 5) in case there is an existing health center, the new one must be at least 8 km away.

9) Agricultural facilities

Agriculture is the main occupation of the population of the study area. People are engaged in growing rice, cassava, sugarcane, rubber, fruit trees, pineapple, and chicken raising, etc. As far as agricutural facilities in the study area are concerned, there are few large scale facilities which can be mentioned except for some rice warehouses of the 300 ~ 2,500 ton class in the paddy regions.

10) Agricultural mechanization

In the study area, ploughing has generally been practiced by hired tractors. The tractors used for ploughing on the upland field are mostly of the 60-horsepower class and ploughing fees range from 120 to 150 Baht per rai (0.16 ha).

The other works are carried out by manual labor.

(3) Infrastructural supporting measures

As aforementioned, the integrated rural development including land and water couservation in the East is understood to be one of the important stratagies for the Thai economy in line with the Sixth NESD Plan.

While, the success of land and water conservation development will depend on the efforts of the farmer's themselves as well as government support.

However, the living conditions of people in the rural area are poor compared with the progressive area adjacent to the planning area and/or the Central Region.

Therefore, in order to expedite land and water conservation development in the East, the following rural development countermeasures, particularly agricultural infrastructure which may be implemented by DLD and/or with the cooperation of other agencies concerned are recommended to be introduced in the project sites. Those countermeasures should correspond with the villager's needs found during the first and second phase field surveys.

- Developing small scale water resources
- Maintaining and paving the rural roads
- Installing electricity

- Introducing cottage industry
- Constructing warehouse and meeting hall
- Providing fish ponds

(4) Agro-industry

The main agro-industries located in the four provinces concerning processing of upland crops are sugar mills and refineries, and pineapple canning factories (canned fruit and juice). Both sugarcane and pineapple are cultivated by farmers who have contracted with processing factories for purchase of their crop. The area to be cultivated and the quality and quantity of production are fixed in the contract.

Credit is available from the factories for both crops. In the case of pineapple, credit is available in kind (seed, fertilizer, pesticide, etc.) only and technical assistance is provided by the factory free of charge. In the case of sugarcane, credit is available in the form of a cash loan.

Concerning prices, a guaranteed minimum price for pineapple is agreed to in the contract between the farmer and the factory. Since there are several factories located in the area, 6 in Chonburi and 3 in Rayong, and the market price for fresh pineapple is competitive, the farmers are able to receive a fair purchasing price from the factory for their crop. Prices for sugarcane fluctuate according to market demand so the farmer is at a disadvantage in cultivating sugarcane since he will not know the actual value of his crop until the day it is cut and transported to the factory.

Fruits and products generated 4.15% of total agricultural exports in 1986 with pineapple products accounting for 68.34% of them. Also, raw sugar and products made up 6.27% of the same total agricultural exports. This means that factory processed pineapple and sugar products accounted for approximately 9.11% of the total volume of agricultural exports in 1986.

Future prospects for exports of pineapple products (fresh, canned, juice, dried, etc.) appear favorable as they have increased 41.5% over the period from 1982-1986 and should maintain at least a 5% growth per annum.

The outlook for sugar appears to be one of increasing prices which will mean stability for the industry.

(5) Education of farmers

In spite of long endeavors by DLD to transfer technology in prevention of erosion through lectures or exhibition farmers, there are still some farmers who complain of lack of technical know how concerning countermeasures against soil erosion.

Although there appear to be some very eminent farmers in the rural area, however, in any country, most of them have rather limited formal education and basically this is the main bottle neck of agricultural development.

The real motive behind rural development must be the farmers desire to improve their living standards and if this philosophy is agreeable, encouraging farmers by giving as many chances of education as possible should be emphasized.

The endeavors of DLD in this field in recent years should be appreciated but they must be enforced with much more support of the government.

(6) Institutional cooperation

There are several government agencies concerned with integrated rural development. Among them DLD, DOAE and DA are three main agencies responsible for technical problems in agriculture for the time being. They have their own extension agents or research staff for the purpose of increasing agricultural production in the area. They should have very close relations in order to carry out their responsibilities effectively. It is observed that relations between these agencies or staff themselves are very close and they are helping each other by exchanging their personal information but their official cooperation on an institutional basis seems to have room for more improvement. For instance, in case of making a plan of activities for coming year(s), these three agencies have to exchange ideas among each other in order to share their duties and to make their positions clear.

Since the purpose of this study is for integrated rural development, it is also necessary to integrate the efforts of related agencies to raise the level of the farmers' living standards.

Chapter 5.

IMPLEMENTATION AND PROJECT COST

CHAPTER 5 IMPLEMENTATION AND PROJECT COST

5-1 Implementation Plan

(1) General

The area of soil erosion occurring at a rate of more than 5 ton/ha/year is more than 17,231 thousand hectares for the whole country (34% of national land) and 1,841 thousand hectares are located in the 7 provinces of the Eastern Region (49% of 7 provinces). This is not only a simple matter of agricultural production but an important problem in consideration of national land conservation.

This basic plan calls for the setting down of an integrated rural development plan for the four provinces of the eastern coast centering on land conservation. In parallel with this, 16 pilot areas were selected in the four provinces and a feasibility study has been carried out. Furthermore, DLD has planned the establishment of the "Land and Water Conservation Center", which will be the technological headquarters of civil works of DLD. Correspondingly, these plans must be realized following the 10-Year implementation plan and the long term implementation schedule.

In order to promote the project and coordinate various ministries and departments, DLD should be the most suitable organization. However, this does not mean that DLD must carry out the project alone, the project shall be implemented by each agency according to its allotted task. For satisfactory implementation, a steering board such as the "Board of Land and Water Conservation" shall be established within the MOAC, as well as the "Steering Committee on Land and Water Conservation".

(2) 10-Year implementation plan

1) The feasibility study of the 16 pilot areas and the B/P of the four provinces will be completed in 1988.
2) As stated in this report the top priority "Land and Water Conservation Center" should be completed by 1990.

3) The 16 Pilot areas shall be formed into two groups and their construction utilizing the Center's construction equipment will start from 1990. (Figure 5.1-1)

4) During the construction of the pilot areas and after completion, data collection, monitoring and evaluation activities shall continue.

(3) Long term implementation schedule

1) The total project period is planned for 30 years from the first to the sixth 5-year plan.

2) The first 5-year plan starts from 1991 for the preparation works of the implementation of the long term plan and to gain various experience. Therefore, the first 5-year plan is allotted only 10,000 ha per year in the 4 provinces.

3) From the second 5-year plan, conservation works of approximately 35,000 ha shall be completed annually in the 4 provinces. (Table 5.1-1)

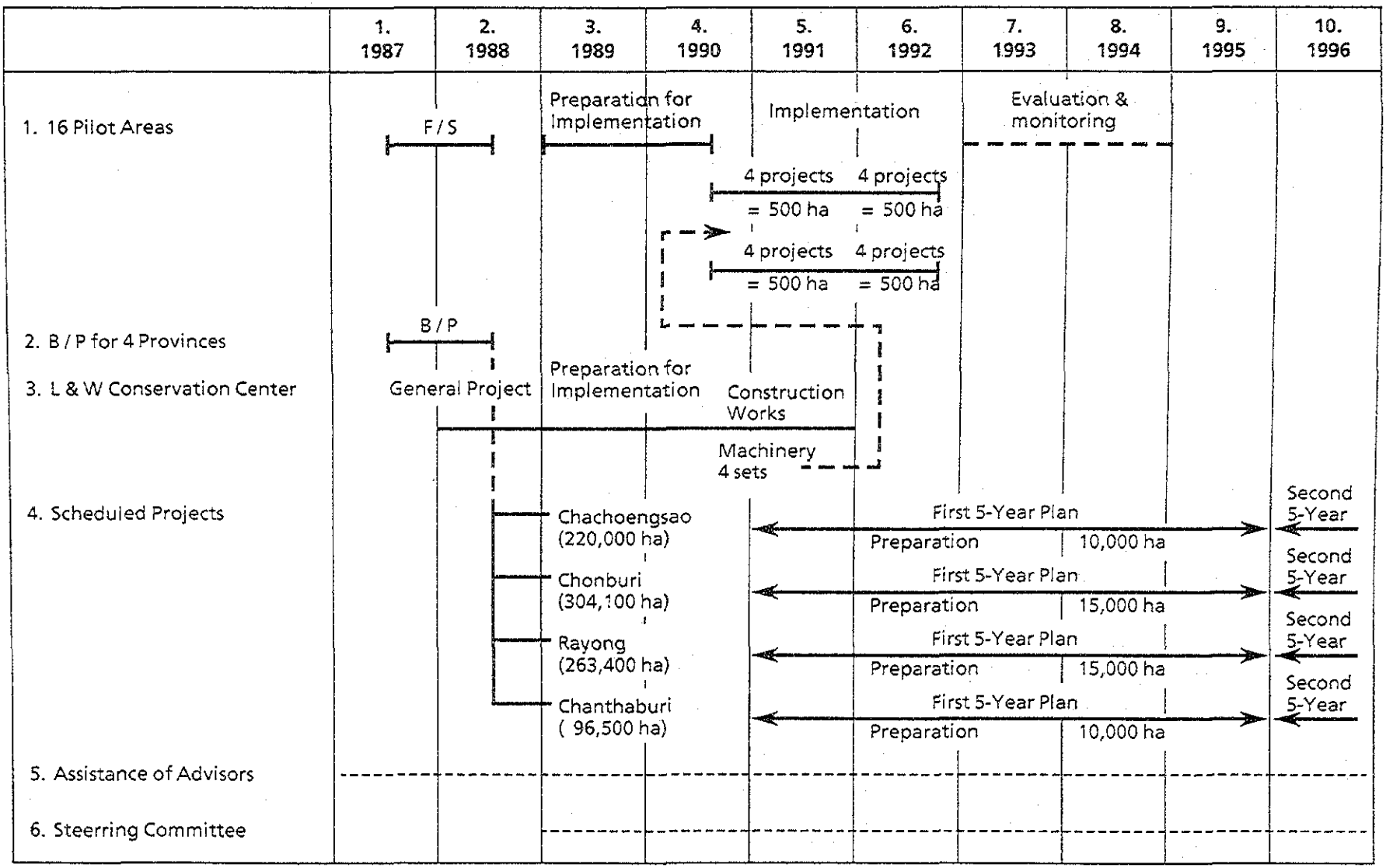

Figure 5.1-1 10-Year Implementation Plan

Table 5.1-1 Long Term Implementation Schedule (Tentative)

(ha)

Province	Classified Area		1991/1995	1996/2000	2001/2005	2006/2010	2011/2015	2016/2020	Remark
Chachoengsao	1. Top Urgent	38,800	10,000	28,800					
	2. Urgent	55,300		11,300	41,000	3,000			
	3. Necessary	52,300				37,300	15,000		
	4. Normal	35,100					25,000	10,000	
	5. Not Necessary	38,500						38,500	
	Sub-total	220,000	10,000	40,100	41,000	40,300	40,100	48,500	
Chonburi	1. Top Urgent	124,500	15,000	59,500	50,000				
	2. Urgent	52,100			12,100	40,000			
	3. Necessary	43,900				23,000	20,900		
	4. Normal	2,300					2,300		
	5. Not Necessary	81,300					40,000	41,300	
	Sub-total	304,100	15,000	59,500	62,100	63,000	63,200	41,300	
Rayong	1. Top Urgent	92,300	15,000	35,000	42,300				
	2. Urgent	17,000		12,000	5,000				
	3. Necessary	86,400				53,000	33,400		
	4. Normal	22,300					22,300		
	5. Not Necessary	45,400						45,400	
	Sub-total	263,400	15,000	47,000	47,300	53,000	55,700	45,400	
Chanthaburi	1. Top Urgent	33,100	10,000	23,100					
	2. Urgent	26,800		6,000	20,800				
	3. Necessary	32,800			9,000	23,800			
	4. Normal	1,200				1,200			
	5. Not Necessary	2,600				2,600			
	Sub-total	96,500	10,000	29,100	29,800	27,600	–	–	
Total	1. Top Urgent	288,700	50,000	146,400	92,300				
	2. Urgent	151,200		29,300	78,900	43,000			
	3. Necessary	215,400			9,000	137,100	69,300		
	4. Normal	60,900				1,200	49,700	10,000	
	5. Not Necessary	167,800				2,600	40,000	125,200	
	Sub-total	884,000	50,000	175,700	180,200	183,900	159,000	135,200	
Annual Average		29,500	10,000	35,140	36,040	36,780	31,800	27,040	

5-2 Alternative Plan

The project covers such a large area, therefore, physical, agricultural and socio-economic conditions will vary greatly according to the location of each land and water conservation development site. In order to select the most suitable land and water conservation countermeasures based on the particular conditions of each site, an alternative plan by grade has been formulated as follows.

Project grade shall be classified into three levels; Plan I (High Grade), Plan II (Medium Grade) and Plan III (Common Grade), each grade is explained below :

a) Plan I (High Grade)
   - Target : prevention of soil loss by 90%
   - Selected mechanical measures shall be applied full scale.
   - Irrigation facilities shall be applied with one large farm pond (Tameike), pump station, fixed pipeline and tank.
   - Supporting measures shall be considered on a suitable scale.

b) Plan II (Medium Grade)
   - Target : prevention of soil loss by 85%
   - Selected mechanical measures shall be applied on a medium scale
   - Irrigation facilities shall be applied with some small scale farm ponds, portable pumps and portable hose.
   - Supporting measures shall be considered on a medium scale.

c) Plan III Common Grade
   - Target : prevention of soil loss by 80%
   - Selected mechanical measures shall be applied to a certain scale.
   - Irrigation facilities shall be applied by small scale farm pond, portable pump and portable hose.
   - Supporting measures shall include only well for drinking water.

Table 5.2-1 shows the summary of the contents of each case.

Table 5.2-1 Alternatives of Soil Conservation Plan

Condition : Total Area = 154 Ha = 962.5 rai
Farm Size = 100 m × 500 m = 31.25 rai/Farm

Measure	Plan I	Plan II	Plan III
Target (soil loss)	90 % (50→5 t/ha/y)	85 % (50→7.5)	80 % (50→10)
1. Mechanical Measures			
a. Sub soiling	50 % of the Area	25 %	–
b. Contour terrace	Interval 40 m (40 m/rai)	50 m (32 m/rai)	60 m (26.7 m/rai)
c. Collecting canal	Masonry canal + drops Interval 200 m (= 8.0 m/rai)	Grass water-way + drops 300 m (= 5.3 m/rai)	Grass water-way 400 m (= 4.0 m/rai)
d. Sediment trap	1 pl/25 rai	1/50 rai	1/100 rai
e. Draining ditch	Masonry water-way (3.2 m/rai)	Grass water-way (3.2 m/rai)	Soil water-way (3.2 m/rai)
f. Road			
– lateral	8.0 m/rai	5.3 m/rai	4.0 m/rai
– trunk	1.6 m/rai	1.6 m/rai	1.6 m/rai
g. Check dam	1 pl/250 rai (masonry)	1 pl/250 rai (masonry)	1 pl/250 rai (earth dam)
h. Slope protection	6.4 m^2/rai (sodding)	3.2 m^2/rai (sodding)	–
2. Irrigation Facilities			
i. Farm pond	one, large scale	1 pl/300 rai small scale	1 pl/800 rai small scale
j. Irrigation facilities	Pump station, Pipeline, Tank } Package	Portable pump Portable hose	Portable pump Portable hose
3. Supporting Measures			
k. Fish pond	1 pl/250 rai	1 pl/500 rai	–
l. Shallow well	1 pl/150 rai	1 pl/250 rai	1 pl/350 rai
m. Meeting house	200m^2	100m^2	–
n. Warehouse	500m^2	300m^2	–

Measure	Plan I	Plan II	Plan III
(Note) Target of Irrigable area	Storage capacity (S.C) = 125,000 m^3 Irrigable area 50 ha = 312 rai	10,000 × 3 places = 30,000 m^3 12 ha = 75 rai	10,000 × 2 places = 20,000 m^3 8 ha = 50 rai
Useless area	15 %	10 %	7 %

5-3 Project Cost Estimation

(1) Project cost

The project cost for the planning area of 8,840 km² has been estimated under the following conditions.

- Project construction will be implemented under contract basis.
- Unit project cost is estimated for Alternative Plan II for all 4 provinces.

Province	Area	Unit Project Cost	Total Project Cost
	(km²)	(Baht/rai)	(MB)
Chachoengsao	2,200	12,825	17,633
Chonburi	3,041	12,825	24,373
Rayong	2,634	12,825	21,111
Chanhtaburi	965	12,825	7,734
Total	8,840		70,851

The exchange rate applied for cost estimation is US $1.00=25.52 Baht=¥ 128.92.

The project cost schedule by each five year in line with the implementation program is shown in Table 5.3-1.

(2) Components of the project cost

The project cost consists of the following components.

1) Civil work costs

- Preparatory works ; Tentatively 5% of other items of civil work cost was given.
  - Pre-engineering ; Topographical and cadastal survey, soil survey, geological survey, etc.
  - Preparation ; Access roads, transmission line, land clearing, field camps, office, etc.

- Land conservation facilities ; Terrace, waterway, sediment pond farm roads, drop structure, tree belt, etc.
- Irrigation facilities ; Farm pond, irrigation canal and pipeline, pump station, etc.
- Agricultural supporting services ; Rural development facilities, marketing facilities, inland fishery facilities, training services, etc.

2) Construction equipment ; Purchasing cost for construction equipment
(Force account basis or contract basis in case equipment supplied by government)

3) Project administration ; Administrative charge of government staff
(100,000 Baht/month)

4) Engineering services ; Engineering cost for consultants of foreign and local experts for the implementation of the detailed design and supervision of the Project implementation (Tentatively 10% of civil work cost was given)

5) Physical contingency ; 10 percent of total cost for minor difficulties in construction, possible change in plan and uncertainties in foundation conditions

6) Price contingency ; Price escalation rates for both manufactured goods and civil works.
6.5%/year for local currency portion and 7.5%/year for foreign currency portion.

Data source ; Thailand Rural Land Use Project June 1986
Thailand Development Research Institute, NESDB

Note : In accordance with the regulation of the Rural Development Act, land aquisition and compensation costs were not included in the cost estimate.

(3) Unit price

The cost of construction work is estimated based on the data collected on prices from DLD and RID as of February 1988.

The unit prices used for estimation of project cost are as follows ;

1) Labour unit price

Item	Rate (Baht/day)
Foreman	160
Equipment Operator	150
Operator Assistant	80
Driver	120
Steel Worker	200
Concerete Worker	80
Carpenter	150
Mechanic	190
Electrician	170
Mason	135
Common Labourer	75

2) Unit price of materials

Item	Unit	Rate (Baht)
Sand	cu.m	160
Gravel	cu.m	250
Rip Rap	cu.m	240
Laterite	cu.m	100
Reinforcement Bar	ton	12,000
Cement	ton	1,700
Diesel Oil	litre	6.7
Electrical Charge	KWH	3.5
Timber (Soft)	cu.m	6,500
Timber (Hard)	cu.m	8,500

3) Rate of foreign and local currency

Project costs in foreign and local currencies will be applied proportionally according to the following table, referring to actual figures used in Projects implemented by the International Bank for Reconstruction and Development (IBRD), Asian Development Bank (ADB) and Japan International Cooperation Agency (JICA).

Description	Rate of Foreign Currency	Rate of Local Currency
Cement	60 %	40 %
Steel bar	70 %	30 %
Timber	20 %	80 %
Fuel & Oil	80 %	20 %
Labour	-	100 %
Spare parts	90 %	10 %
Gravel	-	100 %
Sand	-	100 %
Laterite	-	100 %
Concrete block	40 %	60 %
Reinforced concrete pipe	50 %	50 %
Construction equipment	100 %	-

4) Rate of overhead

Contractors' overhead and profit is estimated at 15% of unit cost.

(Unit : %)

Item	Local Contract Case
(1) Profit	5.0
(2) Administration	1.0
(3) Tax	3.4
(4) Cost reserved	4.1
(5) Insurance	1.5
(6) Overhead rate	15.0 of (1)~(5)

Table 5.3-1 Project Cost

Province	Project Cost & Acreage			1991/1995	1996/2000	2001/2005	2006/2010	2011/2015	2016/2020	Remark
Chachoengsao	Project Cost	MB	17,633	802	3,214	3,286	3,230	3,214	3,887	12,825 Baht/rai = 80,156 Baht/ha
	Acreage	ha	220,000	10,000	40,100	41,000	40,300	40,100	48,500	
Chonburi	Project Cost	MB	24,373	1,202	4,769	4,977	5,049	5,066	3,310	
	Acreage	ha	304,100	15,000	59,500	62,100	63,000	63,200	41,300	
Rayong	Project Cost	MB	21,111	1,202	3,767	3,791	4,248	4,464	3,639	
	Acreage	ha	263,400	15,000	47,000	47,300	53,000	55,700	45,400	
Chanthaburi	Project Cost	MB	7,734	801	2,333	2,388	2,212			
	Acreage	ha	96,500	10,000	29,100	29,800	27,600	–	–	
Total	Project Cost	MB	70,851	4,007	14,083	14,442	14,739	12,744	10,836	
	Acreage	ha	884,000	50,000	175,700	180,200	183,900	159,000	135,200	

5-4 Construction Schedule

(1) Mode of construction

As for the project execution, two modes can be considered one being force account basis under DLD and the other contract basis.

Contract basis will be adopted for the Project after taking the following matters into consideration.

1) The project cost on the contract basis is estimated to be lower than on the force account basis due to exclusion of the purchase of construction equipment. Moreover, if the force account basis were taken for the project construction many engineers, labourers, construction equipment and materials, in particular, experts and special equipment would be provided temporarily by DLD according to the characteristic features of the project. After completion of the project, it would be difficult to appropriate such equipment and personnel for another project effectively. DLD would have to provide personnel expenses and equipment maintenance fees during the period between projects (idling period). Therefore, the force account basis is not economical from the viewpoint of the total cost of the Project.

Although the force account basis for project construction had been utilized in the initial stage of economic development even in advanced countries with the purpose of promoting employment, the government budget has become oppressed financially due to the annual increase in maintenance costs. Therefore, most projects have recently come to be constructed on a contract basis in Thailand except in special cases.

Construction under the contract basis applying lending of construction equipment to the contractor from the government has almost a similar characteristic to that as mentioned above. Namely, the government will have to maintain a lot of construction equipment and to employ personnel during the idling period.

2) The increased capability of private firms will be very useful for the further development of the Thai economy in the future. The technology level of private Thai firms for public works will be increased by executing the works on the contract basis.

(2) Construction schedule

The construction schedule for the project is as shown in section 5-1.

Chapter 6.

PROJECT EVALUATION

CHAPTER 6 PROJECT EVALUATION

6-1 Introduction

At present, soil erosion, mainly attributable to improper utilization of land, causes serious damage not only to agricultural production but also to natural resources and environment.

These damages lead to numerous socio-economic problems such as a decrease in farm income and food supply, destruction of forests, migration from rural to urban areas in order to seek employment opportunities, reduction in the availability of water due to sedimentation, occurence of floods, etc. The diagram of the damages caused by soil erosion is given in Figure 6.1-1.

The proposed project would primarily prevent degradation of agricultural land through the implementation of proper measures and thereby, would sustain and also increase agricultural productivity in combination with the introduction of modern and intensive agricultural technologies. Furthermore, it is anticipated that the project would contribute toward rural development in the East through promotion of secondary and tertiary industry sectors by effective utilization of increased agricultural output as well as provision of social infrastructure. These objectives conform with the national development policy under the Sixth NESD Plan.

6-2 Methodology

The economic evaluation of the project is undertaken essentially to provide a basis for assessment of the contribution to the objective of national development relative to the use of the scarce resources employed. This is basically done by comparison of quantifiable monetary benefits and costs of the future situation with and without the project implementation.

Market prices with which these benefits and costs are estimated are not considered reflective of the real efficiency value of goods and services to the country due to various tariff and non-tariff restrictions

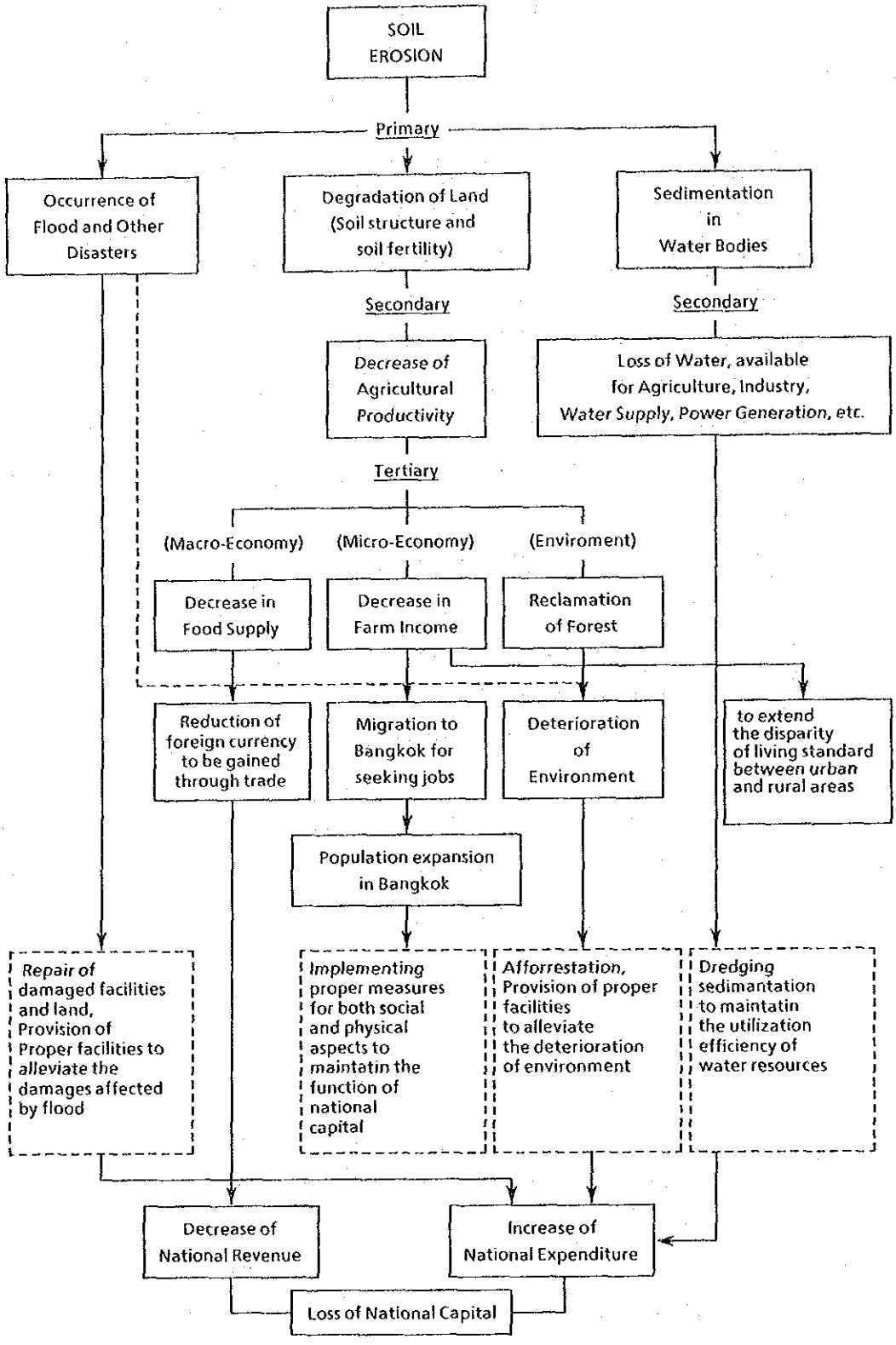

Figure 6.1-1 Diagram of Damages Caused by Soil Erosion

in trade as well as distorted factors of production in the domestic market. To redress these price distortions, adjustment has been made to enable comparison of the traded/tradable components valued at border prices with the non-traded/tradable components initially valued at domestic prices and adjusted by various conversion factors.

The criteria employed to evaluate the economic performance of the project are the economic internal rate of return (EIRR) which can be worked out by discounting both streams of economic cost and benefit over the project life and the benefit cost ratio (B/C) at a discount rate of 8 percent, 10 percent and 12 percent. Sensitivity analysis is undertaken in order to assess the effect of change in basic economic parameters on the economic performance of the project and thus to provide some indication to support the expected result of project implementation and development. Financial evaluation is made through the analysis of the cost recovery index from the viewpoint of farm economy.

Finally, the feasibility of the Project is also investigated through a concise analysis of socio-economic impacts of the project's implementation on its beneficiaries and the environment.

6-3 Economic Evaluation

The economic evaluation is carried out for the first ten years of the B/P which covers an area of 225,700 ha, taking into consideration the implementation schedule of the construction work and the growth of benefits from the investment period to full development.

(1) General parameters

Based upon the collected data and the field investigation, the basic parameters employed for economic evaluation have been determined as follows.

1) Standard conversion factor and other factors

The World Bank estimate in 1980 of 0.92 has been employed as the standard conversion factor and other specific factors are also quoted from the World Bank's estimates. (Source: Shadow

Prices for Economic Appraisal of Projects in Thailand, March, 1982)

2) Exchange rates

As of March, 1988, the exchange rate of the Thai Baht to the US Dollar is 25.52. Conversion of border prices is based on this rate.

3) Price basis

The economic evaluation has been carried out applying 1988 constant prices.

4) Project life

The project life is considered to be 30 years assuming that the major construction components would have a corresponding durable life under proper operation and maintenance conditions.

5) Opportunity cost of capital

The estimated EIRR is subjected for comparison to the opportunity cost of capital which indicates the social marginal productivity of capital invested in the project. The opportunity cost of capital invested to agricultural development projects in Thailand is judged at 12.5 percent considering the annnal interest of the long-term loan as of late 1987 under BAAC. Taking into account the nature of the land and water conservation project, however, which would substantially secure benefits not only to agricultural production but also to social services and the environment, it is reasonable that the opportunity cost of capital for the Project is lower than that for ordinary agricultural development projects. Hence 10 percent seems appropriate as the minimum acceptable rate of capital to be employed for the justification of the economic viability of the Project.

(2) Project benefit

The project benefit consists of three (3) categories namely, crop production, inland fishery, and conservation of natural resources and environment.

1) Crop benefit

The crop production benefit is measured by the incremental net production value (NPV) resulting from project implementation. The annual incremental NPV as expressed in economic terms is the difference of the annual gross production value (GPV) net of production cost between the with project and the without project conditions in the future.

The benefit considered is the incremental net income from the annual crops presently cultivated crops of which yields are expected to be sustained and further increased as well as the proposed crop diversification made possible by the provision of the proper measures, such as Para rubber and fruit trees. The perennial crops and paddy rice, already planted within the project area, are excluded from the benefit estimate because these crops are unlikely to be substantially benefitted by the Project.

The benefit derived from the newly irrigated areas occupied mainly by tree crops are dominant over the benefit from the rainfed areas remaining in the future. This means that the magnitude of the crop production benefit depends mainly on the acreage of irrigated areas developed by the Project.

The benefit for each province is estimated on the basis of the incremental benefit per unit area for the relevant pilot area which was selected for the F/S as a representative case of each province.

The annual incremental benefit at the full development stage is estimated at 878 million Baht for Chachoengsao Province, 1,395 million Baht for Chonburi Province, 1,144 million Baht for Rayong Province, and 665 million Baht for Chanthaburi Province.

2) Inland fishery benefit

The inland fishery benefit would be derived from the proposed fish culture to be intensively introduced in the fish ponds which will be constructed by the Project. The annual

benefit expected at full development is estimated at 4,437 Baht per pond. (Vol. IV Annex 4)

3) Conservation of natural resources and environmentel benefit

The benefit relative to conservation of natural resources and the environment is valued in terms of the reduction of costs required for dredging of sediment from water bodies directly resulting from the alleviation of soil loss from farm land.

This benefit can be estimated on the assumption that all soil carried away from the project area would finally accumulate in reservoirs and other water bodies, leading to the reduction of water available for productive activities and social needs, and become a cause of flooding. Soil erosion causes the loss of national resources with both productive and non-productive value. In order to retain efficiency of utilization of scarce resources, national capital is required. In fact, a large amount of the national budget has been allocated for dredging sediment from canals, rivers, etc. in recent years. Therefore, the economic value of the soil carried away as a result of soil erosion can be appraised as the expense of dredging sediment with the same quantity as the wasted soils from rivers and coasts.

The dredging operation cost to be employed for estimation of benefit from reduction of sediment has been quoted from the unit cost authorized by the Department of Harbors.

The unit cost for dredging is set up at 50 Baht per cu.m by considering the type of soil being carried away to water resources affected by soil erosion. Thus, the economic cost is given at 47 Baht per cu.m by applying the conversion factor for construction of 0.88 to the local currency portion which is assumed to account for 50% of the total cost.

In estimating the volume of sediment one ton of accumulated siltation is assumed to be equivalent to 0.5 cu.m by considering the soil type and physical condition of the soil.

Based on the above concept and parameters, the annual economic benefit estimated for each province is 51 million Baht

for Chacheongsao Province, 82 million Baht for Chonburi Provice, 64 million Baht for Rayong Province and 41 million Baht for Chanthaburi Province.

4) Total benefit

All benefits accruing from the project's implementation are summarizedd in Table 6.3-1. Out of the total benefits, crop production benefit would account for more than 90 percent for every province.

The total benefits expected at the full development stage would amount to 4,300 million Baht per annum for the 10 year project area of 225,700 ha. Full benefits would be attained in project year 25 in accordance with the proposed implementation schdule and the development of each catagory's benefit accrual.

(3) Economic cost

The project cost consists of initial investment cost, operation and maintenance cost, and replacement cost. Residual value of facilities and equipment at the end of the project life is considered on the benefit side.

1) Investment cost

The economic investment cost can be worked out by deducting the price contingency from the estimated financial cost and by applying the specific conversion factors to the local cost components.

Out of the local cost, the unskilled construction labor csts would have a two to eight percent share depending on the cost item. In converting the financial unskilled labor cost to the economic one, the conversion factor for unskilled construction labor estimated at 0.49 is applied. (Vol. IV Annex 4)

2) Operation and maintenance cost

The recurrent operation and maintenance costs cover salaries and wages for project personnel, material and fuel

supplies, etc. These costs are converted into economic costs by applying the S.C.F. to the local currency cost.

3) Replacement cost

Replacement costs for the facilities and equipment which have shorter durable life than the project life of 30 years should be taken into account in the economic cost. The economic replacement cost can be estimated by applying specific conversion factors in the same manner as for the investment cost.

The respective economic costs estimated by province are summarized in Table 6.3-2

Table 6.3-1 Summary of Economic Benefit
(at the full development stage, per annum)

Items \ Province	CS	CN	RY	CT	Overall
Grade of Plan Applied	II	II	II	II	II
Project Area (ha)	50,100	74,500	62,000	39,100	225,700
1. Crop Benefit					
a) Present Cultivated Area *1 (ha)	45,000	67,100	55,800	35,200	203,100
b) Irrigated Area *2 (ha)	5,300	7,800	6,500	4,100	23,700
c) Incremental NPV per ha (10^3 Baht/ha)	17.5	18.7	18.5	17.0	18.1
d) Total (10^6 Baht)	878.3	1,394.8	1,144.2	665.3	4,082.6
2. Inland Fishery Benefit					
a) No. of farm ponds *3	770	1,150	950	600	3,470
b) NPV per pond (10^3 Baht/pond)	4.4	4.4	4.4	4.4	4.4
c) Total (10^6 Baht)	3.4	5.1	4.2	2.7	15.4
3. Natural Resources & Environmental Benefit					
a) Soil loss reduced per ha (t/ha)	47.2	51.0	47.7	48.4	48.8
b) Total soil loss reduced (10^3t)	2,169	3,495	2,718	1,739	10,121
c) Incremental NPV per ha (10^3 Baht/ha)	1.0	1.1	1.0	1.0	1.1
d) Total (10^6 Baht)	51.0	82.1	63.9	40.9	237.9
4. Total					
a) Incremental NPV per ha (10^3 Baht/ha)	18.6	19.9	19.6	18.1	19.2
b) Total (10^6 Baht) (1.d) + 2.c) + 3.d))	932.7	1,482.0	1,212.3	708.9	4,335.9

Note : *1 Applying the ratio of the cultivated area to the project area (gross) of 0.90, which is the average figure of the 16 pilot areas'.

*2 Applying the ratio of the irrigated area to the project area of 0.105 which is the averagae figure of the six (6) areas with Plan II.

Benefits from the irrigated area are estimated on the basis of the benefit per unit area from Durian, which is a representative of crops to be planted in newly irrigated area. While the benefit from the rainfed area for each province is estimated based on the cropping ratio by crops for the rainfed area of the pilot areas selected for the F/S; CS-No.3, CN-No.8, RY-No.2 and CT-No.8.

*3 Based on the average acreage of the 16 pilot areas of 130 ha.

Table 6.3-2 Summary of Economic Cost

Items \ Province	CS	CN	RY	CT	Overall
Grade of Plan Applied	II	II	II	II	II
Project Area (ha)	50,100	74,500	62,000	39,100	225,700
1. Project Cost (10^6 Baht)					
a) Investment cost	3,247	4,828	4,018	2,534	14,627
b) O & M	5,605	8,348	6,934	4,365	25,252
c) Replacement	225	335	279	176	1,015
d) Total	9,077	13,511	11,231	7,075	40,894
2. Cost per ha (10^3 Baht/ha)					
a) Investment cost	64.8	64.8	64.8	64.8	64.8
b) O & M *	111.9	111.9	111.9	111.9	111.9
c) Replacement *	4.5	4.5	4.5	4.5	4.5
d) Total	181.2	181.2	181.2	181.2	181.2

Note : * Based on the average acreage of the 16 pilot areas of 130 ha.

Table 6.3-3 Summary of Economic Analysis

Items \ Province		CS	CN	RY	CT	Overall
1. EIRR	(%)	8.9	12.3	9.8	11.9	10.8
2. B/C Ratio						
a) discount rate	8%	1.09	1.42	1.19	1.34	1.27
b) discount rate	10%	0.90	1.20	0.98	1.15	1.07
c) discount rate	12%	0.74	1.02	0.82	0.99	0.90

Table 6.3-4 Sensitivity Analysis (EIRR) (Unit : %)

Case \ Province	CS	CN	RY	CT	Overall
1. 10 % increase in construction cost	8.3	11.5	9.2	11.0	10.0
2. 10 % decrease in benefit	7.8	11.0	8.7	10.5	9.5
3. Two year delay in benefit	7.4	10.3	8.3	10.1	9.1
4. Combination of 1. and 2.	7.3	10.2	8.1	9.6	8.9
5. Combination of 1. and 3.	6.8	9.6	7.8	9.4	8.5
6. Combination of 2. and 3.	6.4	9.1	9.3	8.9	8.0
7. Combination of 1., 2. and 3.	5.9	8.5	6.8	8.2	7.5

(4) Economic evaluation

On the basis of the estimated economic cost and benefit by province, the EIRR has been worked out for the four provinces. The economic indicators including benefit cost ratio which has also been calculated by province are summarized in Table 6.3-3.

The estimated EIRRs range from 8.9 percent for Chachoengsao Province to 12.3 percent for Chonburi Province. Only the Projects for Chonburi and Chanthaburi Provinces would be economically viable, showing EIRR's higher than the assumed minimum acceptable rate of return on the capital invested to the Project of 10 percent. However, it can not be simply concluded whether this Project would be feasible or not by focusing only on these results because the indirect benefits, though intangible they may be, would outweigh the direct or tangible ones of which crop production benefit represents more than 90 percent in this analysis. As mentioned in section 6-1 and further discussed in section 6-5, the implementation of the Project would generate significant socio-economic and environmental benefits most of which can not be valued in monetary terms because the method for quantifying these benefits has not been established yet. Also, costs for supporting measures have been included in the Project cost even though they are not directly related to the land and water conservation works. Therefore, the feasibility of the Project should not be evaluated only from the viewpoint of economic efficiency, which is analyzed using the quantifiable benefits as mentioned above. It is considered that some allowance would have to be made in judging the Project's feasibility as a whole.

(5) Sensitivity analysis

Sensitivity analysis is an effective way of testing the risk and uncertainty of the Project. The analysis is undertaken for various assumptive cases. The results of the analysis are shown in Table 6.3-4. This analysis reveals that the Project would be more sensitive to the benefit side and less sensitive to the cost side. Therefore, the agricultural development plans which will be actually made possible under the Project have to be envisaged.

6-4 Financial Analysis

The financial feasibility of the Project is investigated from the viewpoint of the beneficiary farmers. The criterion employed for the B/P is the recovery of the project cost from the farmers through the comparison between the willingness- and ability-to-pay of the farmers and cost-recovering charges of the project cost including recurrent O&M and replacement costs.

This financial analysis is made by using financial prices (at 1988 constant prices).

The annual incremental net income (at the full development stage) through the implementation of the Project has been estimated at 12,000-16,000 Baht per ha from crop production and at 70 Baht per ha from inland fishery. Benefits from the conservation of natural resources and the environment are, however, excluded from the financial analysis because they could neither entail the monetary flow nor directly contribute toward improvement of the farm economy.

The maximum willingness-to-pay of the farmers is deemed to be half of the incremental net income, corresponding to 6,000-8,000 Baht per ha from the aforesaid two benefit categories. The remaining income is considered to be spent for farmer's living expenditure in order to improve rural living standards.

As for the project cost (in financial terms), the investment cost is estimated at 80,160 Baht per ha and the O&M cost including the replacement cost at 4,200 Baht per ha per annum.

The cost-recovering charge for the investment cost is estimated by assuming various repayment conditions. Estimated annual cost-recovering charges are compared with the farmers' willingness- and ability-to-pay. Table 6.4-1 summarizes the results of this analysis.

As a result of the above analysis it can be said that it is impossible for the farmers to repay the entire project cost even if repayment conditions in favor of the farmers are provided. The appropriate cost recovery is considered to be 20-40%. The remaining portion of the project cost should be supplemented by governmental subsidy. It is judged reasonable that Government would subsidize part of

the project cost when undertaking such a land and water conservation project because of the following reasons.

- As described in section 6-1, the project can reap large benefits not only to the beneficial farmers themselves but also to other residents employed by non-agricultural sectors. Indirect benefits which are unquantifiable such as flood protection, conservation of surface run-off and groundwater, prevention of land slide, etc. would improve the living environment and security for both the rural and urban population. Therefore, it is apparent that the farmers should not be required to shoulder the total project cost which would be spent in improving social services as well as agricultural productivity.
- In Thailand, Government imposes general or indirect taxes and duties that range from the municipal (tax) to the national (export duties and premiums) level for agricultural production. Therefore, it is anticipated that part of the Project cost would be recovered by general and specific, or indirect and direct levies to be imposed on the incremental agricultural production resulting from the implementation of the Project.

In conclusion, an appropriate amount of subsidy from Government is prerequisite to the Project's implementation. The rate of Government's subsidy for the Project cost is preliminarily estimated at 60-80%. This corresponds to 48,000-64,000 Baht per ha.

It is recommended that the ratio of Government's subsidy to the project cost should be set up after taking into consideration the results of monitoring and evaluation of the Pilot Projects.

Table 6.4-1 Summary of Cost Recovery Analysis

(Unit : Baht per ha)

Items \ Province	CS	CN	RY	CT
I. Farmers' Ability-to-pay *1				
1. Incremental net income	13,000	15,800	13,900	12,300
2. Willingness-to-pay (50% of 1.)	6,500	7,900	6,950	6,150
II. Annual O & M Cost including Replacement Cost *2	4,200	4,200	4,200	4,200
III. Cost-recovery Charge for Investment Cost				
1. Repayment period 10 yrs				
a) annual interest 5 %	10,400	10,400	10,400	10,400
b) annual interest 10 %	13,000	13,000	13,000	13,000
c) annual interest 12 %	14,200	14,200	14,200	14,200
2. Repayment Period 15 yrs				
a) annual interest 5 %	7,700	7,700	7,700	7,700
b) annual interest 10 %	10,500	10,500	10,500	10,500
c) annual interest 12 %	11,800	11,800	11,800	11,800
3. Repayment Period 20 yrs				
a) annual interest 5 %	6,400	6,400	6,400	6,400
b) annual interest 10 %	9,400	9,400	9,400	9,400
c) annual interest 12 %	10,700	10,700	10,700	10,700
IV. Recovery Index (%)				
1. II./I.1	32	27	30	34
2. II./I.2	65	53	60	68
3. (II + III.1.a))/I.1	112	92	105	119
4. (II + III.1.b))/I.1	132	109	124	140
5. (II + III.1.c))/I.1	142	116	132	150
6. (II + III.1.a))/I.2	225	185	210	237
7. (II + III.1.b))/I.2	265	218	247	280
8. (II + III.1.c))/I.2	283	233	265	299
9. (II + III.2.a))/I.1	92	75	86	97
10. (II + III.2.b))/I.1	113	93	106	120
11. (II + III.2.c))/I.1	123	101	115	130
12. (II + III.2.a))/II.2	183	151	171	193
13. (II + III.2.b))/II.2	226	186	212	239
14. (II + III.2.c))/II.2	246	202	230	260
15. (II + III.3.a))/I.1	82	67	76	86
16. (II + III.3.b))/I.1	105	86	98	111
17. (II + III.3.c))/I.1	115	94	107	121
18. (II + III.3.a))/I.2	163	134	153	172
19. (II + III.3.b))/I.2	209	172	196	221
20. (II + III.3.c))/I.2	229	189	214	242

Note : *1 Based on the gross acreage of the project area.
*2 Based on the average acreage of the 16 pilot areas of 130 ha.

6-5 Socio-economic and Environmental Impacts

In addition to the quantative benefits mentioned above, the Project would entail large socio-economic and environmental impacts which are intangible. The major impacts expected are discussed below.

(1) Creation of employment opportunities

The Project's implementation would give rise to employment opportunities for the unskilled labor force.

The unskilled laborers required for the construction works under the first ten year plan of the B/P is estimated at 7 million man-days. This estimation is based upon the assumption that unskilled labor costs would account for 3% of the total construction cost and that unskilled construction labor would be hired at a wage of 75 Baht per day.

The demand for farm labor would increase by 18 million man-days per annum through introduction of intensive agriculture under the first ten years of the B/P. Promotion of inland fishery will also help to enlarge employment opportunities in the rural area.

Furthermore, development of secondary and tertiary industries associated with increased agricultural production is expected to offer employment opportunities to the rural population.

(2) Reduction of regional disparity

Improvement of living conditions among the rural farmers in the Eastern Region through an increase in farm income as well as provision of supporting facilities, e.g. wells and meeting halls would have a significant socio-economic impact not only in the East but in the neighboring regions as well.

A more settled down style of agricultural life and increased farm income would encourage farmers to invest more in education and other social services which would improve communication and thus accelerate the integration of the local population. This would greatly help in rectifying regional disparity which is the current concern of Government.

Improvement of rural living conditions is also expected to prevent the younger generation from migrating to Bangkok where the Thai economy is now greatly concentrated and there are lots of socio-economic problems in the wake of the population expansion.

Furthermore, the settlement of the rural population would contribute to the maintenance of national security especially in the sensitive border area with Cambodia.

(3) *Saving and earning of foreign exchange*

Large amounts of nutrients available for crop growing which are contained in soil have been washed away due to lack of proper land conservation measures. The implementation of the Project is expected to reduce these nutrient losses.

The amount of major elements to be saved annually in the area of 225,700 ha is estimated at 89,000 t for N, 7,400 t for k_2O and at 20,600 t for P_2O_5. This corresponds to 640 million Baht, 60 million Baht, and 70 million Baht, respectively when expressed in monetary terms using the current international prices of chemical fertilizers. The project's implementation would indirectly reduce the quantity of fertilizer imports, resulting in the saving of foreign exchange.

The increase in agricultural production is expected to earn foreign exchange. In response to the Government's policy and the current domestic market, the emphasis of this project is on expansion of production of commercial or exportable crops such as Para rubber, pineapple, durian, etc. Exportation of one-tenth of the incremental crop production expected from an area of 225,700 ha would earn 1,200 million Baht (equivalent to US $ 47 million) per year (at 1988 constant prices).

(4) Enhancement of cooperation among farmers

It is necessary to establish a farmer's group for success of the proposed land conservation measures and irrigated agriculture. Also, establishment of client groups consisting of at least five farmers is prerequisite for farmers without collateral to utilize agricultural loans under the BAAC which are indispensable for the promotion of the

proposed crop diversification. These organization activities would enhance the cooperative spirit among the farmers and help improve their technical and management skill.

(5) Environmental impact

The Project's implementation would contribute to conservation of the environment as stated above. The major environmental impacts considered are summarized below.

- to prevent disorderly deforestation, and thereby to retain existing ecosystems (e.g. to retard the occurence of erratic rainfall and extinction of wildlife)
- to conserve surface run-off and groundwater
- to alleviate flooding and drainage damage in lower reaches

Chapter 7.

PROJECT IMPLEMENTATION PROGRAM

CHAPTER 7 PROJECT IMPLEMENTATION PROGRAM

7-1 Policy

The final target of this project is to achieve the most appropriate and efficient agricultural land and water conservation measures through either agricultural or mechanical aspects in the planning area of the 4 provinces located in the East.

The future of agricultural production in the Eastern Region has received much concern due to the problem of soil erosion. The 6th NESD Plan also places significant importance on this problem in the National Resources and Environmental Development Program.

In case of project implementation, DLD shall take the initiative in carrying out the land conservation works by extending and strengthening its organization.

7-2 Role of DLD

DLD was established in 1963 to survey the land and to analyze the soil or land in order to determine its fertility and suitability for utilization, classification and development, and to prepare the land census or conduct economic surveys of the land.

After its establishment, DLD has been enlarged and strengthened year by year and at present DLD is divided into three sectors each headed by a Deputy Director-General, namely administration, operation and engineering, and technical. (Figure 7.2-1)

The administration sector consists of 4 Divisions, namely Office of Secretary, Personnel, Financial and Planning.

The Planning division is responsible for studying, analyzing and planning principal guidelines of DLD projects, including the operation of foreign affairs and requesting overseas technical and financial assistance for development projects.

The operation and engineering sector consists of 1 Division and 12 Land Development Regional Offices covering the whole country. The Engineering Division is the central organization for implementation of

land conservation works. The 12 Regional Offices can be considered as implementing field offices for land conservation works.

The technical sector consists of 5 Divisions namely Soil and Water Conservation, Surveying and Cartographic, Land-Use Planning, Soil Survey and Land Classification, and Soil Analysis. This sector has the most advanced experience in land and soil survey, land and water conservation as well as land-use survey and planning.

In the Thai government there are many land-related agencies, namely the Department of Lands, Department of Public Welfare, Royal Forestry Department, Agricultural Land Reform Office, Department of Land Development, Cooperatives Promotion Development, etc.

Within so many land-related governmental agencies, it is considered that DLD is the most suitable agency to take the initiative in the land conservation work since DLD has the functions of both research and implementation.

The role of DLD is, therefore, to fulfill a coordinating function for land-related agencies and an implementing function as the most advanced agency concerning land conservation works. Therefore, DLD is expected to take the initiative for surveying, planning and designing concerning land and water conservation projects among the related agencies.

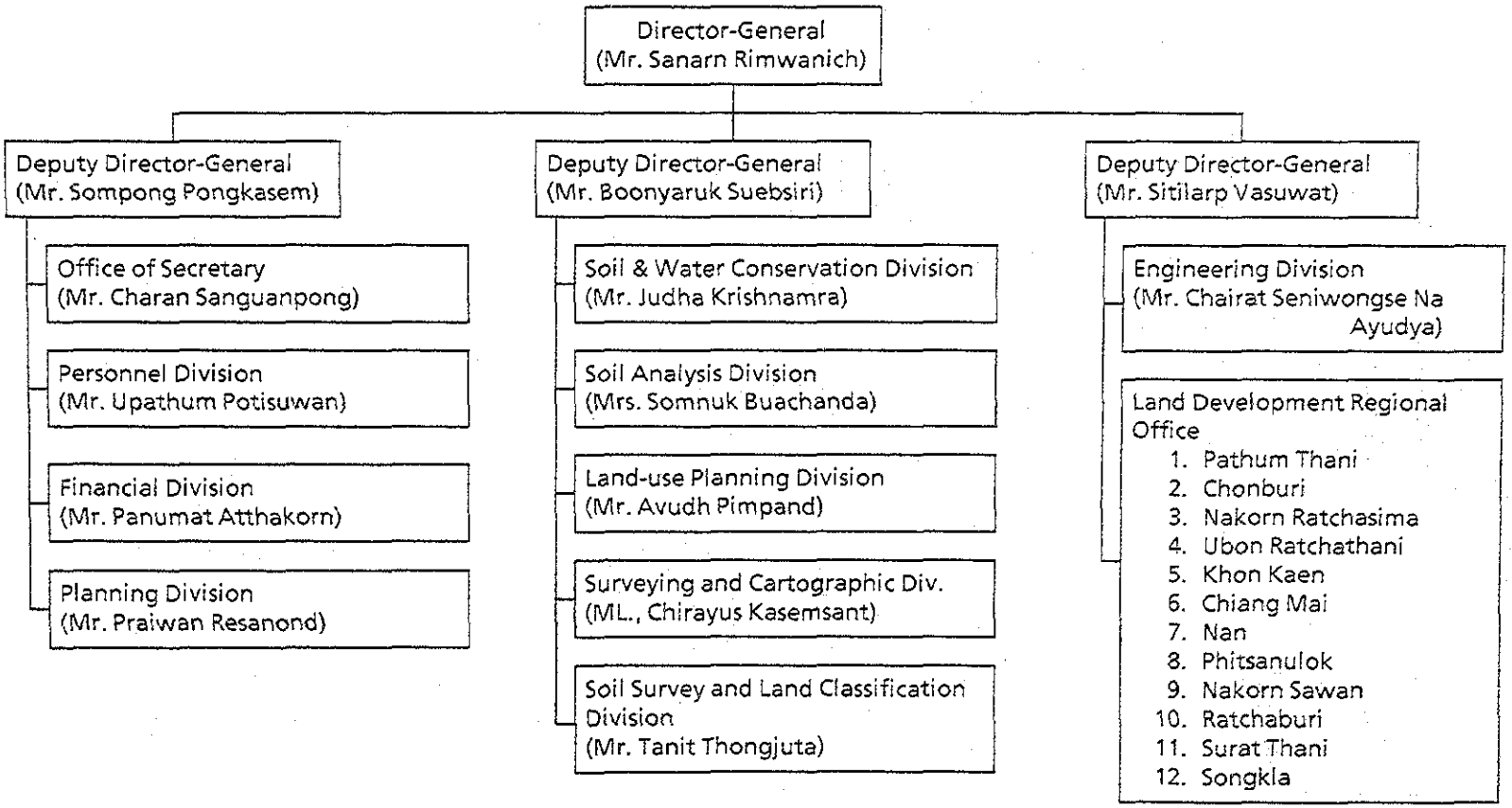

Figure 7.2-1 DLD Organization Chart

7-3 Land and Water Conservation Center

(1) Necessity of the Land and Water Conservation Center (LWCC)

To prevent soil erosion from the huge upland crop area of 716,200 ha, systematic technical standards for land conservation are required based on sufficient investigation and testing.

In the 6th NESD Plan land conservation is given priority as one of the important agricultural targets, as well as forest conservation and reforestation.

As mentioned above the importance and necessity of land and water conservation are recognized and emphasized, however, this project is just in the beginning stages and it is expected to carry out survey, planning and prevention measures.

The land conservation project is a comparatively new project which is to be carried out according to the 6th NESD Plan. Establishment of the Land and Water Conservation Center in DLD is indispensable to implement the project successfully.

(2) Role of the LWCC

The role of the LWCC is as follows;

1) Data and information collection concerning land and water conservation from domestic and international sources.
2) Analysis of data and information, arrangement of technical know-how and regulations for utilization.
3) Data collection and analysis of the 16 pilot areas.
4) Preparation of technical standards of survey, planning, design and implementation.
5) Preparation of extension manual for farming.
6) Preparation of long term and annual development plan of scheduled projects.
7) Preparation of detailed design for annual implementation.
8) To carry out bidding, supervision, inspection annually.
9) Training of local staff and key farmers.
10) Other activities required.

Moreover, DLD shall be required to establish a machinery system to achieve the above targets of the land conservation works. This construction machinery shall be used for civil works in addition to maintenance of already completed projects, restoration of areas damaged by disasters, etc.

(3) Facilities

Buildings	:	Technology Introducing Center	1 place
		Land and Water Conservation Center	1 place
		Land and Water Conservation Station	5 places
		Ancillary apparatus for each building	
Machinery	:	Heavy construction machinery and work shop	

7-4 Role of Pilot Areas

The planning area of 884,000 ha shall be improved through conservation works including irrigation works, etc. according to the long term plan. For improvement of the 884,000 ha a technical standard should be prepared and tested in the 16 pilot and other areas.

The 16 pilot areas were selected with parameters of topography, soil, crop and climate based on the soil erosion classification of the B/P.

One pilot area is approximately 80 - 160 ha in size and their locations are as follows;

Chachoengsao	4 sites	Rayong	5 sites
Chonburi	5 sites	Chanthaburi	2 sites

The 16 pilot areas are considered to play the role of testing farm as the model of the land conservation works. That is the pilot areas shall be utilized by DLD to collect data on farming, technical and civil works.

Data collection which shall be carried out by the LWCC in the pilot areas is proposed as follows;

	Survey	Item	Object
(1)	Survey on civil works	- Work efficiency of machinery, - Combination system of machinery, - Specification for tendering.	- Preparation of implementation standard
(2)	Survey on effect of civil works	- Annual variation of soil loss, - Consumption process of soil moisture, - Irrigation system and its effect, - Maintenance of facilities.	- Most suitable works - Preparation of planning manual.
(3)	Survey on farming and economy	- Farm management - Production, - Farm economy	- Establishment of farming system - Basic data for extension

The 16 pilot areas play a very important role in achieving the objective of the huge land conservation works. Therefore, the pilot areas should be established as satellites of LWCC.

7-5 Implementation Organization

(1) General

In the subject 4 provinces approximately 884,000 ha of upland crop area require land and water conservation works. As before mentioned DLD's role for coordinating and implementing the project is significant in achieving the target of land and water conservation.

DLD already has the necessary functions of both research and implementation, therefore, the most important matter is to strengthen the existing organization.

DLD has published the plan of Establishment of Land and Water Conservation Center (LWCC) in the East in March, 1987. This plan has been submitted through DTEC as the request for grant aid to the Japanese government.

The LWCC plan can be utilized as a reference to prepare the plan to institutionally strengthen the DLD organization.

(2) Headquarters Organization (TIC)

In DLD Headquarters, the Technology Introducing Center (TIC) directed by a Deputy Director General shall be established in addition to the 3 existing sectors mentioned previously. This Center's activities are collection and analysis of data and information, preparation of technical guidelines and regulations and budget control for conservation works as the center of LWCC's mentioned below.

If there is any problem to establish TIC as a new sector, an interim administrative system should be adopted.

For instance, instead of Deputy Director-General in charge of TIC, a managing committee, whose members are composed of existing three Deputy Director-Generals and some senior staffs of DLD, will be organized until the establishment of the proposed plan.

(3) Land and Water Conservation Center (LWCC)

LWCC shall be established in Chonburi Province in the East to strengthen the Land Development Regional Office (LDRO) No.2, for carrying out the land conservation works such as O&M of facilities, planning and monitoring, etc.

In the near future, it is expected that another 4 LWCC one each in the North-east, North, Central and South shall be established. These 5 LWCC's shall be under the administration of the Technology Introducing Center.

(4) Land and Water Conservation Station (LWCS)

5 LWCSs shall be established one each in Chachoengsao, Chonburi, Rayong, Chanthaburi and Prachinburi to strengthen each Land Development Station for carrying out the land conservation field works such as O&M of

machinery, supervision, etc. Existing and recommended organization is shown in Figure 7.5-1.

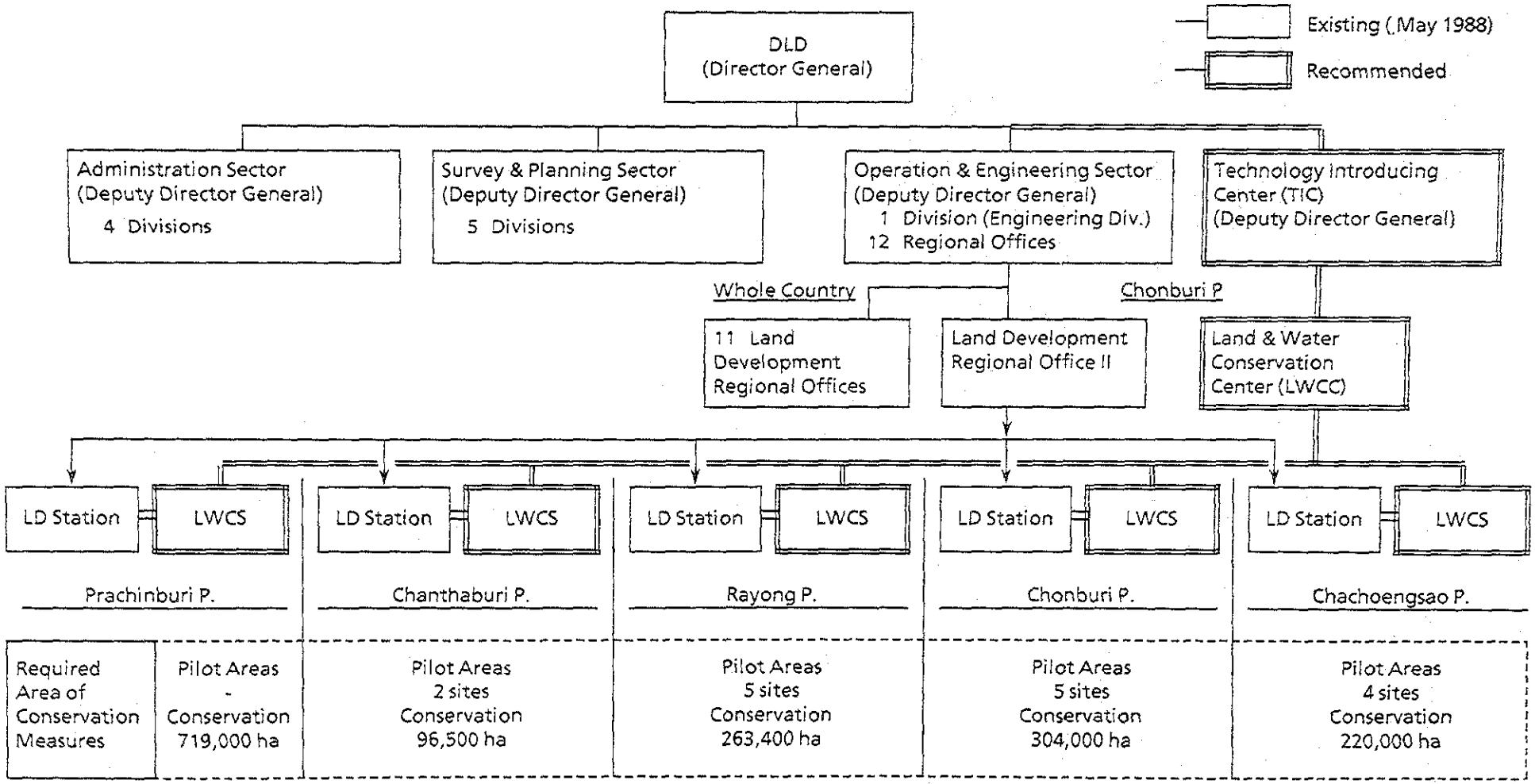

Figure 7.5-1 Organization Chart of DLD Existing and Recommended

7-6 Project Management and Monitoring

(1) Project management

Project management means effective control of the project organization in order that the project system may fulfill its function. In this project, management is separated into two fields, namely agricultural production and civil work.

In the field of agricultural production the management shall carry out the training and extension for staff in the local offices and farmers in the pilot areas, scheduled project areas and other areas, with the objective of increasing production.

In the field of civil work, the management is to supervise and inspect the contractors for efficient and less expensive works.

The project management system is shown in Figure 7.6-1. This is also shown in the following chart.

1) Preparation of standard and manual

↓

Training of staff and farmers

↓

Extension to farming and economy in pilot, scheduled and individual farm.

2) Planning and detailed design

↓

Tendering of contractors

↓ Supervision

Scheduled projects

(2) Project monitoring

Project monitoring means to collect data and to follow the result of extension works.

This will require the assignment of a staff member to each pilot area. The assigned staff member shall carry out the survey and extension works. Data collected through the LWCS shall be analysed by the LWCC with the equipped computer system. This data shall be utilized for the new scheduled projects.

On the other hand from the scheduled project sites, contractors' works are supervised and evaluated by the LWCS's staff as a part of the monitoring.

The project monitoring system is also shown in Figure 7.6-1.
This is also shown in the following chart.

1) Collection of monitoring data from

↓

Pilot, scheduled and individual farm

↓

Data analysis by computer system

Preparation of standard and manual

2) Scheduled projects

↑↓

Inspection and evaluation

↓

Utilization for supervision and next detailed design.

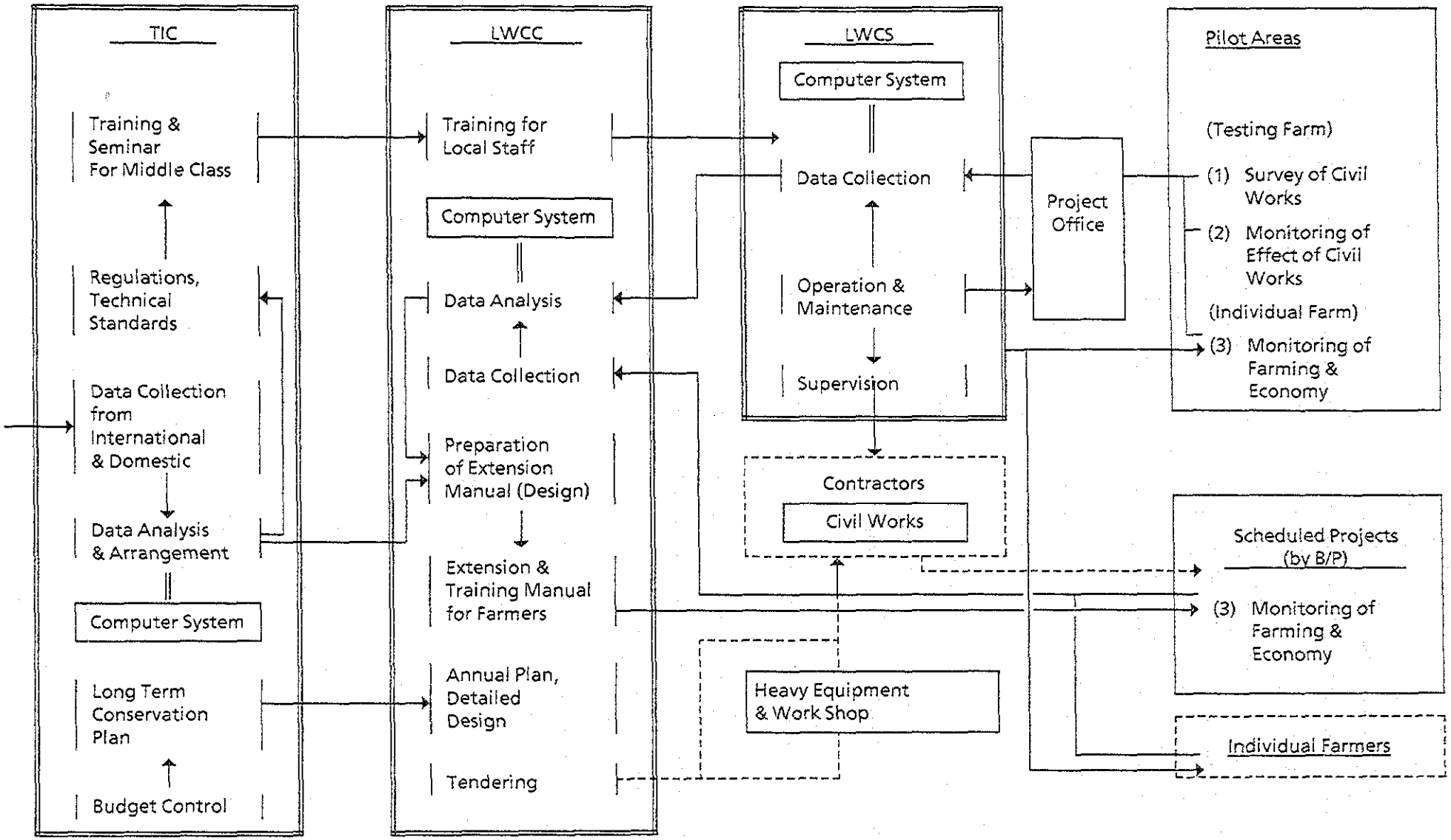

Figure 7.6-1 Project Management and Monitoring System