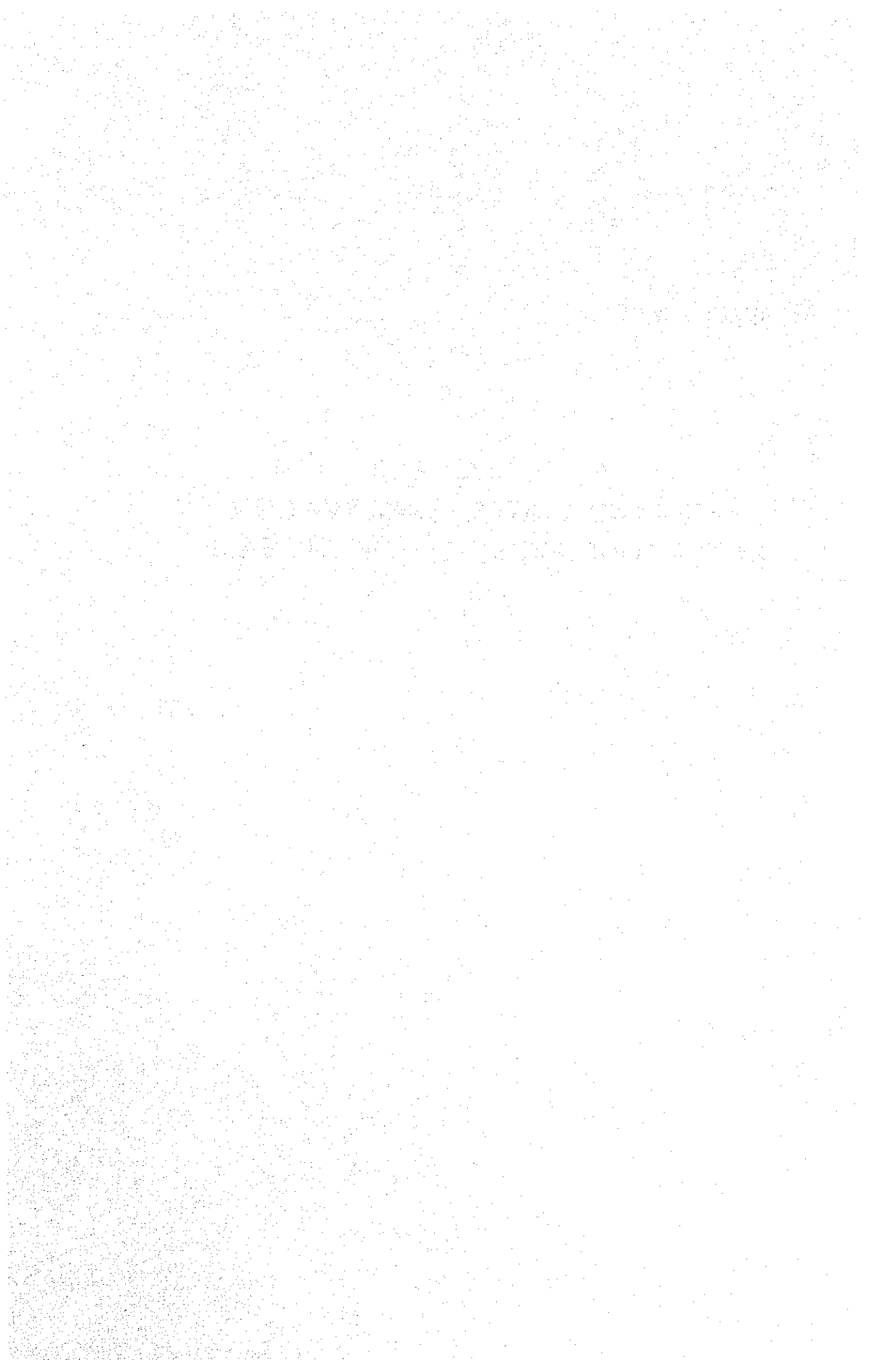


Chapter 5.

BASIC PLAN FOR LAND AND WATER CONSERVATION IN THE FOUR PROVINCES OF THE EAST



CHAPTER 5 BASIC PLAN FOR LAND AND WATER CONSERVATION IN THE FOUR PROVINCES OF THE EAST

5-1 Characteristics and Objectives of B/P

In relation to the objectives, strategies and programmes of the Sixth NESD Plan, this B/P will lay down the long-term integrated rural development plan centering on agricultural land conservation for the four provinces located in the Eastern Region. Integrated rural development has two aspects, improvement in both the productivity of agriculture and agricultural land, and the living conditions of the rural community and farmers.

In the case of this project, the most important method for improvement in productivity of agricultural land is the prevention of soil erosion. The major causes of soil erosion in the 4 provinces are due to many conditions such as undulating topography, weathered sandy soil which has poor water holding capacity, the reckless encroachment of the forest area and improper cultivation method, etc.

The necessary measures to be taken for improvement of agricultural production are securing irrigation water resources and diversification of crops. Further, improvement in the living conditions of the rural community and farmers can be measured through the increase in employment opportunities created by introduction of rural industries and the completion of service facilities such as education, health care, communication, etc.

Since the Study Area is located near to Bangkok and includes the Eastern Seaboard Industrial Zone and the Pattaya resort area, the marketability of products and the opportunities for employment should be very high.

After thoroughly investigating the circumstances in the surrounding area, an integrated type basic plan will be indispensable in carrying out future development as well as land conservation.

The B/P has set forth 3 major objectives. They are; first, to clarify the actual condition of soil erosion and to prepare the agricultural land and water conservation plan in the 4 provinces, second,

to survey the actual condition of rural facilities and farmers' living condition, and to prepare the rural development plan, and third, to determine the measures for land and water conservation.

To achieve the above-mentioned 3 major objectives, 8 strategies have been set down and utilized for the project establishment.

- (1) to adopt the appropriate methods for the survey of erosion, farmers' needs,
- (2) to consider the agricultural (soft) measures for land conservation
- (3) to consider the mechanical (hard) measures for land conservation also,
- (4) to consider the introduction of an irrigation system together with the mechanical measures,
- (5) to consider the establishment of the Land and Water Conservation Center (LWCC) for the successful completion of land conservation projects,
- (6) to recommend the introduction of rural development works into the project,
- (7) to recommend the establishment of the Committee of Land and Water Conservation for coordination of the many agencies concerned, and
- (8) to consider the organization and training of farmers.

5-2 Study Area

(1) Study area

Study area, which can be called survey area, means the whole area of the 4 provinces, Chachoengsao, Chonburi, Rayong and Chanthaburi. In the study area, data and information collection, and reconnaissance surveys were carried out.

(2) Project area

Project area means the gross area including the planning area, and other existing areas such as roads, forest, villages, etc. in the case of this Study the whole area of the 3 provinces of Chachoengsao, Chonburi and Rayong and for Chanthaburi 1,981 km² or 1,238,125 rais (31.3%) which is approximately one third of the western side of the province.

(3) Planning area

Planning area means the area of actual planning or design and implementation. In the case of this project, upland farms requiring land conservation are included in the planning area.

Province	(km ²)		
	Study Area	Project Area	Planning Area
Chachoengsao	5,351	5,351	2,200
Chonburi	4,363	4,363	3,041
Rayong	3,552	3,552	2,634
Chanthaburi	6,338	1,981	965
Total	19,604	15,247	8,840

Breakdown of the project area in each province is shown in Table 5.2-1.

Table 5.2-1 Present and Plan of Land-use

Planning Area (km²)

Land Classes	Chachoengsao		Chonburi		Rayong		Chanthaburi	
	Present	Plan	Present	Plan	Present	Plan	Present	Plan
Rice field	1,983.2	1,409.4	667.7	667.7	297.2	297.2	106.1	106.1
Upland								
Surgar cane								
Cassava								
Other crops								
(sub total)	1,974.2	1,974.2	3,139.1	2,356.5	2,233.2	1,614.3	717.9	572.6
Tree								
Fruit trees	5.4		176.5		128.9		18.4	
Para rubber	25.0		3.2		516.9		374.0	
(sub total)		30.4		179.7		645.8		392.4
Grass field		195.5		505.1		373.8		
Forest	1,020.9	1,020.9	351.8	351.8	314.0	314.0	764.6	764.6
Reservoir		135.5	15.9	97.8	12.9	37.7		43.6
Unused land	342.3	342.3	7.7	7.7	30.8	30.8		43.5
others		242.8	1.2	196.8	18.1	238.4		58.2
Total	5,351.0	5,351.0	4,363.1	4,363.1	3,552.0	3,552.0	1,981.0	1,981.0

5-3 Soil Erosion in the Study Area

5-3-1 Target and Classification of Soil Erosion Map

For the formulation of the Basic Plan and the selection of pilot areas a Soil Erosion Map of the Study Area was made.

(1) Target of the Map

- 1) 4-provinces Chachoengsao, Chonburi, Rayong and Chanthaburi
- 2) Upland crops not including forest, paddy field and abandoned area
- 3) Scale 1 : 250,000

The Map shall contribute to the formulation of a basic plan and selection of pilot areas.

(2) Classification of the Map for soil conservation

	Classification	Soil Loss Volume
1	Top Urgent	more than 50 ton/ha/year
2	Urgent	50 - 30
3	Necessary	30 - 20
4	Normal	20 - 5
5	Not necessary	less than 5

This classification was proposed by the JICA Study Team.

5-3-2 Basic Formula

For calculation of soil loss volume, the Universal Soil Loss Equation (USLE) shall be used.

Namely ;

$$A = R \cdot K \cdot Ls \cdot C \cdot P$$

where A : Total Soil Loss Volume (ton/ha/year)

R : Rainfall Factor

K : Soil Erodibility Factor

Ls : Slope and Slope Length Factor

C : Crop Management Factor

P : Soil Conservation Measures

P-value was omitted since it is required to find the value of A before adopting soil conservation measures.

Following data shall be used;

- Soil classification map (S = 1/250,000)
- Topographic map (S = 1/250,000)
- Land-use map (S = 1/250,000)
- Isohyetal map (S = 1/250,000)

These maps were overlapped and traced for calculation of soil loss volume using USLE.

5-3-3 Result of Soil Erosion Map

The result of the Soil Erosion Map is shown in Table 5.3.3-1. According to the result of calculation of soil loss volume, planning area which is under upland crops at present is a total of 8,840 sq.km of which 7,162 sq.km or 81 percent are erodible area.

Most of the pilot areas were selected from Top-Urgent (more than 50 ton/ha/year in soil loss volume). However, in Chachoengsao, most of the pilot areas were selected from Urgent (50 - 30 ton/ha/year) because most of the Top-Urgent areas belong to reserved forest areas.

Table 5.3.3-1 Erodible Area in 4 Provinces

		(km ²)				
Classification		Chachoengsao	Chonburi	Rayong	Chanthaburi	Total
1. Top Urgent	ton/ha/yr. (50 <)	388	1,245	923	331	2,887
2. Urgent	(50 - 30)	553	521	170	268	1,512
3. Necessary	(30 - 20)	523	439	864	328	2,154
4. Normal	(20 - 5)	351	23	223	12	609
1 - 4 Total (Erodible Area)		1,815	2,228	2,180	939	7,162
5. Not Necessary (5 >)		385	813	454	26	1,678
Total (Planning Area)		2,200	3,041	2,634	965	8,840

5-4 Soil Conservation Measures

5-4-1 General

Four approaches to soil and water conservation are selected as follows;

- 1) Agricultural measures
- 2) Mechanical measures
- 3) Irrigation facilities
- 4) Supporting measures

Agricultural measures mean how to prevent soil erosion and how to keep and utilize natural water resources agronomically.

Mechanical measures mean applying civil engineering techniques such as terrace making.

Irrigation facilities mean how to save the water resources and utilize them.

All of these three measures are directly connected with the topic but 4) supporting measures, has a rather indirect relation with it. It has very wide fields to discuss but since the topic is under the scope of integrated rural development, the next four items have been selected.

- Infrastructure
- Agro-industry
- Education of farmers
- Institutional cooperation

Focusing on the direct relation between soil and water conservation and its measures, crop diversification and contour strip cultivation in the agricultural sector, and establishment of a drainage system and graded terrace in the mechanical sector should be emphasized. These should be the four main measures in the East in future and their priority will depend on the physical conditions of each area.

5-4-2 Agricultural Measures

(1) Basic method

1) General

Agricultural measures can be called biological measures in other words, agricultural measures meant to prevent soil erosion and preserve groundwater with the biological or farming measures.

The outline of the measures of the activities mentioned above are classified as follows;

- | | |
|-----------------------|------------------------------|
| 1. Mulching | 1) Live mulching |
| | 2) Non-live mulching |
| 2. Cropping method | |
| 3. Cultivation method | 1) Contour ploughing |
| | 2) Contour ridging |
| | 3) Contour strip cultivation |
| 4. Canopy improvement | |
| 5. Soil management | 1) Tillage |
| | 2) Soil property improvement |

2) Mulching

Mulching for protection of soil and prevention of evaporation has been recognized as the best measure by experience or by so many experiments all over the world.

Practically, how to prepare the materials for mulching is a problem on farms. In the Eastern Upland Area, some suitable cover crops as live mulching have been recommended by DLD but no appropriate non-live material is found except compost which is available at sugarcane factories in the region.

Rice straw is the most suitable for the purpose according to the experience in the past but transportation of it from remote rice cultivation areas is the bottleneck of the measure.

3) Cropping method

Cropping method means continuous cropping of a certain crop, rotation of crop and intercropping, etc.

Successive cultivation of cassava is so popular in the Eastern Region and it has been said that it is the main reason of erosion there. Then tree and fruit tree crops are suggested for cassava among so many alternative crops. Since they are perennial, intercropping at the beginning stage has to be recommended for the purpose of erosion prevention. This is not only for soil conservation but also for getting extra income by full utilization of the space.

4) Cultivation method

As for cultivation method, contour cultivation is now common in cultivation in any sloping farm. Judging from the present condition in the Eastern Region, contour cultivation will be the most adaptable and practical method. It may be sufficient to cope with the erosion problem if it is enforced with some modification such as ridge making or tree crop planting along the ridges for fixing soil and preventing erosion.

5) Canopy improvement

Leaf canopy improvement is the same with mulching in the sense of soil protection. It means to make a block with the crop's own leaves to prevent raindrops which degenerate soil character. In case of cassava monoculture, it takes roughly three months from planting to make a canopy. Then, for planting at the beginning of the rainy season, the situation of erosion is very serious because the soil surface is almost bare. If a canopy is established as soon as possible, a better situation is expected.

6) Soil management

Soil management is another very important factor in the soil and water conservation problem. So far almost all information regarding the relationship between tillage operation and erosion tells that no tillage or minimum tillage is better than conventional method.

However, according to the result in a cassava cultivation trial carried out in Kasetsart University ploughing and disking followed by contour ridging is best judging from sediment. Second best is subsoiling at 40 cm depth.

Results mentioned above show that soil condition and other

environmental factors of each locality are closely connected with soil and water conservation, showing different reaction to rain.

It is suggested to recheck the effect of tillage operation in the region from the view point of soil and water conservation.

(2) Cropping pattern

Cropping pattern in the Eastern Region looks rather simple because 1) perennial crops like Para-rubber and fruit tree crops are popular 2) water resources are very limited and number of crops is not so many and 3) cassava has been the dominant crop due to the environmental condition.

A comprehensive cropping pattern on upland in the region is suggested in Volume II. This is based on the present pattern of the Eastern Region with some modification.

For future crop production in the project area, the ideas mentioned below are suggested.

- 1) Following the national policy of crop diversification, cassava is suggested to be replaced mainly with fruit tree crop and Para-rubber.
- 2) Cassava will still be the most adaptable crop in the region and the improvement of its production should be emphasized.
- 3) Pineapple may be one of the most stable cash crops in the region though not being emphasized in the Plan.
- 4) Intercropping is to be emphasized to intensify land-use.
- 5) Strengthening of infrastructure is indispensable for high and efficient crop production.

5-4-3 Mechanical Measures

(1) General

The role of the mechanical measures shall be considered as supporting practices of the agricultural measures. There is a possibility to prevent soil erosion completely by mechanical measures such as concrete paved drainage and road network system, sediment ponds and filtration facilities at the outlet of each farm.

However, such perfect measures require huge investment for construction and large amounts of funds for operation and maintenance and are not practical.

Mechanical measures should be established on the balance of input and output of the project and it will be appropriate to assume 30 years for the project life under the present condition.

(2) Items and types of mechanical measures

Mechanical measures shall be classified as follows;

<u>category</u>	<u>items</u>
1) Soil management system	• Sub soiling
2) Terracing system	• Contour terrace
	• Graded terrace
	• Bench terrace
	• Zing terrace
3) Drainage system	• Catching ditch
	• Collecting ditch
	• Draining ditch
	• Appurtenance
	drops
	sediment trap
	connecting pit
	rectifying pit
4) Farm road system	• Lateral road vertical
	and horizontal
	• Trunk road (main road)
5) Farm Pond (Tameike)	

<u>category</u>	<u>items</u>
6) Check dam (Sediment pond)	<ul style="list-style-type: none"> • Woven-wire dam • Brush-wood dam • Loose-rock dam • Plank or slab dam • Masonry dam • Concrete dam • Earth dam
7) Slope protection	<ul style="list-style-type: none"> • Spray method • Sodding • Concrete wall • Wooden wall
8) Others	<ul style="list-style-type: none"> • Sand bag • Woven-wire mat

Each measure shall be selected depending on actual site conditions of the Project.

(3) Specification and application criteria

These items and types of mechanical measures shall be applied in accordance with the actual condition of each project area. The farmers' ability should be considered as well as the conditions of topography, climate, crop, soil, etc.

In the feasibility study of this project, therefore, the development grade are classified into 3 levels such as high, medium, and common grades.

5-4-4 Irrigation Facilities

(1) Present conditions

As for the surface water resources development in the study area, there are 10 large and medium scale irrigation projects and 104 small scale irrigation projects including 32 reservoir projects constructed under the RID as of 1986. The total reservoir capacity of the said projects including medium scale projects under the office of the coordinating committee for Royal Development Projects is 231.46 MCM.

Assuming that the run-off water is equivalent to 30% of the precipitation, the storage capacity of reservoirs in the study area being only 2% of the assumed run-off water is the least in the country.

The cultivated area is 729,200 ha, equivalent to about 37% of the total land (19,604 km²), furthermore, 24% (175,400 ha) of it is irrigated. The irrigation rate of the area is almost the same as the average rate (22%) of the whole country, however, most of the irrigated area is paddy land. Therefore, the upland area which covers 44% of cultivated land is under rainfed farming.

The major problems concerning irrigation facilities in the area 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 greatest 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, an irrigation system with small reservoirs is recommended for introduction to the Project area.

(2) Irrigation method

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.

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

- After getting the water from the pond by such methods as gravity flow method through outlets for the down-stream area and pumping up method for the up-stream area, 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) Water requirement for irrigation

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

Presently, the project area (8,840 km²) is under rainfed cultivation except for certain areas especially in Chanthaburi. In case that the soil conservation measures are introduced to the project area according to the regional characteristic of each province, about 530 km² of irrigable area for upland crops will be possible by constructing a total of about 212.0 MCM of reservoir capacity as shown in the table below.

DEVELOPMENT PLAN FOR THE PROJECT AREA

Province	Area (km ²)	Plan	Possibility of Irrigable Area		Required Water Resources (1000 m ³)
			Rate (%)	Acreage (km ²)	
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

5-4-5 Supporting Measures

(1) General

The Sixth Economic and Social Development Plan is the key governmental policy from 1987 to 1991 to which all of the governmental activities should be concentrated.

The Plan contains two overall targets, three main strategies and ten working programs. Some of the working programs have very close connection with soil and water conservation and rural development, which are the purpose of this study. For the promotion of agricultural industry and to improve living standards in the rural area which have been mentioned in the Sixth NESD Plan, supporting systems should be emphasized as well as the development of farm land itself.

Concerning the supporting system, infrastructure which are directly related to daily life, agro-industry, farmers' education and public services were selected and surveyed.

(2) Infrastructural measures

The conditions of road and transportation, motorization, water supply, electrification, postal and telephone service, children's education, public health, agricultural facilities and agricultural mechanization were studied and are mentioned in detail in Volume II.

The villagers' needs related to infrastructure collected through the field survey in the first and second phase, were as follows;

- 1) Development of small scale water resources
- 2) Maintaining and paving the rural roads
- 3) Installing electricity
- 4) Introducing cottage industry
- 5) Constructing a warehouse and a meeting hall

To find appropriate measures to meet these farmers' needs is an urgent problem.

Though soil erosion in the study area is becoming serious, most of the villagers have not given it a high priority. The reason will be that they have much more immediate problems to solve than soil erosion or they have no knowledge with which to cope with this problem or they feel that it is not such a serious a problem.

(3) Agro-industry

As for agro-industry approach, sugarcane and pineapple related industries are selected. Both of the industrial crops are very familiar with the East. There are several factories or mills for the processing of these products in the area. So far the prospects of these industries are hopeful and the farmers are receiving many conveniences from the factory and earning a certain level of income by contract. Of course there are so many points to be improved from the farmers side under such contract based production and not very much encouragement has been placed on the cultivation of these two crops in the NESD Plan but, especially, future prospects for exports of pineapple products appear favorable and its cultivation was encouraged for ordinary and intercropping cultivation in the suggested cropping patterns.

The prospects of establishment of canning factories of other crops, such as some kinds of vegetables were not discussed though there is a high possibility in the Eastern Seaboard Project.

(4) Education of farmers

DLD has a long career in the transfer of technology to farmers concerning how to prevent soil erosion through lectures and exhibition fields.

Basically, the success of rural development activities depends on the farmer's desire to improve their own living standard. The objectives of the activities must be thoroughly understood and accepted by the farmers through discussion and explanation.

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

(5) Institutional cooperation

Integrated institutional cooperation among the governmental agencies concerned with rural development should be strengthened. Out of the agencies mentioned above, DLD, DOAE and DA were selected as examples, since they have their own specialized fields in rural development activities. In case of extension activities, these agencies have their own role in the integrated technology to be transferred to farmers. It is observed that personal communication among agents or researchers of these organizations is quite good, however, improvement from the viewpoint of institutional cooperation is requisite for successfully carrying out rural development activities.

5-5 Implementation and Project Cost

5-5-1 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 ha for the whole country (34% of national land), and 1,841 thousand ha in the 7 provinces of the Eastern Region (49% of 7 provinces). Moreover, it is 716 thousand ha in the project area in the 4 provinces in the Eastern Region (47% of 4 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, in order to promote this project DLD has planned the establishment of the "Land and Water Conservation Center". Correspondingly, the project 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, but that the project shall be implemented by each agency according to its allotted task. For satisfactory implementation, a steering board such as "Board of Land and Water Conservation" shall be established in the MOAC, as well as the "Steering Committee of 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.
- 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 at 30 years until the end of sixth 5-year plan.
- 2) From the second 5-year plan, conservation works of approximately 35,000 ha shall be completed annually in the 4 provinces as shown in Table 5.5.1-1.
- 3) The first 5-year plan starts from 1991. These first 5 years are spent on the preparation works for the implementation of the long term plan and to gain various experience. Therefore, the first 5-year plan is allotted only 10,000 ha in the 4 provinces as shown in Figure 5.5.1-1.

Table 5.5.1-1 Long Term Implementation Schedule (Tentative)

(ha)

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

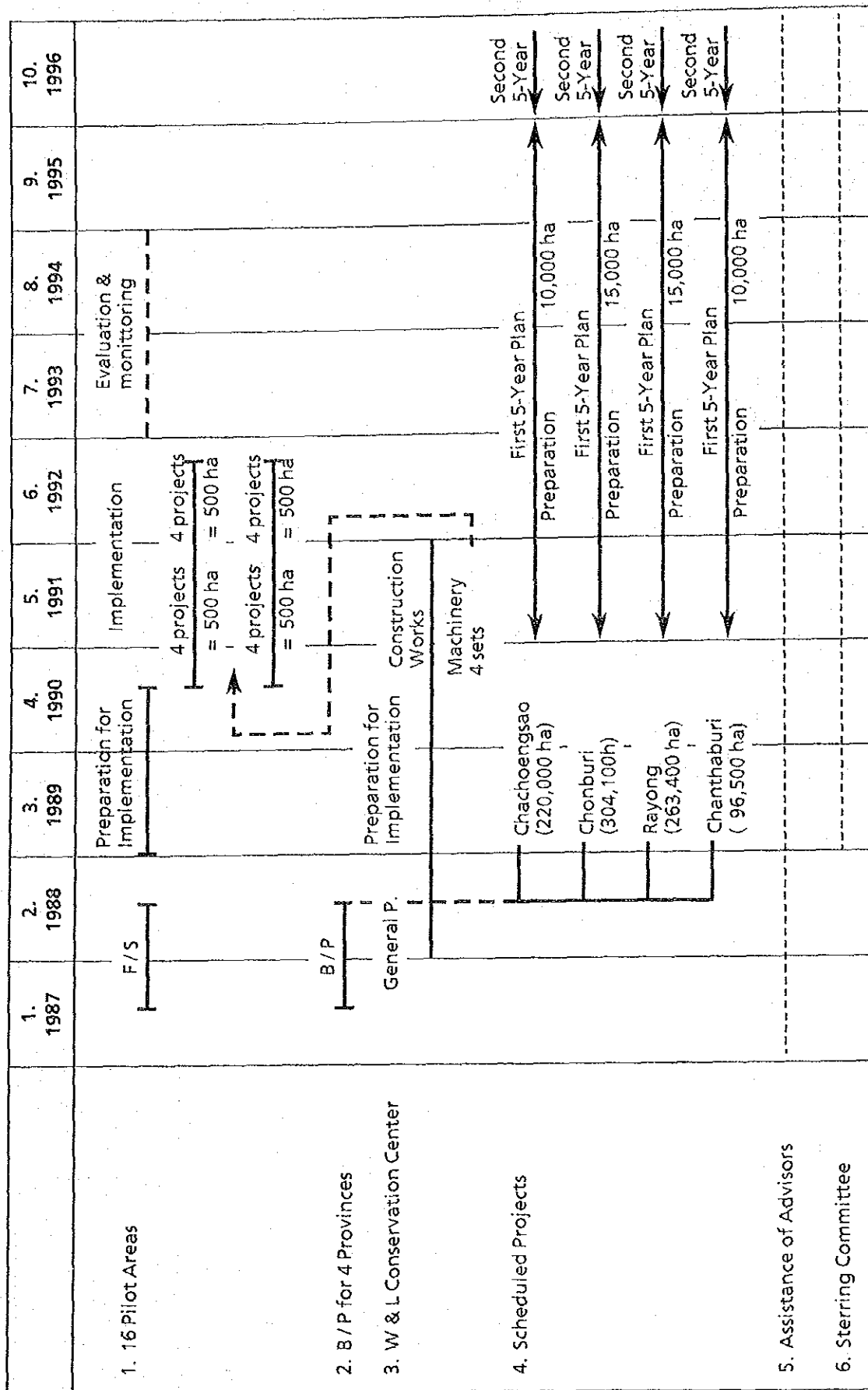


Figure 5.5.1-1 10-Year Implementation Plan

5-5-2 Project Cost Estimation

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

- Project construction will be implemented on contract basis.
- Unit project cost estimated for Alternative Plan II is applied in estimating the project cost.

<u>Province</u>	<u>Area</u> (km ²)	<u>Unit Project Cost</u> (Baht/rai)	<u>Total Project Cost</u> (× 10 ⁶ Baht)
Chachoengsao	2,200	12,825	17,633
Chonburi	3,041	"	24,373
Rayong	2,634	"	21,111
Chanthaburi	965	"	7,734
<u>Total</u>	<u>8,840</u>		<u>70,851</u>

5-6 Project Evaluation

5-6-1 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 the 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, occurrence of floods in communities, etc.

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 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.

5-6-2 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 to the real efficiency value of goods and services of the country due to various tariff and non-tariff restrictions in trade as well as distorted factors of production in the domestic market. To redress these price distortions, adjustment has been made for 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 rate of return (EIRR) which can be worked out by discounting both streams of economic cost and benefit over the project life and the net present value (NPV) 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.

The economic evaluation is carried out for the first ten (10) year plan 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.

5-6-3 Economic Evaluation

On the basis of the estimated economic cost and benefit by Province, the EIRR has been worked out for the four (4) province. The economic indicators including the net present value and benefit cost ratio which have also been calculated by Province are summarized in Table 6.3-1~6.3-4, Vol II.

The estimated EIRR are shown below.

		(%)				
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

5-6-4 Environmental Impact

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

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

5-7 Implementation Organization

5-7-1 Role of DLD

DLD was established in 1963 to survey the land and to analyse 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 categories each headed by a Deputy Director-General, namely administration, operation and engineering, and technical.

The administration sector consists of 4 divisions namely, office of secretary, personnel, financial and planning.

Planning division is responsible for studying, analysing and planning principal guidelines of DLD projects, including the operation of foreign affairs, 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.

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

Within so many land-related governmental agencies, it is considered that DLD is the most suitable agency to take the initiative in land conservation work because DLD has the function 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.

In particular, except for private farms DLD is not able to carry out project implementation by itself. Therefore, DLD is expected to take the initiative for surveying, planning, designing and implementation concerning land and water conservation projects among related agencies as well as King's Project already executed.

5-7-2 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 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. These 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	

5-7-3 Implementation Organization

(1) General

In the subject 4 provinces only 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

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

(3) Land and Water Conservation Center (LWCC)

LWCC shall be established in Chonburi in the East to strengthen the Land Development Regional Office (LDRO) No.2.

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

(4) Land and Water Conservation Station (LWCS)

5 LWCS's shall be established one each in Chachoengsao, Chonburi, Rayong, Chanthaburi and Prachinburi to strengthen each Land Development Station. Existing and recommended organization is shown in Figure 5.7.3-1.

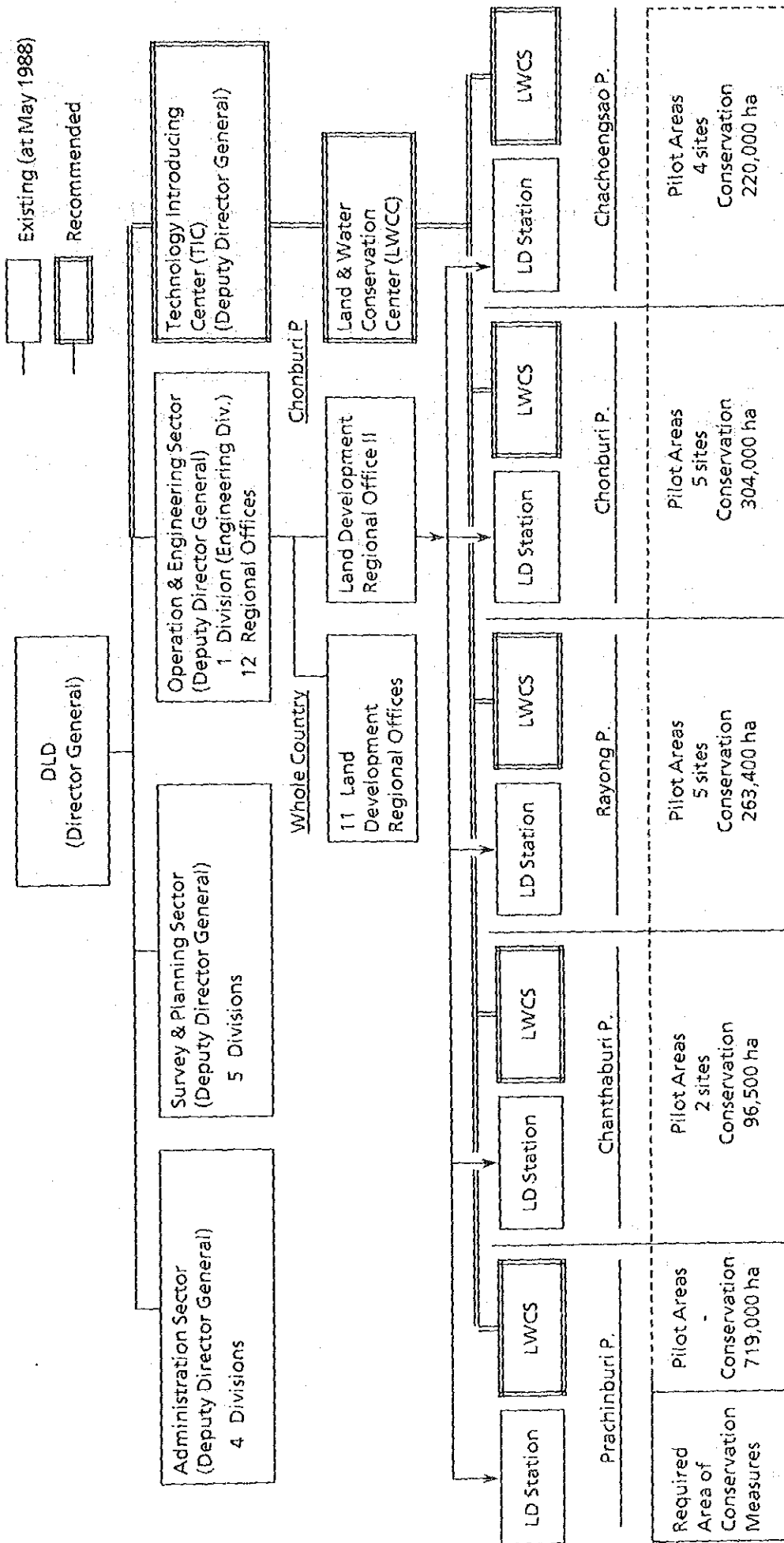


Figure 5.7.3-1 Organization Chart of DLD Existing and Recommended

5-7-4 Project Management and Monitoring

(1) Project Management

Project management means to effectively control the project organization in order that the project system may fulfill its function.

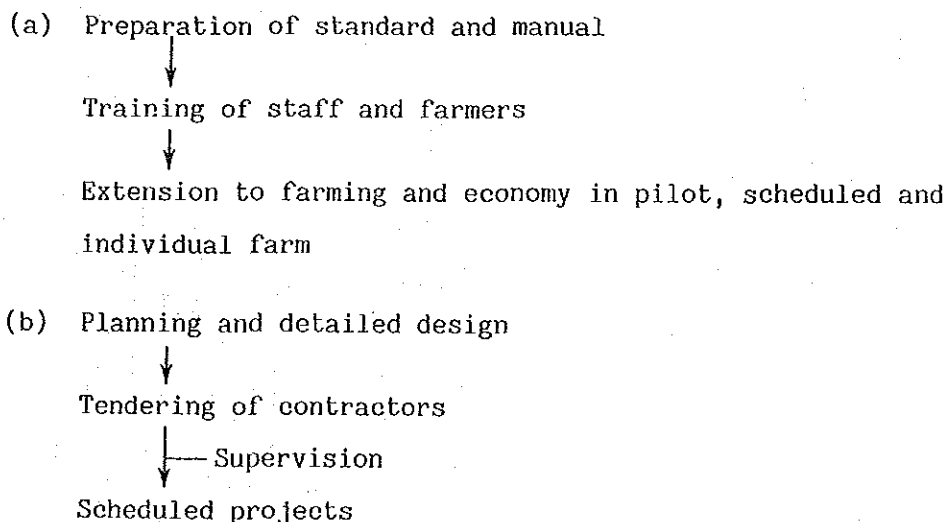
In this project, management is separated into two fields, namely the field of agricultural production and the field of civil work.

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 carrying out the efficient and less expensive works.

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

The project management system is shown in Figure 5.7.4-1. This is also shown in the following chart.



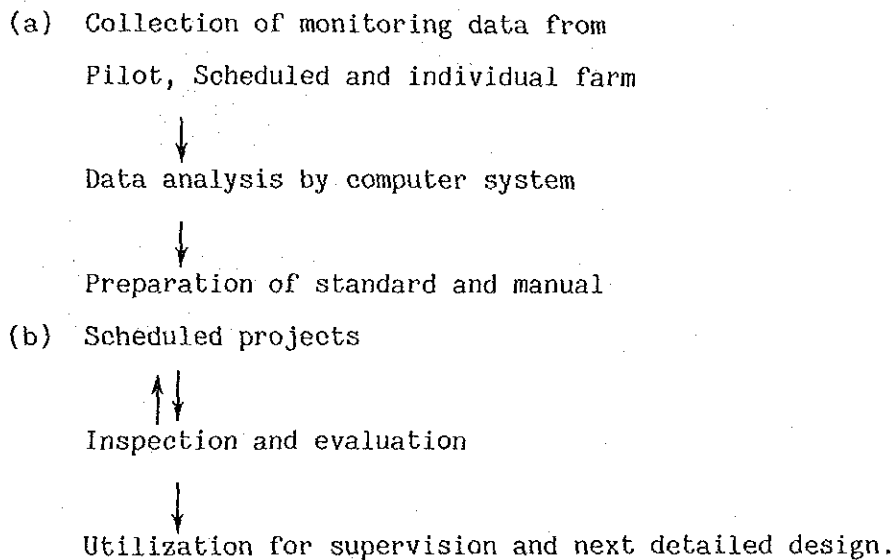
(2) Project monitoring

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

This will require the assignment of a staff to each pilot area. The assigned staff shall carry out the survey and extension works. Data collected through the LWCS shall be analysed by the LWCC with the equipped computer system. These 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 5.7.4-1. This is also shown in the following chart.



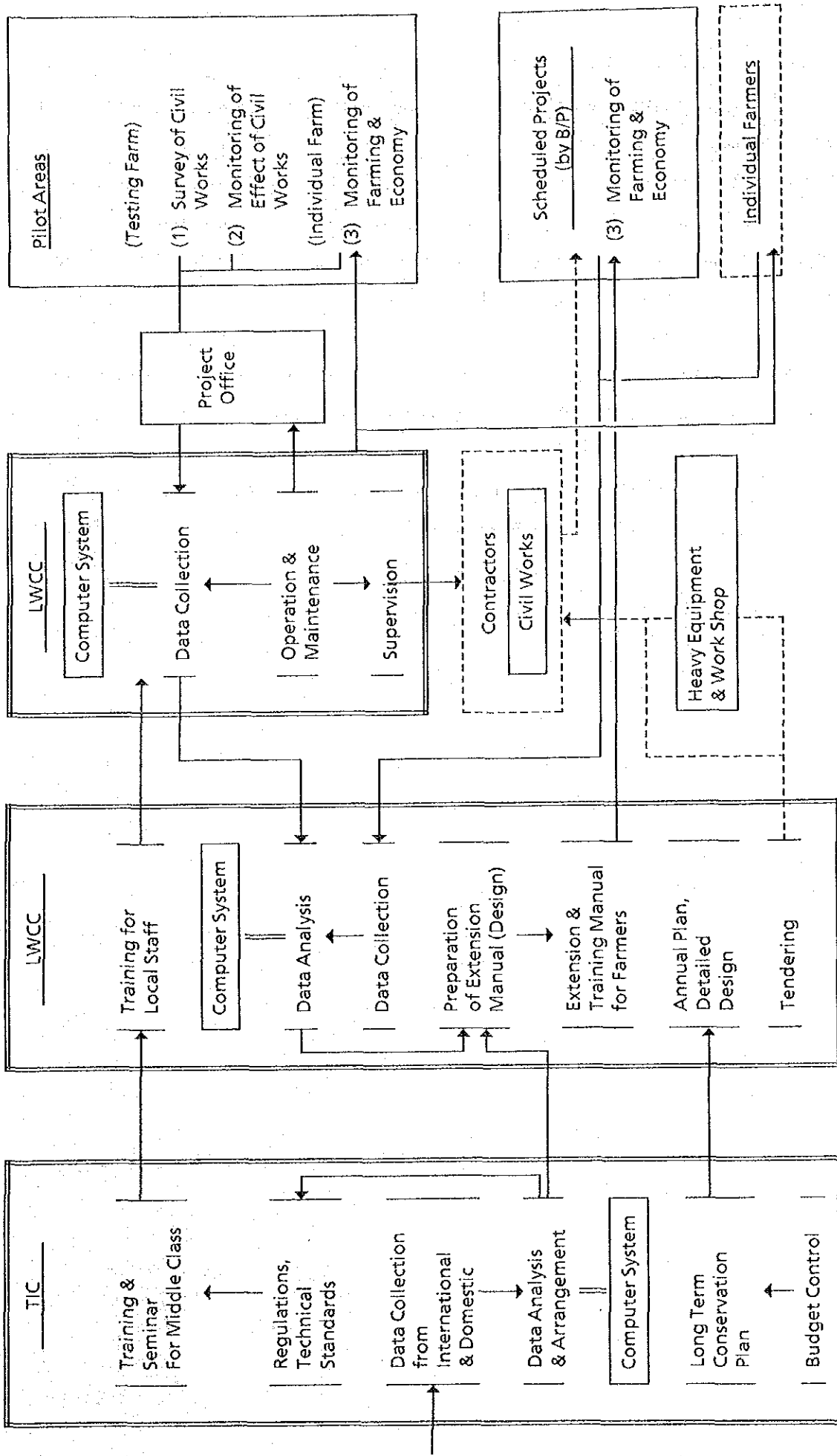


Figure 5.7.4-1 Project Management and Monitoring System

Chapter 6.

FEASIBILITY STUDY OF 16 PILOT AREAS

CHAPTER 6 FEASIBILITY STUDY OF 16 PILOT AREAS

6-1 Necessity and 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 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 B/P.

One pilot area is approximately 80 - 160 ha in size.

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

The 16 pilot areas are considered to play the role of testing and as a model farm of the land conservation works, not only for individual farms. 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

Survey	Item	Object
(2) Survey on effect of civil works	- Annual variation of soil loss,	<ul style="list-style-type: none"> - Most suitable works - Preparation of planning manual.
	- Consumption process of soil moisture,	
	- Irrigation system and its effect,	
	- Maintenance of facilities.	
(3) Survey on farming and economy	- Farm management	<ul style="list-style-type: none"> - Establishment of farming system - Basic data for extension
	- Production,	
	- Farmers economy	

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

6-2 Selection of Pilot Areas

6-2-1 General

The project area of 8,840 km² for the Basic Plan covering the four provinces is upland crop area mainly utilized for planting cassava under rainfed farming and has recently been shifted from the forest area. The people living there suffer from land erosion problems due to poor natural conditions of soil and water, and lack of irrigation knowledge.

Therefore, the Thai government through DLD intends to rehabilitate the land resources and improve the living standards of farmers by introducing the land and water conservation project to the area.

From the above background, thirty (30) candidate pilot areas were selected by DLD during the Phase I stage of the study. Among them, sixteen (16) pilot areas were finally selected for making the feasibility study taking into account farmers needs, land right condition, efficiency of demonstration and other factors, at the beginning of the Phase II stage.

The total acreage of the 16 pilot areas was found to be 2,062 ha.

6-2-2 Selection Criteria

The main purpose for the implementation of the pilot areas is to instruct the necessity of land and water conservation to the farmers in the Eastern Region in order to prevent the further degradation of land and water resources and to improve the living standards of villagers. Moreover, the implementation of the pilot areas is expected to result in a high degree of demonstration effect on activities of farmers in the adjacent lands.

Based on the policy mentioned above, the selection criteria for pilot areas were established as follows;

- (1) Number of farmer's family who shall be land owner and/or have government permission for living and cultivation in the area such as under SPK shall be multiple.
- (2) The farmers and/or land owners of the area shall understand and expect implementation of land conservation works under DLD.
- (3) The area shall exhibit erosion and/or be considered to be erodible due to such poor soil conditions as sandy soil, sandy loam and sloping topography.
- (4) The area shall be undulating with a small watershed and/or potentiality of water resources development.
- (5) The major crops in the area shall be upland crops as cassava, sugarcane, pineapple, etc.
- (6) The area shall be located nearby a main road and/or be accessible to a main road for demonstration effect.
- (7) The area shall be such that the farmer's income and living conditions will increase and improve due to the land conservation project.
- (8) The acreage of the area will be 50 to 250 ha (300~1,500 rai)

6-2-3 Selection of 16 Pilot Areas

(1) Selection of 16 pilot areas

Based on the selection criteria as mentioned in sub-section 6-2-2, thirty (30) sites were nominated 8 sites in Chachoengsao, 9 sites in Chonburi, 9 sites in Rayong and 4 sites in Chanthaburi.

From them, 16 sites were selected for the feasibility study as shown in the table below taking into account the following conditions.

- 1) The area should not belong or be under administration of another agency's project, particularly the reserve forest and wildlife sanctuary under RFD.
- 2) The areas shall not be concentrated in the same place to maximize the demonstration effect.
- 3) The areas shall have representative characteristics of soil, topography, crop, water resources and socio-economy.

List of Pilot Area

<u>Province</u>	<u>Pilot Area</u>
Chachoengsao	CS-NO 3, 4, 5, 8
Chonburi	CN-NO 1, 2, 4, 8, 9
Rayong	RY-NO 1, 2, 3, 5, 7
Chanthaburi	CT-NO 2, 3

The characteristics of each pilot area nominated are classified as shown in Table 6.2.3-1, (1~4).

Table 6.2.3-1 Present General Conditions of Pilot Areas (1/4)

Description	CHACHOENGSAO			
	CS-NO 3	CS-NO 4	CS-NO 5	CS-NO 8
Province Pilot Area				
I. General				
1) Location	Sanamchaikhate Lat Kra Ting B. Khun Klang, B. Lum Tone 186.9	Plang Yao Nong Mai Kaen B. Nongpladuk 79.0	Sanamchaikhate Khu Yai Mo B. Pai Tan, B. Klomg Ta Phung 92.0	Phanomarakham Kao Hin Sorn B. Nong Langnar, B. Muang Phlong 115.5
2) Area (ha)	3.2	26.6	7.3	38.6
3) Watershed (Km ²)	1,650	1,650	1,650	1,650
4) Average annual rainfall (mm.)				
II. Agricultural condition Major crops	Cassava, Para-rubber Sugarcane.	Cassava, Sugarcane, Pineapple, Eucalyptus Fruit tree	Cassava, Mango, Coconut	Cassava, Eucalyptus, Pineapple, Fruit tree
III. Physical condition				
1) Topography	EL 80 - 100 m Undulating-Rolling (2 - 10 %)	EL 60 - 80 m Undulating (2 - 6 %)	EL 30 - 45 m Undulating (2 - 6 %)	EL 25 - 45 m Undulating (2 - 6 %)
2) Geology	Qt deposit/Bedrock (Schist)	Qt deposit	Qt deposit	Granite deposit
3) Eroded condition	Top.U (63.8 t/ha/y)	Nec (16.8)	Urg (34.7)	Urg (34.7)
4) Soil	Hat Yai (SCLV.G.C)	Sattahip (LS/LS)	Ko Khanum (SU/GSCL)	Warin (SU/SCL)
5) Transportation means	V.R (Earth road)	ARD.R (Earth road, Good)	V.R (Earth road, Poor)	V.R (Earth road)
6) Water resources	Two small streams (very poor) / shallow well	Huai Muang (Poor) / Shallow well (1.5 m)	Huai Kom (poor) / Deep well (8.5 m)	Lower Huai Nam (Comparative rich) / shallow well
IV. Social condition				
1) Land right condition	Sor Por Kor	Sor Por Kor	Sor Por Kor	Sor Por Kor
2) Number of landowners	48	29	36	29
3) Average land holding (rai) inside pilot area	23.4	15.7	15.3	23.2
4) Major problem	Water shortage Land erosion	Water shortage Land erosion	Water shortage	Land erosion
V. Other			There is one RID reservoir.	There is one RID reservoir and some irrigation system.

Table 6.2.3-1 Present General Conditions of Pilot Areas (2/4)

Province		CHONBURI				
Description	Pilot Area	CN-NO 1	CN-NO 2	CN-NO 4	CN-NO 8	CN-NO 9
I. General						
1) Location	Si Racha Bang Phra B. Wan Kaung	94.4	116.8	Bang Lamung Huai Yai B. Ban Nok	94.1	Ban Bung, Nong Yai Nong I Run B. Chai Wat
2) Area (ha)					130.6	127.2
3) Watershed (Km ²)		13.1	20.9		1.9	62.3
4) Average annual rainfall (mm.)		1,540	1,540	1,540	1,540	1,540
II. Agricultural condition						
1) Major crops	Cassava, Asparagus Para-rubber, Pineapple		Cassava, Sugarcane, Para-rubber, Coconut	Cassava, Coconut, Pineapple		Sugarcane, Cassava
III. Physical condition						
1) Topography	EL 65 - 90 m Undulating-Rolling (3 - 10 %)		EL 105 - 145 m Undulating (2 - 6 %)	EL 60 - 125 m Hill side (5 - 10 %) Plain side (2 - 5 %)		Undulating (2 - 5 % rather flat)
2) Geology	Granite		Granite	Granite/Ad.		Granite
3) Eroded condition	Urg (41.1v/ha/y)		Top (75.3)	Top (86.9)		Urg (34.7)
4) Soil	Sattahip (SL/LS)		Sattahip (LS/LS)	Map Son (SL/SCL)		Satuk (SU/SCL)
5) Transportation means	V.R (Earth road, poor)		N.R (Route 331)	V.R (Earth road)		National highway (Route 331)
6) Water resources	Khlong Huai Kruat/ Pon Din Dam reservoir		Huai Prap (rich)	one small stream (poor)		Huai Nong Nai / Huai Chai Wat (poor)
IV. Social condition						
1) Land right condition	Sor Kor 1, Bai-chong		Nor Sor 3	Nor Sor 3, Chanode		Chanode, Nor Sor 3
2) Number of landowners	9		18	14		8
3) Average land holding (rai) inside pilot area	64.0		36.2	40.3		92.5
4) Major problem	Land erosion Water shortage		Land erosion	Water shortage Land erosion		Water shortage
V. Other	Down-stream of RID reservoir There are some RID irrigation facilities.					

Table 6.2.3-1 Present General Conditions of Pilot Areas (3/4)

Province	RAYONG				
	RY-NO 1	RY-NO 2	RY-NO 4	RY-NO 8	RY-NO 9
Description					
I. General					
1) Location	Pluak Daeng Maenam Ku B.Map Kha, 8.Patamapank 2 173.7	Ban Khai Pana Nikhom B.Chark Char Deao 219.5	King A. Wang Chan Chum Saeng B.Dao Ta Inn 96.7	King A. Wang Chan Payup Wai B. Payupnai 155.8	Pluak Daeng Mapyangporn B. Chakauey 89.9
2) Area (ha)	3.4	8.1	1.4	4.0	3.9
3) Watershed (Km ²)	2,040	2,040	2,040	2,040	2,040
4) Average annual rainfall (mm.)					
II. Agricultural condition					
1) Major crops	Pineapple, Cassava, Eucalyptus	Cassava, Pineapple Fruit tree	Cassava, Sugarcane, Para-rubber, Fruit tree	Cassava, Sugarcane Para-rubber, Pineapple	Cassava, Fruit tree
III. Physical condition					
1) Topography	EL 65 - 90 m Undulating-Rolling (3 - 10 %) Granite Top (83.2 v/ha/y) Map Bon (SUSCL) V.R (Earth road poor) Klong Map Kahmin (poor)	EL 105 - 145 m Undulating-Rolling (3 - 10 %) Granite Top (62.8) Map Bon (S/SL-VGSU) N.R (Route 36) Klong Chakch (poor)	EL 55 - 100 m Undulating-Rolling (3 - 10 %) Granite small mass/Qt Top (167.6) Phangnga (S/SL) V.R (Earth road) Khleng Klle (poor)	EL 50 - 60 m Undulating (3 - 8 %) Bedrocks (Gniss schist) Top (64.0) Phangnga (S/SL) V.R (Earth road) Khleng Sip Paed (poor) / High ground table	EL 60 - 80 m Undulating (2 - 6 %) Granite Top (64.0) Map Bon (LS/SL) V.R (Earth road) Khleng Rawang (very poor) / Shallow well
2) Geology					
3) Eroded condition					
4) Soil					
5) Transportation means					
6) Water resources					
IV. Social condition					
1) Land right condition	P.W.D Nor Khor	P.W.D Nor Sor 3	C.P.D	C.P.D	Nor Sor 3
2) Number of landowners	75	44	16	21	25
3) Average land holding (rai) inside pilot area	12.8	27.6	36.4	43.9	21.4
4) Major problem	Land erosion Water shortage	Land erosion Water shortage	Water shortage Land erosion	Water shortage	Water shortage Land erosion
V. Other					
	Up-stream of Dok Krai reservoir (RID)				

Table 6.2.3-1 Present General Conditions of Pilot Areas (4/4)

Description	CHANTHABURI		Remarks
	Province Pilot Area	CT-NO 2	
I. General			
1) Location	Tha Mai Thung Benja B. Wangpla Pattana	Tha Mai Thung Benja B. Tapong	V.R ; Village road ARD.R ; ARD road N.R ; National road Qt ; Quaternary Top ; Top urgent Urg ; Urgent Nec ; Necessary
2) Area (ha)	143.1	146.8	
3) Watershed (Km ²)	2.2	8.1	
4) Average annual rainfall (mm.)	2,400	2,400	
II. Agricultural condition			
1) Major crops	Cassava, Para-rubber, Mango	Pineapple, Para-rubber Pepper, Cassava	
III. Physical condition			
1) Topography	EL 20 - 60 m Undulating (3 - 8 %)	EL 20 - 80 m Undulating (2 - 8 %)	
2) Geology	Bedrocks (SL, SS), Qt	Bedrocks (SL, SS)	
3) Eroded condition	Top (142.6 t/ha/y)	Top (99.2)	
4) Soil	Chumpon (CU/VGCL)	Chumpon (CU/VGCW)	
5) Transportation means	Earth road (8 - 5.0 m)	Earth road (8-5.0m)	
6) Water resources	Small stream (very poor) / some spring	Two streams (poor)	
IV. Social condition			
1) Land right condition	Nor Sor 3 Kor	Nor Sor 3 Kor	
2) Number of landowners	34	34	
3) Average land holding (rai) inside pilot area	23.8	25.6	
4) Major problem	Water shortage		
V. Other	Some existing irrigation facilities	East side : Rather developed area West side : Rainfed area	

6-3 Project Formulation

6-3-1 Present Condition of Soil Erosion

According to the field survey in each pilot area soil loss volume was calculated using the Universal Soil Loss Equation (USLE) as follows.

<u>Project No.</u>	<u>Soil Loss Volume</u> (ton/ha/yr)	<u>Classification</u>
CS No.3	63.8	Top Urgent
NO.4	16.8	Necessary
No.5	34.7	Urgent
No.8	34.7	Urgent
CN No.1	41.1	Urgent
No.2	75.3	Top Urgent
No.4	86.9	Top Urgent
No.8	33.2	Urgent
No.9	34.7	Urgent
RY No.1	83.2	Top Urgent
No.2	62.8	Top Urgent
No.3	167.6	Top Urgent
No.5	68.6	Top Urgent
No.7	64.0	Top Urgent
CT No.2	142.6	Top Urgent
No.3	99.2	Top Urgent

6-3-2 Alternative Plan of Development Grade and Classification of Pilot Areas

Soil conservation measures consist of the following items;

1. Agricultural measures
2. Mechanical measures
3. Irrigation facilities
4. Supporting measures
5. Organization and management

The countermeasures consist of two main categories, namely software and hardware. Software contains agricultural measures including biological measures, crop cultivation system and farm management system and organization and management system.

Hardware contains mechanical measures including civil engineering, land preparation and operation system, irrigation facilities and supporting measures as the supporting system of software.

As to cost estimation of the Project, only hardware shall be counted. Software shall be included in the production cost of crops and operation and maintenance cost of the Project.

(1) Alternative plan

Alternative plan of the study area development shall be formulated in the following depending on the grade of soil conservation measures.

Project grade shall be classified into three levels such as High grade, Medium grade and Common grade, each grade is explained below:

1) High grade (Plan I)

- Target : prevention of soil loss by 90%
- Selected types of mechanical measures shall be applied on a 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.

2) Medium Grade (Plan II)

- Target : prevention of soil loss by 85%
- Selected types of 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.

3) Common Grade (Plan III)

- Target : prevention of soil loss by 80%
- Selected mechanical measures shall be applied on 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 6.3.2-1 shows the summary of the contents of each case.

Table 6.3.2-1 Alternatives of Soil Conservation Plan

Measures	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 %	0
b. Graded Terrace	Interval 40m (40m / rai)	50m (32m / rai)	60m (26.7m / rai)
c. Collecting ditch	Masonry ditch + drops Interval 200m (= 8.0m / rai)	Grass water-way + drops 300m (= 5.3m / rai)	Grass water-way 400m (= 4.0m / rai)
d. Sediment trap	1 pl / 25 rai	1 pl / 50 rai	1 pl / 100 rai
e. Draining ditch	Masonry water-way (3.2m / rai)	Grass water-way (3.2m / rai)	Soil water-way (3.2m / rai)
f. Road			
- lateral	8.0m / rai	5.3m / rai	4.0m / rai
- trunk	1.6m / rai	1.6m / rai	1.6m / rai
g. Check dam	1 pl / 250 rai (masonry)	1 pl / 250 rai (masonry)	1 pl / 250 rai (earth dam)
h. Slope protection	6.4m ² / rai (sodding)	3.2m ² / rai (sodding)	-
2. Irrigation facilities			
i. Farm Pond	one large scale	1 pl / 300 rai small scale	1 pl / 500 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	-

(2) Project cost of alternative plan

Case study of each alternative plan was carried out for setting down project cost in Rayong No.2 summarized in the following.

Unit : 10^3 Baht/rai

<u>Description</u>	Plan I	Plan II	Plan III
1. Civil Works			
1.1 Preparatory Works	0.6	0.4	0.2
1.2 Mechanical Measures	4.3	3.5	3.1
1.3 Irrigation Facilities	4.4	3.7	1.6
1.4 Supporting Measures	2.4	1.2	0.2
<u>Sub-total (1)</u>	<u>11.6</u>	<u>8.8</u>	<u>5.1</u>
2. Project Administration	0.6	0.5	0.4
3. Engineering Service	1.2	0.9	0.5
<u>Sub-total (1 to 3)</u>	<u>13.4</u>	<u>10.2</u>	<u>6.0</u>
4. Physical Contingency	1.3	1.2	0.6
<u>Total (1 to 4)</u>	<u>14.8</u>	<u>11.3</u>	<u>6.6</u>
5. Price Contingency	2.0	1.6	0.9
<u>Total (1 to 5)</u>	<u>16.8</u>	<u>12.8</u>	<u>7.5</u>

where : 3 = $1 \times 10\%$

4 = $(1 \sim 3) \times 10\%$

5 = $(1 \sim 4) \times 15\%$ in FC, $(1 \sim 4) \times 10\%$ in LC

Note : Detailed estimation is shown in Vol. V
Annex 5, 5-10.

(3) Classification of pilot areas

In the pilot area, the most important factor is assumed to be gross farm income to measure the capability for paying operation and maintenance cost after completion of the Project.

The result of classification is shown below:

Plan	CS	CN	RY	CT	Total
I		No.1, *No.8 No.9	* No.2	No.3	5
II	No.4, No.8	No.2	No.3, No.5	* No.2	6
III	*No.3, No.5	No.4	No.1, No.7		5
Total (Places)	4	5	5	2	16

* Representative of each plan and province.

6-3-3 Soil Conservation Plan

(1) Agricultural measures

Basic concept of agricultural measures against erosion and cropping pattern for that purpose are mentioned and suggested in 4-1 of Volume II. This section deals with what crops should be planted in each pilot area based on those principles.

Selection of crops should be in line with the Sixth Plan and the targets of production, planting area and productivity of each crop in the Plan are shown in Volume III. Share of production in the Eastern Region in the last year of the plan, 1991 and that of the four provinces in the region are shown as well.

Judging from the study, production of some industrial and fruit crops is encouraged and major crops at present, such as rice or maize, are going to be kept at present levels or lower. It is planned to decrease the planting area of cassava but production will be maintained by increasing yields.

In Volume III there shows the production tendency of some selected crops in the plan in the Eastern Region and the four provinces. As mentioned earlier, instead of the existing major crops such as rice, maize, pineapple or sugarcane, tree crops or fruit trees are being emphasized.

In the irrigable area, mango and durian are the main fruit trees and pineapple or cassava will be intercropped for a few years.

In the non-irrigable area, Para-rubber and cashew nut are the main crops with the same intercrops as mentioned above.

The precise cropping patterns in the four representative pilot areas are suggested in Volume III.

(2) Mechanical measures

Appropriate mechanical measures were applied to each pilot area based on the development grade.

The results are shown below.

- 1) Major applied measures are summarized in Table 6.3.3-1.

2) Gross cultivable areas after completion of Project are shown in Table 6.3.3-2.

3) Soil conservation effects are shown in Table 6.3.3-3.

To minimize project cost and non cultivable area, the following matters were considered.

1) Bench terrace was not applied.

2) Horizontal interval of graded terrace should be determined according to the adopted grade and slope of farmland. However, this method was not applied and the interval was the same in all of the proposed plans. The reason is to avoid the cost to be shared by farmers.

3) Total width of water way and terrace were minimized as much as possible by detailed hydraulic calculation for the full use of farmland.

Table 6.3.3-2 Gross Cultivable Area of Pilot Areas

Unit: ha

Name	Total A	Cultivable A	Non-cultivable Area										Increased non. C.A. * (%)				
			Stream	Exist. R	New R.	Water-way	Terrace	Farm R.	Green Belt	Resident	Others	Total					
CS - 3	Present	186.9 (100)	179.9 (96.3%)	3.3	3.1	-	-	-	-	-	-	-	0.6	-	-	7.0	
	Plan - III	186.9 (100)	164.8 (88.2)	3.3	"	3.0	2.0	8.7	1.4	-	-	-	"	-	-	22.1	△ 8.1
CN - 8	Present	130.6 (100)	126.3 (96.7)	2.9	1.3	-	-	-	-	-	-	-	0.1	-	-	4.3	
	Plan - I	"	103.6 (79.3)	"	"	3.5	3.2	8.4	7.6	-	-	-	"	-	-	27.0	△ 17.4
RY - 2	Present	219.5 (100)	194.1 (88.4%)	7.2	17.4	-	-	-	-	-	-	-	0.8	-	-	25.4	
	Plan - I	"	160.7 (73.2)	"	"	5.4	4.2	13.0	10.8	-	-	-	"	-	-	58.8	△ 15.2
	Plan - II	"	173.0 (78.8)	"	"	4.2	3.4	11.0	2.5	-	-	-	"	-	-	46.5	△ 9.6
	Plan - IV	"	177.9 (81.0)	"	"	3.6	2.5	9.4	0.7	-	-	-	"	-	-	41.6	△ 7.4
CT - 2	Present	143.1 (100)	129.4 (90.4)	8.4	4.9	-	-	-	-	-	-	-	0.1	-	-	13.7	
	Plan - II	"	112.0 (78.3)	"	"	2.6	2.5	7.1	5.5	-	-	-	"	-	-	31.1	△ 12.1

* Increased non cultivable area compared with without Project.

Table 6.3.3-3 Effects of Soil Conservation

Name	Plan	Project Area Ha	Crop Land Ha	Non Crop Area Ha	Soil Loss t/ha/y	S. Texture	Monetary Loss (10 ³ Baht)			Saving (10 ³ Baht)	Mechanical Measures			Soil Depth Infiltration
							Nutrient	Dredging	Total		Terracing	C. Ridging	C. Ploughing	
CS - 3	Present	186.9	179.9	7.0	63.8 x 20%	CL	1,662	574	2,236		-	-	-	<25 cm Low
	Plan - III	"	164.8	22.1	12.8	"	305	105	410	△ 1,826	ctc 60 m			
											(A = 16.5 ha)		Dep. 0.6 m	
													168.3 ha	
CN - 8	Present	130.6	126.3	4.3	33.2 x 10%	SL	232	210	442					50 ~ 100 Low
	Plan - I	"	103.6	27.0	3.3	"	19	17	36	△ 406	ctc 40 m			
											(A = 104 ha)			
RY - 2	Present	219.5	194.1	25.4	62.8 x 10%	SL	674	609	1,286					50 ~ 100 High
	Plan - I	"	160.7	58.8	6.3 x 15%	"	56	51	107	△ 1,179	ctc 40 m			
											(A = 169 ha)			
	Plan - II	"	173.0	46.5	9.4 x 20%	"	90	81	171	△ 1,115	ctc 50 m			
											(A = 173 ha)			
	Plan - IV	"	177.9	41.6	12.6	"	124	112	236	△ 1,050	ctc 60 m			
											(A = 178 ha)			
CT - 2	Present	143.1	129.4	13.7	142.6 x 15%	CL	2,672	923	3,595					25 ~ 50 High
	Plan - II	"	112.0	31.1	21.4	"	347	120	467	△ 3,128	ctc 50 m		Dep. 0.6 m	
											(A = 112 ha)		56.0 ha (50%)	

where ; Nutrient Cost CL = 144.8 Baht/ton
Dredging Cost SL = 55.3 Baht/ton
= 50.0 Baht/ton

(3) Irrigation facilities

As mentioned in the Basic Plan (Volume II), irrigation facilities shall be introduced to the Pilot Areas as one of the effective soil conservation measures;

- To obtain stable agricultural productions.
- To diversify from cassava to other upland crops including tree crops.

The irrigation facilities of each pilot area are planned as follows;

<u>Plan</u>	<u>General ideas</u>	<u>Pilot area</u>
I	One large pond (maximum dam height, 6.0 m) with a pump station	CN-NO1, CN-NO8, CN-NO9, RY-NO2, CT-NO3
II	Three small ponds (maximum dam height, 4.0 m) utilizing portable pumps	CS-NO4, CS-NO8, CN-NO2, RY-NO3, RY-NO5, CT-NO2
III	One small pond utilizing portable pumps	CS-NO3, CS-NO5, CN-NO4, RY-NO1, RY-NO7

Table 6.3.3-4 Irrigable Area of 16 Pilot Areas

Province	Pilot Area	Project Area (ha)	Pond Total Capacity (1,000 m ³)	Irrigable Area (ha)	Plan	Remarks
Chachoengsao	CS - No.3	186.9	11.2	1.5	III	One pond
	∕ - No.4	79.0	13.8	2.3	II	One pond
	∕ - No.5	92.0	11.5	4.0	III	One weir
	∕ - No.8	115.5	-	-	II	No farm pond
	<u>Sub-Total</u>	<u>473.4</u>	<u>36.5</u>	<u>7.8</u>		
Chonburi	CN - No.1	94.4	79.4	10.8	I	One pond
	∕ - No.2	116.8	11.0	46.8	II	One weir/ large watershed
	∕ - No.4	94.1	5.0	5.7	III	One pond
	∕ - No.8	130.6	123.5	19.0	I	One pond
	∕ - No.9	127.2	4.5	7.5	I	One weir
	<u>Sub-Total</u>	<u>563.1</u>	<u>223.4</u>	<u>89.8</u>		
Rayong	RY - No.1	173.7	12.5	9.0	III	One pond
	∕ - No.2	219.5	122.5	45.0	I	One pond
	∕ - No.3	96.5	32.6	5.8	II	Two pond
	∕ - No.5	155.8	24.1	9.6	II	One pond
	∕ - No.7	89.9	12.1	1.1	III	One pond
	<u>Sub-Total</u>	<u>735.6</u>	<u>203.8</u>	<u>70.5</u>		
Chanthaburi	CT - No.2	143.1	48.1	9.8	II	Two pond
	∕ - No.3	146.8	39.3	9.2	I	Three pond
	<u>Sub-Total</u>	<u>289.9</u>	<u>89.4</u>	<u>19.0</u>		
Total		<u>2,062.0</u>	<u>553.1</u>	<u>187.1</u>		

Note ;

- (1) Irrigation rate (In case of excluding CN-No.2 and CS-No.8)
- | | | |
|---------------|---------|---------|
| Total average | ; 9.1% | (7.7%) |
| Plan I | ; 12.7% | (12.7%) |
| Plan II | ; 10.5% | (5.8%) |
| Plan III | ; 3.3% | (3.3%) |
- (2) Required pond capacity for irrigable area
Average ; 3,000m³/ha (4,000m³/ha)
- (3) The irrigable areas excluding CS-No.3, CN-No.8, RY-No.2 and CT-No.2 were assumed based on the results of detailed water balance study for said four pilot areas.

(4) Supporting measures

1) Villagers' needs

As a case study, previously mentioned villages were selected to understand villagers' needs in connection with the soil conservation project.

The followings were strongly requested by the village heads.

- i) Developing water sources for drinking, domestic and agriculture.
- ii) Maintaining and paving the existing rural roads in order to ensure the availability of all-weather roads.
- iii) Promoting rural electrification.
- iv) Creating employment by introducing agro-industry and/or other industries.
- v) Warehouses were also requested by several villages.

2) Recommendation

Firstly, the following must be considered.

i) Small scale water resources development

The top priority of selection for the project site will be whether there is a stream which can be developed or not.

ii) Rural road development

Farm road network will be developed by the project and in that case the network should be considered to develop not only the agricultural aspects but also convenience of villagers' daily life.

iii) Changing the existing dispersed households to the ideal style of the settlement for rural development.

Agricultural land conservation has a useful measure, what is called disposition for substitute lots.

By using this useful measure, a residential area should be established in the area. Of course, immediate reorganization of the settlement will not be able to be expected from a viewpoint of economic and social conditions, however, when the opportunity comes this countermeasure will be very useful.

That area should be used for farming by the respective

owners until the time comes. Anyhow, it is obvious that the existing style of settlement has been preventing rural development.

iv) Village fish-pond development

Most of the villagers seek employment, and infant malnutrition can be still seen in 11 villages concerned.

From the viewpoint of location, marketing and investment, notwithstanding the strong villagers' request it is not so easy to introduce cottage industry to the area.

Fortunately, small reservoirs will be developed by the project and therefore, small scale inland fishery using the reservoirs should be created, so it will meet with the villagers' request.

v) Developing a forest for firewood and charcoal by allocating a part of the project area to be for common use.

Villagers living in 14 out of the 16 villages in which the proposed pilot project areas are located have been using firewood and/or charcoal for fuel.

Most of the villagers said that they collect wood at the outside of the forest reserved area, however, in order to protect valuable natural resources, trees should be grown expressly for firewood and using the material a cottage industry for charcoal would be introduced.

6-4 Cost Estimation

6-4-1 Unit Cost and Efficiency per Unit Cost

(1) Unit cost

The unit cost for the construction works is estimated in taking into account the costs such as efficiency of the construction equipment, labour, materials, and operation cost of the construction equipment. The estimated unit costs for each major work are shown in Vol. V, Annex 5, of which details are given in Vol. W Chapter 4.

(2) Labour efficiency per unit cost

The labour efficiency per unit cost is mainly based upon the data available in Thailand. However, those not available are obtained from the standard figures used in Japan.

In this estimation of labour efficiency, some allowance is made in consideration of the working capability of local labour and quality/capacity of the construction materials and equipment to be supplied for the project implementation.

(3) Equipment efficiency per unit cost

The basic data for estimation of the equipment efficiency per unit cost consists of purchase price, life time, depreciation rate, repair rate and maintenance equipment.

The purchase price of the construction equipment is estimated making reference to data collected in Thailand and Japan. The life time and operation rate are obtained considering the prevailing situation of the construction works in Thailand. The depreciation rate, repair rate, maintenance rate and fuel/oil consumption are from standard data used in Japan.

The portion of foreign and local currency of the above-mentioned equipment efficiency are decided as follows;

- Depreciation cost : 100 percent of foreign portion assuming the construction equipment will be imported.

- Repair cost : 80 percent of foreign portion and 20 percent of local portion, for spare parts and labour costs.
- Maintenance cost : 50 percent of foreign and 50 percent of local portion, for tools and equipment and labour cost, respectively.

The operation costs for major construction equipments are shown in Vol. V, Annex 5.

6-4-2 Project Cost

The project cost of the 16 pilot areas are estimated on the contract basis by using the above-mentioned unit costs and they are estimated as follows;

Pilot Area	Plan	Acreage	Total	(,000 Baht)	
				Foreign Currency	Local Currency
Chachoengsao		(ha)			
CS - NO.3	III	186.0	7,473	2,332	5,141
- NO.4	II	79.0	8,097	3,274	4,823
- NO.5	III	92.0	4,184	1,166	3,018
- NO.8	II	115.5	6,318	2,142	4,176
Chonburi					
CN - NO.1	I	94.4	12,741	5,672	7,069
- NO.2	II	116.8	9,075	2,972	6,103
- NO.4	III	94.1	6,311	2,343	3,968
- NO.8	I	130.6	16,104	7,301	8,803
- NO.9	I	127.2	11,415	4,048	7,367
Rayong					
RY - NO.1	III	173.7	8,638	2,864	5,774
- NO.2	I	219.5	23,108	9,926	13,182
- NO.3	II	96.7	9,638	3,896	5,742
- NO.5	II	155.8	12,953	5,095	7,858
- NO.7	III	89.9	7,392	2,946	4,446
Chanthaburi					
CT - NO.2	II	143.1	11,789	4,263	7,526
- NO.3	I	146.8	14,456	5,776	8,680
<u>Total</u>		<u>2,062.0</u>	<u>169,692</u>	<u>66,016</u>	<u>103,676</u>
			(100%)	(39%)	(61%)

6-5 Implementation

6-5.1 Construction Schedule

Based on the result of the construction plan for RY-NO.2 (219.5 ha) mentioned above, the construction schedule for all pilot areas is estimated as follows;

- Average acreage of one pilot area : 130 ha
- Average output of construction per month
 - : 219.5 ha/9 months
 - ≅ 24 ha/month
- Average construction period per one site
 - : 130 ha/24 ha/month
 - ≅ 6.0 months (0.5 year)
- Total construction period : 16 sites × 0.5 year
 - = 8 years per crew

In case that all pilot areas are to be completed within two years as described in Vol. II Chapter 5, four (4) construction crews will be required to be mobilized.

The tentative construction schedule is shown in Figure 6.5.1-1.

Pilot Area	Acreage (ha)	1st year	2nd year
Chachoengsao			
CS-NO. 3	186.9		
CS-NO. 4	79.0		
CS-NO. 5	92.0		
CS-NO. 8	115.5		
Chonburi			
CN-NO. 1	94.4		
CN-NO. 2	116.8		
CN-NO. 4	94.1		
CN-NO. 8	130.6		
CN-NO. 9	127.2		
Rayong			
RY-NO. 1	173.7		
RY-NO. 2	219.5		
RY-NO. 3	96.7		
RY-NO. 5	155.8		
RY-NO. 7	89.9		
Chanthaburi			
CT-NO. 2	143.1		
CT-NO. 3	146.8		
Total	2,062.0		

Figure 6.5.1-1 Construction Schedule for 16 Pilot Areas

6-5-2 Construction Equipment

(1) Equipment for construction of one pilot area

Required construction equipment for one pilot area was estimated based on the construction schedule as shown in Vol. III Table 5-2-1. Its total procurement cost by C.I.F. basis was 33.8 million Baht.

(2) Required construction equipment

Construction for the total project area of 8,840 km² was recommended to be implemented on contract basis through international competitive bidding taking into account economy and work volume as described in Vol. II (B/P) Chapter 5. However, as for the construction of the pilot areas, the following consideration shall be taken into account.

- In order to extend the land and water conservation project throughout the country, DLD is required to have more experience in implementation of projects through direct execution of the works.
- After completion of the pilot projects, DLD will have responsibility for maintenance of the pilot areas using the construction equipment procured during the construction stage.
- The pilot areas are mostly cultivated ones, therefore, negotiations between the farmers and construction personnel may require suspending the construction works. In those cases, the construction works under DLD force-account basis are more convenient and progressive than that of contract basis because of easy arrangement.
- On the other hand, the construction on contract basis has several merits as mentioned in Vol. II (B/P) Chapter 5.

Consequently, considering the comparatively huge amount of work volume and the time schedule for pilot projects, half of the pilot projects are recommended to be executed under DLD and the other half on contract basis.

Based on the results mentioned above, the list of construction equipment to be procured for implementation of pilot areas under DLD is proposed as shown in Table 6.5.2-1.

Table 6.5.2-1 List of Construction Equipment for Pilot Project (2 crews)

Equipment	Specification	Unit	Unit 1) Price	Amount	Remarks
- Bulldozer	11 t 108PS	4	(1,000 Baht) 2,350	(1,000 Baht) 9,400	2 units x 2 sites
- Bulldozer	21 t 211PS	4	3,500	14,000	2 x 2
- Backhoe	0.7m ³ 140PS	2	2,300	4,600	1 x 2
- Front loader	1.4m ³ 110PS	4	1,800	7,200	2 x 2
- Dump truck	8t 240PS	10	920	9,200	6 + 4 (considered by diversion)
- Portable concrete mixer	0.6m ³ 7.5KW	2	330	660	1 x 2
- Truck crane	2t 86PS	1	430	430	considered by diversion
- Motor grader	3.1m 113PS	3	2,400	7,200	1 x 2 + 1 (maintenance)
- Grass spreader	1,300L 10PS	1	530	530	considered by diversion
- Soil compacter	80-100kg 4PS	4	40	160	2 x 2
- Water tank truck	6,000L 180PS	1	880	880	considered by diversion
- Drainage pump	φ 100m/m	4	30	120	2 x 2
- Pick up truck	4 wheel drive	4	500	2,000	1 x 2 + 2 (maintenance)
- Pick up	light truck	6	200	1,200	1 x 2 + 2 (maintenance)
- Motorcycle	125cc	6	30	180	1 x 2 + 2 (maintenance)
- Farm tractor	67PS	6	980	5,880	1 x 2 + 2 (maintenance)
- Spare parts	(10%)	L.S		6,360	
- Total				70,000	

Note 1) : C.I.F. price as of March, 1988, excluding tax

6-6 Project Evaluation

6-6-1 General

The project evaluation has been carried out for all 16 pilot areas and in detail on the four (4) representative pilot areas; CS-NO.3, CN-NO.8, RY-NO.2 and CT-NO.2 to ascertain the feasibility of each project in view of economic and financial aspects. The basic concepts and procedures of the evaluation for the F/S are the same as for the B/P (refer to Vol.II, Chapter 6).

(1) Economic analysis for the representative pilot areas

The economic feasibility of the project is judged from the viewpoint of national economy mainly by computing the economic internal rate of return (EIRR).

The economic benefit from crop production for each representative pilot area is estimated on the basis of the proposed agricultural development plan. Benefits from inland fishery and conservation of natural resources and the environment are worked out in the same manner as in the B/P. The results of the analysis are summarized in Table 6.6-1.

(2) Financial analysis for the representative pilot areas

Financial feasibility of the project is investigated from the viewpoint of farm economy. The analysis is carried out employing two (2) criteria, namely farm budget and cost recovery index (at 1988 price levels).

Farm budget analysis has been made for the typical farm type under both the with and without project conditions. The size and land-use pattern of the typical farm is determined for each representative pilot area on the basis of the results of the farm-economic survey.

The results of the farm budget analysis for the representative pilot areas are shown in Table 6.6-2.

Recovery of the project cost including recurrent O&M and

replacement costs has been analyzed by comparing farmer's willingness and ability-to-pay (farm economic surplus for the with-project condition) to the cost-recovery charge for the total project cost. The maximum willingness-to-pay of beneficial farmers is presumed to be half of the incremental agricultural net income. Cost-recovery charges for the capital and replacement costs are estimated at an interest rate of 12 percent per annum for a repayment period of 30 years including a grace period of 10 years.

Table 6.6-3 shows the results of the cost recovery analysis.

6-6-2 Project Evaluation

(1) Representative pilot areas

The results of the economic analysis reveal that the proposed three (3) alternative plans should be selected taking into account the physical and agricultural conditions of each pilot area as well as the socio-economic status of the beneficial farmers. Because the economic viability of the Project would be different mainly according to the physical and agricultural conditions of the project areas and not to the grade of development plan (Plan-I, Plan-II, and Plan-III). In case that a larger irrigated area could be provided under the Project, the implementation of the Project would be economically feasible as indicated by the economic analysis of RY-NO.2 and CT-NO.2. On the contrary, when expansion of the irrigated area is limited due to natural conditions, even selecting a higher grade plan does not necessarily mean that the Project will become economically feasible. The result of the economic analysis of CN-NO.8 reveals this prospect. Pilot areas with smaller watersheds such as CS-NO.3 and CN-NO.8 and CN-NO.8 should be implemented applying the common grade development plan. However, the EIRR estimated for CS-NO.3 shows that even lower grade development plans for small watershed areas can not give sufficient economic returns to the investment costs in spite of the lower amount of costs required.

The results of the farm budget analysis indicate that the implementation of the Project would ensure significant increase in farm income leading to improvement of living standards. As for the beneficial

farmer's cost recovery ability, they should be able to pay O & M and replacement costs, however, they can not recover the total cost. Thus, a governmental subsidy will be required in undertaking the Project. It is recommended that the subsidy ratio of the government to be set up would be different according to the site because the economic viability of the pilot areas are largely different depending on the localities as mentioned above.

In view of the nature of the land and water conservation project, some allowance should be made in judging the project's feasibility as a whole.

According to the aforementioned analysis, it is appraised that the most important key for success of the Project is governmental assistance in both financial and technical aspects. It is considered that the following governmental assistance is prerequisite for successful implementation of the Project.

- Provision of governmental subsidy for the Project investment cost.
- Establishment of post-project technical services, especially relating to land conservation management.
- Strengthening of agricultural extension services for crop diversification.
- Provision of institutional loans with low interest rates to reduce the burden of the project cost on the farmers as well as encourage crop diversification.

(2) 16 pilot areas

The economic analysis for the 12 pilot areas (excluding the four representative pilot areas) has been carried out based on the cropping patterns and the net returns of crops for the representative areas.

Table 6.6-4 summarizes the results of this analysis including the representative areas.

Table 6.6-1 Summary of Economic Analysis for the Representative Pilot Areas

	CS-NO. 3	CN-NO. 8	RY-NO. 2	CT-NO. 2	Overall
Grade of Plan	III	I	I	II	
1. Area, with Project (ha)					
a) Cultivated Area *	139.6	96.1	127.1	85.7	448.5
b) Irrigated Area	1.5	19.0	45.0	9.8	75.3
2. Annual Benefit (10 ³ Baht)					
a) Without Project	379	418	1,074	230	2,101
b) With Project	2,406	3,297	6,673	2,433	14,809
3. Incremental Annual Benefit (10 ³ Baht)					
a) Crop Production	1,807	2,766	5,314	1,817	11,704
b) Inland Fishery	-	22	22	9	53
c) Natural Resources & Environment	220	91	263	377	951
d) Total	2,027	2,879	5,599	2,203	12,708
e) Total per ha	10.8	22.0	25.5	15.4	18.7
4. Economic Project Cost (10 ³ Baht)					
a) Investment Cost	5,988	13,120	18,774	9,500	47,392
b) Investment per ha	32.0	100.5	85.6	66.4	69.7
c) O & M per annum	493	493	493	493	1,972
d) Replacement (every 5 or 10 years)	117	509	509	117	1,252
5. Economic Indicators					
a) EIRR (%)	8.5	9.3	11.6	10.8	10.4
b) B/C (discount rate 8%)	1.05	1.13	1.48	1.23	1.26
c) B/C (discount rate 10%)	0.87	0.94	1.18	1.06	1.04
d) B/C (discount rate 12%)	0.72	0.78	0.95	0.92	0.86
e) NPV (discount rate 8%, 10 ³ Baht)	553	2,494	11,671	3,519	18,236
f) NPV (discount rate 10%, 10 ³ Baht)	-1,402	-1,125	4,252	875	2,600
g) NPV (discount rate 12%, 10 ³ Baht)	-2,766	-3,736	-1,049	-1,055	-8,606
6. Sensitivity Analysis, EIRR (%)					
a) 10% increase in construction cost	8.0	8.6	10.8	10.0	9.7
b) 20% increase in construction cost	7.5	7.9	10.2	9.2	9.0
c) 10% decrease in benefit	7.4	8.2	10.6	9.4	9.2
d) 20% decrease in benefit	6.1	7.0	9.4	7.8	8.0
e) Combination of a) and c)	6.9	7.5	9.8	8.6	8.5
f) Combination of a) and d)	5.6	6.3	8.8	7.0	7.4
g) Combination of b) and c)	6.4	6.9	9.2	7.8	7.9
h) Combination of b) and d)	5.2	5.8	8.2	6.4	6.8

Note : * Excluding the existing perennial crops and paddy rice area

Table 6.6-2 Summary of Farm Budget Analysis for the Representative Pilot Areas

Item	Pilot Area		CS-NO. 3 (Plan III)		CN-NO. 8 (Plan I)		RY-NO. 2 (Plan I)		CT-NO. 2 (Plan II)	
	W.O.P	W.P	W.O.P	W.P	W.O.P	W.P	W.O.P	W.P	W.O.P	W.P
1. Farm Size (ha)	3.3	3.0	12.5	10.2	4.5	3.7	8.0	7.1		
2. Cropped Area (ha)										
a) Cassava	3.3	1.2	11.2	1.8	3.5	0.6	8.0	2.3		
b) Pineapple	-	-	-	-	1.0	0.5	-	-		
c) Sugarcane	-	-	1.3	3.2	-	-	-	-		
d) Para-rubber	-	1.7	-	-	-	1.2	-	4.0		
e) Cashew nut	-	-	-	3.2	-	-	-	-		
f) Durian (Irrigated)	-	-	-	2.0	-	1.3	-	0.8		
g) Mango (Irrigated)	-	0.1	-	-	-	-	-	-		
3. Farm Budget (Baht)										
a) Agricultural income	8,560	28,390	39,920	290,150	35,080	154,930	21,710	122,330		
b) Off-farm income	9,980	9,980	36,290	36,290	31,270	31,270	20,400	20,400		
c) Farm Household income	18,540	38,870	76,210	326,440	66,350	186,200	42,110	142,730		
d) Increase in net income		(20,330)		(250,230)		(119,850)		(96,020)		
e) Household expenditure *	29,910	37,390	62,080	77,610	64,530	80,680	38,710	48,400		
f) Farm economic surplus	-11,370	1,480	14,130	248,830	1,820	105,520	3,400	94,330		

Note: W.O.P Without Project
W.P With Project

* including taxes, levies, etc.

It is assumed that household expenditure for the with-project condition would increase by an average annual growth rate of 1.5% until the target year (the project year 15) with an aim of improving the living standards of the beneficiaries of the Project.

Table 6.6-3 Summary of Cost Recovery Analysis for Representative Pilot Areas

	CS-NO. 3	CN-NO.8	RY-NO. 2	CT-NO. 2
Grade of Plan	III	I	I	II
1. Farm Size (ha) *1	3.0	10.2	3.7	7.1
2. Cost-recovery Charge (Baht/year)				
a) Investment Cost	18,200	212,300	71,200	100,100
b) O & M Cost	9,500	51,200	12,000	33,000
c) Replacement Cost	500	5,200	1,200	1,600
d) Total	28,200	268,700	84,400	134,700
3. Farmers' ability-to-pay (Baht/year)				
a) Farm economic surplus	1,500	248,800	105,500	94,300
b) Willingness-to-pay *2	10,200	125,100	59,900	50,300
4. Recovery Index (%)				
a) 2. a) / 3. a)	1,213	85	67	106
b) 2. b) / 3. a)	633	21	11	35
c) 2. c) / 3. a)	33	2	1	2
d) 2. d) / 3. a)	1,880	108	80	143
e) 2. a) / 3. b)	178	170	119	199
f) 2. b) / 3. b)	93	41	20	66
g) 2. c) / 3. b)	5	4	2	3
h) 2. d) / 3. b)	276	215	141	268

Note : *1 cultivated area under the with-project condition

*2 50% of the incremental net farm income derived from the implementation of the Project

Table 6.6-4 Summary of Economic Analysis for the 16 Pilot Areas

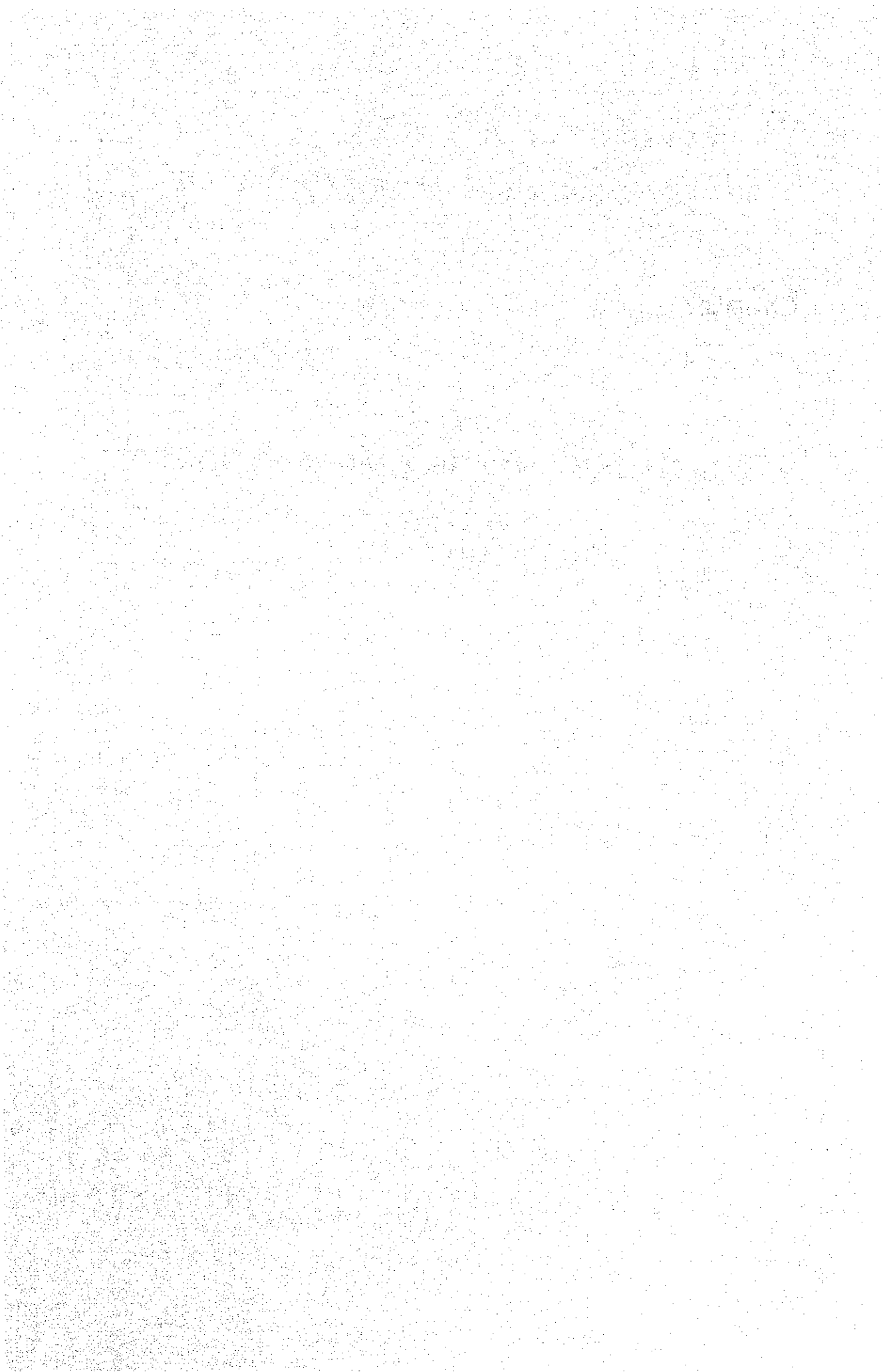
Pilot Area	CS						CN			RY			CT		Over-all		
	NO.3*1	NO.4	NO.5	NO.8	NO.1	NO.2	NO.4	NO.8*1	NO.9	NO.1	NO.2*1	NO.3	NO.5	NO.7		NO.2*1	NO.3
	III	II	III	II	I	II	III	I	I	III	I	II	II	III		II	I
I. Area (ha)																	
a) Project Area (Gross)	187	79	92	116	94	117	94	131	127	174	220	97	156	90	143	147	2,062
b) Cultivated Area (w.o.p)*2	153	66	56	81	92	81	64	117	118	127	153	86	105	70	99	73	1,541
c) Cultivated Area (w.p)*2	140	59	52	73	78	73	60	96	100	118	127	77	95	65	86	62	1,261
d) Irrigated Area	1.5	2.3	4.0	-	10.8	46.8	5.7	19.0	7.5	9.0	45.0	5.8	9.6	1.1	9.8	9.2	187.1
II. Incremental Annual Benefit (10 ³ Baht)																	
a) Crop Production	1,808	1,418	1,277	1,393	2,020	4,414	1,300	2,766	1,905	2,391	5,314	1,520	2,312	1,430	1,817	2,142	35,226
b) Inland Fishery	-	9	-	9	22	9	-	22	22	-	22	9	9	9	9	22	164
c) Natural Resources & Environment	220	25	48	76	81	138	149	90	88	259	263	320	206	94	377	258	2,692
d) Total	2,028	1,452	1,325	1,478	2,123	4,561	1,449	2,878	2,015	2,650	5,599	1,849	2,527	1,524	2,203	2,422	38,082
e) Total per ha	10.8	18.4	14.4	12.7	22.6	99.0	15.4	22.0	15.9	15.2	25.5	19.1	16.2	16.9	15.4	16.5	18.5
III. Economic Project Cost (10 ³ Baht)																	
a) Investment	5,998	6,534	3,360	5,099	10,358	7,324	5,068	13,120	9,280	6,936	18,774	7,778	10,453	5,936	9,500	11,753	137,271
b) Investment per ha	32.1	82.7	36.5	44.0	110.2	62.6	53.9	100.2	73.1	39.9	85.3	80.2	67.0	66.0	66.4	80.0	66.6
c) O & M per annum	493	493	493	493	493	493	493	493	493	493	493	493	493	493	493	493	7,888
d) Replacement (every 5 or 10 years)	117	117	117	117	509	117	117	509	509	117	509	117	117	117	117	509	3,832
IV. Economic Indicators																	
a) EIRR (%)	8.5	8.3	8.1	8.2	8.3	18.6	9.4	9.3	8.6	9.8	11.6	8.5	8.5	8.1	10.8	9.3	10.1
b) B/C (discount rate 8%)	1.05	1.02	1.01	1.02	1.02	2.42	1.10	1.13	1.05	1.21	1.48	1.04	1.05	1.01	1.23	1.12	1.20
c) B/C (discount rate 10%)	0.87	0.89	0.87	0.88	0.86	2.02	0.96	0.94	0.89	0.98	1.18	0.88	0.86	0.86	1.06	0.94	1.01
d) B/C (discount rate 12%)	0.72	0.77	0.76	0.76	0.73	1.69	0.84	0.78	0.76	0.79	0.95	0.75	0.71	0.74	0.92	0.80	0.85
e) NPV (10 ³ Baht, discount rate 8%)	552	229	72	175	361	18,201	1,079	2,494	785	2,659	11,671	574	735	71	3,519	2,064	45,220
f) NPV (10 ³ Baht, discount rate 10%)	-1,402	-1,264	-996	-1,195	-2,114	12,131	-378	-1,125	-1,549	-218	4,252	-1,425	-2,164	-1,430	875	938	1,061
g) NPV (10 ³ Baht, discount rate 12%)	-2,766	-2,351	-1,742	-2,170	-3,905	7,779	-1,431	-3,736	-3,241	-2,239	-1,049	-2,864	-4,232	-2,510	-1,055	-3,109	-30,623

Note : *1 Representative Pilot Areas

*2 Excluding the existing perennial crops area, and paddy area, w.o.pwithout project, w.pwith project

Chapter 7.

CONCLUSION AND RECOMMENDATION



CHAPTER 7 CONCLUSION AND RECOMMENDATION

7-1 Conclusion

- (1) In the project area in the Eastern 4 provinces there are 884 thousand ha of upland farm, of which 716.2 thousand ha or 81 percent are erodible area.
- (2) This soil erosion causes degradation of agricultural land and deterioration of the environmental pollution of rivers and seaboard.
- (3) For prevention of the soil erosion, in the B/P, the land conservation and irrigation plan for 884 thousand ha are proposed extending over 30 years. Total project cost required is 70,851 million Baht and EIRR 8.9%.
- (4) Land conservation project itself does not produce any direct monetary benefits, therefore, it is expected to be carried out by the public budget, not by the farmers' burden. It is also expected that the project is carried out effectively with irrigation and rural development together.
- (5) Development grade is classified into the following 3 kinds which should be adopted according to the field condition as well as farmers burden ability.

Class	Grade	Soil Loss Prevention	Unit Cost
Plan I	High grade	90%	16,800 Baht/rai
Plan II	Medium grade	85%	12,800 /
Plan III	Common grade	80%	7,500 /

- (6) The 16 pilot areas were selected with parameters of topography, soil, crop and climate based on the soil erosion classification of B/P. One pilot area is approximately 50 - 250 ha in size.

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

Concerning acreage of the project area, the total area of the 16 sites is 2,062 ha, maximum is 219.5 ha and minimum 79.0 ha per site. Total project cost of the 16 pilot areas is 167 million Baht, and EIRR 9.5% on average.

- (7) To reach the goal of this Project it is requested that DLD's organization should be strengthened and DLD should coordinate many government agencies concerning land and water conservation.
- (8) For the completion of this huge area of land conservation, to strengthen DLD's organization as follows is indispensable, namely.
 - 1) TIC (Technology Introducing Center) should be established in the Headquarters in Bangkok for collecting data and information on land and water conservation technology, preparing technical standard, etc.
 - 2) LWCC (Land and Water Conservation Center) should be established in Chonburi Province for carrying out plan and design of conservation project in the Eastern Region.
 - 3) LWCS (Land and Water Conservation Station) should be established in each province for implementing conservation projects.

7-2 Recommendation

- (1) This land and water conservation project has the important role not only to prevent the degradation of agricultural land but also to preserve the national land from deterioration.

To complete this purpose, it is requested that DLD's organization should be strengthened and DLD should coordinate many government agencies concerning land and water conservation.
- (2) As a first step, establishment of the Land and Water Conservation Center and operation of the 16 pilot project areas is urgently required.
- (3) JICA Study Team recommends strongly DLD shall commence this project as soon as possible as the responsible agency of the Thai government.
- (4) The Thai government has been promoting the soil and water conservation project centering on DLD, however, the government allocated budget is insufficient to achieve such an enormous amount

of conservation work. Therefore, as a supplementary measure the Thai government should introduce international support as required due to the urgency and importance of the Project.

