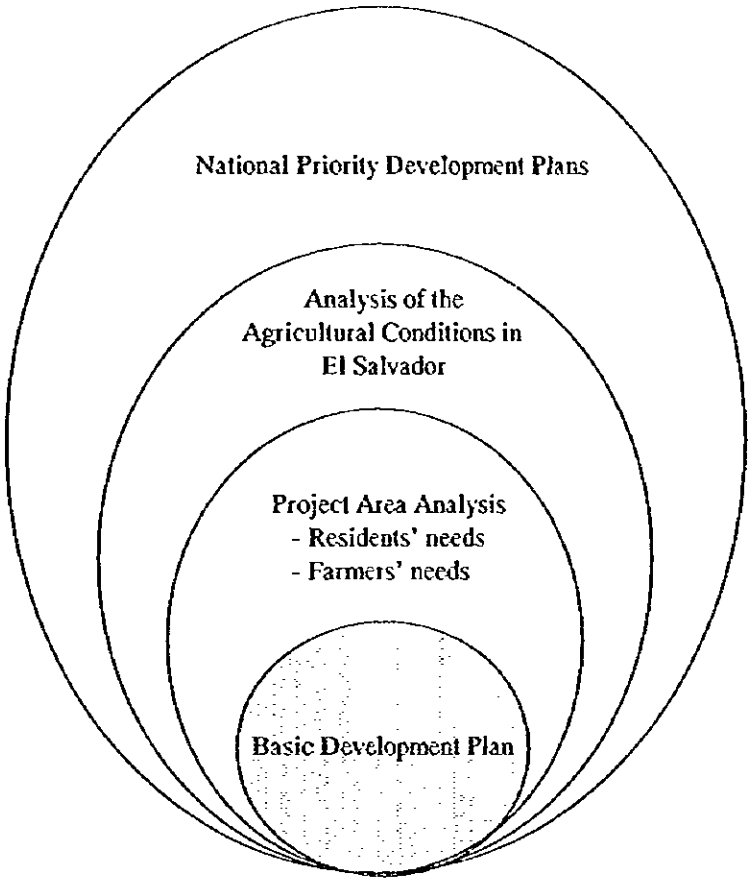
CHAPTER 4

BASIC DEVELOPMENT PLAN FORMULATION

CHAPTER 4 BASIC DEVELOPMENT PLAN FORMULATION POLICY

4.1 Basic Development Plan Formulation Policy

As illustrated in the figure below, the basic development plan was formulated by first understanding the priority development plan of the government and then the agricultural conditions in El Salvador. Thereafter, the development potential of the project area and the needs of the residents, particularly the farmers, were analyzed including the factors that could impede development.



Basic Development Plan Formulation Policy

4.2 Analysis of the Agricultural Conditions in El Salvador

4.2.1 Current Agricultural Conditions

(1) Economic Importance of the Agricultural Sector

Until the1970s, El Salvador was the only industrial country in Central America. Basically an agricultural country, 35% (1,980,000) of the 1994 population were into agriculture and the agricultural working populace made up 34% (640,000) of the economically active population. The country mainly produces coffee, maize, sugarcane, frijol beans and sorghum, and agricultural production made up 44% of the 1993 GDP. Accordingly, the national economy is dependent on agriculture.

The 1994 land use estimate indicated that 64% (1,340,000 ha) of El Salvador is made up of agricultural lands: 730,000ha (35%) of cultivated land and 610,000ha (29%) for livestock raising and grazing. Forested area covers 4.9% (100,000ha) of the total land. Of the total cultivated land acreage, 120,000ha (16%) are irrigated.

The main agricultural crops are coffee, sugarcane, cotton, maize, frijol beans, and rice. Coffee, sugarcane and cotton are produced for exportation, while the rest are produced for the domestic market or for self-consumption. Being the most important product in the country, maize production monopolizes almost half of the cultivated area. Meanwhile, cotton production has declined remarkably in recent years. Although agricultural production nose-dived in the 1980s as a result of the civil war, the 1990s figures showed recovery, as a result of the liberalization of trade and the end of the government's monopoly of the marketing system.

(2) National Development Plan

The development strategies of the 5 Year Socioeconomic Development Plan (1994-1999) for the agricultural sector entailed crop diversification, improvement of productivity, agrarian reforms, expansion of agricultural financing system for small-scale farmers, prevention of environmental pollution by agricultural chemicals, and an increase in drainage facilities. The element that could render the national reconstruction plan unstable is the government's capability or incapability to provide the war guerrillas and soldiers with jobs for them to be able to start anew. The government gives priority to the conduct of programs that would help the soldiers assimilate the rural agricultural way of life, as a means to restore agricultural production.

(3) Agricultural Development Plan

The national agricultural development plan entails programs that would facilitate land acquisition by the farmers, agricultural loans, developments in production, and the rehabilitation and construction of small scale irrigation facilities. As a long term plan, MAG puts

importance on agricultural development, which it considers as the driving force behind rural development, the elimination of poverty in rural areas, and the foundation for improved agricultural productivity. Accordingly, it gives importance to the improvement of production, acquisition of foreign reserves, creation of job opportunities, improvement of the rural standard of living, and preservation of natural resources -- by viewing agriculture and rural conditions as one. It, therefore, aims in the long term to establish a sophisticated agricultural system through the elimination of traditional practices, improvement of technical skills, activation of the local economy, and crop diversification.

The following are the specific development strategies:

a) To develop the agricultural sector to make it suitable to a market system and globally competitive by conducting programs that would contribute to production improvement.
b) To make use of agricultural loans for agricultural development.
c) Introduce irrigation facilities for the modernization and diversification of agriculture. To establish relevant laws and regulations, support agricultural financing, and extend guidance in technical training.
d) To eliminate worries/instabilities in the socioeconomic conditions in the rural area, and establish safety by introducing a legal system that would improve and reinforce the land registration system and legal agricultural negotiations.
e) To improve a commercial system that entails information services, marketing organizations and facilities, to properly market agricultural products of good quality.
f) To reinforce sanitary measures for the prevention of epidemics among livestock and agricultural produce, and improvement of quality control and marketing measures.
g) To activate production activities and improve earning power to establish a globally competitive agricultural and livestock industry.
h) To strengthen the organizational structure of CENTA for the improvement of technological research activities for the agricultural and livestock sector, and to expand technical extension activities.

(4) Problems in the Agricultural Sector

A lot of the agricultural infrastructure was destroyed during the war resulting in the suspension of agricultural production and remarkable delays in agricultural development. In particular, the retarded conditions of rural areas have rendered farmers impoverished. The following are the problems in the present agricultural conditions in El Salvador:

a) Monocultural practices (traditional crop cultivation)
b) Dependence on agricultural exports significantly influenced by international market prices
c) Destruction of agricultural production facilities and capital during the war

d) Disintegration of rural community due to massive migration to urban areas

e) Agricultural reforms and inadequate land use system

f) Inadequate use of natural resources

The extensive impacts of the progressive degradation of environmental conditions have also generated the following problems which are urgently in need of attention:

a) Soil erosion widely affects 75% of the national land area, and is particularly progressive in the hilly areas in San Salvador. Unless aggressive countermeasures are immediately taken, this could affect 50% of the national territory.

b) About 90% of the rivers are contaminated with agricultural chemicals and industrial wastes, thereby requiring water quality analysis and the reinforcement of anti-pollution legislation.

c) Deforestation is particularly rampant in the rural areas where firewood is used extensively.

4.2.2 Agriculture Problems in El Salvador

1) Agricultural Structure

After the civil war, which occurred due to economic disparity, the policy of the government is focused on national reconstruction. To prevent the civil war from recurring, the government aims to create job opportunities for the poor through industrial development, mainly agricultural development. It is, therefore, very important and urgent to conduct programs that would aid in stabilizing the economic conditions of the majority of the small scale farmers.

2) Agricultural Problems

a) Development and Extension of Agricultural Techniques for Small Scale Farmers

It would be considerably difficult to install new and modern infrastructure that would fully contribute to the improvement of the economic conditions of small scale farmers with current problems in funding. Accordingly, the extension of agricultural techniques is considered an effective measure to improve productivity and introduce crop diversification in an agricultural system that promotes the effective use of natural resources. The development and extension of agricultural techniques are significantly important for farmers (most of which are inexperienced) benefiting from the agrarian reform system.

b) Improvement of the Distribution System

The acquisition of routes for the distribution of agricultural produce is as important as the improvement of production techniques to medium and small-scale farmers, since failure in selling the products would mean no income and delays in the importation of sophisticated and improved techniques. The processing of agricultural products into manufactured products

expands the distribution route and entails a certain proportion of *value added* -- factors that significantly contribute to income increase and employment. This undertaking would, however, require the development of an efficient market system. The formulation of a system that would provide the farmers with stable production and a distribution route is without doubt vital to agricultural development nationwide.

c) Irrigation Facilities Improvement

The improvement of irrigation facilities is one of the focal points in the government's agricultural policy. Because agriculture is concentrated in one season due to climatic conditions in the area, the installation and improvement of irrigation facilities are considered highly necessary as a means of stabilizing the economic conditions of medium and small scale farmers. These works require tremendous funding. However, it is impossible for the government to allocate the majority of the budget for this endeavor, as almost every sector demanding development and improvement necessitates significant spending.

With the exception of one project, irrigation development projects are in a state of immobility due to ongoing retrenchments in the DGNR and other departments related to irrigation. Therefore, it is very important to conduct studies to determine facilities suitable to the area in consideration of their use as a model for future irrigation development.

d) Farmers' Organization

The formulation of a farmers' organization (a system outside of the administrative system) is important for the dissemination of measures, e.g., agricultural techniques extension and distribution system improvement, adopted by the government for the farmers. In the past, farmers were organized by groups for the conduct of extension activities. This time around however it is necessary to build an autonomous farmers' organization.

Farmers' organizations were previously thought of as antigovernment organizations and were rejected politically, thereby making farmers hesitant about the idea at present. Nonetheless, developments in this area can be felt nationwide.

Guidance in the application of suitable techniques and the granting of farming loans are also considered necessary for the development of the economic conditions of small scale farmers. Because loan applications of most farmers are rejected due to lack of trust, the forming of a farmers' organization should be expedited.

e) Natural Resources Conservation

Due to El Salvador's high population density, population increase rate, poverty problems, and the disorganized utilization and development of natural resources, the recoverable natural resources far outweigh the sustainable volume. Also, further developments have radically destroyed many of the country's natural resources. The government is currently pressed with the need to counter-act land devastation problems resulting from soil erosion and deforestation.

The preservation of natural resources is seen as an important factor for the realization of a sustainable agricultural development.

4.3 Study Area Analysis

The study area was analyzed in terms of development potential and development constraints.

4.3.1 Development Potential

(1) Water Resources (Surface Water and Groundwater)

1) Surface Water (Useable Volume and Water Quality)

The surface water resources in the Jiboa River basin consist of the Jiboa River and Ilopango Lake.

The Jiboa River basin can be largely divided into two hydrologic basins, namely Jiboa River and Ilopango Lake. From these two basins, it can be further subdivided into five small basins or blocks.

Annual rainfall in the basin ranges from 1720 mm to 2060 mm, and the total surface runoff is estimated to be 20% of this amount. The remaining percentage is presumed to infiltrate the soils or evaporate. The Jiboa River downstream discharge was estimated at 1.0 m^3/sec in the dry season. Based on the 5 year-non-excess probability rate, Jiboa River has a 185-day discharge of about 1.49 m^3 and a 355-day discharge of about 1.46 m^3. Therefore, about 1.5 m^3/sec of the discharge of the river can be utilized in the dry season.

As for Ilopango Lake, the results of the study conducted by ANDA estimate 1.5 m^3/sec as the usable discharge of the lake. ANDA is currently studying the water quality of the lake for use as a water supply source for the eastern part of the city of San Salvador, by sampling the water at an extraction rate of 1.0 m^3/sec. However, the implementation of this plan will reduce the usable discharge of the lake to 0.5 m^3/sec. Putting aside problems in water quality, the development of the lake and the river as water resources would not be practical as a total discharge of only 2 m^3/sec can be used.

Ilopango Lake and the Jiboa River cannot be used as effective drinking and agricultural water resources as they contain concentrations of arsenic, boron, and cadmium that significantly exceed the guidelines of WHO for drinking water quality, and FAO for agricultural water quality. However, ANDA, in cooperation with OPS, is currently developing a plant that would reduce the arsenic and boron concentrations in the lake to make it suitable for drinking.

2) Groundwater

The groundwater resources (aquifer potential) in the basin were assessed, as shown below, based on the specific capacity (Sc) of existing wells.

①	Areas where aquifer potential is relatively high (Sc <= 500 m²/day)	Rosario vicinity; Ilopango Lake north bank; San Vicente Mountain
②	Areas where aquifer potential is of medium scale (100 m²/day <= Sc < 500 m²/day)	Hilly zone in the central basin area; coastal zone downstream
③	Areas where aquifer potential is relatively low (Sc < 100 m²/day)	Areas on the east bank of Jiboa River upstream; Areas within the vicinity of the international airport Downstream

Areas with high aquifer potential are not considered suitable for development if the groundwater level is deep due to well construction methods and costs. The groundwater level downstream was observed to be 2 ~ 5 m from the ground surface, and mostly 20 ~ 30 m in the ridges upstream and midstream. Developments in the ridges of mountains and hills would not be suitable as well, even with a high aquifer potential, because the groundwater reserves are too deep.

The average annual runoff rate of the Jiboa River recorded by the Montecristo observation station is about 0.19. The water resources in the Study Area are assumed to be mainly stored as groundwater. Since the water quality of the river is not suitable for irrigation use, past irrigation projects have always focused on the development of groundwater resources.

(2) Land Resources

The classification of lands in the Study Area is shown in Table 4.3.1.1. Lands categorized under classes II and III are suited to mechanized farming. Lands categorized from class IV onwards are not suited to this farming practice and have always relied on manpower and animals for cultivation. On the other hand, it is necessary to take protective measures for lands categorized from class VI onwards (over 26% slope gradient) against soil erosion which is very progressive in these areas.

Lands categorized under classes II, III, and V are free from soil erosion problems. These lands make up 83% (4500 ha) of D block and 13% (900 ha) of B block.

Lands categorized under class IV are characterized as: ① not suited to mechanized agriculture, ② susceptible to soil erosion, and ③ suited to traditional farming practices such as the intercropping of maize, sorghum and frijol beans. These land classes make up 32% (2500 ha) of B block and 28% (2200 ha) of C block.

4.3.2 Development Constraints

The main factors that would impede integrated agricultural development in the Study Area are as follows:

(1) Constraints in Natural Resources

1) Water Resources

a) Water Quality

- Ilopango Lake

The surface area of Ilopango Lake is approximately 70 km², therefore a depth of 1 m would provide about 70 million m³ of water. The only discharge outlet of the lake's flow is shaped like a tunnel, which facilitates ponding regulation with the use of simple facilities; operation and maintenance are also made easy. However, the analysis of the water quality of the lake shows arsenic and boron levels exceeding the permissible values for drinking and irrigation use. Although there are plans to treat the lake water (the suitable treatment technique is currently being developed) and use it as the future drinking water supply source of San Salvador, none are taken for irrigation use. The quality and quantity of the lake water makes it very unsuitable for irrigation use.

- Rivers

Like Ilopango Lake, the waters of the Desague River, the source of which is Ilopango Lake, and the Jiboa River downstream from the confluence with the Desague River are not suitable for drinking and irrigation use as they contain high boron and arsenic concentrations.

b) Water Cost

There are no problems in the water quality of Jiboa River upstream and its tributaries. However, because the river forms a deep gorge upstream, the utilization of these waters for irrigation would require very large capacity pumps or very long headraces. Accordingly, construction and operation and maintenance would be very costly. The dispersed location of the farmlands would also make irrigation impractical.

2) Land Resources

According to the 1992 census, the Jiboa River basin made up 2.5% of the national territory and 5.4% of the country's population, the latter due to proximity to San Salvador. With the exception of urban areas, rivers and the lake, lands with a slope gradient of 11% make up 54% of the basin; these sloping areas are considered to be in need of erosion control measures. Conclusively, the topography of the area is a serious constraint to agricultural development.

3) Human Resources

The results of the questionnaire survey indicate that almost all farmers in the study area have had more than 10 years of traditional farming experience. However, 58% of these farmers wish to plant cash crops (vegetables, fruits, etc.), while 29% want to introduce livestock.

The farmers in the area were observed to be ready to embrace diversified farming practices, with 94% wanting to learn new farming techniques, 62% eager to acquire new livestock raising techniques, and 53% resource conservation techniques. Although the farmers are adept in traditional farming practices, which is mainly small scale grain cultivation, only a few are well informed in improved agricultural techniques that are helpful in solving environmental problems and the conduct of agricultural reconstruction.

(2) Socioeconomic Constraints

1) Unsuitable Land Use

Lack of an adequate land use plan and insufficient land resources resulted in excessive cultivation and over felling of trees for timber and firewood which destroyed the forests. This unplanned and inadequate land use has reduced the recharge capacity of the water resources in forests, accelerated soil erosion, caused a decline in land productivity and flooding downstream.

The government does not have enough policies, technology, extension and education programs that would help improve these land use conditions. Regardless of excessive felling practices, reforestation is not carried out. Although contour cropping may be evident in some areas, other soil erosion countermeasures such as vegetation, mulching, and terrace cultivation are rarely practiced.

2) Insufficient Development and Diffusion of Farming Techniques

The extension of farming techniques is mainly carried out by CENTA, and the organization of agricultural cooperatives under the agrarian reform system is the responsibility of ISTA. Some farmers receive technical guidance from enterprises they are under contract with for the production of fixed crops. Extension activities were found to be insufficient in the basin based on the questionnaire survey which showed that 40% of the farmers receive technical guidance from CENTA, while 55% do not.

Agricultural production in the upstream and middle basin of the Jiboa River is low due to financial problems and inadequate agricultural input, soil erosion control measures, and irrigation techniques. The techniques and diffusion activities for the introduction of cash crops and livestock in order to increase the income of farmers owning small lands are underdeveloped.

3) Insufficient Agricultural Support

a) Tenant Farmers

The results of the questionnaire survey show that 36.8% of the farmers in the study area are

tenant farmers. Tenancy is generally carried out for less than a year for fear that farmers might assert their rights on the lands. This condition does not encourage the farmers to conduct any form of investment that would bring about soil improvement, control of soil erosion, agricultural diversification, and irrigation -- factors that would ensure an increase in land productivity and the conservation of natural resources.

b) Credit System

The credit system impedes agricultural development as it imposes a short term high interest rate (generally one cropping period). This short term credit compels farmers to sell products immediately right after harvest at the cheapest price. It is hardly beneficial to small scale farmers who want to acquire lands. According to the questionnaire survey, only 23% of the total number of farmers in the study area benefit from the credit system.

c) Marketing System and Facilities

Shortage in collection and loading facilities and poor roads impede the timely shipment of products, thereby lowering product marketability. Poor road conditions also impede the timely use of agricultural inputs and the reinforcement of the farmers' socioeconomic activities. As subsistence farming is predominant in the study area, the products are distributed in small scale markets and are no match to agricultural imports, particularly cash crops, in terms of volume.

d) Poor Living Environment

The farmers are not equipped with sanitary facilities e.g. potable water supply, toilets, that make daily life safe and comfortable.

4.3.3 Basin Characteristics

The Jiboa River basin is divided into 5 blocks (small basins) based on hydrological conditions (see figure on Basin Division on the front page). The natural and socioeconomic characteristics of each block are as follows:

1) A Block

This block is composed of the Ilopango Lake basin and the Desague River basin. A tourist site constructed with parks, golf courses, hotels, seafood restaurants and resorts, was developed in the Ilopango Lake basin. Progressive urbanization can be observed on the western part of this block which constitutes more than 40% of the city of San Salvador. This block has an extremely high population density, 1,040 persons/km^2, and the lowest ratio of farmers (38%) to the working population. The water of the lake is neither suitable for drinking or irrigation use as it contains high levels of arsenic and boron concentrations. However, there is a plan to treat the lake water for use as the water supply source of San Salvador in the future.

Sixty four (64) percent of the block is made up of steep slopes, and cultivated fields only amount to 1.9 ha per farm household. Many of the fields are planted with fruit trees and coffee. The agricultural practice in this block is forecast to further reduce in scale, becoming tourist-oriented through the practice of either "You Pick Farming" or the sales of produce in the field. To protect the beautiful landscapes in this block, soil conservation measures, including vegetation, should be implemented.

2) B Block

This block covers the upstream Jiboa River basin up to the confluence with the Desague River. Although there are no river water quality problems, inflow volume (0.1 m^3/sec) is limited in the dry season, hence the ongoing water supply project for Cojutepeque uses groundwater. Although the request for irrigation is higher in this block than the other blocks, the use of surface water is difficult in view of its topographic features. Forty six (46) percent of the steep slopes are cultivated for subsistence farming which covers an average of 2.4 ha. Annual crops are mainly cultivated in these fields, and only a few are planted with fruit trees and coffee, hence the need for soil erosion countermeasures.

Because there are only a few tenant farmers in this block (8.4%), soil conservation measures and afforestation are highly required. The block's proximity to the Pan American Highway and its favorable location would be advantageous to the development of sustainable agriculture that mainly focuses on grain cultivation but also encompasses agroforestry coupled with the introduction of cash crops, livestock, and inland fishery. To succeed in these undertakings, a technical and material support organization, and a farmers' organization for agricultural production and distribution should be established. The application of erosion control measures is also vital.

3) C Block

This block encompasses the San Vicente mountain area. It is made up of steep slopes (61%) which are cultivated with coffee, sugarcane, and fruit trees. After D block, this block has the highest ratio of cultivated lands (75%). Because the fields are mostly cultivated with coffee and fruit trees, this block has enough protection against soil erosion. Nonetheless, erosion control through agroforestry should be introduced to prevent soil erosion in 42% of the steep slopes cultivated with annual crops. Groundwater reserve is estimated to be plentiful in the area from the abundant surface volume of Chorreron River in the dry season. The block is therefore considered to have a high potential for small scale irrigation development.

4) D Block

This block covers the coastal plain in the Jiboa River downstream basin and its terrain is 92% flat. The block has extensive lands that have a high development potential. It is highly agricultural, with the highest number of farmers (98%) and farmlands (86%) in the basin.

Natural and Socioeconomic Characteristics of Each Block

Items	Unit	A Block	B Block	C Block	D Block	E Block
Area Coverage	km²	223.73	74.57	131.11	56.86	119.32
Population Density	person/km²	1040	571	242	193	181
Number of Farmers	%	38.4	59.6	68.8	97.5	59.9
Terrain	%					
Plains (less than 10%)		36.2	45.4	39.0	100.1	52.7
Steep slopes (11 - 25%)		23.7	31.5	26.0	3.9	18.0
Steep slopes (more than 25%)		40.1	23.1	35.0	4.6	29.3
Cultivated Land	%					
Annual Crops		32.5	47.9	48.4	84.7	58.4
Fruit Trees		12.5	9.5	12.2	0.7	10.1
Coffee		9.7	5.4	14.1	0.1	2.4
Cultivated lands in steep slopes	%	31.7	46.0	42.2	77.9	48.9
Forest Area	%	35.9	3.5	23.6	9.5	25.9
Number of Tenant Farmers	%	29.7	8.4	43.8	22.9	12.1
Size of Farms	ha	1.9	2.4	2.9	1.4	2.1
Farmers' Association	%	22.5	29.9	27.6	80.0	30.3
Farmers' Needs	%					
Irrigation		36.5	67.3	48.6	54.3	36.4
Soil Conservation		69.7	79.4	72.4	57.1	74.2
Afforestation		57.3	82.3	79.1	91.4	87.9
Flood Control		14.6	13.1	11.9	31.4	13.6
Solutions		• soil conservation • afforestation • water quality pollution control • tourist-agriculture • road improvement	• soil conservation • afforestation (agroforestry) • cash crop introduction • livestock (domestic pigs, poultry) • inland fisheries • road improvement • reinforcement of farmers' organization	• soil conservation • afforestation (agroforestry) • groundwater for irrigation • road improvement	• cash crop introduction • livestock development • flood control measures	• soil conservation • afforestation (agroforestry) • cash crop introduction • groundwater for irrigation • road improvement

Agricultural cooperatives cover most of the flat section which is mainly cultivated with sugarcane on a contract basis, and partly with cash crops and grains for self consumption. About 3,500 ha are inundated every year in the rainy season due to soil runoff upstream which causes the downstream river bed to rise, and due to deforestation. The application of flood control measures would facilitate the effective use of these vast lands.

A part of this block is included in the Comalapa Irrigation Project due to its abundant groundwater reserves. Aside from watermelon and sesame, animal husbandry is also promoted in the area. The realization of an irrigation system in the area would make agricultural diversification possible.

Farmers in the area do not have any desire to cultivate other crops as the contractual cultivation of sugarcane brings in most of the agricultural profits. To further raise agricultural profits and to avoid the risks involved in the practice of monoculture, preliminary projects that would introduce diversified agricultural practices should be implemented. Ninety one (91) percent of the farmers in this block indicate a high need for afforestation in view of scarcity of forest resources (10%) and for firewood production.

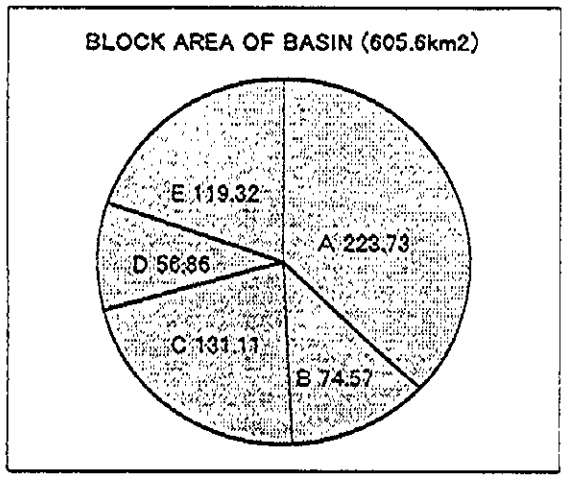
5) E Block

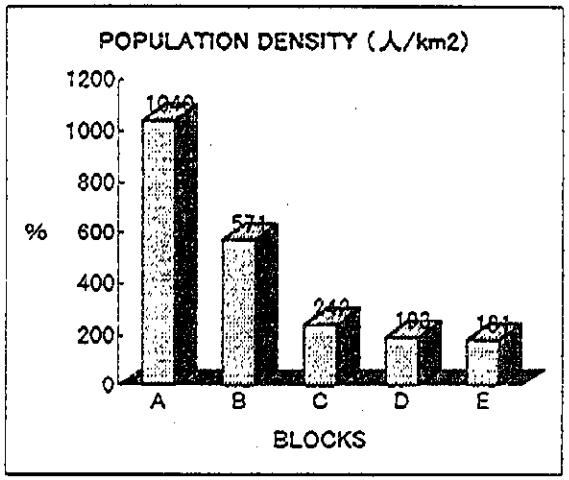
This block covers the Sepaquiapa and Tilapa river basins. The use of groundwater resources for irrigation is possible in this block. Fifty three (53) percent of the block terrain is flat as it covers a part of the downstream plain. Forty nine (49) percent of the steep slopes are cultivated and soil erosion countermeasures, e.g., agroforestry, are necessary in this area. The development of fruit tree cultivation is expected to satisfy the farmers' significant need for soil conservation and afforestation. Because, after B block, this block has the lowest number of tenant farmers, any form of investment that would contribute to agricultural improvement in the area is greatly desired. Taking this into consideration, it would be easy to encourage the farmers to participate in the project. The improvement of roads is also deemed necessary to facilitate access to the mountain area.

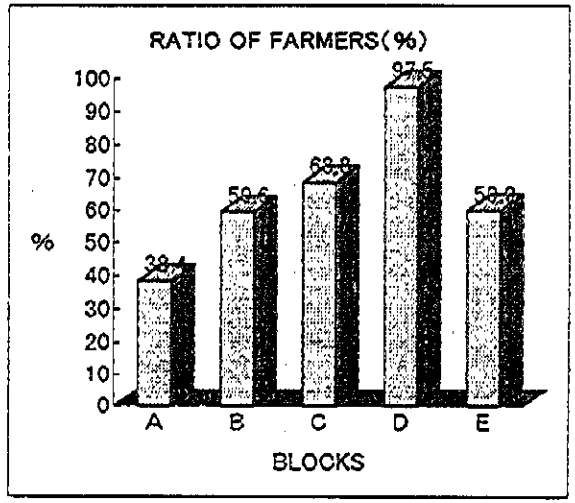
4.4 Basic Development Plan

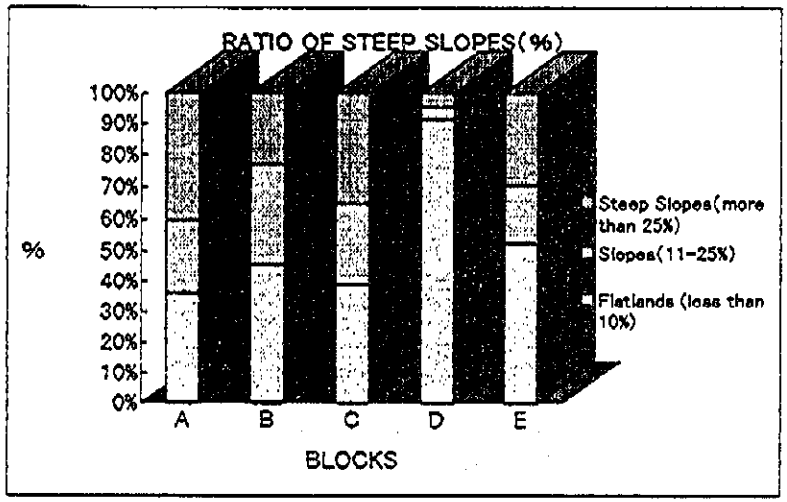
4.4.1 Development Policy

The final target of the integrated agricultural development plan shall be the ① establishment of an agricultural system that would supplement the provisions for San Salvador, ② increase in agricultural yield, ③ continuous improvement of the residents' economic conditions, ④ improvement of the residents' environment, ⑤ and adequate management of natural resources.









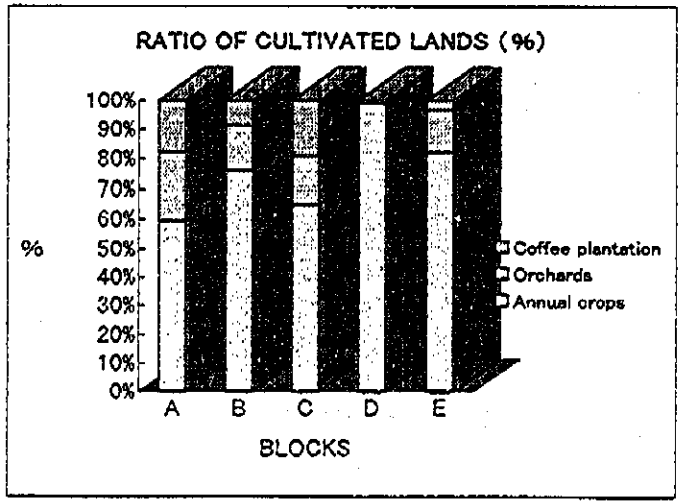
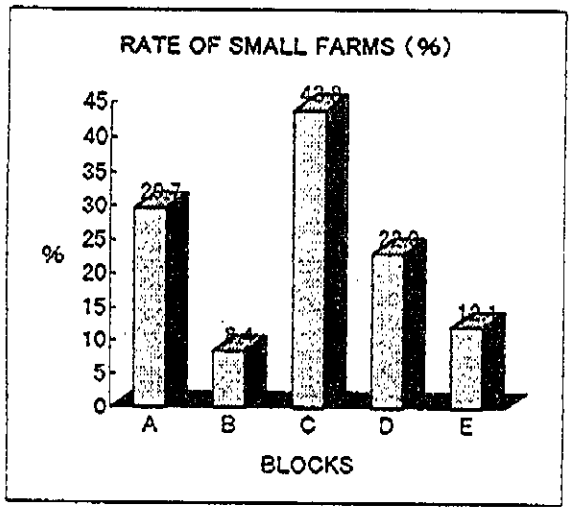
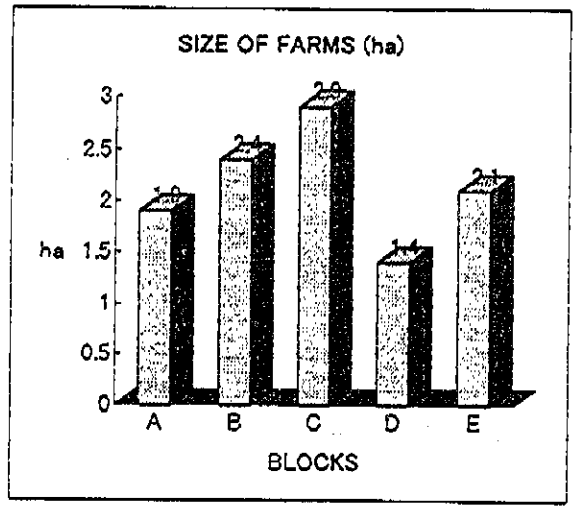


Figure 4.3.3.1 Characteristics of Each Block (1/2)





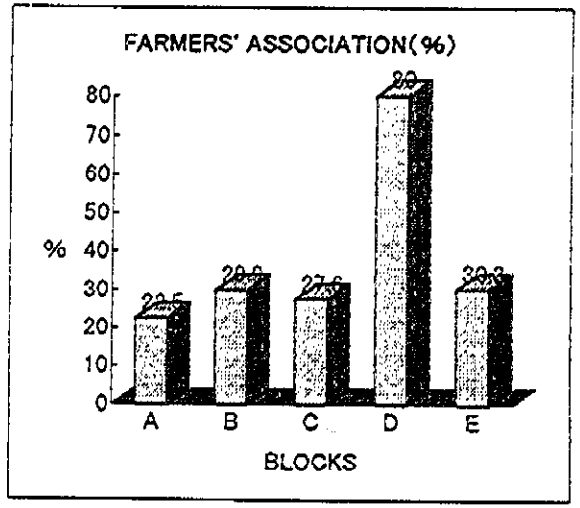


Figure 4.3.3.1 Characteristics of Each Block (2/2)

4.4.2 Development Objectives

(1) Development Measurement

These goals may be achieved by developing and improving agricultural conditions in the area through crop diversification, improvement of productivity, reinforcement of agricultural support, and farmers' organization (guidance in agricultural techniques and expansion of financing system) -- activities that would guarantee improvements in farmers' income, development in afforestation and soil conservation measures, and basin conservation (protection and conservation of natural resources).

Conclusively, these goals aim for agricultural diversification, the development of an agricultural system based on improved productivity and a sustainable environment, development and extension of agricultural techniques in harmony with basin conservation measures and the farmers' educational level.

The following are the development policies adopted in this project:

1) To improve farmers' income by the reinforcement of stable agricultural practices starting with the introduction of agroforestry for the effective use of the land, the implementation of soil erosion countermeasures, and introduction of value added crops (coffee, vegetables, fruit trees).

2) To protect farms and households from disasters by conducting soil conservation works upstream and flood control works downstream, to improve land productivity and the farmers' living environment.

3) To improve and stabilize farmers' income through agricultural diversification which can be achieved by introducing livestock and inland fisheries.

4) To improve productivity by the improvement and installation of irrigation facilities, and the improvement of cultivation techniques.

5) To improve current distribution system which relies on a mediator, by improving road conditions and collection and loading areas, and establishing distribution routes.

6) To improve the farmers' standard of living and environmental conditions through rural infrastructure improvement.

(2) Development Objectives

The following are the objectives of the project for the Study Area:

1) Basin Management

a) Flood Control Measures: An embankment shall be constructed downstream to block the river mouth, control flooding, and prevent flood damage.

b)	Afforestation:	Diffusion of the concept of agroforestry through the construction of nurseries and the supply of seedlings; afforestation not only controls soil runoff but also provides firewood; this measure shall be conducted to protect forests from felling practices.
c)	Soil Conservation Measures:	Farmers in the upstream basin should be educated and trained on soil conservation techniques to prevent farm soil runoff, deterioration of land productivity, and to reduce flood damage due to unstable river bed conditions.
d)	Improvement in Water Management:	Installation and improvement of meteorological and hydrological facilities to reduce flood damage.
2)	Agricultural Development	
a)	Agricultural Diversification:	Introduction of cash crops, livestock and inland fisheries to small scale farmers to improve their income.
b)	Improvement of Productivity:	Installation and improvement of irrigation and drainage facilities, extension of irrigation based agriculture for the stabilization and improvement of agricultural productivity.
c)	Improvement of Farmers' Lifestyle:	Improvement of productivity and quality of agricultural products, and consequently the standard of living of the farmers, through the development and extension of agricultural techniques.
d)	Improvement of Rural Life:	Installation and improvement of water supply facilities and other sanitary facilities, e.g. toilets, to improve rural life.
3)	Agricultural Support Group and Farmers' Organization	
a)	Agricultural Support Group:	Reinforcement of CENTA (extension office) and DGRNR for the adequate and efficient extension of soil conservation and farming

techniques.

b) Marketing: Improvement of distribution system for agricultural produce by the improvement of roads and collection and loading areas.

c) Agricultural Loans: Expansion of an agricultural financing system for small scale farmers, to improve farming management and stabilize agricultural conditions.

d) WID Support: To establish a program that would involve training women on new techniques and skills they can later profit from.

4.4.3 Development Approach

The integrated agricultural development plan in the Jiboa River basin entails:

I: The production and distribution of saplings to the farmers for afforestation, as a means of diffusing agroforestry techniques and the realization of a sustainable agricultural development.

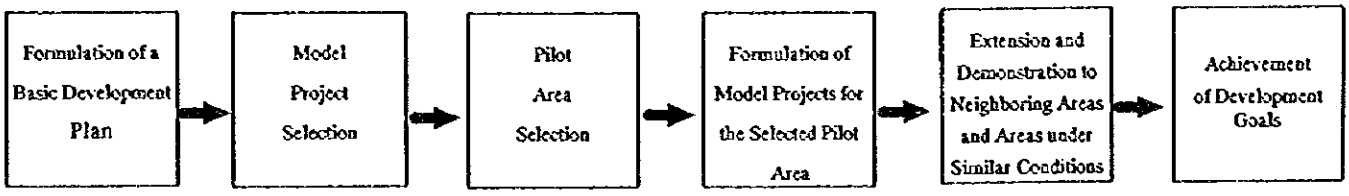
II: The extension of soil conservation techniques to farmers by providing the necessary materials and equipment, in order to prevent the deterioration of the productivity of the land due to soil runoff. The application of these techniques will also prevent soil runoff upstream and consequently stabilize river bed conditions, reduce flood damage, and safeguard agriculture downstream.

III: Introduction of vegetables, cash crops, fruit trees for cultivation, livestock raising and inland fisheries for agricultural diversification.

IV: Guidance in groundwater irrigation techniques and farm management to improve land productivity and to shift to a sustainable agricultural practice. In addition, roads and loading areas shall be improved for a better distribution of agricultural products.

V: Reinforcement of extension offices and collection and loading areas, to be able to help in the extension of agricultural techniques to the farmers and in the formation of a farmers' organization; expansion of the agricultural financing system that would benefit all farmers in the area.

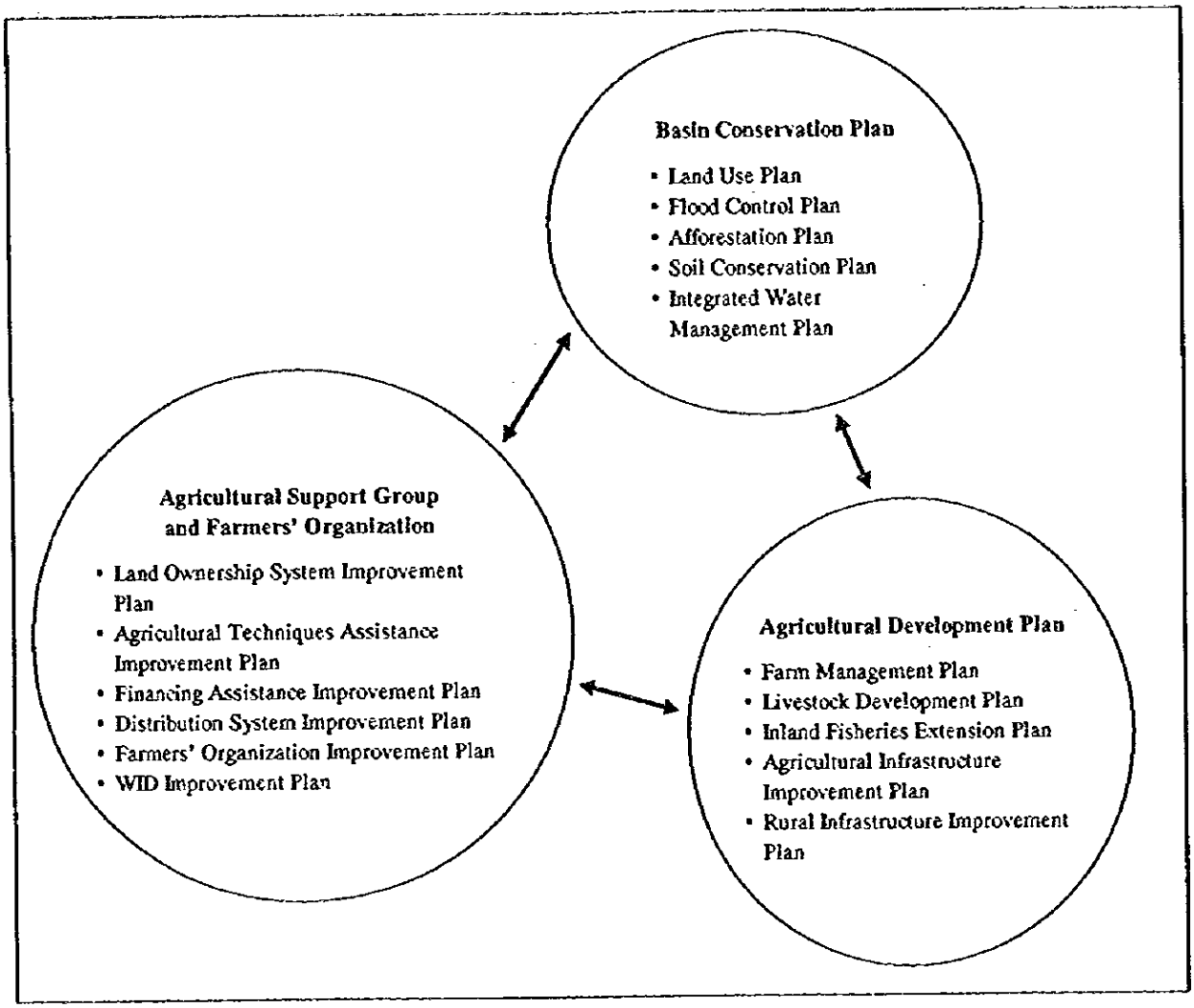
Since the majority of the farmlands in the Study Area are located in hilly areas and are small in scale, the kind of integrated agricultural development suitable to El Salvador has not been established yet. Further, because the farmers' capability to carry out this type of development is still not ascertained, the type of agricultural development to be implemented in the Study Area shall entail: ① the making of a basic development plan that would incorporate basin management based on socioeconomic conditions, and the formulation of a farmers' support group and a farmers' organization, ② the selection of a model project, ③ the selection of the most suitable pilot area, ④ the formulation of a model project for the selected pilot area, and ⑤ the extension of the model project to the surrounding area and areas under similar conditions.



Model Development Method

4.4.4 Considerations in the Formulation of the Integrated Agricultural Development Plan

This integrated agricultural development plan takes into account basin conservation. Hence, it mainly incorporates a basin conservation plan, an agricultural development plan, and a plan to formulate an agricultural support group and a farmers' organization. The following aspects were taken into consideration during the formulation of this development plan:



MASTER PLAN

(1) Basin Conservation Plan

A plan will be formulated for the conservation, practical use, and management of water and soil, the most important resources for agricultural development. Studies on the correlation between changes in land use conditions and agricultural production activities, and flood control, water use, soil runoff, and water quality, led to the formulation of a basin conservation plan incorporating the following:

i) Land use plan: agricultural use of lands in the basin with due consideration of flood and soil erosion control measures

ii) Flood control plan: improvement of river channels, dikes, revetments, and groin works to prevent flooding downstream

iii) Afforestation: development and extension of agroforestry techniques for the conservation of water and soil resources

iv) Soil conservation plan: introduction of soil conservation measures for farmlands, pastures and forests in the basin to counter-act soil erosion

v) Water management plan: water management plan taking into consideration present and future problems in water quality and quantity

In spite of the excessive cultivation of the lands, the formulation of the land use plan must take into consideration the farmers cultivating the lands for a living. Using the present land use conditions as a basis, therefore, the plan shall actively introduce soil conservation measures such as agroforestry, contour cropping, drainage canals, terraces, etc. It shall incorporate a well organized extension and training program so that farmers can actively participate in the implementation and management of these soil conservation measures. The provision of the facilities necessary for the conduct of extension and training activities, particularly with regard to soil conservation, shall also be included in the plan.

(2) Agricultural Development Plan

The agricultural development plan shall entail crop diversification, improvement of productivity, extension of support to farmers, and the improvement of farmers' income through the conduct of the following:

1) Farm Management

The farm management plan was formulated with due consideration of the limited land resources in the Study Area. It aims to effectively use natural resources to increase land productivity by improving soil conditions through the improvement of farm management techniques, the introduction of irrigation, erosion control measures, and agroforestry. The plan also aims to stabilize productivity and increase agricultural profits through agricultural diversification, by introducing the cultivation of cash crops, livestock raising, and inland fisheries. Further, it also intends to facilitate technical extension activities, obtain agricultural implements, improve the financing and distribution system, as a means of increasing farmers' income.

2) Irrigation and Drainage Plan

The irrigation and drainage plan aims to, as much as possible, effectively use water resources, which excludes Ilopango Lake and Jiboa River both of which were analyzed as unsuitable for irrigation use due to the water quality problems. In view of the Study Area's topographic and geological conditions, this plan shall make use of groundwater resources and hence take into consideration past utilization of this water resource. Although the Master Plan Study was not able to comprehend the necessary details, the use of small scale surface water irrigation was observed to be possible almost everywhere, and a study on the implementation of this type of irrigation should be undertaken.

3) Rural Road Improvement Plan

The improvement of the road network that connects every village and district to the Pan American Highway shall significantly contribute to the transportation of agricultural implements and products, and the activation of the rural socioeconomy. This improvement plan shall therefore entail the improvement of roads that connect each villages and these villages to farmlands. And in view of traffic volume and to protect the products from any damage during transit, the roads shall be paved with gravel.

4) Rural Infrastructure Improvement Plan

The rural infrastructure improvement plan shall take into consideration the educational level of the farmers, public health, group activities, and the participation of rural women in community activities.

(3) Agricultural Support Organization and Farmers' Organization

Because the introduction of cash crops, livestock raising, inland fisheries, and soil conservation measures is very important to agricultural diversification in the area, the development and extension of relevant technologies, and support in the acquisition of required materials and equipment should be sufficiently conducted. The farmers should be made aware of the importance of these elements in improving their agricultural lives.

The plan shall also entail the expansion and reinforcement of agricultural extension agencies, the improvement of the distribution system, and the improvement of women's organization.

The farmers' organization for the production and distribution of agricultural products shall need the guidance of government bodies until they are ready to supervise the works on their own. Otherwise, it would be difficult to realize such organization because the farmers are considerably inexperienced in this domain.

(4) Recommendations

The progress of the project is considered to be significantly affected by the tenant farmers in the Study Area. Tenant farmers hardly benefit from any form of investment made on the land, therefore, they are assumed to take a passive stance regarding the implementation of the project. Hence, to encourage them to participate, recommendations on how to improve tenancy conditions and the obtaining of financing for the purchase of lands shall be made.

In consideration of the fact that it is difficult for farmers to get agricultural loans under the present financing system, as well as the role of agriculture in national economic development, recommendations on how to improve the financing system shall be made.

CHAPTER 5

INTEGRATED AGRICULTURAL DEVELOPMENT MASTER PLAN

CHAPTER 5 INTEGRATED AGRICULTURAL DEVELOPMENT MASTER PLAN

5.1 Basin Management Plan

The significant problems in the basin are deforestation and farmland development upstream which result in soil erosion and sediment runoff -- factors that raise the river bed and cause flooding downstream.

Accordingly, the agricultural and forestry industries upstream were requested to carry out basin conservation measures, e.g. sediment runoff countermeasures and water resource recharge measures, in addition to measures to improve production.

Small scale farming is predominant in the upstream area due to rugged terrain. Therefore, farmers in this area are not economically capable of independently implementing these countermeasures. Unless the government extends financial assistance to the formulation and execution of a plan that would render the mountain villages self-sufficient, the development of an agricultural area fully capable of conducting the above measures would be impossible. Therefore, the basin management plan this study shall undertake should fully consider the mutual dependence of agriculture in the basin downstream which constantly suffers from calamities, and subsistence agriculture in the basin upstream. The implementation of this plan should be able to contribute to the development of the farmers' ability to sustain agricultural development in the basin, and the growth of the rural community as a whole.

Based on this viewpoint, studies on the correlation between changes in land use conditions and agricultural production activities, and flood control, water-use, soil runoff, and water quality were made. A basin management plan incorporating the following was therefore formulated:

(1)	Land use plan	agricultural use of lands in the basin with due consideration of flood and soil erosion control measures
(2)	Flood control plan	improvement of river channels, dikes, revetments, and groin works to prevent flooding downstream
(3)	Afforestation	introduction of agroforestry techniques and afforestation for the conservation of water and soil resources
(4)	Soil conservation plan	introduction of soil conservation measures for farmlands, pastures and forests in the basin to counter-act soil erosion, and which will be independently carried out by the farmers
(5)	Water management plan	water management plan taking into consideration future problems in water quality and quantity

5.1.1 Land Use Planning

The hillsides of the Ilopango Lake area and Vicente Volcano steeply slope. In other areas, steep slopes form both sides of the river course dissecting the plateau, which gently slopes. Blocks C and E in the midstream basin area still cover a comparatively vast plateau, while the plateau area in Block B gradually diminishes in expanse as the river course branches off to different directions. Therefore, the land use plan shall be formulated bearing in mind that steep slopes (Class VI or above) are distributed on both sides of the river course. The following paragraphs describe the basic policy of the land use plan.

For agricultural land conservation on hillsides along rivers, it is essential to suppress soil erosion and rapid rain water outflow, particularly at the transitional boundary between Classes IV and VI. A green belt made of coffee and fruit trees shall be planted along the edges.

The cultivation of maize in some lands categorized under Class VI or above, and current land use practices in Class IV lands shall be continued in the future. However, vetiver grass shall be planted parallel with the contour line, further dividing the lands into sections.

Lands categorized under Classes II and III shall be completely used.

Of the Class II and Class III lands in D block, 2,300 ha are fallow due to flooding and cultivation contracts with factories. Maize cultivation and beef and dairy cattle raising shall be introduced in these lands. Previous land use practices shall be continued, however.

5.1.2 Flood Control Plan

(1) Basic Policy

The basic policies of the flood control plan are as follows:

1) Design Target Year

The design target year shall be 2010 in consideration of the importance of this project in the area.

2) Design Scale

The flood control plan for the Jiboa River shall be formulated taking into account a flood return period of 100 years. The drainage plan shall be formulated based on a return period (flooding by heavy rain) of 5 years.

3) Basic Policy of the Flood Control Plan

To formulate an effective flood control plan, it is very important to determine the relevance of the soil conservation plan for sediment runoff control to the flood control plan for river flow adjustment. The following are requested for flood control:

- Rehabilitation of river channels
- Construction of embankments
- Construction of drainage channels

During the formulation of the flood control plan, soil erosion control was deemed necessary due to the following reasons, hence the separate formulation of a soil conservation plan.

a) The soil and forest conservation measures introduced to control the production of sediments are also effective in reducing rainfall runoff.

b) Sediment runoff upstream can be controlled with the construction of soil conservation facilities. This will consequently stop flooding as it will prevent the river bed from rising, and protect the river channels from erosion due to river channel realignment.

c) Sediment runoff upstream can be controlled with the construction of soil conservation facilities, to prevent the destruction of the revetments of the midstream and downstream river channels, and the obstruction of water intake operations. If the amount of sediment runoff is small, the amount of sediment supplied to the midstream and downstream river channels is considerably reduced, thus preventing the riverbed from rising.

(2) Study of Basic Flood Discharge

The basic flood discharge in the basin shall be established by setting the flood control point at the area downstream from the confluence of the Sepaquiapa and Jiboa rivers.

1) Design Rainfall

A daily rainfall exceedence probability of 1/100 and a daily maximum rainfall amount of 163 mm/day shall be the design rainfall of this study.

2) Flood Runoff Calculation Model

The model required to illustrate the effects of runoff control facilities in the Study Area must be able to calculate peak runoff and runoff undulations, and express fluctuations in runoff. The tank model would be an effective runoff calculation model for the conversion of design rainfall to runoff discharge, but it would be difficult to use in this case in view of data availability and accuracy. Accordingly, the Iwai method was used to determine rainfall probability, and the rational method was used to calculate the basic flood runoff.

3) Calculation of Design Flood Discharge in the Jiboa River

The basic design flood discharge without flooding and natural retarding functions was calculated using the design rainfall. The design flood discharge was established under a heavy rainfall probability of 1 in 100 years. The results of the calculation are shown in the table below.

Daily Rainfall Exceedence Probability	*Daily Rainfall in Cojutepeque (mm/day)*	*Design Flood Discharge m^3/sec*
1/5	100	490.3
1/10	112	548.1
1/20	120	604.4
1/30	125	637.4
1/50	140	678.8
1/100	168	735.8

(3) Alternative Plans

The basin was divided into blocks in consideration of geologic and land use conditions, and flood countermeasures in harmony with the characteristics of each block were formulated. Thereafter, flood control plans were prepared.

1) Regional Division by Flood Control Function

Because the natural and social conditions in the Study Area vary, the formulation of the flood control measures must take into account the characteristics of each block. In this study, the basin was divided into the following two districts:

Storm Water Retention District (ABCE blocks):

This district is predominantly made up of hilly areas and stores a lot of the water resource recharge volume. Therefore, there is a need to consider water management, mainly in terms of the acquisition of or increase in primary rainfall seepage, soil runoff prevention measures, and water retention functions. A soil conservation plan should be separately formulated for this district.

Low-lying District (D block):

Rainwater is mainly retained in this district and not discharged into the river. Because the river channels are unstable, flooding occurs. Accordingly, flood countermeasures should be implemented especially in areas susceptible to flooding due to river inflow.

2) Applicable Flood Control Measures

An integrated alternative plan was formulated in accordance with the above mentioned division of the basin.. As previously mentioned in the basic policy section, the flood control plan to be proposed shall incorporate both hard and soft countermeasures for flood control and water management. The flood countermeasures applicable in the Study Area are as follows:

Hard Countermeasures:

Countermeasure A: River channel and drainage rehabilitation

To improve the flow capacity of the river channel, widening and dredging should be carried out, and

embankments should be constructed.

Countermeasure B: Construction of training dike, separation levee, revetment, and groin
To stabilize the alignment of the river channels, training dikes, separation levees, revetments, and groins of natural form planted with willows should be constructed.

Countermeasure C: Construction of Drainage Canals for Agricultural Use
Drainage canals shall be constructed to direct the flow retained in the downstream area outside of the Study Area.

Countermeasure D: Elevated Facilities (community centers, elevated concrete wells and lavatories)
Community centers shall be constructed in villages usually flooded.

The implementation of an alternative plan which is a combination of the above countermeasures in the downstream area was planned in consideration of current land use conditions.

Soft Countermeasures (Non-structural Measures)

Non-structural measures shall be incorporated in the flood control plan for areas not capable of implementing the hard countermeasures due to financial restrictions. These measures are as follows:

- Land use restriction in areas or districts prone to flooding
- Flood warning and evacuation system
- Education programs

(4) Examination of Flood Control Plans

The basic design conditions of the facilities for the established flood control plans were studied.

1) Calculation of the Design Flood Discharge

The runoff calculation model was adjusted for the alternative plans to calculate the design flood discharge at the main points and of the facilities. The flood discharge probabilities at the Montecristo observation station, the Sepaquiapa River confluence and the mouth of the Jiboa River are shown in the table below.

Flood Discharge Probability at Different Points

Probability / *Station*	1/5 m³/sec	1/10 m³/sec	1/50 m³/sec	1/100 m³/sec
Montecristo Station	240.93	267.2	339.77	371.85
Sepaquiapa River Confluence	445.77	471.03	587.55	638.70
Jiboa River Mouth	490.30	548.10	678.78	735.81

2) Study of the River Channel Stabilization Plan

Constant flooding in the downstream basin of the Jiboa River is considered to be caused by the rise in river bed due to sediment accumulation, lack of water cross sections, and unregulated river flow. The river channel stabilization plan shall therefore consider the rehabilitation of the 10 km section from the Sepaquiapa River confluence to the Jiboa River mouth.

a) Calculation Condition

Section Interval: right bank: 13 km; left bank: 12.5 km

Gross Head: 23.5 m

Riverbed gradient at the Sepaquiapa River Confluence: io = 0.00436

b) Wave Length and Amplitude of River Meander

The wave length and amplitude of river meander from the Montecristo observation station down to the Sepaquiapa River confluence, and from the said confluence down to the Jiboa River mouth are as shown in the table below.

Wave Length and Amplitude of River Meander from the Sepaquiapa Confluence to the Jiboa River Mouth

Section	*Distance (km)*	*Wave Length (m)*	*Amplitude (m)*	*Width of low water channel (m)*
Upstream	0	2,923	585	50
Midstream	8	3,766	753	95
Downstream	15.5	4,849	970	180

(5) Flood Control Plan

1) River Improvement Plan

The outline of the river improvement plan is as follows (see Figure 5.1.2.1). The discharge of the sand deposits that constantly accumulate downstream by traction force during flooding was given particular attention in the formulation of the river improvement plan. The plan shall cover the section between the Sepaquiapa River confluence and the

river mouth.

a) River Section Rehabilitation

A single cross section shall be constructed to acquire the required traction force. Due to the closure of the Jiboa River mouth, the river bed rises, flooding and resulting damages occur. To repair unstable river channels, embankments and dredging will be conducted on the 12.5 km section between the Sepaquiapa River confluence and the river mouth (right bank: 13.0 km, left bank: 12.5 km). (An embankment and dredging plan shall be formulated for the 3.0 km section between Las Flores Village and the confluence of the Sepaquiapa and Jiboa rivers -- the river bed of the Jiboa River shifts annually.)

b) Embankment Materials

Studies were conducted on the river bed materials downstream to be used for the construction of embankments. The results of the analysis are shown in Table 5.1.2.1.

Table 5.1.2.1 Grain Size of Borrow Materials for Filters and Rock Protection of Dikes

Grain Size	*Passing (%) Bank A*	*Passing (%) Bank B*	*Passing (%) Bank C*	*Passing (%) Bank D*	*Passing (%) Bank E*
3"	100	100	100	100	
2"	79	82	86	88	100
1 1/2"	61	67	77	77	95
1"	53	56	65	69	83
3/4"	49	51	61	64	77
1/2"	44	45	55	59	72
3/8"	41	42	53	56	69
No.4	34	36	48	49	64
No.8	26	29	41	37	58
No.16	20	24	34	28	46
No.30	10	15	21	15	23
No.50	4	6	8	6	10
No.100	2	2	2	2	3
No.200	1	1	1	1	1
Max. Size	5"	4"	4"	6"	5"
Abrasion	35%	40%	50%	40%	40%

2) Elevated Facilities Construction Plan

Elevated facilities (including community centers) shall be constructed in villages usually flooded. The center shall function as an emergency shelter and as a venue for the

extension of agricultural techniques to farmers.

- Wells : Diameter: 100cm; Mouth Level: 1.5m above the ground
- Lavatories : Area: 1.43m3; Floor Level: 1.5m above the ground
- Community Centers : Area: 300m2; Level: 1.5m above the ground

Table 5.1.2.2 further details the construction of these facilities.

Table 5.1.2.2 Elevated Facilities to be Constructed in Flood-Prone Villages

Areas	*Elevated Wells*	*Lavatories*	*Community Centers*
Caserio San Jose Luna	5	5	1
Campamento San Jose Luna	3	3	
Caserio El Porvenir	11	11	1
Caserio San Marcos Jiboa	3	3	
Caserio San Carlos	5	5	
Coop. Santa Maria del Coyol	10	10	1
Coop. Brisas Marinas (Las Moras)	11	11	1
Caserio Las Hojas	10	10	1
Caserio San Marcelino	1	1	
Caserio El Pimental	30	30	1
TOTAL:	89	89	6

5.1.3 Afforestation Plan

According to the "Outline of the Conservation of the Jiboa River Watershed" (Original title: Perfil sobre Ordenamiento de la Cuenca Hidrografica del Rio Jiboa) prepared by the Watershed and Soil Conservation Division of DGRNR as the basic document for this Project, there is a plan to execute afforestation including agroforestry system on 10,000 ha of land in 5 years in order to conserve the watershed. This target figure is about 20% of the total Study Area, and the achievement of a yearly average of 2,000 ha is thought to be very difficult. Accordingly, it is judged that a yearly average of 1,000 ha is suitable. Therefore, the afforestation plan during the 15-year period, until 2010 -- the target year of this Master plan – will cover a total of 15,000 ha. This coverage shall be equally divided into 7,500 ha for the establishment of a plantation and 7,500 ha for the introduction of agroforestry system.

*Note:
It is difficult to specify the total area to be covered by tree planting activities, as trees are either planted individually or in rows, including the planting methods for agroforestry. However, for convenience, this shall be clearly specified in the afforestation plan.

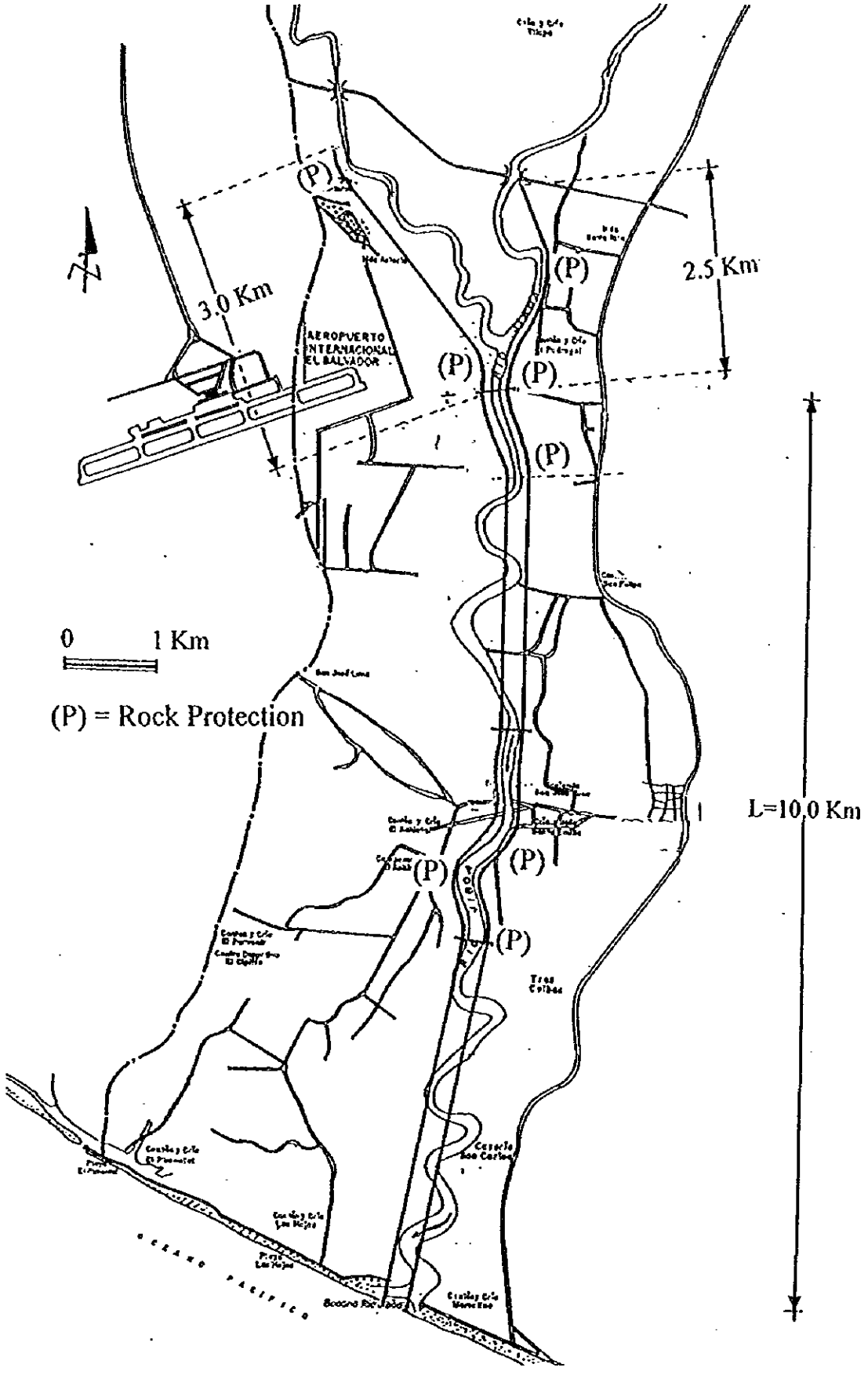
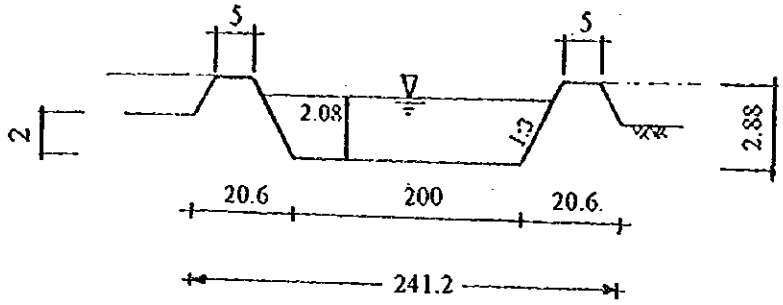


Fig. 5.1.2.1 Outline of River Improvement Plan

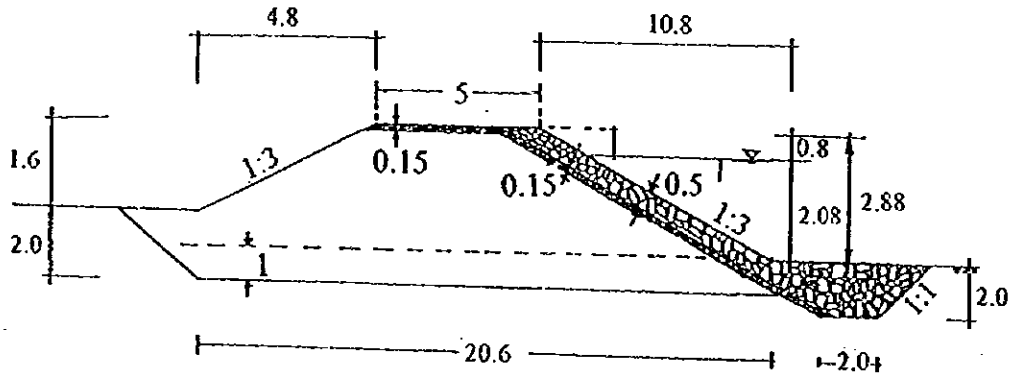
MASTER PLAN OF THE JIBOA RIVER BASIN
INTEGRATED AGRICULTURAL DEVELOPMENT
IN THE REPUBLIC OF EL SALVADOR

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Note: Dimensions in Meters



Typical Section of Channeling and Diking Works



Typical Section of Dikes with Rock Protection

Fig. 5.1.2.2 Typical Cross Sections of the Channeling, Diking and Rock Protection Works

MASTER PLAN OF THE JIBOA RIVER BASIN INTEGRATED AGRICULTURAL DEVELOPMENT IN THE REPUBLIC OF EL SALVADOR

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

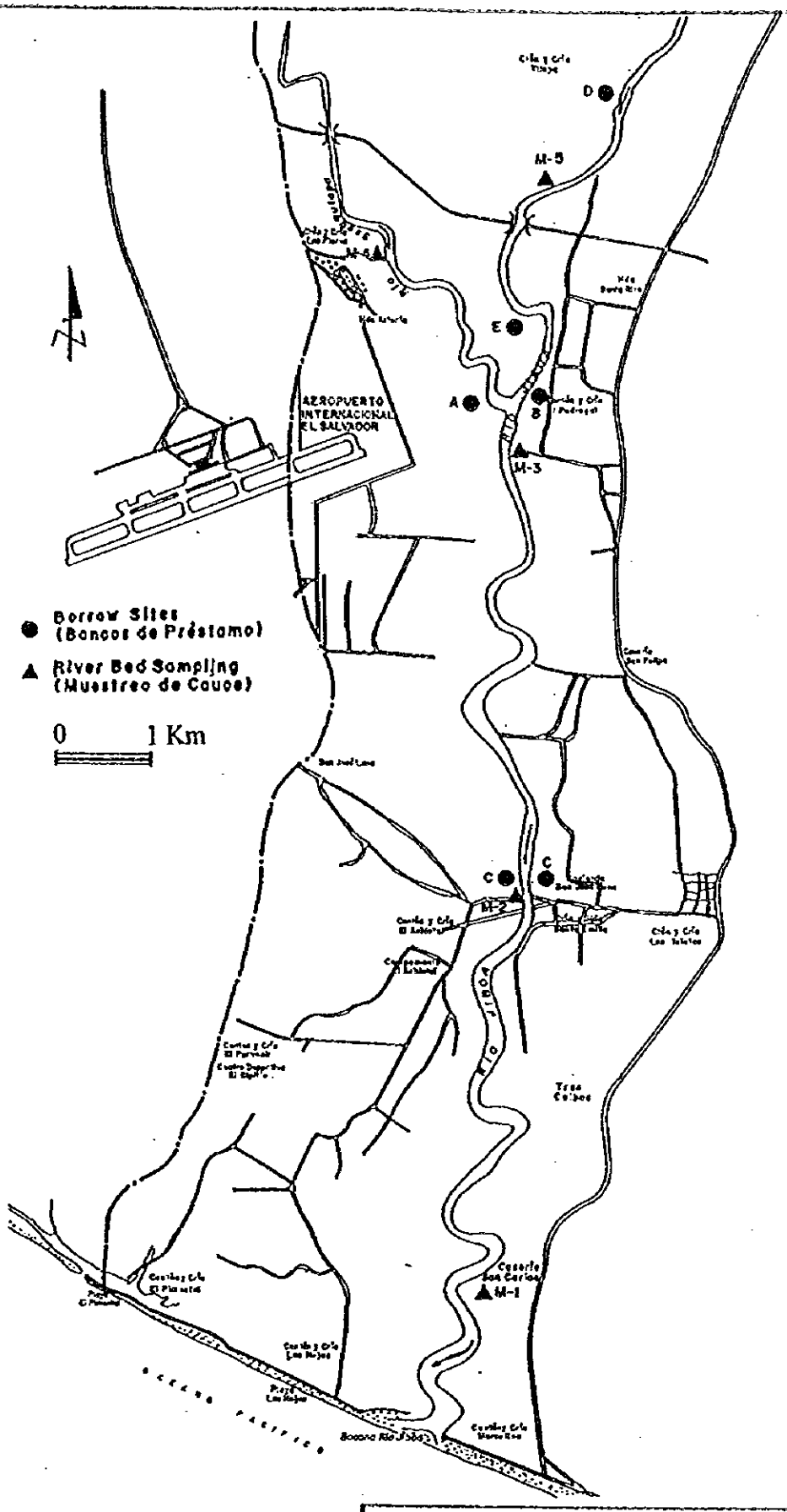


Fig. 5.1.2.3 Location of Borrow Materials, and River Bed Sampling Sites

MASTER PLAN OF THE JIBOA RIVER BASIN
INTEGRATED AGRICULTURAL DEVELOPMENT
IN THE REPUBLIC OF EL SALVADOR

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

(1) Plan for the Establishment of Plantation

In the Project area including the plains in the lower Jiboa River basin, there are a lot of brush-lands and unused grasslands. These areas naturally include lands not suitable for cultivation in terms of soil condition and the work involved. There are also a lot of uncultivated areas because of the ignorance of the rural people, lack of technology, and difficulties in the procurement of seedlings and other materials. Therefore, it is necessary to facilitate the establishment of plantations in the following lands, regardless of size, through the cooperation and understanding of the land owners and the residents:

a) Unused land around cultivated area
b) Unused land around pasture
c) Brush-lands
d) Open lands in the forest
e) Others

1) Plan by Block and Department

As aforementioned, the establishment of a 7,500ha plantation is planned. This coverage shall be divided by block and department as shown in the table below, based on present land use conditions, e.g. cultivation, woodland, and gradient.

(Unit: ha)

Block	*A*	*B*	*C*	*D*	*E*	*Total*
Department						
San Salvador	1,077					1,077
Cuscatlan	1,104	777	73			1,954
La Paz	392	24	1,498	299	1,508	3,721
San Vicente		283	465			748
Total	2,573	1,084	2,036	299	1,508	7,500

2) Tree Species for Planting

The tree species to be planted shall be selected in accordance with the purpose of the establishment of the plantation:

a) Plantation for wood production

Tree species shall be different depending on the kind of wood produced from the plantation.

- Production of wood for timber or plywood:

  The tree species to be planted shall be fast growing, producing large poles which are straight and non-tapering, such as:

  Balsa (Ochroma lagopus), Caoba (Swietenia humilis), Cedro (Cedrela odrata),

Conacaste blanco (Albizzia caribaca), Conacaste negro (Enterolobium cyclocarpum), Eucalipto deglupta (Eucalyptus deglupta), Laurel (Cordia alliodora), Melina (Gmelina arborea), Pino caribe (Pinus caribaea), Teca (Tectona grandis), etc

- Production of pulp and chip:

  The tree species to be planted shall be fast growing, have short rotations, can be regenerated by their sprouts, and have straight stems, such as:

  Acacia mangium (Accacia mangium), Eucalipto camaldulensis (Eucalyptus camaldulensis), Eucalipto citriodora (Eucalyptus citriodora), Eucalipto deglupta (Eucalyptus deglupta), Leucaena (Leucaena leucocephala), Madrecacao (Gliricidia sepium), etc.

- Production of fuelwood:

  The tree species to be planted shall be fast growing, have short rotations, and can be regenerated by their sprouts; tree forms are irrelevant.

  Casuarina (Casuarina equisetifolia), Chaperno(Lonchocarpus caulatus), Eucalipto camaldulensis (Eucalyptus camaldulensis), Guachilipín (Diphysa robinoides), Leucaena (Leucaena leucocephala), Madrecacao (Gliricidia sepium), Pepeto(Inga edulis), Pino caribe (Pinus caribaea), Roble negro (Quercus hondurensis), Roble blanco (Quercus skinneri), etc.

- Production of minor forest products:

  The tree species to be planted shall be able to produce non-wood forest products such as food, beverage, fodder, medicine.

  Funera (Dalbergia funera), Laurel (Cordia alliodora), Leucaena (Leucaena leucocephala), Liquidambar (Liquidambar styraciflua), Mano de león (Dendropanax arboreum), etc.

b) Plantation for conservation

Since the purpose is to control soil erosion and restore devastated lands, the tree species to be planted are those that grow well in barren soils and under severe weather conditions, having a deep and large root system, long-life, and that can be easily regenerated. Indigenous tree species are preferable.

Chaquiro (Colubrina ferruginosa), Flor amarilla (Delonix regia), Eucalipto camaldulensis (Eucalyptus camaldulensis), Laurel (Cordia alliodora), Leucaena (Leucaena leucocephala), Madrecacao (Gliricidia sepium), Pino caribe (Pinus caribaea), Quebracho (Piptadermia constricta), etc.

(2) Plan for the Introduction of Agroforestry

In the upper and middle basin of the Jiboa River, slash and burn agriculture or similar

cultivation methods are practiced by comparatively poor farmers on the mountainous slope areas which should be kept as a forest resource. In such areas, it is considerably difficult to completely recover the forest through reforestation, because these areas have already become important to many rural people as fields for subsistence agriculture. Therefore, it is necessary to introduce an agroforestry system that would supplement subsistence agriculture and stock raising by the production of fertilizer and fodder, as well as provide the fuelwood and timber necessary for the livelihood of the rural people. In addition, the system should also be able to help conserve soil and water resources in areas where the construction of plantations is difficult. The agroforestry system which can be introduced to the Study Area are as follows:

1) Plan by Block and Department

As aforementioned, the establishment of a 7,500ha plantation is planned. This coverage shall be divided by block and department as shown in the table below, based on present population, agricultural population, land use for cultivation, and gradient.

(Unit: ha)

Block / *Department*	*A*	*B*	*C*	*D*	*E*	*Total*
San Salvador	1,051					1,051
Cuscatlan	867	1,068	59			1,995
La Paz	267	24	1,352	585	1,515	3,743
San Vicente		286	426			711
Total	2,185	1,378	1837	585	1,515	7,500

2) Tree Species for Planting

The selection of tree species to be planted for the introduction of the agroforestry system shall be as follows:

a) Agroforestry system in cultivated lands

- Trees scattered in cultivated lands:

  In order to increase crop production, diversify products and protect crops, trees are planted in a latticed design or at random in cultivated lands.

  Caoba (Swietenia humilis), Cedro (Cedrela odrata), Conacaste negro (Enterolobium cyclocarpum), Eucalipto camaldulensis (Eucalyptus camaldulensis), Eucalipto citriodora (Eucalyptus citriodora), Eucalipto deglupta (Eucalyptus deglupta), Melina (Gmelina arborea), Pino caribe (Pinus caribaea), Teca (Tectona grandis), etc.

- Contour strip of trees:

In order to control soil erosion in slopes and increase soil fertility, trees are planted in strips along the contour.

Eucalipto camaldulensis (Eucalyptus camaldulensis), Eucalipto deglupta (Eucalyptus deglupta), Flor amarilla (Cassia siamea), Leucaena (Leucaena leucocephala), Paraiso (Melia azedarach), etc.

- Alley cropping (hedgerow intercropping):

This method refers to the cultivation of annual crops in an ally between rows of planted trees to improve and fertilize the soil, to control soil erosion, as well as provide various forest products.

Acacia mangium (Accacia mangium), Chaquiro (Colubrina ferruginosa), Flor amarilla (Cassia siamea), Nim (Azadirachta indica), Paraiso (Melia azedarach), etc.

- Trees in home gardens:

This method introduces the planting of trees which provide wood, fodder, fiber, fuel, medicine, organic fertilizer, resin, etc., into home gardens, and the cultivation of vegetables, fruits, edible roots etc. in the space among the trees.

Aguacate (Persea americana) [Avocado], Citricos (Citrus sp.) [Citrics], Mango (Mangifera indica) [Mango], Marañón (Anacardium occidentaslis) [Cashew], Marañón japonés [Japanese cashew], Níspero (Acharas zapota) [Nispero], Zapote (Pouteria mamosum) [Zapote], etc.

(Note):Name in parenthesis [ ] is common name.

- Taungya system (Trees in fallow):

In order to recover the fertility of soil, trees are planted instead of crops in fallow. Laurel (Cordia alliodora), Madrecacao (Gliricidia sepium), etc.

b) Agroforestry in grazing lands:

Trees planted in grazing lands are useful for the production of fodder for livestock besides wood, fuelwood, fruits etc. They are also useful for the continuing stabilization and fertility of the soil, and preventing deterioration of the ground.

Ceiba (Ceiba pentandra), Cenícero (Albizzia guachapele), Conacaste blanco (Albizzia caribaea), Conacaste negro (Enterolobium cyclocarpum), etc.

c) Agroforestry in open spaces:

- Live fence:

Trees are planted as a hedge to control the entry of livestock and wild animals into gardens, orchards, cultivated lands, etc.

Eucalipto camaldulensis (Eucalyptus camaldulensis), Eucalipto citriodora

(Eucalyptus citriodora), Eucalipto deglupta (Eucalyptus deglupta), Jiote (Bursera simaruba), Jocote (Spondias mombim), Madrecacao (Gliricidia sepium), Paraiso (Melia azedarach), Pito (Eritrina berteroana), Tihuilote (Cordia dentata), etc.

- Trees on boundaries:

  Trees are planted on the boundary line between two different properties or land uses. There are many methods to plant trees: leaving or narrowing space between trees, or in singular or multiple rows. However, trees are usually planted widely apart or in rows.

  Eucalipto citriodora (Eucalyptus citriodora), Eucalipto deglupta (Eucalyptus deglupta), Madrecacao (Gliricidia sepium), etc.

- Windbreak (Shelter belt):

  Generally, trees are zonally planted on multiple rows to prevent wind or wind-driven earth and sand from damaging cultivated lands, dwellings and so on, forming a storied forest.

  Acacia mangium (Accacia mangium), Ciprés (Cupressus lusitanica), Copalchi (Croton reflexifolius), Eucalipto camaldulensis (Eucalyptus camaldulensis), Flor amarilla (Cassia siamea), Pino caribe (Pinus caribaea), etc.

- Trees along waterways and flood plain:

  The purpose of planting trees along the waterway and flood plain is to protect the fragile ground and to improve soil productivity.

  Eucalipto camaldulensis (Eucalyptus camaldulensis), Eucalipto citriodora (Eucalyptus camaldulensis), Eucalipto deglupta (Eucalyptus deglupta), Sauce (Salix chilensis), etc.

- Trees along roads and pathways:

  Lands along roads and pathways are suitable to the planting of trees that provide shade and protect passers-by from dust. The proper management of these trees can also provide useful forest products.

  Almendro macho (Andira inermis), Chaguiro (Colubrina ferruginosa), Conacaste blanco (Albizzia caribaea), Conacaste negro (Enterolobium cyclocarpum), Cortez blanco (Cybistax donell-smithii), Cortez negro (Tabebuina guayacan), Eucalipto camaldulensis (Eucalyptus camaldulensis), Eucalipto citriodora (Eucalyptus camaldulensis), Eucalipto deglupta (Eucalyptus deglupta), Flor de fuego (Delonix regia), Maquilishuat (Tabebuiya rosea), Pino caribe (Pinus caribaea), Zorra (Phitecolobium saman), etc.

- Trees around dwellings and public facilities:

  Trees are planted around dwellings and public facilities such as schools, markets and so on, to improve and create a beautiful and pleasant environment.

  Almendro macho (Andira inermis), Ceiba (Ceiba pentandra), Cortes blanco (Cybistax donell-smithii), Flor de fuego (Delonix regia), Maquilishuat (Tabebuiya rosea), Mora (Chlorophora tintoria), Pito (Eritrina berteroana), etc.

(3) Plan for Seedling Production

As stated before, the 15-year afforestation plan targets 15,000 ha, which shall be attained by the establishment of a 7,500 ha plantation and the introduction of agroforestry in 7,500 ha of land. In order to smoothly implement the afforestation plan, it is necessary to formulate and steadily implement a seedling production plan.

The tree planting density adopted in tropical regions is generally from 1,100 seedlings per hectare (3m×3m) to 2,500 seedlings per hectare (2m×2m) depending on the growth rate and the cultural treatment requirement of tree species. The same pattern is adopted in El Salvador. Therefore, if an average planting density of 2.5m×2.5m is applied for plantations, the number of seedlings to be required shall total 1,600/ha. However, for agroforestry, only a total of 800 seedlings/ha shall be planted considering that trees shall be planted individually or in rows.

Accordingly, the afforestation plan shall require 18,000,000 seedlings for 15,000ha (7,500 ha×1,600 seedlings/ha for plantations and 7,500 ha×1,600 seedlings/ha for agroforestry).

Therefore, the annual number of seedlings required by block and department is as follows.

(Unit: thousand seedlings)

Block / *Department*	*A*	*B*	*C*	*D*	*E*	*Total*
1. Plantation						
San Salvador	115.2					115.2
Cuscatlan	118.4	83.2	8.0			208.0
La Paz	41.6	3.2	160.0	32.0	161.6	396.8
San Vicente		30.4	49.6			80.0
Total	275.2	115.2	217.6	32.0	161.6	800.0
2. Agroforestry						
San Salvador	56.0					56.0
Cuscatlan	46.4	56.8	3.2			106.4
La Paz	14.4	1.6	72.0	31.2	80.8	200.0
San Vicente		15.2	22.4			37.6
Total	116.8	73.6	97.6	31.2	80.8	400.0
3. Total Afforestation						
San Salvador	171.2					171.2
Cuscatlan	164.8	140.0	11.2			314.4
La Paz	56.0	4.8	232.0	63.2	242.4	596.8
San Vicente	-	45.6	72.0			117.6
Total	392.0	188.8	315.2	63.2	242.4	1,200.0

More seedlings are necessary depending on the rate of survival after planting.

(4) Supporting Plan

Since a system to promote planting has not been institutionally established in El Salvador, it is difficult for the residents to conduct planting on a wide scale, despite their interest, because of economic and technical restrictions. It is necessary to adopt a positive policy on afforestation placing emphasis on the establishment of a technological system and incentives program as well as the formulation of an afforestation plan that incorporates seedling production.

1) Technological System

The establishment of a technological system is important to promote the smooth implementation of a planting plan by land owners and residents. It is especially necessary to establish the facilities and equipment for the development and transfer of the technology for nursery work, which involves the production of good seedlings based on the selection of tree species most suitable to the site

2) Incentives Program

In order to implement smoothly a planting plan relevant to the establishment of plantations and the introduction of agroforestry, it is necessary to execute positively the incentives

program provided by the government for land owners and residents who are willing to independently conduct these activities. It is also desirable to execute a separate incentive program for the beneficiaries using economic variables and assuming the principle of fair distribution among land owners. The following are listed as potential incentives.

a) Payment of bounty
b) Credit
c) Accord
d) Foodstuff
e) Raw materials (saplings, pots, seeds, insecticides, fertilizers, others)
f) Tax exemption
g) Technical assistance (extension, training)
h) Others

Since the success or failure of the execution of the planting plan is dependent on the quality of seedlings, the provision of raw materials and technical assistance are especially important incentives. Therefore, utilizing the facilities and equipment mentioned in (1), it is necessary to develop seedling production techniques and transfer these to the land owners and residents who actually implement planting in the project area, by extension and training activities.

The incentives program is a means of stimulating the public to participate positively in the protection and recovery of natural resources, mainly in the field of forestry. However, from the same point of view, this program should also be able to promote biodiversity and soil conservation.

5.1.4 Soil Conservation Plan

(1) Basic Policy

The basic policy of the soil conservation plan is as follows:

1) Design Target Year

The design target year shall be 2010 based on the importance of this project to the government's national development plan and relevant existing projects.

2) Design Scale

Soil conservation techniques shall be extended to farmers. A soil conservation system (hillside ditch and contour cropping) which is a mixture of farmland conservation and engineering techniques will be introduced to a total of 11,000 ha of land in the basin sloping at a gradient of 11-55% to reduce soil erosion to about 50% by 2010. This plan shall be conducted on 1,200ha of farmlands and shall encompass 1,100 farmers.

3) Basic Soil Conservation Policy

The soil conservation plan should have the following objectives.

- Maintain agricultural productivity
- Prevent disappearance of farmlands and farm roads
- Reduce flood damage caused by rise in river bed due to soil runoff
- Extend soil conservation techniques to farmers
- Rehabilitate demonstration farm and reinforce farm's operation and maintenance system
- Maintain the independent conduct of soil conservation of farmland by the farmers

The main focus of the soil conservation plan is to formulate countermeasures against sheet erosion. In view of the current conditions in the Study Area, the soil conservation plan shall be formulated with consideration of the flood control plan.

The soil conservation countermeasures shall be comprised of a sediments retention dam (sabo dam), hillside ditches, bench terraces, and masonry. Non-structural countermeasures for the management of cultivated lands (by contour cropping) and forest conservation are also under consideration.

(2) Formulation of Soil Conservation Plans

In consideration of geographic and land use conditions, the basin area was divided according to soil conservation functions. Soil conservation plans incorporating soil erosion countermeasures in harmony with the respective characteristics of the blocks were formulated.

1) Regional Division by Soil Erosion Control Functions

Because the natural and social conditions in the Study Area vary, the formulation of soil erosion countermeasures must take into account the characteristics of each block. In this study, the area below was selected for the application of soil conservation measures, in consideration of the flood control plan.

Storm Water Retention District (ABCE blocks):

This district is predominantly made up of hilly areas and stores a lot of the water resource recharge volume. Therefore, there is a need to consider water management, mainly in terms of the acquisition of or increase in primary rainfall seepage, soil runoff prevention measures, and water retention functions. A soil conservation plan should be separately formulated for this district.

2) Examination of Soil Conservation Plans

Soil conservation plans were formulated based on the division of the Study Area. As previously mentioned in the basic policy section, the soil conservation plan to be proposed shall incorporate both hard and soft countermeasures. The soil conservation measures

considered to be applicable in the blocks are as follows:

a) Soil Conservation Farming Techniques

These techniques are comprised of contour cropping and contour strip cropping, both of which can be independently carried out by the farmers. These techniques should be aggressively promoted in the area as they are considered to be effective in accelerating rainwater seepage into the ground, improving the water retention capacity of the soil, and in reducing surface runoff velocity. The introduction of contour cropping is forecast to reduce the present annual soil erosion volume to less than 50%.

b) Engineering techniques

i) Hillside ditch with vegetation:

The implementation of this technique is considered to be effective as it is considerably inexpensive and will therefore be agreeable to the resident farmers. This system is exhibited at the Santa Cruz Analquito demonstration farm. Figure 5.1.4.1 shows a typical example of a hillside ditch. Vetiver grass is the preferred vegetation to be planted on the hillside ditch. The agreeable points about this system are:

- it is an adequate soil conservation farming system that reduces the possibility of erosion on the farm;
- enables the continuous cropping of major crops like maize and peanuts;
- it is comparatively inexpensive to construct as it can mostly be made by hand;
- unlike the bench terrace, the construction of the ditch will only have a small impact on the farms in terms of coverage;
- the study and design of this system can be easily carried out;
- the construction and maintenance of the ditch are easy and can be independently carried out by the farmers;
- the construction of this ditch only requires a limited amount of work as it is not very long;
- this ditch shall be introduced also in fields planted with short term and perennial crops;
- the bench terrace of the ditch can be used as an access to the slope area;
- the vetiver grass planted on the ditch can be used as domestic animal fodder or for mulching.

Soil conservation methods, e.g. hillside ditch and loose-rock dam, are most effective when combined with appropriate crop cultivation techniques. It is, therefore, very important to introduce contour cropping between hillside ditches.

ii) Loose-rock Dam

In comparison with the hillside ditch, this method is more suited to hilly areas where the soil is shallow. The dam must have the same interval as the hillside ditch.

iii) Bench Terrace

This is the most effective soil conservation method. Although the implementation of this method would depend on the depth of the soil, it is usually effective in controlling soil erosion in areas with a 45% gradient. Nonetheless, this system has the following disadvantages:

- The unit price per hectare for the construction of a bench terrace is comparatively higher than the hillside ditch. Therefore, it would be financially difficult to introduce this method in fields cultivated with cheap food crops.
- The construction of a bench terrace is difficult and requires a lot of technical assistance. Accordingly, it will not be appealing to the farmers.
- Although this method is expensive, it can be utilized in fields planted with expensive cash crops or plants (e.g. flowers, vegetables).

iv) Gullies and Erosional Valleys Countermeasures

The installation of the check dam and sabo dam shown below is very important to counter the development of gullies and erosional valleys in the area (see section 5.1.3 (5)).

c) Agricultural Conservation Measures

The above methods protect the soil particles in the slope area from the impacts of erosion by flooding. The introduction of agricultural conservation measures would prevent soil particles from dispersing due to the impact of raindrops.

Agricultural conservation measures ① protect the soil from the direct impact of rainfall, and ② prevent the dispersion of organic matter in the soil. For example, the cultivation of maize effectively prevents soil dispersion due to rainfall. Soil erosion prevention may not be effective within the first three weeks of the growing period, but conditions may be improved with the intercropping of peanuts. Mulching with vetiver grass is also considered to be an effective soil conservation measure.

3) Examination of Alternative Plans

The following studies, particularly on countermeasures requiring the use of facilities, were carried out for the alternative soil conservation plans.

1) Calculation of Soil Erosion Volume

Using the runoff analysis model (USLE), the soil erosion volume to be considered by each

alternative plan was calculated. The results are shown in Table 5.1.4.1 and Figure 5.1.4.2.

The effects of the previously mentioned engineering methods and agricultural soil conservation systems in reducing soil erosion are almost the same. Using the USLE, a 50% reduction in the present soil erosion volume in the Jiboa River basin can be attained if all soil control plans (contour cropping and construction of hillside ditches in areas with a gradient of 11 - 55%) are carried out by the target year 2010. Because the implementation of these countermeasures will not be appealing to farmers because they are capital and labor intensive, the introduction of contour cropping combined with mulching and the construction of ridges would still make soil conservation possible.

Hadson (1981) states that it is possible to reduce the volume of soil loss in half in lands between the hillside ditches through the construction of contour ridges.

Accordingly, through these countermeasures the annual soil loss of 100 tons/ha/year can be reduced as follows:

100	×	50% reduction by hillside ditch	×	50% reduction by contour ridge	=	25 t/ha/yr

(3) Development of Soil Conservation Techniques and Extension Program

This plan shall particularly focus on the extension of soil conservation techniques to the farmers and the application of these techniques by the farmers through the improvement of the soil conservation demonstration farm. To be explicit, farmers shall be taken to areas where soil conservation measures are progressive, and the farmers' groups shall be provided with machinery and tools to lease, to enable the farmers to expand soil conservation measures independently. This program shall entail the following:

a. The establishment of a system that would support technological extension and training of farmers.
b. The installation and improvement of facilities for the establishment of soil conservation techniques.
c. The establishment of facilities to store and manage the necessary soil conservation materials and equipment to lease to farmers' groups.
d. The execution of soil conservation works (farm maintenance) in farmlands in districts where soil erosion is critical.

1) Soil Conservation Techniques Development Plan

It is very important to establish the soil conservation techniques to be effectively promoted to the farmers. In El Salvador, data on soil runoff, which affects agricultural engineering works, are very few and old. The soil runoff data obtained from surveys done in the Metapan District between 1975 - 1980 is the only one reliable.

Accordingly, this plan intends to accumulate relevant data and establish and promote soil conservation techniques in the basin and nationwide by rehabilitating the soil conservation demonstration and experimental farm in Santa Cruz Analquito and the experimental facilities.

2) Soil Conservation Techniques Extension Program

a) Soil Conservation Techniques Extension Program for Farmers

The farmers have established soil conservation techniques in the model district within the basin of Coatepeque Lake in El Salvador. These techniques, however, are not dispersed. Therefore, a system that would facilitate the extension of such techniques and the training of farmers in the application of these techniques shall be established. Accordingly, facilities for the weekly training of at least 30 farmers (1,200/year; 6,000/5 years) and vehicles (micro-bus, 4WD) for the participation of farmers in training activities shall be provided.

b) Soil Conservation Demonstration Farm Rehabilitation Program

This program entails the farmers independent execution of the engineering works (introduction of hillside ditch with vetiver grass) in farmlands of districts, such as San Antonio Masahuat and the small basin of Ilopango Lake, seriously affected by soil erosion. The farmers will be encouraged to expand the soil conservation coverage by lending them the necessary machinery. Soil conservation shall be carried out with the Coatepeque Lake basin as a model.

This program shall establish bases in Cojutepeque, El Rosario and Santiago Texacuangos to hold the necessary machinery for the construction of hillside ditches, small sabo dams (masonry), bench terraces, and channels. The machinery shall be leased to farmers' groups to enable them to independently conduct soil conservation techniques.

(4) Soil Conservation Incentives

Incentives granted in the past for the conduct of soil conservation included ① provision of a credit with low interest for the conduct of soil conservation works, ② provision of improved seedlings, ③ provision of vetiver grass and improved seedlings.

Past incentives for afforestation included the provision of two ounces of agrochemicals and fertilizers to farmers for the construction of live barriers in farmlands of 0.7 ha or less, as well as the distribution of madrecacao seeds.

It is good to provide the farmers with the necessary materials, equipment and tools during the conduct of the works. It is also good to give farmers 850 colones for the planting of grain on every 0.7 ha, to form a soil conservation association, to loan this association the relevant materials, equipment and tools, and to organize a system to be operated by the association for the maintenance of these materials and tools.

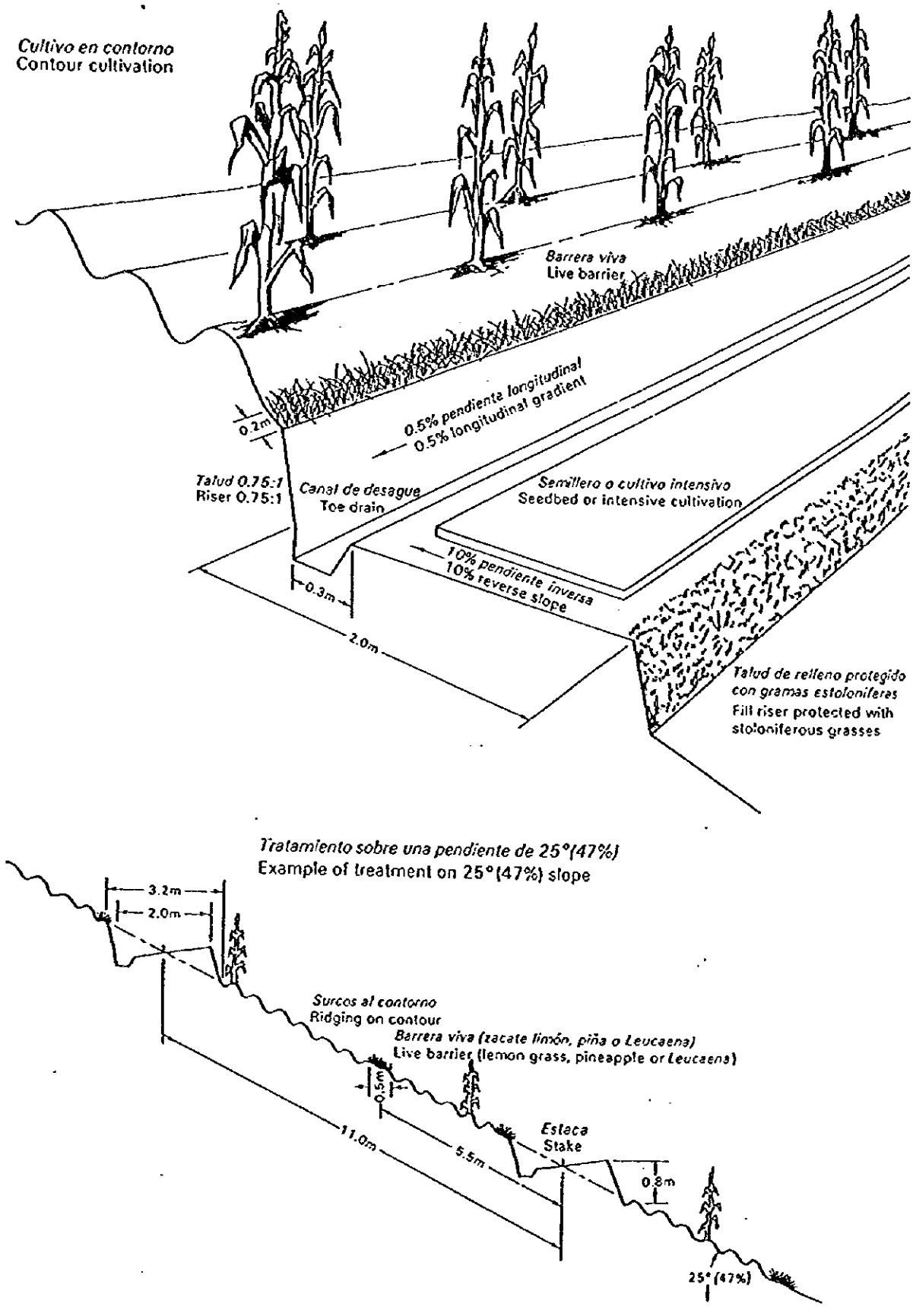


Figure 5.1.4.1 Hillside Ditch with Live Barriers

Table 5.1.4.1 Amount of Presured Soil Erosion after Soil Conservatin Measures

1. Non Measures

A1 district

Unit:Ton

	Classification of Gradient						
	I	II	III	IV	V	VI	Total
1. Farm land	14,000	131,000	379,000	2,055,000	1,070,000	20,000	3,669,000
2. forest	0	3,000	11,000	67,000	47,000	1,000	129,000
3. Urban area, Infractu	15,000	63,000	90,000	360,000	218,000	4,000	750,000
4. Lake, pond & River	0	0	0	0	0	0	0
Total	29,000	197,000	480,000	2,482,000	1,335,000	25,000	4,548,000

All basins total (excluding A1)

Unit:Ton

	Classification of Gradient						
	I	II	III	IV	V	VI	Total
1. Farm land	130,000	609,000	1,377,000	5,269,000	1,496,000	20,000	8,901,000
2. forest	0	9,000	23,000	125,000	74,000	4,000	235,000
3. Urban area, Infractu	12,000	42,000	54,000	89,000	26,000	0	223,000
4. Lake, pond & River	0	0	0	0	0	0	0
Total	142,000	660,000	1,454,000	5,483,000	1,595,000	24,000	9,359,000

2. Measures. 1

(In the Case of the slope area with 11-55% gradient of Countour farming :Reduction rate of 50%)

A1 district

Unit:Ton

	Classification of Gradient						
	I	II	III	IV	V	VI	Total
1. Farm land	14,000	131,000	189,500	1,027,500	1,070,000	20,000	2,452,000
2. forest	0	3,000	11,000	67,000	47,000	1,000	129,000
3. Urban area, Infractu	15,000	63,000	90,000	360,000	218,000	4,000	750,000
4. Lake, pond & River	0	0	0	0	0	0	0
Total	29,000	197,000	291,000	1,455,000	1,335,000	25,000	3,332,000

All basins total (excluding A1)

Unit:Ton

	Classification of Gradient						
	I	II	III	IV	V	VI	Total
1. Farm land	130,000	609,000	689,000	2,636,000	1,496,000	20,000	5,580,000
2. forest	0	9,000	23,000	125,000	74,000	4,000	235,000
3. Urban area, Infractu	12,000	42,000	54,000	89,000	26,000	0	223,000
4. Lake, pond & River	0	0	0	0	0	0	0
Total	142,000	660,000	766,000	2,850,000	1,596,000	24,000	6,038,000

2. Measures. 2

(In the Case of the slope area with 11-55% gradient, introduction of Hillside ditches of Countour faraing :Reduction rate of 75%)

A1 district

Unit:Ton

	Classification of Gradient						
	I	II	III	IV	V	VI	Total
1. Farm land	14,000	131,000	94,750	513,750	1,070,000	20,000	1,844,000
2. forest	0	3,000	11,000	67,000	47,000	1,000	129,000
3. Urban area, Infractu	15,000	63,000	90,000	360,000	218,000	4,000	750,000
4. Lake, pond & River	0	0	0	0	0	0	0
Total	29,000	197,000	196,000	941,000	1,335,000	25,000	2,723,000

All basins total (excluding A1)

Unit:Ton

	Classification of Gradient						
	I	II	III	IV	V	VI	Total
1. Farm land	130,000	609,000	345,000	1,317,000	1,496,000	20,000	3,917,000
2. forest	0	9,000	23,000	125,000	74,000	4,000	235,000
3. Urban area, Infractu	12,000	42,000	54,000	89,000	26,000	0	223,000
4. Lake, pond & River	0	0	0	0	0	0	0
Total	142,000	660,000	422,000	1,531,000	1,596,000	24,000	4,375,000

Unit: 103ton/year

	0-5%	6-10%	11-25%	26-55%	56-100%	100<%	Total
Measures.2	142	660	422	1531	1596	24	4375(47%)
Measures.1	142	660	766	2850	1596	24	6038(65%)
No Measures	142	660	1454	5483	1596	24	9359(100%)

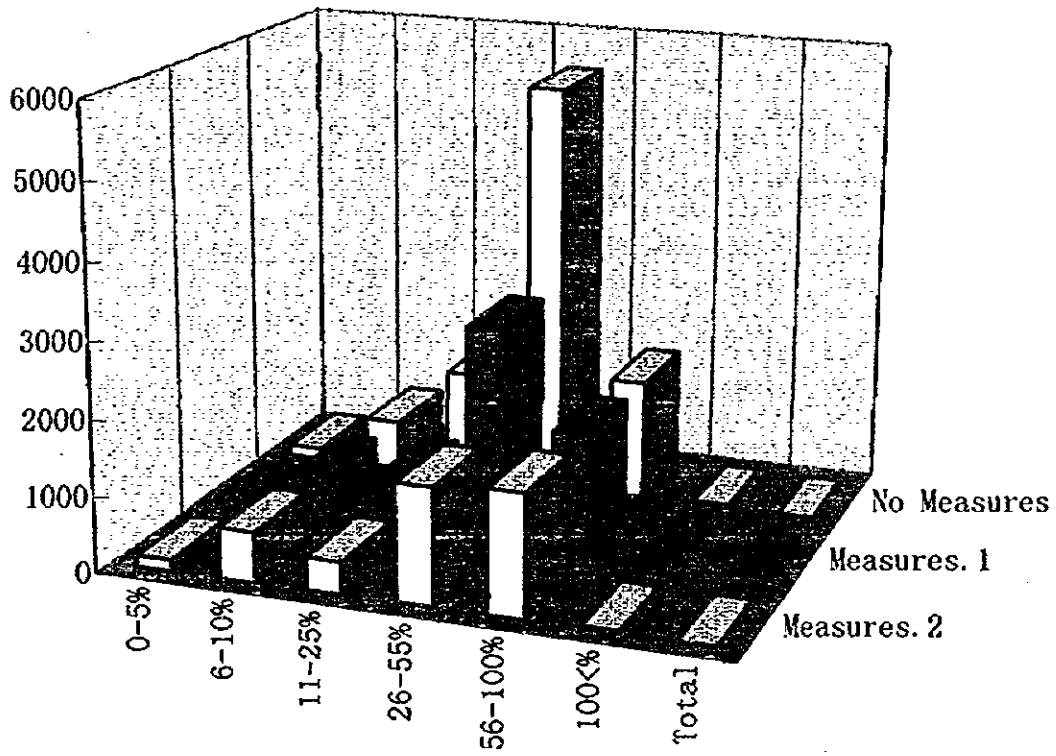


Fig. 5. 1. 4. 2
Amount of Presumed Soil Conservation Measures except Ilopango Lake

For the planting of fruit trees, demonstration activities are considered important and materials, equipment and tree saplings should be provided instead of money.

The importance of having farmers independently conduct soil conservation measures is quite acknowledged and so is the significance of incentives to encourage the farmers to do so. Nonetheless, the effects of incentives applied in the past have never been evaluated.

(5) Sediment Control Dam (Sabo Dam) Plan

1) Basic Policy of the Sabo Plan

This plan shall be formulated for rivers with significant sediment discharge, and in accordance with river gradient. The gradient of the river is divided into over 1/30, 1/30 - 1/60, and less than 1/60.

a. River channel cross section on a river bed gradient of over 1/30

A sabo dam shall be constructed on the area where the riverbed gradient becomes shallower than 1/30. The river channel on the river bed gradient of over 1/30 is a mudflow section. Sediment transported to this section in the form of mudflow when flooding occurs may cause rapid sediment runoff and river channel erosion.

Therefore, the construction of a sabo dam is important for the regulation of rapid sediment runoff and the stabilization of the river bed, river channel and the river bank.

b. Section where the river bed gradient ranges from 1/30-1/60

A sabo dam shall be constructed in this section to regulate sediment flow and stabilize the river bed. This section is shaped like a water pipe and is where sediments are transported to.

The construction of a sabo dam shall stabilize the river bed and prevent it from further decline. It shall also block the discharge of sediment downstream, regulate sediment flow during floods, and prevent sediment runoff to the downstream river channel.

c. River channel in the shallow area where the river bed gradient is below 1/60

Because the river channel meanders in this section, there is no place suitable for the construction of the dam. Accordingly, multiple consolidation works shall be established in this area to control river flow and erosion.

d. Others

Revetment works shall be conducted in areas where the meander is quite predominant, for erosion control.

2) Sabo Plan

The construction of a sabo dam is planned for the basins of the Sepaquiapa and Tilapa rivers, where the sediment runoff volume is estimated to be large. The layouts of the sabo dam and the check dam are shown in Figure 5.1.4.3. The dam shall be 3m tall and

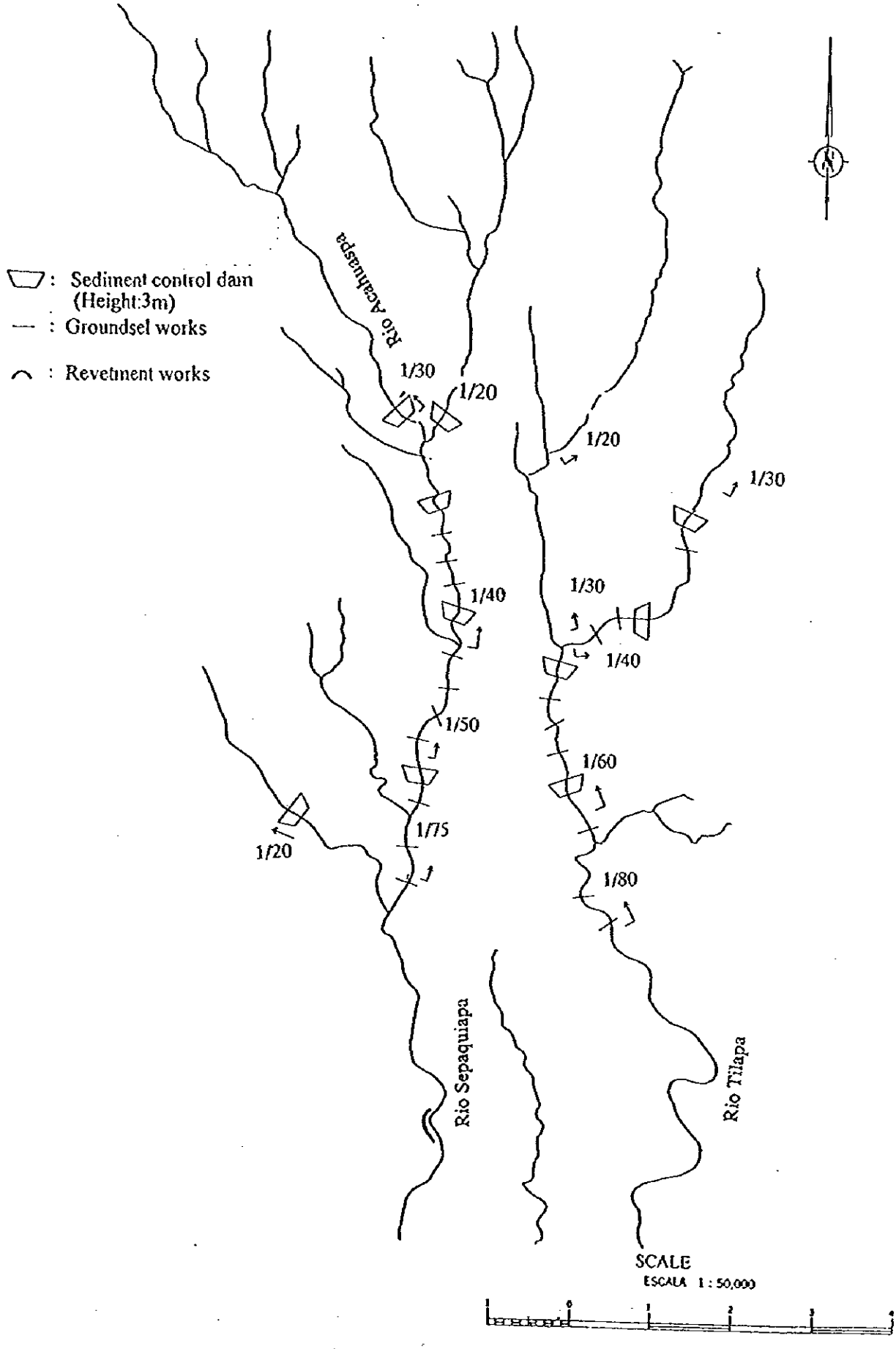


Figure 5.1.4.3 Location of Sediment Control Plan
(Upstream part of the Sepaquiapa and Tilapa Rivers)

constructed in 11 places; the embankment shall be about 5 m.

5.1.5 Integrated Water Management Plan

(1) Basic Policy

The integrated water management plan is as follows:

1) Design Target Year

The design target year shall be 2010 based on the importance of this project to the government's national development plan and to relevant existing projects.

2) Design Scale

The scale of the project shall be determined based on actual disasters. The scale of the project shall depend on the following objectives:

- To reinforce the National Emergency Committee so it can understand how disaster (flood) prevention and water resources (amount and quality) are managed in the Jiboa River basin, by improving meteorological and hydrological observation facilities and equipment.
- To especially reinforce the Ilopango meteorological observation station in the Ilopango airport who is centrally responsible of warning the nation of forthcoming weather related disasters.
- To reinforce groundwater monitoring activities in addition to surface water (conduct groundwater survey and conservation).

3) Basic Policy of the Integrated Water Management Plan

The integrated water management plan shall be formulated with due consideration of the following:

- Suitability to the current conditions in the Study Area

  In view of future conditions in the Study Area, the flood control plan, water resource development plan, and water quality conservation plan should be able to indicate the river management objectives through the facilities and countermeasures they adopt. However, it is basically important that the water management plan aims to properly manage current river water conditions.

- A long term and extensive plan

  River water is significantly influenced by discharges in the basin. Therefore, a plan that can cope with the changes in the basin area should be formulated. This plan should also take into consideration future conditions in the basin and must be in harmony with relevant basin policies.

The basic components of the integrated water management plan are as follows:

- To establish a river water and rainfall monitoring system that would provide information to the National Emergency Committee (COEN) in periods of drought and flood, monitor rainfall volume, water table, and river discharge, and estimate water volume.
- To formulate a data base for the maintenance of data on land use condition in the basin, population, conditions of water intake and drainage facilities, flood control plan, water resource development plan, water quality conservation plans, and parameters for river water management.
- To establish an organization and operation system for the systematic and daily conduct of water management based on the above items.

(2) Formulation of Integrated Water Management Plan

The basic principles for the management of the rainfall and river water monitoring system – the rainfall and river water information center – shall be studied, as well as the organization and the system relevant to the operation of the center. The results of these studies shall be used for the formulation of the integrated water management plan which shall focus on flood control.

1) River Water and Rain Water Monitoring System

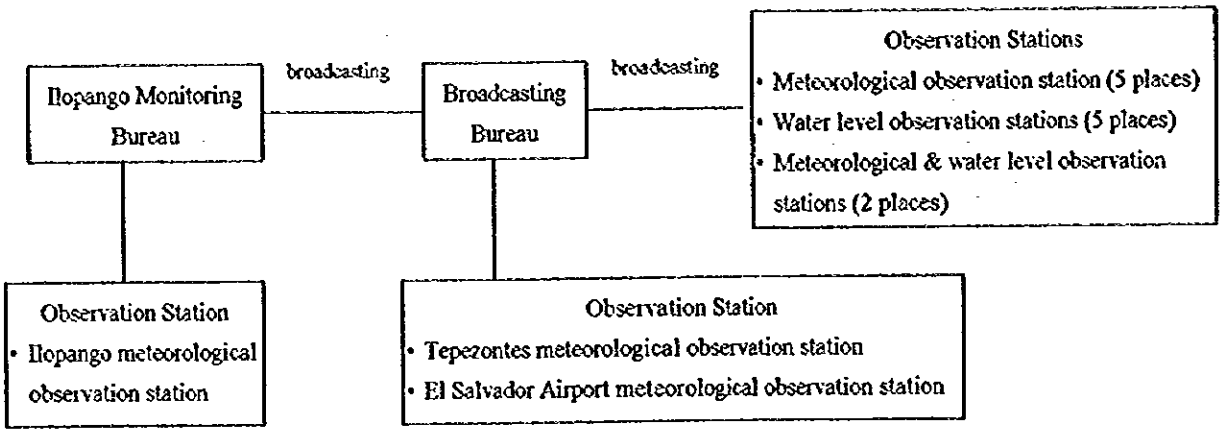
A monitoring system that shall act as an information center is indispensable to the integrated management of river water. The following points were given consideration in the formulation of the monitoring system:

- A system that can efficiently operate and manage current flood control and water-use facilities.
- A system that can function as an information center for the establishment of a flood alarm system and an evacuation area.
- A system in correlation with the flood control plan, the water resource plan, and the water quality conservation measures.
- A system that is in correlation with policies and strategies recommended for water resources development and water quality control measures.
- A system that would promote the effective use of existing facilities.

The proposed monitoring system shall constitute a monitoring network, information center and a water quality analysis center.

(a) Monitoring network

Meteorological and Hydrological Monitoring System



①	Monitoring bureau	1 place
②	Meteorological sub-station within the monitoring bureau	1 place
③	Meteorological sub-stations	5 places
④	Water level observation sub-stations	5 places
⑤	Meteorological and water level observation sub-stations	2 places
⑥	Meteorological broadcasting bureau	1 place

a) Meteorological & Rainfall Observation Stations

Meteorological & Rainfall Observation Stations

Number	Observation Station	Conditions
1	Ilopango Airport Meteorological Station	renewal of observation equipment
2	Buena Vista Rainfall Observation Station	to be constructed
3	Cojutepeque Meteorological Station	renewal of observation equipment
4	Santo Domingo Rainfall Observation Station	to be constructed
5	San Ramon Meteorological Station	to be constructed
6	El Salvador Airport Meteorological Station	existing
7	San Miguel Tepezontes Rainfall Observation Station	to be constructed
8	San Pedro Rainfall Observation Station	to be constructed
9	Montecristo Meteorological Station	to be constructed
10	El Salvador Meteorological Station	existing
11	Olocuilta Rainfall Observation Station	to be constructed
11		

b) Water Level & Runoff Observation Stations

Water Level & Runoff Observation Stations

Number	Observation Station	Conditions
1	Apuro Observation Station	repair of existing and installation of new equipment
2	San Ramon Observation Station	to be constructed
3	Montecristo Observation Station	installation of new equipment
4	Rio Tilapa Observation Station	to be constructed
5	Rio Sepaquiapa Observation Station	to be constructed
6	Rio El Pedregal Observation Station	to be constructed
7	Rio El Desague Observation Station	to be constructed
7		

c) Groundwater Level Observation Stations (see Figure 3.1.1.14)

(b) Monitoring Network Operation & Maintenance System

The meteorology and hydrology division of the DGRNR, MAG, is made up of three sections. The meteorology section operates, maintains and monitors the activities of meteorological observation stations, and supervises the national headquarters for meteorological observations, The hydrological section operates, maintains and monitors water level and flow observation stations, as well as supervises groundwater surveys. The machinery maintenance section is in charge of the installation and repair of the equipment of the meteorological and hydrological stations.

The proposed operation and maintenance system for the monitoring network is as follows:

a) Installation of an Information Center

To fully grasp the rainfall and runoff patterns observed by the monitoring network, a Jiboa information center shall be established within the national meteorological information monitoring headquarters within the Ilopango airport. By the timely relay of information from all the proposed observation stations, this information center shall forecast flooding and other weather conditions, as well as data relevant to river management. The national meteorological information monitoring headquarters is currently operating 24 hours a day. Assigning two if its monitoring experts to the information center would grant the center fully operative.

However, because the center is not fully coordinated, it shall require the assistance of the hydrological section. The center shall require the following equipment:

- personal computer and printer for data input, processing & monitoring 3
- copy machine 1

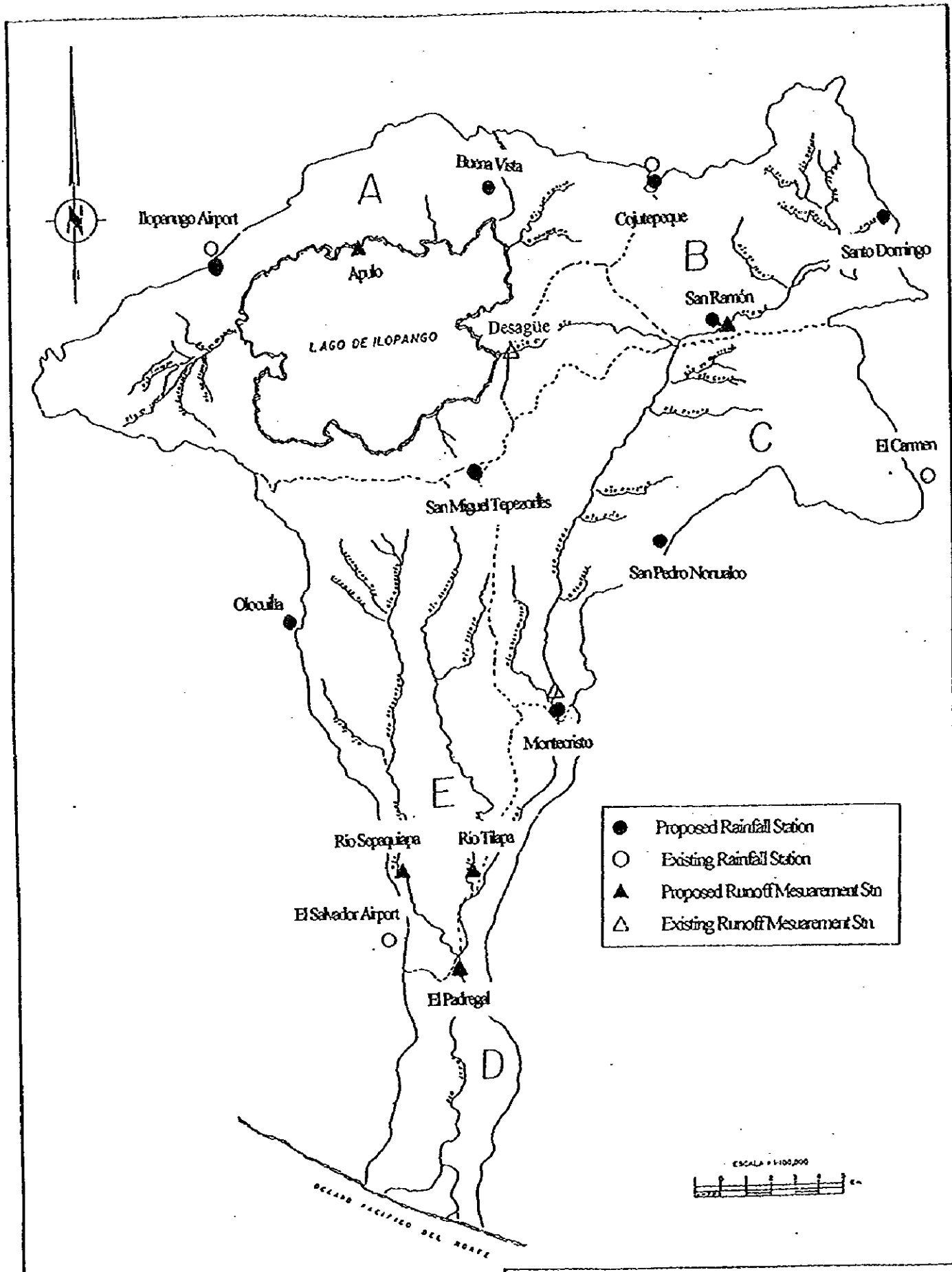


Figure 5.1.5.1

Monitoring System of River Water and Rain Water

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON (JICA)

- fax machine 1
- communications equipment (telephone or wireless radio) 2 lines
- air conditioner, office supplies 1 set

b) Operation & Maintenance of Observation Station (Personnel)

The meteorological and hydrological sections should respectively train their personnel (staff assigned at the Ilopango observation station shall be reduced) in the proper repair and maintenance of new equipment to fully enable the conduct of regular inspections of the meteorological and rainfall observation stations and the water level and flow observation stations.

The meteorological and hydrological sections shall assign staff to the information center for the commpilation and analysis of data. With the provision of a personal computer, the conduct of the works in the information center shall be efficiently carried out. Conclusively, this will serve a s a model to the conduct of meteorological and hydrological monitoring works nationwide.

c) Water Quality Analaysis System & Improvement

There is a need to extensively and continuously monitor the water quality of rivers, lakes, ponds, and groundwater in the Jiboa River basin in the future. In addition, effluent analysis should be further developed to effectively monitor pollutant sources, such as factories. With these as a premise, the present MAG water quality analysis laboratory shall be reinforced by the installation of relevant equipment and the employment and training of personnel. The renovation of the laboratory shall be completed by 1999 with BID financing.

5.2 Agricultural Development Plan

5.2.1 Farm Management Plan

(1) Land Use

1) Farmers

The farmers in the study area are classified as ① land owners, ② tenant farmers, ③ agricultural cooperative members, ④ farm laborers, ⑤ housewives and children. Keeping in mind the need to preserve the agricultural lands in the Study Area, the land use plan and farm management plan shall have the land owner as their focal point. The land owners to benefit from these plans are : ① owners of land measuring 1 - 15 Mz, ② land owners with numerous tenant farmers, ③ land owners cultivating crops different from its tenant farmers, and ④ land owners that can specify the crops the tenant farmers should cultivate and the

kind of land management method the tenant farmers should adopt.

2) Land Use Plan

a) Land Use Planning Policy

The lands in the Study Area are either cultivated lands, forests, pasture, constructed with facilities, or covered with lakes and rivers. The population in the area is forecast to increase from 32.4 million to 41 million in the year 2010. This 27% (8.8 million) increase is considered to result in demands for housing and industrial developments. Block A is considered to consist of areas estimated to have significant increase in population, followed by blocks B and C, respectively. Blocks A and D are considered to make up areas forecast to undergo industrial development; facilities are forecast to cover an additional 6 km^2 in these areas, about 1% of the entire Study Area coverage. The vacant lot within the former residential area and the sloping cultivated area (10% gradient) within the vicinity shall be used for housing and factory developments. This plan shall make sure that deforestation is stopped.

With the exclusion of those in D block, grasslands shall be transformed into forests with the planting of fruit trees. This would, however, exclude tame pastures which are estimated to make up 10% of the grassland. The conversion of grasslands in D block, which are mainly made up of sandy soil, to tame pasture shall be considered after flood control measures are implemented. There are no grasslands in areas cultivated by agricultural cooperatives mainly due to the absence of floodplains.

The soil in the Study Area is very permeable because it is mainly made up of sediments from the eruption of the volcano in Ilopango. Gully erosion hardly occurs, but surface erosions are rampant due to unstoppable rain water infiltration. Cultivation methods that would control this type of erosion are, therefore, necessary. The cultivation of pineapple and vetiver grass should be considered in the sloping areas.

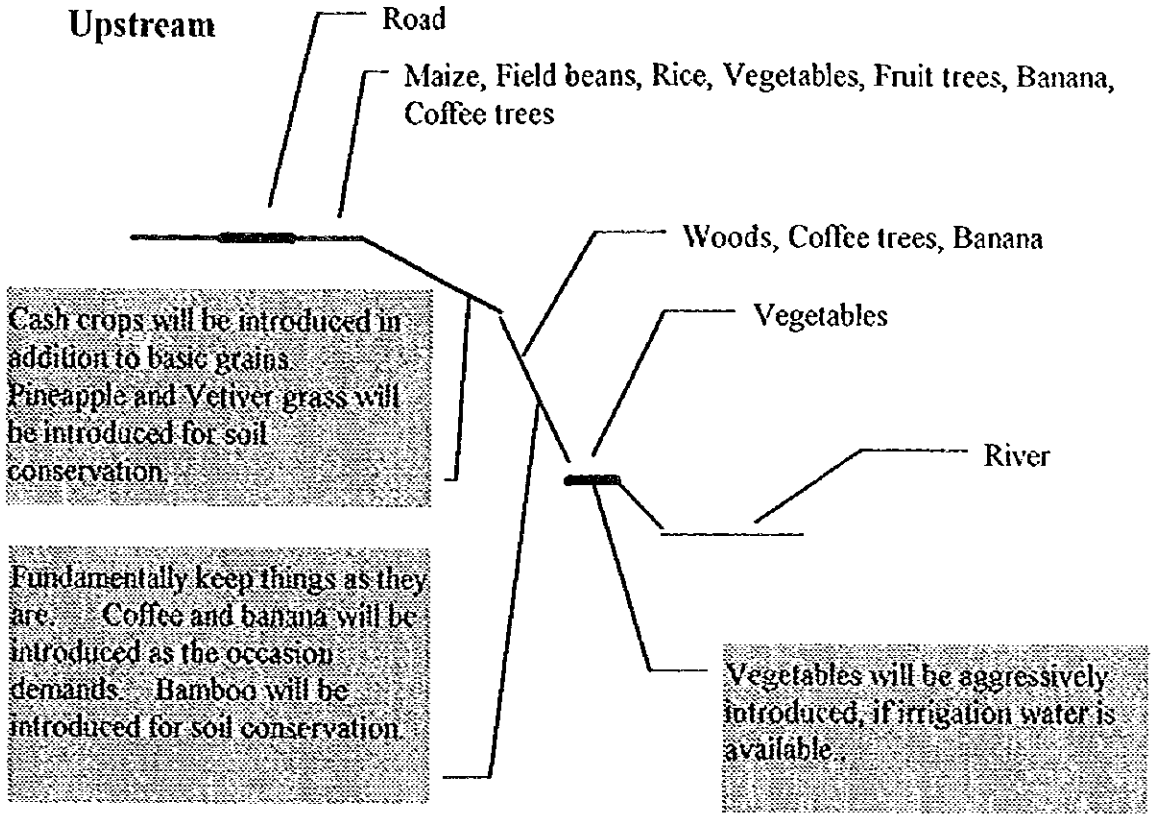
Figure 5.2.1.1 shows the land use policy to be adopted in the upstream and middle basin areas. Table 5.2.1.1 shows the land use plan for the entire Study Area.

The rainy season cultivation of rice shall be introduced downstream (approximately within 100m elevation). In lands that can be irrigated, the dry season planting of the staple food maize and rice shall be introduced.

(2) Farm Management Planning

1) Farm Management Planning Policy

It would be difficult to compete with the cheap agricultural imports by proposing the cultivation of low-priced crops in small scale fields. Instead, it would be more appropriate to work on improving the quality of cultivated crops, and the production of special quality products. Exotic crops cultivated in the study area are summarized below.



Middle Basin Area (altitude from river - about 400 m above sea level)

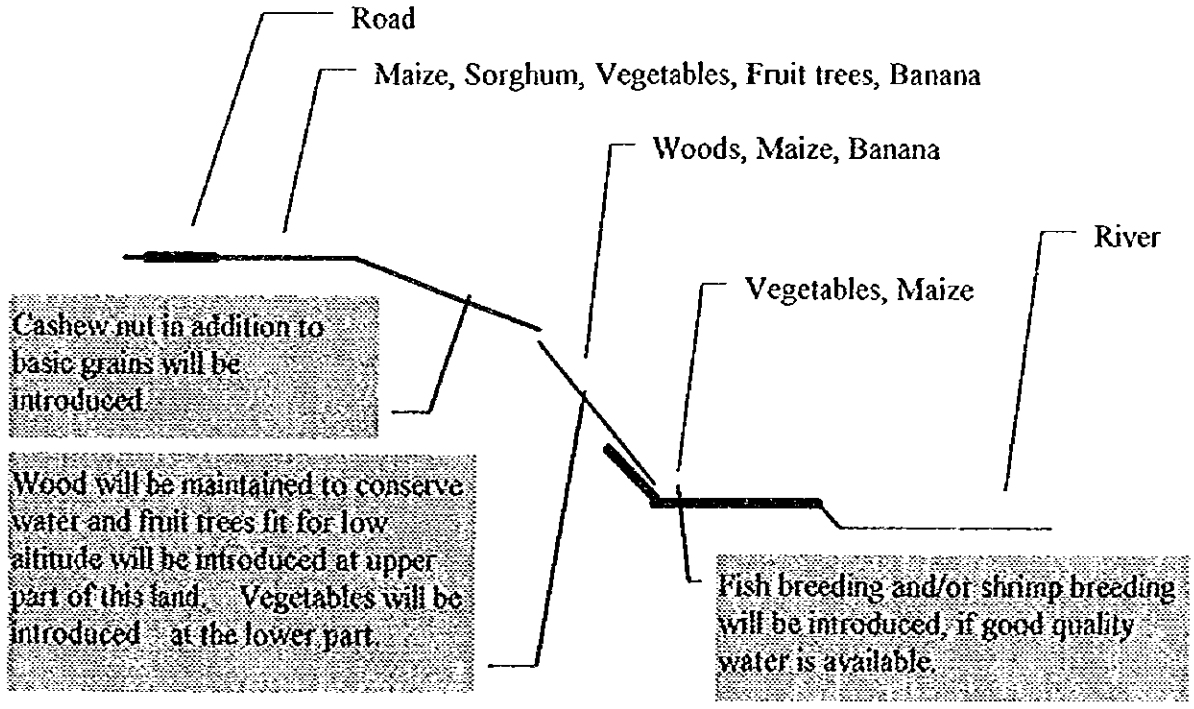


Figure5.2.1.1 Outline of Land Use Plan at Upstream & Middle Basin Area

Table 5.2.1.1 Land use plan

Land use	Blaock											
	A		B		C		D		E		Total area	
	Present	Plan	Present	Plan	Present	Plan	Present	Plan	Present	Plan	Present	Plan
	Area (km^2)											
Cultivated land	44.51	40.78	29.44	28.84	54.78	54.36	29.95	29.60	56.54	55.68	215.23	209.28
Grass land	5.33	0.53	6.30	0.63	8.60	0.86	18.23	18.23	13.15	1.31	51.61	5.16
Forest land	57.08	57.08	26.23	26.23	33.16	33.16	5.30	5.30	33.14	33.14	154.91	154.91
Fruit trees	17.17	21.97	5.86	11.53	13.77	21.51	0.47	0.47	9.80	21.63	47.08	93.53
Coffee tree	14.83	14.83	4.00	4.00	18.41	18.41	0.06	0.06	2.85	2.85	40.15	40.15
Urban area	13.63	17.36	2.67	3.27	1.51	1.93	1.28	1.63	3.15	4.01	22.23	28.18
Lakes, marshes and rivers	71.19	71.19	0.06	0.06	0.87	0.87	1.57	1.57	0.67	0.67	74.36	74.36
Total	223.73	223.73	74.56	74.56	131.10	131.10	56.86	56.86	119.31	119.31	605.57	605.57
	Ratio (%)											
Cultivated land	19.9	18.2	39.5	38.7	41.8	41.5	52.7	52.1	47.4	46.7	35.5	34.6
Grass land	2.4	0.2	8.4	0.8	6.6	0.7	32.1	32.1	11.0	1.1	8.5	0.9
Forest land	25.5	25.5	35.2	35.2	25.3	25.3	9.3	9.3	27.8	27.8	25.6	25.6
Fruit trees	7.7	9.8	7.9	15.5	10.5	16.4	0.8	0.8	8.2	18.1	7.8	15.4
Coffee tree	6.6	6.6	5.4	5.4	14.0	14.0	0.1	0.1	2.4	2.4	6.6	6.6
Urban area	6.1	7.8	3.6	4.4	1.2	1.5	2.2	2.9	2.6	3.4	3.7	4.7
Lakes, marshes and rivers	31.8	31.8	0.1	0.1	0.7	0.7	2.8	2.8	0.6	0.6	12.3	12.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: CNES, 1996.01.15, Spot Image, field survey by JICA Study Team (1996)

Table 5.2.1.2 Amount of fertilizer applied and effect of increase of fertilizer application to yield increase

	N %	Maize (sloped land)			Maize (plain)			Rice (sloped land)		
		qq/Mz.	N kg/ha	kg/ha ¢/qq	qq/Mz.	N kg/ha	kg/ha ¢/qq	qq/Mz.	N kg/ha	kg/ha ¢/qq
Present										
Fertilizer										
Compound fertilizer (16-20-0)	16	2.20	22.9		2.20	22.9		4.4	45.8	
Ammonium sulfate	21	2.20	30.1		1.10	15.0		2.2	30.1	
Urea	46	-	-		0.75	22.5		-	-	
Total			53.0			60.4			75.9	
Yield		25		1,627	45		2,929	45		2,929
Cost per unit yield				66			60			71
Plan										
Fertilizer										
Compound fertilizer (16-20-0)	16	2.20	22.9		2.20	22.9		4.4	45.8	
Ammonium sulfate	21	1.00	13.7		3.30	45.1		2.2	30.1	
Urea	46	1.50	44.9		2.25	67.4		1.5	44.9	
Total			81.5			135.4			120.8	
Yield		35		2,278	60		3,905	55		3,579
Cost per unit yield				54			54			64

Source: Each agricultural extension office in the Study Area and interview survey by JICA Study Team (1996)

Table 5.2.1.3 Years, cost and income to start harvest and constant yield of permanent crops

Crops	Harvesting period	Grafting	Renovation	To start harvesting		To constant yield		
			years	Years	Cost (¢)	Years	Cost	Income (¢)
Avocado	March - May	Yes	25	5	10,823	7	17,573	24,960
Coffee	October - January	Yes	30-40	3	16,581	6	39,711	15,400
Mango	April - July	Yes	40-50	5	6,498	8	13,028	37,000
Cashew	March - May	No	20	3	3,205	6	7,741	19,500
Orange	November - April	Yes	25	3	12,645	5	15,635	18,816

Source: Each agricultural extension office in the Study Area and interview survey by JICA Study Team (1996)

Table 5.2.1.4 Production Cost (Plan)

Crops	Agricultural materials	Plowing	Labor cost	Subtotal	Management fee (3 %)	Reserve fund (5 %)	Interest (20 %)	Total	Yield / Mz.	Unit	Unit price (¢)	Income (¢)	Benefit (¢)	Cost per yield (¢)
Basic grains														
1 Maize (slope, intercropping)	785	0	1,120	1,905	57	98	412	2,472	35	qq	75	2,625	153	71
2 Maize (plain, monoculture)	1,521	200	775	2,496	75	129	540	3,240	60	qq	75	4,500	1,260	54
3 Field beans (slope, intercropping)	647	0	450	1,097	33	56	237	1,423	12	qq	270	3,240	1,817	119
4 Sorghum (slope, intercropping)	30	0	570	830	25	43	180	1,077	25	qq	60	1,500	423	43
5 Rice (slope, monoculture)	1,650	150	929	2,729	82	141	590	3,542	55	qq	85	4,675	1,133	64
Industrial crop														
1 Sesame	575	620	1,080	2,275	68	117	369	2,829	10	qq	300	3,000	171	283
2 Coffee	2,153	0	2,770	4,923	148	254	1,065	6,388	12	qq	700	8,400	2,012	532
3 Sugar cane (seedling)	1,215	695	850	2,760	83	142	597	3,582	85	TC	125	10,625	7,043	42
4 Sugar cane (ratoon)	855	0	700	1,555	47	80	336	2,018	75	TC	125	9,375	7,357	27
Vegetables														
1 Green pepper	2,820	200	2,250	5,270	158	271	1,140	6,839	1,000	100 ea.	60	60,000	53,161	34
2 Corn on the cob (with irrigation)	1,314	350	500	2,164	65	111	468	2,808	150	100 ea.	40	6,000	3,192	19
3 Guisquil (bamboo, with irrigation, 1st year)	7,796	1,895	700	10,391	312	535	2,248	10,391	1,400	100 ea.	30	42,000	28,515	10
4 Guisquil (bamboo, with irrigation, 2nd year)	4,376	0	875	5,251	158	270	1,136	6,815	1,400	100 ea.	30	42,000	35,185	5
5 Guisquil (bamboo, without irrigation, 1st year)	7,656	1,895	875	10,426	313	537	2,255	13,531	800	100 ea.	30	24,000	10,469	17
6 Guisquil (bamboo, without irrigation, 2nd year	4,376	0	875	5,251	158	270	1,136	6,815	800	100 ea.	30	24,000	17,185	9
7 Loroco (bamboo, with irrigation, 1st year)	7,905	1,975	9,350	19,230	577	990	4,159	19,230	14	qq	2,000	28,800	3,843	1,733
8 Loroco (bamboo, with irrigation, 2nd year)	3,900	0	9,275	13,175	395	679	2,850	17,099	14	qq	2,000	28,800	11,701	1,187
9 Loroco (bamboo, without irrigation, 1st year)	7,905	1,975	5,550	15,430	463	795	3,338	20,025	8	qq	2,000	16,000	-4,025	2,503
10 Loroco (bamboo, without irrigation, 2nd year)	3,900	0	5,475	9,375	281	483	2,028	12,167	8	qq	2,000	16,000	3,833	1,521
11 Pipian	2,994	650	1,800	5,444	163	280	1,178	7,065	200	qq	60	12,000	4,935	35
12 Tomato (with irrigation)	2,208	200	3,755	6,163	185	317	1,333	7,998	400	qq	60	24,000	16,002	40
13 Tomato (without irrigation)	2,290	200	4,235	6,725	202	346	1,455	8,728	600	qq	60	36,000	27,272	44
Fruit trees														
1 Avocado	1,405	0	775	2,180	65	112	471	2,829	12,480	ea.	1	12,480	9,651	0
2 Mango	1,461	0	1,050	2,511	75	129	543	3,259	470	100 ea.	50	23,500	20,241	7
3 Cashew	775	0	1,025	1,800	54	93	389	2,336	23	qq	1,500	34,500	32,164	102
4 Passion fruit (1st year)	11,139	1,495	3,410	16,044	481	826	3,470	20,822	384	qq	50	19,200	-1,622	54
5 Passion fruit (2nd year)	1,740	0	2,010	3,750	113	193	811	4,867	384	qq	50	19,200	14,333	13
6 Orange	1,530	0	1,845	3,375	101	174	730	4,380	350	100 ea.	40	14,000	9,620	13
7 Pineapple (1st year)	4,950	320	970	5,920	178	305	1,280	7,683	-	-	-	-	-	-
8 Pineapple (2nd year)	1,260	0	1,250	8,430	253	434	1,823	10,940	12,000	ea.	2	24,000	5,377	1
9 Plantain (1st year)	7,204	850	600	8,654	260	446	1,872	10,526	-	-	-	-	-	-
10 Plantain (2nd year)	3,164	0	1,150	12,968	389	668	2,805	15,773	700	100 ea.	35	24,500	8,727	23
11 Watermelon	2,840	600	1,825	5,265	158	271	1,139	6,833	70	100 ea.	250	17,500	10,667	98

Source: Each agricultural extension office in the Study Area and interview survey by JICA Study Team (1996)
qq: quintal = 100 lb = 45.36 kg
TC: short ton = 907.2 kg

Table 5.2.1.5 Farming plan according to block

Items	Crops	Block				
		A	B	C	D	E
				Area (Mz.)		
Possession area		2.74	3.42	4.14	2.05	2.93
	Woods land	0.11	0.28	0.26	-	0.16
	Glass land	0.01	0.03	0.03	-	0.03
	Cultivated land	2.11	2.78	3.04	2.05	2.64
Cultivated area		3.71	4.16	5.26	2.09	4.42
Cropping intensity		1.76	1.49	1.73	1.02	1.67
				Planted area (Mz.)		
Basic grains						
	Maize	1.17	1.47	1.33	1.35	1.97
	Sorghum	0.78	0.66	0.50	0.16	0.51
	Field beans	0.22	0.13	0.67	-	0.88
	Rice	0.02	0.03	0.22	-	0.05
	Subtotal	2.18	2.29	2.71	1.51	3.42
Cash crops						
	Sesame	-	-	0.02	0.53	0.04
	Sugar cane	0.00	0.44	0.65	-	-
	Coffee	0.51	0.33	0.81	-	0.09
	Subtotal	0.51	0.76	1.47	0.53	0.13
Vegetables						
	Green pepper	0.01	-	-	-	-
	Guisquil	0.06	0.15	0.03	-	0.06
	Loroco	0.02	0.06	0.03	-	0.06
	Pipian	0.02	0.09	0.09	-	-
	Watermelon	-	-	-	0.06	-
	Subtotal	0.12	0.29	0.07	0.06	0.12
Fruit trees						
	Avocado	0.18	0.16	0.10	-	0.07
	Mango	0.14	0.12	0.10	-	0.22
	Cashew	0.00	0.00	0.20	-	0.30
	Orange	0.55	0.49	0.30	-	0.11
	Pineapple	0.05	0.04	0.30	-	0.04
	Subtotal	0.91	0.81	1.01	0.00	0.75
				Cultivation ratio (%)		
Basic grains						
	Maize	31.4	35.4	25.3	64.6	44.7
	Sorghum	21.1	15.8	9.5	7.6	11.6
	Field beans	5.8	3.2	12.6	-	19.9
	Rice	0.4	0.7	4.1	-	1.2
	Subtotal	58.7	55.0	51.5	72.2	77.4
Cash crops						
	Sesame	-	-	0.3	25.2	0.8
	Sugar cane	-	10.5	12.3	-	0.0
	Coffee	13.6	7.9	15.4	-	2.1
	Subtotal	13.6	18.4	28.0	25.2	2.9
Vegetables						
	Green pepper	0.3	-	-	-	-
	Guisquil	1.6	3.5	0.6	-	1.4
	Loroco	0.6	1.4	0.6	-	1.4
	Pipian	0.6	2.1	0.0	-	-
	Watermelon	0.0	0.0	0.0	2.7	-
	Subtotal	3.1	7.0	1.3	2.7	2.8
Fruit trees						
	Avocado	4.9	3.9	1.9	-	1.7
	Mango	3.7	2.9	1.9	-	5.1
	Cashew	-	-	3.8	-	6.8
	Orange	14.7	11.7	5.8	-	2.5
	Pineapple	1.2	1.0	5.8	-	0.8
	Subtotal	24.5	19.5	19.2	0.0	16.9

Source: Each agricultural extension office in the Study Area and interview survey by JICA Study Team (1996)

Table 5.2.1.6 Increased agricultural income plan of farmer according to block (¢)

Crops		Block				
		A	B	C	D	E
Basic grains						
	Maize	179	226	204	1,701	303
	Sorghum	331	277	211	67	216
	Field beans	393	238	1,209	-	1,601
	Rice	19	33	245	-	60
	Subtotal	922	774	1,868	1,768	2,180
Cash crops						
	Sesame	0	0	3	90	6
	Sugar cane	1,017	659	1,629	-	188
	Coffee	0	3,217	4,771	-	-
	Subtotal	1,017	3,876	6,403	90	194
Vegetables						
	Green pepper	619	0	0	-	-
	Guisquil	1,001	2,505	572	-	1,060
	Loroco	89	223	127	-	236
	Pipían	115	432	0	-	-
	Watermelon	-	-	-	596	-
	Subtotal	1,825	3,160	699	596	1,297
Fruit trees						
	Avocado	1,755	1,568	976	-	722
	Mango	2,761	2,466	2,046	-	4,544
	Cashew	-	-	6,502	-	9,628
	Orange	5,249	4,689	2,917	-	1,080
	Pineapple	244	218	1,630	-	201
	Subtotal	10,009	8,942	14,072	-	16,176
Total		13,773	16,751	23,042	2,455	19,848

Source: Each agricultural extension office in the Study Area and interview survey by JICA Study Team (1996)

- Field beans are native to Guadalupe and are famous for their superb quality, e.g. softens immediately even when boiled for just a short period. However, they are priced less than they should be because of discoloration resulting from mishandling of the seeds during planting.

- The Cojutepeque vicinity, especially Candelaria, is famous for the production of citrus fruits. Because this product is a native to the area, most of the trees are old. Some of the producers conduct grafting to produce good tasting oranges, and prolong the shipment term for the planting of varieties with different maturing periods. Grafting should be aggressively introduced to the farmers in the study area.

- The slope area (less than 350m in elevation) extending from Rosario de la Paz up to the San Pedro Nomualco vicinity is suited to the cultivation of cashew nuts. Juices and jams can also be manufactured from the fruit of the cashew nuts: this would require a fruit volume of 5 - 10 times more than the nut volume. Therefore, the manufacture of jams and juices using the fruit of this nut should consider the production volume in neighboring producing regions.

The yield of the staple food maize and field beans shall be increased by improving cultivation methods.

Generally, the soil in the Study Aea is considered to be very permeable. Gully erosions are not expected to occur in the Study Area. It is, however, important to determine the cultivation method suitable to the characteristics of the soil to control surface erosion. To control the velocity of surface water flow, the installation of trenches along with contour cropping and pineapple and vetiver grass cultivation are the measures considered for the Study Area; these measures also allow surface water to permeate the soil and act as a soil moisture nutrient.

2) Agricultural Production Cost

a) Need to Increase the Nitrogen Fertiliser Volume for Maize and Rice

Increasing the nitrogen fertiliser application volume for maize shall not only increase maize yield but the yield of field beans and sorghum cropped during the interval as well. This would also decrease the production cost per unit yield (see Table 5.2.1.2).

b) Introduction of New Varieties

The introduction of new varieties requires new investment. In particular, the cultivation of perennial crops like fruit trees cost a lot of money until they are ready for harvest. Table 5.2.1.3 shows when harvest starts and the number of years it takes for the harvest of perennial crops to stabilize, the cost and the revenues until harvest stabilizes. It takes 3 to 5 years before perennial crops can be harvested, and 5 to 8 years for harvest to stabilize. Once harvest becomes stable, this pattern could continue for 20 to 50 years. It would be

difficult to actively promote the cultivation of this crop even if the majority of the farmers can obtain agricultural loans from the bank, especially so if the loan payment term is limited to 1 year. Therefore, the small scale and short term cultivation of this crop was proposed.

Table 5.2.1.4 shows the production cost of and profit from crops that may be introduced in the farm management plan. The present yield and price of the crops, with the exclusion of grains and oranges, were used in this study, in consideration of the fact that the farmers who have undergone the extension and training program have used standard cultivation methods to grow these crops.

3) Agricultural Revenues of the Average Number of Owner Farmers in Every Block

Table 5.2.1.5 shows the farm management conditions in the Study Area. Although each crop shall only be cultivated in a small area, the collective conduct of farming and shipment work shall prevent the concentration of field laborers at one place and contribute to the collection of the volume required for shipment.

Table 5.2.1.6 shows the revenues of the average number of owner farmers by block. The table below shows the agricultural revenues before and after the plan is executed.

Agricultural Revenue Per Average Number of Farmers • Increase in Revenue

Classification	*Block*				
	A	*B*	*C*	*D*	*E*
Revenue before the Implementation of the Plan	3,760	6,136	8,909	1,962	2,552
Revenue after the Implementation of the Plan	13,773	16,751	23,042	2,455	19,848
Increase in Revenue	10,013	10,615	14,133	493	17,296

D block is estimated to acquire an increase of 500 colones, while 10,000 to 17,000 colones can be expected from other blocks.

4) Supply and Demand for Basic Cereals in the Study Area

The supply and demand conditions for maize and field beans in 2010 in the Study Area were calculated and shown below.