CHAPTER 5

DEVELOPMENT PLAN

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5.1 LAND USE PLAN

This development plan consists of achieving sustainable agricultural development for the small and medium-scale farmers through the improvement of the four basic components (Irrigation/Drainage, Flood Protection, Nature Conservation and Farmer Support/Reinforcement) and its results. The specified target of the plan is set as "improvement of farming and partial achievement of diverse/intensive agriculture of the small and medium-scale farmers at the point of 10 years after the construction of the main irrigation facilities are completed (13 years after leadoff)". The subject areas of the plan, counting up to 1,3000 ha (in the Study Area: 35,000 ha), are the fields owned by small and medium-scale farmers on the right bank of Tempisque River cultivated without irrigation.

5.1.1 Zoning of the current land use

The Study Area was categorized into the following three zones according to their features of land classification, soil and topography (refer to Fig.4.1).

(1) The zone where large efficiency of irrigation cannot be expected (Zone A)

Subject blocks: No. 4, 6, 8, 10, and 13
Land classification: Class IV
Prevailing soil order: Inceptisol and Altisol, with low agricultural productivity
Topography: The area is located on the western foot of the mountains, undulate and abundant of slopes
Potential of Water Source: Groundwater: Low
Tempisque river : Transferring the water is not possible

Current land use (ha):

Pasture	Sugar cane	Rice	Melon	Mango	Vegetables	Others*	Total
4,935	720	125	0	10	70	280	6,140

Note)* others: maize (200ha) and beans (80ha)

(2) The zone where efficiency of irrigation can be expected but has difficulty in supplying water by pumping (Zone B)

Subject blocks: No. 1, 2, and 3
Land classification: Class II (partly class III)
Prevailing soil order: Vertisol and Mollisol, with high agricultural productivity
Topography: The area is located in the low flatlands on the upstream edge of the Study Area. Relatively flat but is distributed as enclaves.
Potential of Water Source: Groundwater: High
Tempisque river : Transferring the water is not possible

Current land use (ha):

Pasture	Sugar cane	Rice	Melon	Mango	Vegetables	Others	Total
450	320	410	0	30	0	0	1,210

(3) The zone where efficiency of irrigation and easy of supplying water (Zone C)

Subject blocks: No. 5, 7, 9, 11, and 12
Land classification: Class II
Prevailing soil order: Vertisol and Mollisol, with high agricultural productivity
Topography: The area is located in the low flatlands of the midstream. Flat and forms a relatively wide area.
Potential of Water Source: Groundwater: High
Tempisque river : Transferring the water is possible

Current land use (ha):

Pasture	Sugar cane	Rice	Melon	Mango	Vegetables	Others	Total
1,490	2,845	1,010	0	0	85	0	5,430

5.1.2 Study of crops to be introduced to the respective zones

The directionalities of development were studied for each crop as follows.

(1) Pasture

Cattle raising is an important industry to Tempisque, necessary of improving productivity. However, the pasture of small and medium-scale farmers are low in productivity, and when conditions are profitable, shall be converted to crops of high cash ability. In cases where irrigation is introduced to the fields with suitable topographical and soil conditions, conversion to crops such as vegetables are considerable. On the other hand, in fields of less suitable conditions, conversion to orchards, such as mango may be considered for the diversification of agricultural products. Moreover, when conversion to orchards are not possible, cattle raising will be continued with improvement of farming techniques. Therefore, the proposed directionality of development for the respective zones is as follows.

Directionality of development of pasture in respective zones

Zone A	With the zone having undesirable conditions of soil and topography as well as the poor groundwater potential, basically non-irrigated is proposed but irrigation can be applied for only a few limited land with high groundwater potential, and, a part of the area shall be converted to mango, and improvement of farming shall be practiced through diversified farming with pasture.
Zone B	Though zone has suitable conditions of soil and topography, irrigation utilizing river water is not efficient. However, with the high groundwater potential, irrigation with groundwater shall be introduced with the conversion of pasture to sugarcane, and to vegetables at the final stage. For the irrigation priority is given to vegetables.
Zone C	The zone has suitable conditions of agriculture and topography. Irrigation with pump systems shall be introduced, and conversion to crops such as sugar cane, melon and vegetables shall be practiced. Groundwater is also available.

(2) Sugar cane

Sugarcanes have stable markets and are able to be raised without irrigation. In addition, irrigation has high efficiency on sugar cane (maximum 80% increase of yield). Also with high cultivation techniques, the agriculture of the area shall be developed consisting mainly on sugarcane for the time being. This plan proposes the development of diversified farming consisting on sugarcane and intensive farming of crops such as vegetables.

Directionality of development of sugarcane in respective zones

Zone A	Maintaining the actual state of sugarcane and introducing groundwater irrigation to areas capable (more than 10liters/sec/well).
Zone B	The area has high groundwater potential, and therefore, a part of the area shall be converted to vegetables, while increasing the production of sugarcane in the rest of the areas through the introduction of groundwater irrigation.
Zone C	Irrigation with pumping systems shall be introduced into this area, and conversion of sugarcane to melon and vegetables shall be practiced actively, while pasture is converted to sugarcane.

(3) Rice

At the actual state, rice is being raised at rain-fed paddy fields in locations with suitable soil and topography. Considering the trends of the international market and the balance of demand and supply in the country, the area of rice production shall be basically kept at its actual state. Rice shall not be irrigated during the dry seasons due to the shortage of water resource. On the other hand, replenish irrigation by pump systems or groundwater shall be done in areas capable during the rainy season in order to stabilize the productivity. The production of vegetables shall be introduced for cultivation in the dry season.

Directionality of development of rice in respective zones

Zone A	The production area of rice shall keep its current status.
Zone B	The production area of rice shall keep its current status.
Zone C	The production area of rice shall keep its current status, with the introduction of replenish irrigation in the rainy season.

(4) Melon

Large-scale farmers commercially produce melons in approximately 1,500ha in the Study Area. Previously, small and medium-scale farmers have attempted to raise melons for about 100ha but failed. The reason of failure was not of cultivation techniques, but of measures in marketing. Within this plan, support on organized farming through organizing small and medium-scale farmers as well as on their farming contracts with the processors will be done. On the other hand, in areas with suitable conditions of soil and topography, intensive agriculture will be developed with the conversion of sugarcanes to melon using resources such as groundwater.

Directionality of development of melon in respective zones

Zone A	Shall not be introduced.
Zone B	Shall not be introduced.
Zone C	A part of the sugarcane shall be converted.

(5) Mango

Diversification of crops will be practiced through the converting a portion of the pasture with undesirable conditions of soil and topography into mango. However, for there will be no returns from the converted fields during the first 1-2years after purchasing nursery stocks and converting the fields, support such as agricultural credits will be necessary.

Directionality of development of mango in respective zones

Zone A	A portion of pasture shall be converted.
Zone B	Shall be kept at current state.
Zone C	Shall be kept at current state.

(6) Vegetables

Vegetables are being raised for the area of 100ha using groundwater. With suitable conditions of soil and topography, along with water supply for irrigation being ensured, the diversification of farming through the conversion from sugarcane to vegetables such as watermelon and chili are profitable. For the farming of vegetables requires intensive farming and associated costs, it shall not be introduced to fields with undesirable conditions.

Directionality of development of vegetables in respective zones

Zone A	Shall not be introduced.
Zone B	Diversification of farming shall be achieved through conversion of pasture to sugarcane, and to vegetables at the final stage.
Zone C	Diversification of farming shall be achieved through conversion of pasture to sugarcane, and to vegetables at the final stage.

(7) Others

For other crops, there are such kinds as maize and frijoles for domestic consumption grown in the foot of the mountains in the west part of the Study Area, where conditions of soil and topography are undesirable. Though improvement of productivity through extension of farming techniques shall be proposed, the area of production shall keep its current state.

5.1.3 Summary of study results

Based on the ideas mentioned above, the study of the land use of the Study Area was done as follows.

(1) The zone where large efficiency of irrigation cannot be expected (Zone A, Subject blocks: No. 4, 6, 8, 10 and 13)

The area is low of agricultural productivity, and has difficulty in converting pasture into vegetables due to soil and topographical constraints. Also with features of low groundwater potential, the diversification of farming will be achieved through the conversion of pasture into mango. In the cases where more than 10liters/well can be ensured, irrigation by groundwater will be considerable. In such cases, sugarcane and vegetables shall be raised.

Land use plan of Zone A

	Pasture	Sugarcane	Rice	Melon	Mango	Vegetables	Others	Total
Current state	4,935	720	125	0	10	70	280	6,140
Planned state	4,335	720	125	0	610	70	280	6,140
Balance	-600	0	0	0	600	0	0	0

(2) The zone where efficiency of irrigation can be expected but has difficulty in supplying water by pumping (Zone B, Subject blocks: No. 1, 2 and 3)

The area has high agricultural productivity as well as abundant groundwater resources. However, the efficiency of irrigation using river water is low due to its distribution as small enclaves (300-450ha). Therefore, the improvement of farming shall be achieved through the conversion of pasture and sugarcane to vegetables by using groundwater irrigation.

Land use plan of Zone B

	Pasture	Sugarcane	Rice	Melon	Mango	Vegetables	Others	Total
Current state	450	320	410	0	30	0	0	1,210
Planned state	200	270	410	0	30	300	0	1,210
Balance	-250	-50	0	0	0	300	0	0

(3) The zone where efficiency of irrigation and easy of supplying water (Zone B, Subject blocks: No. 5, 7, 9, 11 and 12)

With the area having relatively large groups of fields (900-1,500ha) with high agricultural productivity, improvement of farming will be achieved through the conversion of pasture into sugarcane, melon and vegetables with the introduction of irrigation using the waters of Tempisque River with pumping systems. The use of groundwater for irrigation will also be considered due to its abundance.

Land use plan of Zone C

	Pasture	Sugarcane	Rice	Melon	Mango	Vegetables	Others	Total
Current state	1,490	2,845	1,010	0	0	85	0	5,430
Planned state	590	3,345	1,010	300	0	185	0	5,430
Balance	-900	500	0	300	0	100	0	0

Note: vegetables will be introduced to 200ha as dry-season cropping for the rice fields. Rice will be introduced to 150ha of the melon fields as rainy-season cropping.

5.2 AGRICULTURAL MANAGEMENT PLAN

5.2.1 Planning conditions

(1) The necessity of farmer's organization and improvement of small and medium-scale farmers

In order to achieve sustainable development for the small and medium-scale farmers, it is necessary to increase agricultural income through the improvement of farming and productivity. As for the actual measures that are assumed to have large effects, there are; increase of productivity through the extension of cultivation techniques and introduction of irrigation, and partial conversion to crops highly cashable. The direct effects by the introduction of irrigation are; the productivity increase of 70% for sugarcane, stable production of rice in the rainy season, enabling the pasture to feed 2-3 times more cows than the current state and enabling cultivation of vegetables and rice during the dry seasons. However, water resources for irrigation is limited, and it is not possible to irrigate all of the fields owned by small and medium-scale farmers during the dry season.

Therefore, it will be necessary consider the reduction of producing costs through the improvement of management and to improve farming through synergistic effects of cost reduction and income increase. Through this manner, sustainable development for small and medium-scale farmers will be achieved. At the current state, the average areas of the fields owned by small and medium-scale farmers are 7ha and 50 ha, respectively. It is important to increase the scale of production to more than 100 ha, which enables cost reduction and diversified farming. The increase of farming scale will be realized through the strengthening of organizations of small and medium-scale farmers, that will lead to the practice of farming by groups of farmers. However, the forms of the groups are assumed to differ depending on

personalities of the constituent members and kinds of crops to be raised, etc. Considering that most of the small-scale farmers are part-time farmers and including settlers with limited experience in farming, the forms of the organizations, as groups of farmers residing asunder with manifold background, are needed to be amply studied. This plan proposes the strengthening of existing organizations while developing new ones with adequate time. The ideal form of the organizations and the measures of achieving it, are discussed in the section of plan of farming and plan of support for strengthening farmer's organizations, respectively.

(2) Expected Crops

In order to achieve to sustainable agricultural development for the small and medium-scale farmers, it is necessary to practice the followings; diversified farming through the diversification of crops in the range of possible technical and financial abilities, equipment of irrigation mainly for sugarcane and rice, and partial introduction of crops of high cash ability considering the balance with marketing.

1) Pasture (graze lands)

Beef is exported to countries such as the USA, and has a large market. Also with the improvement of product quality, development of markets for the tourism is possible. However, considering the financial and technical abilities of small and medium scale farmers, it is quite difficult to increase the breeding number of cattle with intensive pasture production using the irrigation especially for small-scale farmers, and, it is much better to convert to the other crops. Considering the crop diversification in the area, the pastureland with suitable conditions shall be converted to other products.

2) Sugarcane

The production of sugarcane does not reach the capacity of the processing plants in the area. Therefore, as there is a market ready to accept productive increase, the industries are eager to support production both technically and financially. And though the price of sugar in the international market decreased from US$0.88/kg in 1980 to US$0.88/kg in 1999, estimations of the world bank indicates the stable values of US$0.17/kg in 2005 and US$0.18/kg in 2010, and production increase of sugarcane in expected to bring stable increase of income.

3) Rice

Though the shipping price of rice is not expected to improve due to the large influence of the liberalization of the Central American market, regarding the existence of rice mills in the area and established systems of processing and distribution, the production of rice, with the prerequisites of cost reduction by the improvement of productivity, should keep its current status from the viewpoint of food security.

4) Melon

Large-scale farmers are already practicing commercial production of melons in the area. The cultivation of melon requires high technical and financial ability, and farming based on contract with large –scale international distributors are desirable. The degree of difficulty both in cultivation and management results in the high ratability.

5) Mango

Mango is a promising crop capable of conversion in areas with undesirable features of soil and topography without irrigation. However a period of 4-5 years after conversion will be necessary to obtain positive figures in credit balance, and coordination with domestic and international processors /distributors will be necessary for marketing.

6) Vegetables

Coordination with the processors /distributors outside of the area will be necessary for such vegetables as chili and watermelon. For other vegetables, measures to compete with the productive areas around San Jose will be necessary.

5.2.2 Farming plans

(1) Types of farming

Sustainable agricultural development will be achieved by the enlargement of farming scale of the small and medium-scale farmers trough grouping, and by practicing diversified farming through the diversification of crops. Therefore, conversion to farming types as indicated below will be necessary.

1) Enlargement of farming by group management

While strengthening the existing farmer's organizations, the grouping of small and medium-scale farmers to the farming scale of approximately 200ha (about 15 farmers, at least more than 100ha) will be promoted. However, organizations with strong mutual relationships are not expected to occur at the initial stage. The advantages and disadvantages of grouping are estimated as follows:

Advantages and disadvantages of grouping

Advantages	Disadvantages
Easier to receive technical services provided by the public Easier to obtain financing compared to individuals Reduction of production costs by measures such as joint purchase Enabling strategic management such as joint cargo booking/shipping/marketing Easier to practice diversified farming due to the enlargement of farming scale	Occurrence of manpower for maintaining the organization Occurrence of running costs Necessity of integrating individual opinions Difficulty of free management of individuals Necessity of keeping fairness of benefit distribution

Moreover, most of the small-scale farmers are part –time farmers highly relying on off-farm incomes. With these farmers having different degrees of interest in farming, the activities of the farmer's organizations should start moderately as joint purchase of agricultural inputs while training a full-time farmer as a leader to act as the core of the organization. The activities will gradually increase its degree of difficulty, and the formation of entrenched organizations will be achieved.

The process of strengthening group farming

Stage	Process
Current	Individuals practicing small-scale farming.
Initial	Strengthening partnerships through relatively simple activities such as joint purchase of agricultural inputs. The types of farming will not largely differ from individual farming. A leader will be trained to act as the core of the organization.
Middle	Advancement of activities as adjusting water use for agriculture and joint capital investments. Organizational measures for pursuance of profits and practice on diversified farming. The development of measures for fair profit distribution as well as consolidation of organization codes will be necessary.
Final	Strategic development of business will be practiced with the leader managing the organization. If necessary, it is possible for these organizations to form enterprises with small and medium-scale farmers as stakeholders.

2) Diversified farming through diversification of crops

As mentioned in the section of plans for land use, the diversification of crops, in consideration of soil, topography and state of irrigation, will be planned as follows:

- Groups mainly cultivating pasture and mango

  In the pasture areas with unfavorable conditions of soil and topography that have difficulty for conversion to crops such as sugarcane and vegetables, approximately 10% of the area shall be converted to mango. However, organizational measures based on conversion plans will be necessary as the conversion to mango requires time.

- Groups mainly cultivating sugarcane and vegetables

  In areas with suitable conditions of soil and topography, and capable of irrigation, conversion of pasture to sugarcane and then to vegetables shall be practiced. The production areas of vegetables are estimated to be 1-2ha for each small-scale farmer, and adjustments are also to be done considering trading in the group.

- Groups mainly cultivating rice

  For areas where rice is being cultivated at the current state, replenish irrigation during the rainy season and cultivation of vegetables in the dry season shall be practiced in the areas where irrigation is possible.

- Groups mainly cultivating melon

  The cultivation of melon requires the implementation of irrigation and an organization with ample technical/financial ability and stable foundation for agriculture. Rice may be cultivated for the rainy-season cropping of melon fields.

(2) Improvement of cultivation techniques

Farming without irrigation

Presently, rainwater is utilized for the production of pasture or the production of sugarcane and rice by the small and medium-scale farmers. These products already have established traditional cultivation techniques. Though implements of fertilizers and agrochemicals may bring increased production, it shall not be encouraged through the viewpoint of environmental conservation. However, the remains of the crops shall be positively reduced to the soil. For choices of variety, the conventional varieties shall be further continued for they are chosen through ample experience while studies on new ones shall be conducted.

Farming with irrigation

The introduction of irrigation will bring stable production in the rainy season, increased production in the dry season and enables conversion to crops such as vegetables.

1) Replenish irrigation for sugarcane at its germination stage

Sugarcane is harvested from Dec. to Mar. and besides the portion to be renovated, most of the area will be for ratooning (producing crops using the germination from the plant foot after harvesting). Therefore, replenish irrigation shall be done pursuant to the dryness of the soils at the germination stage of the regeneration buds. The supply of water will not be necessary for the ripening stage after head sprout. Presently, the planting for ratooning is done in May when the rainy season begins. In contrast, with irrigation enabling the planting to be earlier than April, the production of the first crop may be increased. With the introduction of replenish irrigation, the average yield of the small and medium-scale farmers (60t/ha at present) is expected to raise to about 100t/ha. Furthermore, premeditated planting with staggered planting periods will highly improve the efficiency of water usage.

2) Replenish irrigation of rice (discontinuance of Arroz secano)

Arroz secano, which is practiced in most of the area has a characteristic of extremely unstable production due to its high reliance on precipitation. The introduction of irrigation in the rainy season along with the maintenance of ridges and conduits will increase and stabilize the production of rice.

3) Irrigation for melon and vegetables

Presently, melon is produced by the enterprise-farms with trickle irrigation using groundwater. Though the production of melon requires high production costs due to the necessity of pumping and facilities expenses, melons are traded at high rates and bare high profits. While trickle irrigation is effective for water saving, its introduction to small and medium-scale farmers will take time, for it requires facilities expenses and techniques for maintenance. On the other hand, vegetables are produced by some progressive farmers through intensive cultivation, but also require certain techniques and finance.

4) Introduction of irrigation farming techniques

When irrigation is to be introduced, it will be essential for the farmers to obtain techniques on water management, in for high production with limited water supplies. In order to maintain high productivity

with minimum water supplies, techniques considering detailed issues such as crop, water necessity for each growing stage, irrigation intervals, conduit construction, management skills of irrigated water amount, countermeasures for water leakage etc., shall be introduced. Large enterprises practice integrated studies on these issues and embraces staffs with technical ability. For their own interests, these enterprises support small and medium-size farmers raising sugarcane, technically and financially, and therefore, farmers shall forwardly use such support.

(3) The possibility of introducing new crops

The area has traditionally raised sugarcane and rice. At present, both of these crops have market value and the needs of introducing new crops are not necessarily high. However, from a longer point of view, new crops shall be introduced, considering such aspects as obtaining further profitability, stabilization of production by diversification of crops and the positive economical impacts to the rural society. At this point, the candidates for the crops to be introduced in the medium or long-term period, are; orchards such as mango and pitayas, vegetables such as pipián, oil crops such as cotton, ornamental foliage plants and flowers. However, the medium or long-term prospects of the situations surrounding agricultural products not being able to see, ample study should be made on these new crops while continuing the short-term development.

Study on crops such as the abovementioned was done considering meteorological fitness and the cultivation ability of the farmers. At the point, mango was the only crop that was assumed to ensure profit without risks. It will be proposed that cultivation plans shall be made mainly based on conventional crops while new crops shall be continuously studied.

(4) Considerations for sustainable agriculture

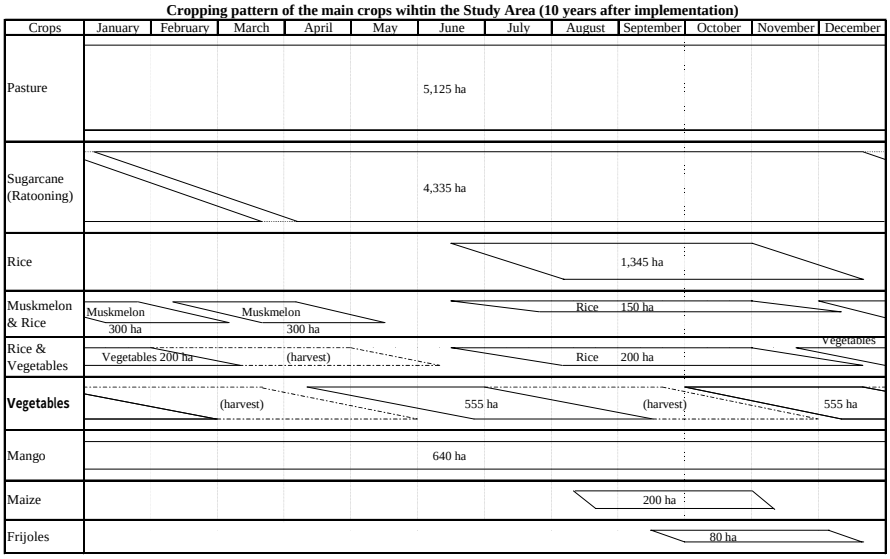
For the achievement of sustainable agriculture for the small and medium-scale farmers, it is important that environmental considerations are made. The amounts and methods of using fertilizers and agrochemicals must be especially considered in order to prevent environmental contamination. Agriculture shall be developed in the directionality of using organic materials and reducing the amount of chemicals. And for this directionality leads to both higher cost and higher value, coordination with consumers with their interest in the safety of food shall be necessary.

5.2.3 Cropping Plan

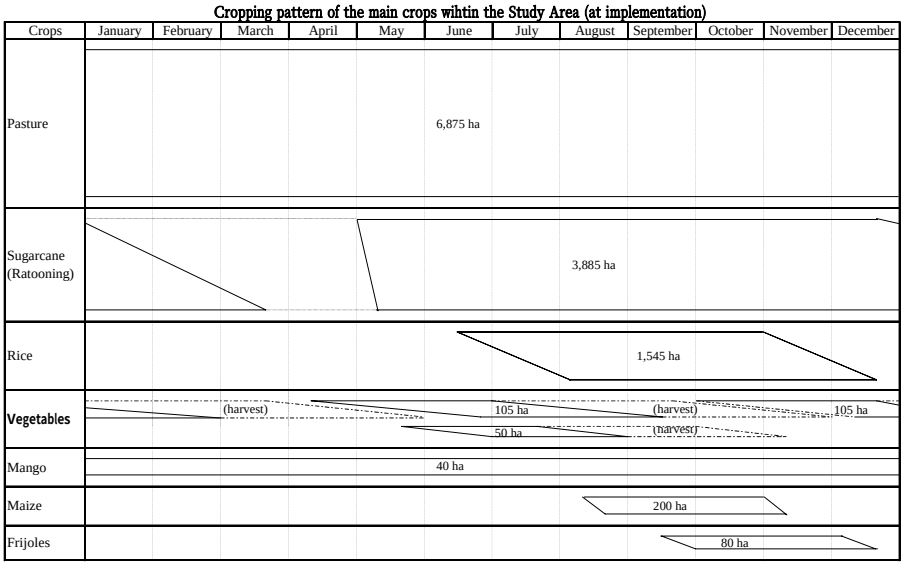
(1) Proposed cropping pattern

The planned cropping pattern is as indicated below.

Cropping pattern of the main crops wihtin the Study Area (10 years after implementation)



Cropping pattern of the main crops wihtin the Study Area (at implementation)



(2) Planting area

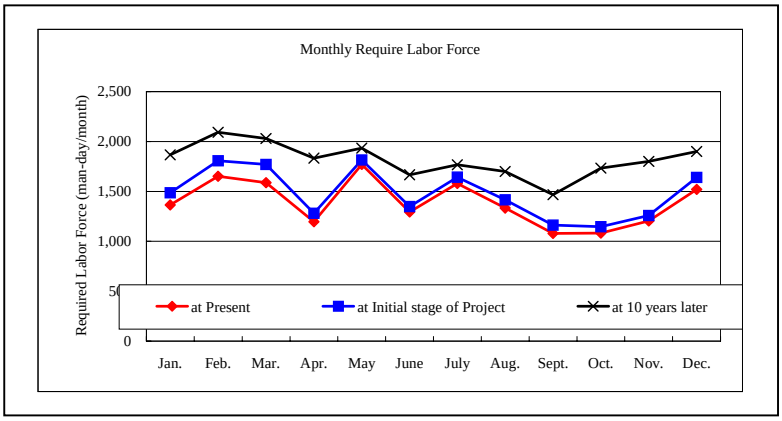
The area to be cropped shall start from its current state, and within 10 years, approximately 1,750ha of the pastures owned by the small and medium-scale farmers shall be converted to sugarcane and mango, depending on its topography, soil and potential for irrigation. Further on, the sugarcane shall be converted to vegetables and melon. The cropping areas after conversion is as follows:

Planting area of the main crops in the Study Area (ha)

Crop	At implementation	10 years after implementation	Balance
Pasture	6,875	5,125	-1,750
Sugarcane	3,885	4,335	450
Rice (rainy season)	1,545	1,645	100
Melon	0	600	600
Mango	40	640	600
Vegetables	260	1,310	1,050
Others	280	280	0
Total	12,885	13,935	1,050

(3) Necessary labor power

Most of the small-scale farmers have off-farm incomes, wherein more than half of them depend on them as their main source of income. Many of these farmers entrust agricultural labor to laborers instead of doing it by them. Besides the small and medium-scale farmers, it is assumed that in the Study Area, there are approximately 5,000 laborers that does not own land. Agricultural work during the farming season (4months/year) is done by these laborers and adequate labor power is available even at the peak of demand. On the other hand, work such as land preparation, fertilizing/sowing, application of agrochemicals and harvesting are usually done under contract. In the cropping plan, the total amount of labor (family labor, employed labor, labor under contract excluding the usage of machinery) increases at the rate of approximately 30%, from 490 man-day to 640 man-day. However, by smoothing the yearly variance, which concentrates in the four months, the changes in the peak period will be from approximately 1,600 laborers to 2,000 laborers.



5.3 IRRIGATION AND DRAINAGE PLAN

5.3.1 Planning conditions

(1) Irrigation methods of the Study Area

Aiming for the achievement of sustainable agricultural development for the small and medium-scale farmers, the plan for irrigation/drainage will be made targeting on the enlargement of farm scale of small and medium-scale farmers through grouping and diversified farming. As mentioned in chapter 4 the resource of irrigation water will be the maximum rate of 3.0 m^3/s and 1.0 3.0 m^3/s from the Tempisque River and groundwater, respectively. Furthermore, considering features such as topography, soil and land use, the plans will be made upon respective zones as indicated below.

Proposed irrigation method for respective zones

Zone	Block No.	Area of Farmland (ha)	Method of irrigation
Zone A	4,6,8,10,13	6,140	Irrigation with groundwater only to areas with high groundwater potential.
Zone B	1,2,3	1,210	Irrigation with groundwater.
Zone C	5,7,9,11,12	5,430	Irrigation with river water using pumps. Irrigation with groundwater.

5.3.2 Irrigation water

(1) Water requirement

The calculation of the water to be used was done as indicated below. The cropping period was devised in order to level the peak usage and to maximize the irrigated area.

1) Potential evapotranspiration

The potential evapotranspiration was calculated with the modified Penman method.

Potential evapotranspiration (mm/month)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.
195	201	215	204	170	132	155	152	129	129	134	163

2) Kc values

The following kc values were used considering the standards of the FAO and the values used by SENARA.

	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month	8th month	9th month	10th month	11th month	12th month
Rice	1.10	1.10	1.15	1.10								
Sugarcane	0.50	0.85	0.95	1.10	1.15	1.15	1.15	1.15	1.15	1.15	0.90	0.00
Pasture	0.49	0.58	0.74	0.85	0.91	0.92	0.92	0.91	0.85	0.80	0.68	0.50
Watermelon	0.50	0.70	1.00	0.70								
Melon	0.50	0.70	1.00	0.70								
Mango	0.63	0.66	0.68	0.69	0.70	0.70	0.70	0.70	0.68	0.67	0.66	0.63
Vegetables	0.40	0.79	0.85	0.52								

3) Effective rainfall

Effective rainfall was calculated as follows using the standards of the national bureau of land reclamation and values of 1/5 years probability was adopted.

Precipitation and effective rainfall (mm/month)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.
Precipitation		0.9	2.9	2.9	20.5	250.3	210.5	138.1	180.3	327.4	276.1	101.1	5.9
Effective rainfall	1/2year	0	0	0	15.1	160	137.1	95.4	121	160	160	85.1	0
	1/5year	0	0	0	13.9	147.2	126.1	87.8	111.3	147.2	147.2	78.3	0
	1/10year	0	0	0	12.5	132.5	113.5	79	100.2	132.5	132.5	70.5	0

4) Irrigation Efficiency

For the irrigation efficiency, 36% for paddy field and 54%, which are same values as adopting by SENARA for similar project, are applied. In case of using the facilitated field irrigation scheme such as sprinkler, drip irrigation, the irrigation efficiency may be increased, but in this study, considering the project will be commenced before the small and medium scale farmers install the field facilities, the same irrigation efficiency is applied for ground water irrigation system. After the improvement of abilities of the small and medium scale farmers financially and technically, it is possible to increase the irrigation area with installation of field irrigation facility such as sprinkler, drip irrigation.

5) Unit water requirement

The unit water usage was calculated as follows:

Unit water requirement (l/s/ha)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.
Rice	0.00	0.00	0.00	0.00	0.00	0.37	1.20	1.53	1.15	1.12	0.74	0.00
Sugarcane	0.62	0.72	1.15	1.36	0.71	0.59	0.90	0.79	0.49	0.47	0.71	0.75
Pasture	0.99	1.31	1.35	1.29	0.53	0.37	0.58	0.43	0.06	0.00	0.17	0.65
Watermelon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Melon	0.99	0.97	1.09	1.11	0.30	0.06	0.00	0.00	0.00	0.02	0.40	0.90
Mango	0.85	1.02	1.01	0.95	0.27	0.18	0.42	0.32	0.06	0.05	0.33	0.71
Vegetables	0.79	0.88	1.01	1.00	0.17	0.00	0.00	0.00	0.00	0.05	0.35	0.81

(2) Water source

1) The Tempisque River

At the completion of the Phase 3 of the Arenal Tempisque Project, the transfer of water rights is planned for the Tempisque river. After the transfer, a total of 10.5 m^3/s of water will be supplied from the west canal to the large-scale farmers in the area. Accordingly, 6.0 m^3/s of the existing water rights are planned to be returned to the MINAE. In this plan, 3.0 m^3/s of the 6.0 m^3/s returned water rights will be utilized as a new source of irrigation water (additionally, 1.5 m^3/s will be released to the river to preserve the river flow). However, it must be considered that the uptake of 3.0 m3/s would be impossible in the years of droughts, for the shortage of river water.

2) Groundwater

Conventionally, usage of groundwater has been actively practiced near the Las Palmas River, due to the high groundwater potentials of the depressions formed near the river. However, the development of groundwater holds many uncertainties and requires ample attention. The estimated recharge of ground water is 62-116 MCM. Referring to the annual usage of ground water being 21MCM, at least 41 MCM/year of ground water is estimated possible of development. However, the excess pumping of groundwater may result in numerous negative affects against the social and natural environment, and development must be done with ample margin. Considering these margins, the utilizable amount of groundwater In the Study Area will be 14 MCM/year (average: 0.4 m^3/s, maximum: 1.0 m^3/s).

The specific policies for groundwater development are as follows:

- Development will be for areas with expectation of ample groundwater yield, and already has past records of groundwater uptake in the area or its vicinities.
- Development will target on the aquifers with high groundwater potentials.
- The uptake from the planned wells will be set based on hydrological dimensions and the results from uptake studies of wells in the area or its vicinities. However, the past records of operating wells will be prioritized.
- In order to avoid intervention, ample distance will be provided between each well. The distance will be decided based on present information and the results of well test if necessary.
- Drilling of the wells will be basically in the respective zones. However, technical and financial studies on plans of guiding water from other areas will be done in cases of low groundwater potentials.

(3) Irrigation area

At the time of implementation, irrigation will be started for blocks No. 5, 7, 9, 11 and 12 using pump systems. The subject of irrigation at this point will be the irrigation for pasture, sugarcane and replenish irrigation for rice in the rainy season. Considering the efficiency of irrigation, it may be pointed that only sugarcane should be irrigated instead of pasture. However, regarding that the farmers mainly producing pasture will convert to other crops, it was judged that pasture should also be irrigated at a certain level. Furthermore, pasture will not be irrigated at the point of 10years after implementation. The planned area of irrigation at the point of 10 years after implementation are as indicated below. At this point, groundwater irrigation systems are to be already equipped and conversion is to be proceeded. In the plan, the area of irrigation was maximized by applying a three-stage time lag to the germination term.

Propose irrigation area (ha)

Crop	At initial	10 years after
Sugarcane (germinated in Jan.) (germinated in Feb.) (germinated in Mar.)	1,520 (510) (510) (500)	2,590 (870) (860) (860)
Pasture	800	0
Rice (rainy season)	1,010	1,360
Vegetables		650 (rainy season: 450)
Melon		300
Mango		0
Total （Total for dry season）	3,330 (2,320)	4, 900 (3,540)

(Note: Existing Irrigation area of Vegetables (105 ha) is not included)

(4) Irrigation water

The plan for irrigation is as follows:

Irrigation water plan (m^3/s)

At indicial	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.
Sugarcane	0.95	1.05	1.73	2.06	1.07	0.89	1.37	1.21	0.74	0.72	1.09	1.17
Pasture	0.52	0.71	0.87	0.94	0.41	0.30	0.52	0.43	0.17	0.13	0.28	0.45
Rice	0.00	0.00	0.00	0.00	0.00	0.38	1.10	1.33	0.99	0.96	0.64	0.00
Total	1.48	1.76	2.60	3.00	1.49	1.57	2.99	2.97	1.91	1.81	2.01	1.62
10 years after	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.
Sugarcane	1.62	1.79	2.95	3.51	1.83	1.51	2.33	2.05	1.27	1.23	1.86	2.00
Pasture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rice	0.00	0.00	0.00	0.00	0.00	0.51	1.48	1.80	1.34	1.29	0.87	0.00
Vegetables	0.59	0.72	0.44	0.15	0.00	0.04	0.18	0.15	0.03	0.00	0.02	0.29
Melon	0.30	0.29	0.33	0.33	0.09	0.02	0.00	0.00	0.00	0.01	0.12	0.27
Mango	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.51	2.81	3.71	4.00	1.92	2.08	3.99	4.00	2.64	2.53	2.86	2.56

The peak of water usage is in July and August as well as April for the plan includes replenish irrigation for rice in the rainy season.

(5) Available water of the Tempisque River

The water right of the usable water for irrigation of the Tempisque River is set as 3m3/s. However, in the dry season of drought years, the uptake from the river shall be decreased in adjustment with the other water rights. While the period of low water flow is from January to April, the peak of water usage also occurs in April (Peaks of water usage also occurs in July and August, however, abundant river flow of this season tempers the problems). The amounts of river flow, water rights and usable water in normal years will be as follows:

The river flow discharge and water rights in normal years (m^3/s)

	Jan.	Feb.	Mar.	Apr.	May-Dec.
River flow discharge	16.80	12.12	9.02	7.61	More than 14.72
Total of water rights	9.49	9.49	7.44	6.69	Less than 5.00
Available water	3.00	3.00	3.00	3.00	3.00
available water for Total of water rights (%)	32%	32%	40%	45%	Less than 30%

The figures will be as follows in years of droughts.

The river flow discharge and available water in droughts year (m^3/s)

1/5 year probability	Jan.	Feb.	Mar.	Apr.	May-Dec.
River water volume	10.94	7.89	5.87	4.95	More than 9.04
Usable amount of water	3.00	2.49	2.37	2.20	3.00
1/10 year probability	Jan.	Feb.	Mar.	Apr.	May-Dec.
River water volume	9.42	6.79	5.05	4.26	More than 7.19
Usable amount of water	2.98	2.15	2.04	1.91	3.00

Note: Though the volume of river water falls below $10m^3/s$ at certain months between May and December, 3.00 m^3/s remains usable due to the corresponding decrease of the total water rights.

In contrast of melon and vegetables, which are crops that require irrigation, sugarcane and pasture are already cultivated without irrigation at the current state and is expected to yield the amount of production as indicated below in absence of irrigation. Therefore, the adjustments on the area of irrigation during the period with insufficient water (Mar. and Apr. in the years of droughts) shall be done in the fields of these crops.

Production of sugarcane and pasture

	Current state		Proposed (10years after)	
	Not irrigated	Irrigated	Not irrigated	Irrigated
Sugarcane	60t/ha	80t/ha	70t/ha*	100t/ha
Pasture	0.9heads/ha	—	1.0 heads /ha*	1.9 heads /ha

(*Note: The productivity without irrigation is estimated to increase with the extension of farming techniques.)

The area of irrigation for sugarcane and pasture during the period with insufficient water (Mar. and Apr. in the years of droughts) shall be as indicated below. The irrigated areas of vegetables and melon will not be changed.

Areas to be irrigated during the dry season of drought years (ha)

At initial	1/5 year probability				1/10 year probability			
Crop	Feb.	Mar.	Apr.	May	Feb.	Mar.	Apr.	May
Sugarcane	1,520	1,380	1,110	1,520	1,520	1,190	970	1,520
Pasture	800	730	580	800	800	620	510	800
10 years after	1/5 year probability				1/10 year probability			
Crop	Feb.	Mar.	Apr.	May	Feb.	Mar.	Apr.	May
Sugarcane	2,590	2,290	2,000	2,590	2,590	2,000	1,790	2,590

For the difficulties of evaluating the decrease of production in the areas where irrigation is sustained during the period with insufficient water (Mar. and Apr. in the years of droughts), the benefits by the production of these areas were evaluated by calculating weighted means of production the area exceeding the irrigated area during March of the respective probability year counted as “not irrigated”, and with the probability years 1/5 and 1/10 occurring at the rate of 20% and 10%, respectively.

Amount of irrigated area for benefit analysis (ha)

		At implementation			10 years after implementation		
		Plan	1/5year	1/10year	Plan	1/5year	1/10year
		70%	20%	10%	70%	20%	10%
Sugarcane	Not irrigated	2,365	2,775	2,915	1,745	2,335	2,545
	Irrigated	1,520	1,110	970	2,590	2,000	1,790
	Total	3,885	3,885	3,885	4,335	4,335	4,335
Pasture	Not irrigated	6,075	6,295	6,365	5,125	5,125	5,125
	Irrigated	800	580	510	-	-	-
	Total	6,875	6,875	6,875	5,125	5,125	5,125

For reference, rough estimates of the benefit/cost values of Zone C were compared for different capacities of pumping facilities corresponding to the water flow in years of droughts. Though the down sizing of pump facilities will lead to lower construction costs, economical efficiencies scarcely changed due to the corresponding decrease of benefits.

Comparison of economical efficiency related to scales of pumping facilities

	Water rights	1/5 year	1/10 year	Remarks
Capacity of pumping facility	3.0 m^3/s	2.2 m^3/s	1.91 m^3/s	
Construction costs (US$1,000)	18,803	17,280	16,272	
O/M costs (US$1,000)	590	510	464	Annual cost
Costs for renewal (US$1,000)	587	472	442	For 15 years
Area irrigated (ha)	3,500	2,870	2,660	
Benefits: at initial (US$1,000)	491	363	309	
Benefits: 10 years after (US$1,000)	8,024	7,683	7,553	
FIRR	14.18%	14.09%	14.08%	
B/C (discount rate: 12%)	1.21	1.20	1.20	
B/C (discount rate: 6%)	2.13	2.12	2.07	

(6) Irrigation guidance in drought years

In cases of water shortage in years of droughts, SENARA will decide the amount of water to be distributed considering of the magnitude of the shortage. After the allocation is distributed to the respective farmers, the farmers will cut down the area to be irrigated under the guidance of SENARA. Since farming at the early stage of farmer's organizations will be done by the respective farmers, adjustments of water usage will be done by the same manner. As the development of the organizations proceeds, adjustments of water usage is assumed to be done organizationally, as farming is expected to shift to organizational measures. However, SENARA should perform strong leadership for the adjustments of water usage at the early stage of the development of the organizations. It is possible to roughly estimate the flow conditions during the dry season by examining the state of the Tempisque River at the beginning of the dry season, the end of November. SENARA should be responsible for estimating the flow conditions and to give technical advice to prepare plans for the cropping of the dry season based on the estimations.

Flow condition of Tempisque River at the end of November in drought years (Guardia)

	Flow rate (m^3/s)	Water level (m)	Water rights during dry season (m^3/s)
Normal year	32.775	1.15	3.00
1/5year	21.330	0.80	2.20
1/10year	18.365	0.55	1.91

Though the cropping area of sugarcane and pasture shall not be changed, the estimation can be used to decide farming plans such as the irrigation area of sugarcane after ratooning, the number of cattle to be raised and the amount of fodder to be bought. The usable amounts of water during the dry season of the years of droughts, along with the flow conditions are indicated below.

Usable water during the dry season of drought years

	Jan.	Feb.	Mar.	Apr.
The minimum flow discharge of Tempisque River (m^3/s)	9.5	9.5	7.4	6.7
amount of available water (percentage of river flow)	32%	32%	40%	45%

For example, when the flow condition in April is 5m3/s, the usable amount of water will be 2.25m3/s, which is 45% of the flow volume. Under this condition, the allocation to the farmers will be 75% of the normal years. At this state, SENARA will give guidance to the farmers to decrease the area of irrigation as it will cut down the amount of water distribution. When an average small-scale farmer (owning 7.3ha of farmland) receives approximately 4l/s of water and irrigates 3.0ha, the state will be as approximately 3l/s of water and 2.2ha as for the area irrigated. The decision of the amount of water to be distributed and the area to be irrigated will be made by SENARA, and detailed guidance as well as explanation will be continued until the small and medium-scale farmers obtain ample experience.

5.3.3 Irrigation Water Distribution Method

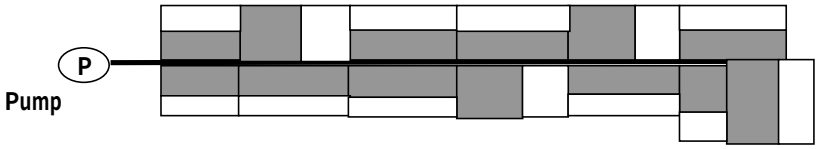
The methods for the distribution of water will be planned separately for the area irrigated by river water through pumping and the area irrigated by groundwater.

(1) Area irrigated with river water from pumping system

The lack of water resources for irrigation was an issue recognized from the leadoff of this study. Developing measures to distribute the limited water efficiently was enumerated as one of the tasks. Comments of residents obtained in public hearings indicated that inclined distribution of irrigation water may lead to problems upon civil administration, such as the enlargement of income differentials between the areas irrigated and not irrigated, or the induction of the sense of inequality. Since these comments were that of the majority of the public, the study team targeted the study of irrigation methods on irrigating the whole area.

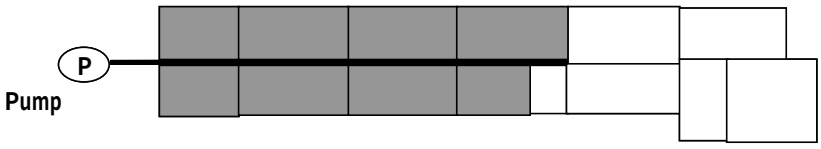
The area that can be irrigated with river water by pumping is 3,300ha. The study was done on how the water should be distributed to Zone C, which embraces approximately 410 farmers and 5,430ha of farmland owned by small and medium-scale farmers. For the differences of the characteristics of soil and topography within Zone C are scarce, the issue was on simple selection of the area to be irrigated. Two ideas were studied for the distribution of the irrigation water as indicated below. One was to spread the distribution to the whole zone (Case-1), and the other was to centralize the distribution to the areas near the location of the pump (Case-2). From the financial viewpoint, centralizing the distribution of pumps, resulting in shorter length of the canals, will be the most less costing in facilities expenses, viz most advantageous. Case-1 enables the distribution of irrigation water to all of the farmers in the zone, while Case-2 limits the distribution and bares a portion of farmers without irrigation.

Case-1: When distributing irrigation water to all of the farmers of Zone C



Normal Year: 3.0m3/s for both dry and rainy seasons
At droughts of 1/5year probability: 3.0m3/s for rainy season and 2.2m3/s for dry season

Case-2: When distributing irrigation water to the farmers located near the pump



Normal Year: 3.0m3/s for both dry and rainy seasons
At droughts of 1/5year probability: 3.0m3/s for rainy season and 2.2m3/s for dry season

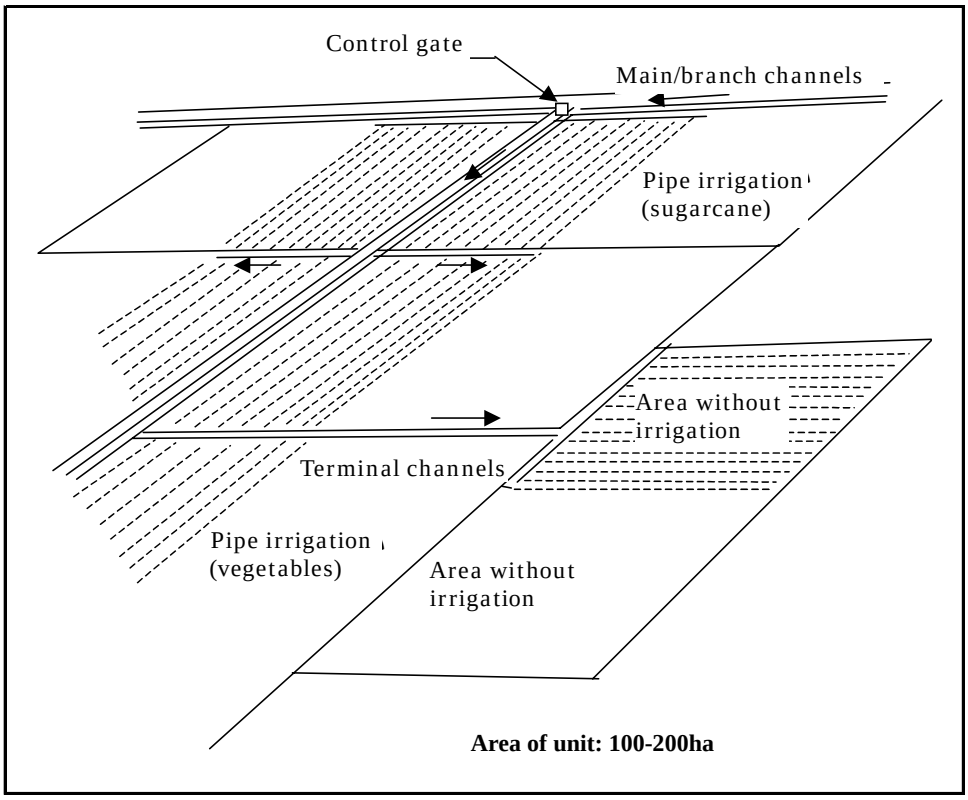
: Area with irrigation

: Area without irrigation

Within this study, the selection of fields to be irrigated were done upon discussions with the small and medium-scale farmers through public hearings and review meetings with working groups constituted by the representatives of farmers, as well as the studies on the criterions of selection based on soil/land conditions, productivity and featured crop. Based on the common recognition that the amount of water is insufficient in irrigating the whole area, the farmers insisted that they wanted the water to be distributed to their farmlands nevertheless the insufficiency in irrigating the whole area of their farmlands. Therefore the consensus of the farmers was that they wanted the water to be distributed to all the small and medium-scale farmers in the Zone. Thus, considering that the subject of this plan is to achieve sustainable agricultural development for the small and medium-scale farmers, and from the

viewpoint of preventing the occurrence of a civil administration problem, the enlargement of income differentials within Zone C, it was concluded that the study on the methods for water distribution should be done in the directionality of distributing irrigation water to all of the farmers in the Zones.

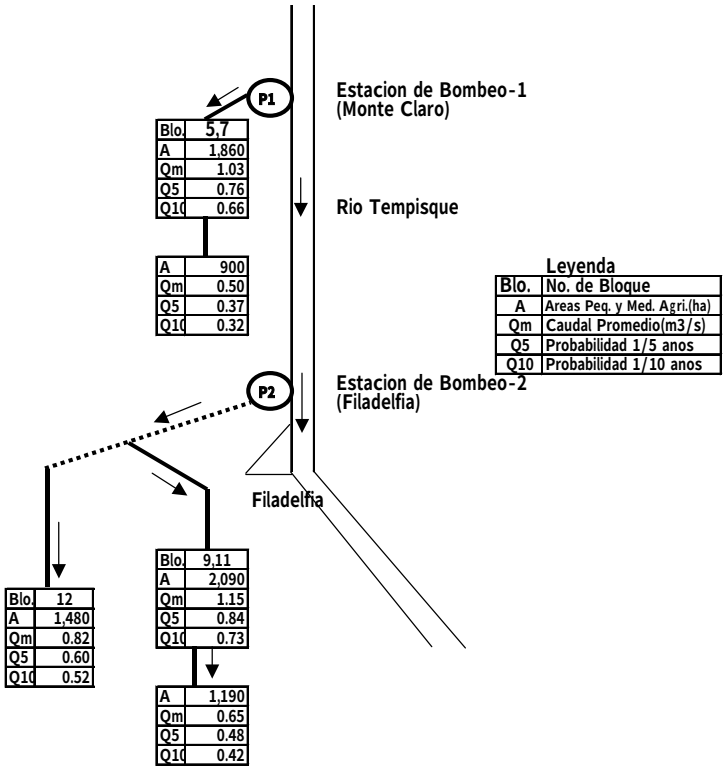
In this case, irrigation will be done by SENARA administrating the overall water management by controlling the flow volume of the water with the intake-gate located at the beginning of the zone, and distributing the amount of water corresponding to the area of irrigation based on the cropping plans of the farmers. The irrigation of the farmlands at the terminus will be done as indicated below, and SENARA will manage the water distribution from the dividing-gate to the respective farmlands.



(Also, irrigation to a portion of land using water for the irrigation of approximately 1ha is being practiced in the existing small-scale groundwater-irrigation areas.)

From the abovementioned notions, the selection of the areas to be irrigated was done as indicated in Fig. 5.1. Furthermore, the flow sheet of water usage is as indicated below.

SIST **System diagram of water distribution**



The assumed concerns in this case were studied as follows.

① Operation

As it is practiced in the I and II stage of the Arenal-Tempisque irrigation project, the plan of water management will be for SENARA to control the water until it reaches the farmlands, and the farmers taking charge afterwards. Water management will be gradually transferred to the farmers as they get experienced. However, for the time being, the adjustments of water usage between the farmers will also be done under the jurisdiction of SENARA. The diversion of the water shall be done by completely opening or closing the diversion gate, in order to clarify the time of operation. The charge of water will be based on the amount of water converted from the cumulated time of water supply. The main canals will be supplying water for 12-24 hours. However, there may be 6-10 days incessantness at the fields in the terminus, and the water distributed to the respective farmers will be 6-9hours/6-10days during the peaks. Furthermore, the operational time of the pumps will be roughly 13hours for most of the year, except for the periods of July-August and March, when the pumps will be operating 24hours/day and 20 hours/day respectively.

Total water usage and pump operation time

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.
Total amount of irrigation water (m3/hr)	1.48	1.77	2.61	3.00	1.49	1.57	2.98	2.96	1.90	1.80	2.01	1.62
Operation time (hrs)	**11.8**	14.2	20.9	24.0	**11.9**	12.6	23.8	23.7	15.2	14.4	16.1	13.0

Draft water management calendar concerning irrigation with river water

Month	Maximum pump up (m3/s)			Time of pump operation (hr)	SENARA activities	Activities of beneficiary farmers
	Normal year	1/5 probability	1/10 probability			
11	3.0	3.0	3.0	16	- Tracking the amount of river flow of the Tempisque. Determining the amount of water intake during the dry season. - Crop planning for the dry season. Estimation of the total area to be irrigated. Technical advisory for the farmers.	- Determining the cropping area of the dry season (done by respective farmers).
12	3.0	3.0	3.0	13	- Determining the amount of water distribution for the farmers corresponding to the amount of river flow. Advisory on irrigation for the farmers. Management of water-conveyance (pump and diversion gate operation).	- Admission of the amount of water distribution and irrigation area.
1	3.0	3.0	2.98	12		- Implementation of irrigation methods matching the amount of distributed water (dry-season crops).
2	3.0	2.49	2.15	14～20		
3	3.0	2.37	2.04	21～24		
4	3.0	2.20	1.91	24		
5	3.0	3.0	**3.0**	12	- Providing guidance for the planning of all-year crop (sugarcane) and rainy-season crop (rice). Calculation of the total beneficial irrigated area.	- Determining the cropping area of sugarcane and rice (rainy season, done by the respective farmers)
6	3.0	3.0	3.0	13	- Management of the amount of water supply for the respective farmers (pump and diversion gate operation).	- Practicing irrigation matching the amount of distributed water (sugarcane, rice, etc.).
7	3.0	3.0	3.0	24		
8	3.0	3.0	3.0	24		
9	3.0	3.0	3.0	15		
10	3.0	3.0	3.0	15		

Note: Dry season (Nov.-Apr.), Rainy season (May- Nov.), ▢ months short of irrigation water.

② Determination the Irrigation Water

The farmers to receive water supply are small and medium-scale farmers owning lands less than 200ha (average area of 7.3ha and 49.9ha for small and medium-scale farmers respectively). The amount of water to be distributed will correspond to the area of farmland and will be supplied at the rate of 0.55l/s/ha as standard. However, the upper limit of distribution for the medium-scale farmers will be 55l/s. At this point, organizational collection of water charges under the guidance of SENARA will be aimed through the formation of farmer's organizations with the total farming area of approximately 200ha (constituting of about 15 farmers). Yet, at the meanwhile, SENARA will supply the water to the respective farmers, and adjustments of water usage will be done under the jurisdiction of SENARA.

③ Collection of water charges

The water charges corresponding to the amount of distributed water (the total operation time of the diversion gate) will be charged on the respective farmers and collected by SENARA. Though organizational collection will be aimed for in the future, SENARA will be in charge for the time being.

(2) Area irrigated with groundwater system

From the point of land classification, Zone A (with 6,140ha of farmland) has only limited capability for crops that are able to be cultivated (perennial and semi-perennial crops). The zone mainly consisting of pasture is also located near the foot of the mountains and has low groundwater potential. Therefore, irrigation was planned for sugarcane, which is cultivated in areas with relatively favorable

land condition, with groundwater from the selected areas with groundwater potential exceeding 10 l/s per point. In contrast, Zone B (with 1,210ha of farmland), is located in the flatlands near the Tempisque River and has high groundwater potentials (50-100 l/s). Therefore, irrigation will be planned for sugarcane and vegetables. Zone C is categorized as the area irrigated with river water by pumping. However, with the background of high groundwater potential and the intake from the pumps not covering the whole area, irrigation with groundwater is also planned for melon, sugarcane and vegetables.

Water will be distributed to irrigation systems, which will be developed under the requests of farmer's organizations to the operational agency at the rate of 5 systems (with the average of 100ha)/year. The development of the systems will continue for 10 years summing up to the development of 50 systems irrigated with groundwater. Furthermore, based on groundwater potential, the total area of farmland to be irrigated in the zone will be 1,000 ha, and the total extract of groundwater will be 14 MCM/year (average: 0.4 m^3/s, maximum: 1.0 m^3/s).

As for the plan of water distribution for this area, in areas with high groundwater potential (50-100 l/s), wells will be installed for the gathered farmland of 50-100ha (5-10 farmers), and water will be distributed to the respective farmers with the precondition of farmers organizing groups intensive agricultural development. Locations of the wells for the respective zones are roughly planned as indicated below.

Zone	Planned location	Number of wells	Amount of extract per well (l/s)	Main crops to be irrigated
A	Area with high groundwater potential and relatively favorable land condition	10	10〜15 l/s	Sugarcane (approximately 100 ha)
B	Mainly the areas of IDA settlements with farmers having the capabilities of organizing groups.	10	40〜80 l/s	Sugarcane, vegetables, etc. (approximately 400 ha)
C	Areas with no interference between the wells and with small-scale farmers having the capabilities of organizing groups.	30	15〜30 l/s	Vegetables, melon, watermelon, sugarcane, etc. (approximately 500 ha)
Total		50		

Furthermore, the utilization of groundwater will be don through the following process.

Organization of beneficiary farmers
: The farmers willing to receive water distribution will organize groups and will jointly plan the crops to be planted and cultivation.

⇩

Application to the operational agency
: The group of farmers will apply for the construction of a well to SENARA, the operational agency, with the abovementioned plan appended to the application form.

⇩

Construction of irrigation facilities
: SENARA will examine the abovementioned plan and when admitted, it will implement the operation at the average rate of 5points/year. Construction costs will be paid by the government.

⇩

Operation and maintenance of irrigation facilities
: The group of beneficiary farmers will be in charge of operation and management of the irrigation facilities under the guidance provided by SENARA. The costs for O/M (electricity bill, etc.) will be paid by the beneficiary farmers.

5.3.4 Facility plan

(1) River Pumping facilities

Considering such features as topography, small and medium-scale farmer distribution, location of rivers, etc., of the Study Area, the following two pumping facilities for the intake of river water will be planned in the right bank of the Tempisque.

Name of facility	Location	Area to be irrigated (ha)	Amount of intake (m3/s)
Up-stream pump	Near Finca Monte Claro	1,860 ha	1.0
Down-stream pump	North on Filadelfia City	3,570 ha	2.0

The location of these pumps will be as indicated in Fig. 5.2. Locations of these pumps were chosen upon the following considerations.

- The pump should be located near farmlands with favorable land classification, enabling short water-conveyance distance.
- Considering the distribution of the small and medium-scale farmers, topographical features and performance of water intake, pumping facilities should be installed in two locations.
- The stability of river course and current status of the Tempisque River.
- The existence of access roads enabling easier management activities.
- Location near the beneficiary area enables rational facility placement.
- The scarce housing will cause fewer problems at the time of construction.

a. Summary of pumping facility

The general features of the pumping facilities are as indicated below.

Name of facility		Up-stream pumping facility	Down-stream pumping facility
Planned location		Right bank of Tempisque River Near Finca Monte Claro	Right bank of Tempisque River North on Filadelfia City
Area to be irrigated		1,860ha (Blocks 5,7)	3,570ha (Blocks 9,11,12)
Pumping station	Design discharge	1.0 m^3/sec	2.0 m^3/sec
	Design total head	H=20 m	H=30 m
	Type of pump	Centrifugal pump, Ø500mm 3pumps (1 for reserve)	Centrifugal pump, Ø700mm 3pumps (1 for reserve)
	Motor capacity	Total 450kw (220kw+220kw+10kw) (10kw for motor accessories)	Total 920kw (450kw+450kw+20kw) (20kw for motor accessories)
	Building	Steel construction 273.6 m2	Steel construction 318.4m2
	Operational method	Units and time operation	Units and time operation

Note) pump efficiency:705, motor efficiency: 85% to 90%

The two pumps will operate parallel in both facilities and as for the operational method, the amount of intake will be adjusted by the number of pumps and time of operation. For the pumps are planned to be operating 24 hours daily during the peak period, one of the three pumps will be equipped as reserve in order to enable operational intervals for the other two pumps.

b. Canals

In the beneficial area, main channels will be installed for where water for the area exceeding 1,000ha will be distributed, while branch channels will be installed to where water for the irrigation of 300-1,000ha will be distributed. Furthermore, terminal channels will be installed connecting the abovementioned channels and the areas with irrigation units of 100-200ha, leading to the respective farmlands of the unit. The length of the main and branch channels with the size of 0.5-1.0m3/s, will be approximately 33km as the total of all four routs.

Section	Categorization	Length (km)	Proposed discharge (m^3/s)
Upper-stream pump system	Main channel	7.10	1.0～0.5
	Branch channel	4.15	0.5～0.3
Down-stream pump system	Main water pipe	4.00	2.0～1.0
	Main channel	12.1	1.0～0.5
	Branch channel	5.65	0.5～0.3
Total		33.00	

c. Terminal channels and field irrigation method

Terminal channels connecting the irrigation units of 100-200 ha with the main and branch channels will be installed in order to distribute the water to farmlands of the respective farmers. Considering the forms of the farmlands, the length of the terminal channels will be about 2.0 km/100 ha. Moreover, the flow rate of these channels will be 20-110 l/s (with the average rate of 50 l/s). The crops such as sugarcane and vegetables are to be irrigated. The pipe irrigation method using the gradient of the fields will be adopted for sugarcane in order to improve the efficiency of irrigation. The method is of irrigating the field with PVC pipes placed between the ridges. The tubes will have small holes in order provide water to the field. The tubes will be moved in the field so that the respective areas could be irrigated with a 10-15 days interval. Terminal irrigation will be done with current control corresponding to the cultivation plans of the respective units using gates.

(2) Groundwater irrigation facilities

a. Facility plan

The amount uptake for the respective irrigation systems varies between the areas (zones), depending on the state of the wells. However, the facility plan of this study will be based on 20 l/s as the planned uptake, for the variance is 10-30 l/s.

Scale of facility/point

	Item	Dimensions
Well	Discharge	10～30 l/s(average20 l/s)
	Diameter	8”～10”
	Depth	30～60 m
Pump facility	Type of pump	Submergible 3”～4”
	Related equipment	Filter
Pipe	PVC	PVC φ100～φ50mm

b. Field Irrigation method

Crops such as sugarcane and vegetables are to be irrigated, and irrigation will be done mainly during the dry season. Trickle irrigation, with high efficiency, will be adopted as the method for field irrigation. Trickle irrigation is already used mainly by the large-scale farmers for the cultivation of melon and sugarcane.

(3) Drainage canals

Presently, the Las Palmas River plays the role of the main drainage canal in the right bank. Considering topographical features, branch drainage that will merge with the Las Palmas River shall be installed. The target area for drainage will be the area with topographical features easily leading to inundation that lays along the Las Palmas River. The planned displacement will be the amount of 1/5year probability, corresponding to the river improvement works of Bolson River.

a. Design drainage discharge

The calculation of hourly precipitation with the daily precipitation of 1/5-year probability (123mm) is as follows:

$$It = Id/24 \times (24/t)^{2/3} = 123/24 \times (24/4)^{2/3} = 16.93 \text{ mm/hr}$$

Where,
- It ：maximum hourly rainfall within (t) hours of continuous rainfall, mm/hr
- Id ：designed daily rainfall, mm/day
- t ：continuous rainfall/excluded time

Thus, using the rational method “Q=0.2778*f*It*A”, the peak of displacement will be calculated as,

Where,
- f : runoff rate
- It : rainfall intensity mm/hr

A : Catchment area km^2

$Q = 0.2778 \times 0.55 \times 16.93 \times 0.01 = 0.0259\ m^3/s/ha$

b. Layout plan of drainage canal

Drainage canals routes are planned mainly for the small and medium-scale farmers of the area capable of prompt drainage at times of floods.

Drainage Plan

Route	Drainage area (ha)	Design discharge (m^3/s)	Length (km)
D-1	220	5.7	1.8
D-2	280	7.3	2.3
D-3	210	5.4	1.7
D-4	250	6.5	2.2
D-5	300	7.8	2.0
D-6	200	5.2	1.8
Total			11.8

The structure of the drainage canals will be an earth drainage canal with the depth ranging from 1.0 to 2.0m. Furthermore, there will be 6 branch drainage canals with the total extension of 11.8 km.

5.3.5 O/M Plan

Plans for O/M of the facilities were made regarding the methods for O/M and steering body as one body, in order to perform O/M of the irrigation facilities (pumps for river water, wells and channels). O/M of the facilities will be done by placing a division for irrigation and drainage in the office newly established for the implementation of the project and O/M activities. The personnel will be provided mainly from SENARA. For the time being, the operational agency will be in charge of the management of all of the facilities. However, the obligation are planned to be transferred to the water management unions in the future. The methods for the O/M of the respective facilities are as indicated below.

(1) Pumping facilities for river water

The management of water will be done consistently by the operational agency, from the pump to the terminal channels. The items periods of the management activities are as indicated below.

Facility	Major items of management activities	Period of execution
Pumping facilities	-Management of facilities in the pump yard -Management of pump operation -Management of console panel and power receiving	Regular inspection and management (2 times per year) During pump activation Regular inspection and management(2 times per year)
Main/branch channels	-Management of channel facility -Management of water distribution (water flow)	Regular inspection and management (about twice/year) Constantly (during pump activation)
Terminal channels	-Management of channel facility -Management of water distribution (water flow)	Regular inspection and management (about twice/year) Constantly (during pump activation)

(2) Wells

During the period right after installation, the management of the water will be done consistently by the operational agency, from the pump to the respective farmers. The operational agency will continuously support the farmer's organizations until they accumulate ample experience and ability.

(3) Strengthening of water users organizations

This plan aims for the improvement of farming through the strengthening of farmer's organizations. And therefore, in the future, the farmer's organizations of the areas where irrigation will be introduced are expected to acquire functions as water management organizations. In order to achieve this condition, it is proposed that SENARA shall provide technical guidance to enable transfer in the future.

However, the water management operations being complex, SENARA shall be providing water and guidance for the irrigation area to the respective farmers for the time being. SENARA will also be in charge of the water distribution in the terminal channels to the respective farmers, but this will also be proposed to be gradually transferred to farmer's organizations (water management organizations), from the blocks with these organizations established. Estimating the period for the adoption of this project and the period for construction as a total of four years, this shall be the preparation period. Including this period, the schedule of transfer and necessary activities of SENARA is assumed as indicated below. The transfer shall not be done at once, but gradually aiming at the target year, considering technical difficulties.

Transfer schedule for water management of the terminal channel system

Issues of activities	Preparation period (4 years)	First 5 years after the introduction of irrigation	Second 5 years after the introduction of irrigation	Beyond 10 years after the introduction of irrigation
i. Organizing of farmer's organizations (water management unions) - Organization of farmer's organizations to be the base of water management unions	———			
ii. Training of water management techniques - Training of basic techniques for water management - Amount of water consumption of respective crop - Seasonal and organizational water usage	———	———		
iii. On-site guidance - Guidance for gate operation - Idea of hourly water supply - Idea of organizational water supply		———	———	
iv. Joint management with farmers - Joint water distribution management by farmer's organizations and SENARA			———	
v. Management by water management unions - Water distribution management by farmer's organizations.			———	———

Furthermore, the employment of personnel for management may be regarded for certain blocks after transfer.

5.4 FLOOD PROTECTION

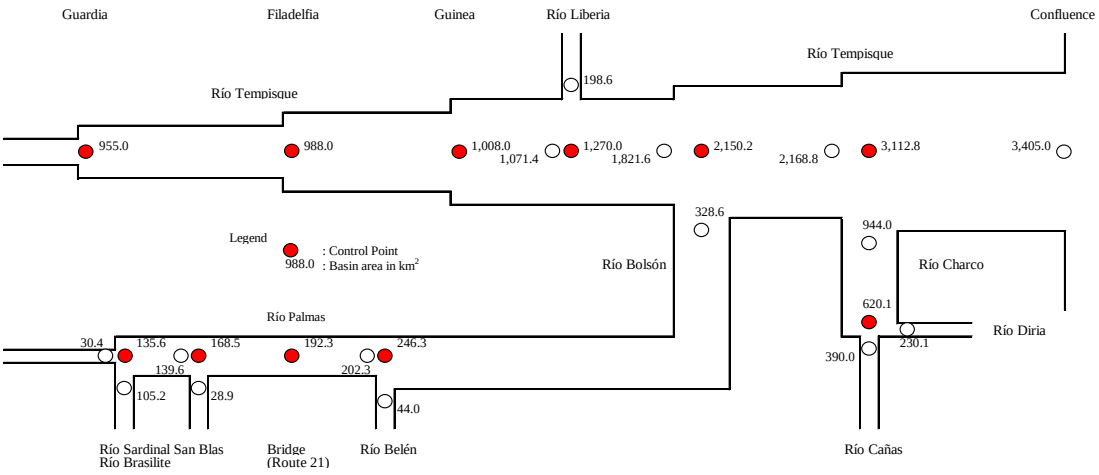
As mentioned in Chapter 4, the objective of this flood protection plan is “achievement of sustainable agricultural development of small and medium scale farmers” and the plan aims to protect the agricultural land from flood damage (to mitigate the inundation damage) which inference the big impact for improvement of faming practice of small and medium scale farmers, therefore, the countermeasures for the perfect flood control is not suggested in this study. Based on this basic development concept, the plan will be formulated with following procedures.

- The calculation of design-flood discharge and the definition of the control point, which will be the basis of the protection plan.
- The assumption of flooded area and water depth at the state of design-flood discharge.
- The planning of river improvement works and definition of dimensions for the raising of roads based on the figures obtained from the abovementioned.

5.4.1 Planning conditions

(1) Control Point

Concerning the conditions of the study area and its surroundings, such as accumulation of population and assets, distribution of damage occurrence, narrow sections of river course and points of confluence, the control point for flood protection is set for 11 points; 6 points in the Tempisque main river course (Guardia, Filadelfia, Guinea, confluence at Liberia, Bolsón, Charco), 4 points in the Palmas- Bolsón river basin (confluence at Sardinal-Brasilite, San Blas, Belén, bridge at Route 21) and 1 point in the Cañas-Charco river basin (confluence at Diria river). Location on the river diagram and basin area at each point is as follows;



River diagram

(2) Design Flood Discharge

A model of Rainfall-Runoff was constructed to estimate the basic flood runoff at each control point. The model was constructed based on the Series-Tank-Model, which represents the runoff mechanism of the basin with a combination of several storage type tanks. Using the area and observed runoff of Guardia observatory. Basic rainfall at each control point was set up with the rainfall estimated by the Thiessen Polygon. Continuous 3-days rainfall is adopted as the basic rainfall for the study. As for the rainfall pattern of the observed data on continuous 3-days rainfall, position of peak rainfall was considered to be located in the center of the period. No compilation is made regarding the hourly rainfall at the respective observatories, therefore, rainfall intensity in the basin was calculated from

daily rainfall. Based on the continuous 3-days rainfall and rainfall intensity, hyeto-graph of rainfall in each probable year is set up by means of Talbot equation. As for the results, the peak of floods at the respective points were as indicated below. The "Up-stream" and "Down-stream" indicated in the following chart represents the section before and after confluence, respectively.

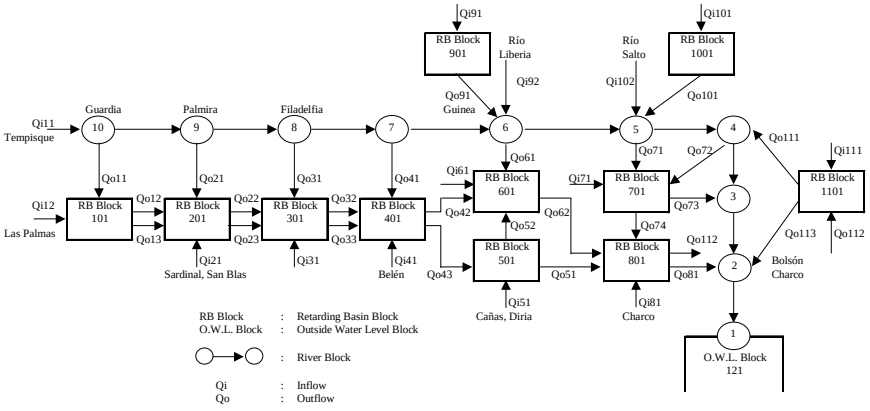
Flood discharge for each probable year

Unit : m^3/sec

Location		Basin No.	Basin Area (km^2)	Probable Year 1/5	1/10	1/20	1/30	1/50
Río Tempisque								
Guardia		1.2	955,0	921	1276	1730	1970	2347
Filadelfia		3	988,0	950	1318	1786	2036	2437
Guinea		4	1008,0	969	1344	1801	2077	2478
	Upstream	5	1071,4	1023	1403	1913	2183	2609
Río Liberia		6	198,6	179	250	338	381	450
	Downstream		1270,0	1165	1599	2200	2492	2977
	Upstream	7	1821,6	1587	2170	2928	3348	3975
Río Bolsón		15	328,6	300	438	596	685	823
	Downstream		2150,2	1861	2526	3439	3930	4679
	Upstream	16	2168,8	1877	2547	3469	3960	4719
Río Charco		19	944,0	838	1168	1624	1859	2234
	Downstream		3112,8	2629	3564	4937	5597	6696
Confluence		20	3405,0	2863	3822	5244	5934	7152
Río Palmas-Bolsón								
	Upstream	8	30,4	33	46	62	70	83
Río Sardinal-Brasilite		9	105,2	109	160	220	252	304
	Downstream		135,6	138	199	270	310	374
	Upstream	10	139,6	142	201	278	319	384
Rio San Blas		11	28,9	33	47	64	73	87
	Downstream		168,5	168	243	334	381	458
Bridge(R21)		12	192,3	187	273	375	431	514
	Upstream	13	202,3	196	285	390	447	535
Río Belén		14	44,0	51	74	103	117	144
	Downstream		246,3	241	344	475	548	656
Confluence		15	328,6	300	438	596	685	823
Río Cañas-Charco								
	Upstream	17	390,0	396	578	814	945	1152
Río Diria		18	230,1	212	306	416	478	572
	Downstream		620,1	582	853	1187	1371	1668
Confluence		19	944.0	838	1168	1624	1859	2234

(3) Inundation by flood

A model was constructed for the computation of the flooded area at the occurrence of the probable foods. The model was constructed by dividing the Study Area into several blocks (retarding basin blocks) regarding the locations of roads and dykes in the area. In this case, the river its self also represents a single block. The relation of the blocks are substituted by structures reflecting the actual status and capable of hydraulic calculation (pumps, channels, conduits, siphons, etc.). Then the blocks are connected so that water could move through the blocks. The diagram of the model is as indicated below.



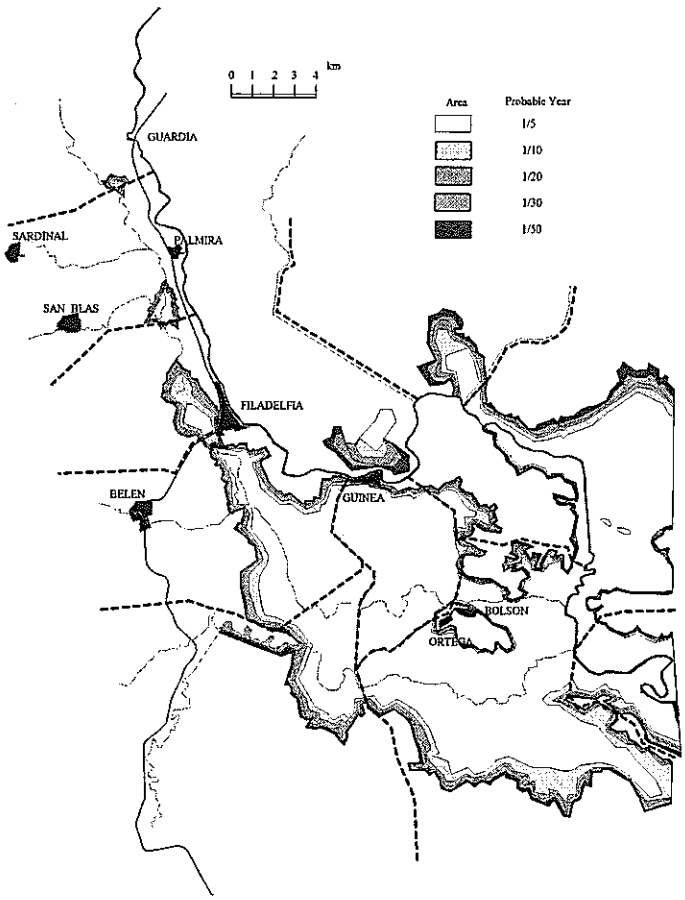
Flood analysis model

For the verification of the model, the hydrological features and flooded area of hurricane Floyd (1999) was used. In the verification process, the relations between the blocks were alternated, and consistency of the computation and actual status was studied. The sum of square differences of the adopted model was below 0.03. According to the model, the flooded area and water depth at the occurrence of probable floods at the return periods of 5, 10, 20, 30 and 50 years are as indicated below.

The results of flood analysis

Retarding	Lowest	1/50		1/30		1/20		1/10		1/5	
Basin Block	E.L. in RBB	Max. W.L.	Max.Area	Max. W.L.	Max.Area	Max. W.L.	Max.Area	Max. W.L.	Max.Area	Max. W.L.	Max.Area
(RBB) No.	(m)	(E.L.m)	(ha)	(E.L.m)	(ha)	(E.L.m)	(ha)	(E.L.m)	(ha)	(E.L.m)	(ha)
101	21.5	23.9	54	23.7	47	23.6	42	23.3	32	23.1	23
201	18.0	20.0	181	19.9	170	19.8	163	19.6	150	19.5	137
301	8.0	14.3	598	14.2	574	14.1	548	13.4	352	12.9	180
401	5.0	10.4	2615	10.2	2570	10.1	2529	9.8	2329	9.4	2106
501	5.0	10.4	1570	10.2	1537	10.1	1507	9.8	1363	9.4	1258
601	4.0	10.4	3092	10.2	3087	10.1	3083	9.8	3060	9.4	3034
701	6.0	10.3	1023	10.2	935	10.1	856	9.7	745	9.4	666
801	2.0	10.3	8953	10.2	8765	10.1	8592	9.7	8224	9.4	7899
901	7.5	9.7	665	9.4	560	9.1	480	8.6	339	8.2	206
1001	5.0	10.3	787	10.1	680	9.8	592	9.2	483	8.4	350
1101	2.0	10.3	6451	10.1	6283	10.0	6136	9.7	5887	9.3	5653
Total			25989		25208		24528		22964		21512

The flooded area indicated in the chart is plotted as the following figure.



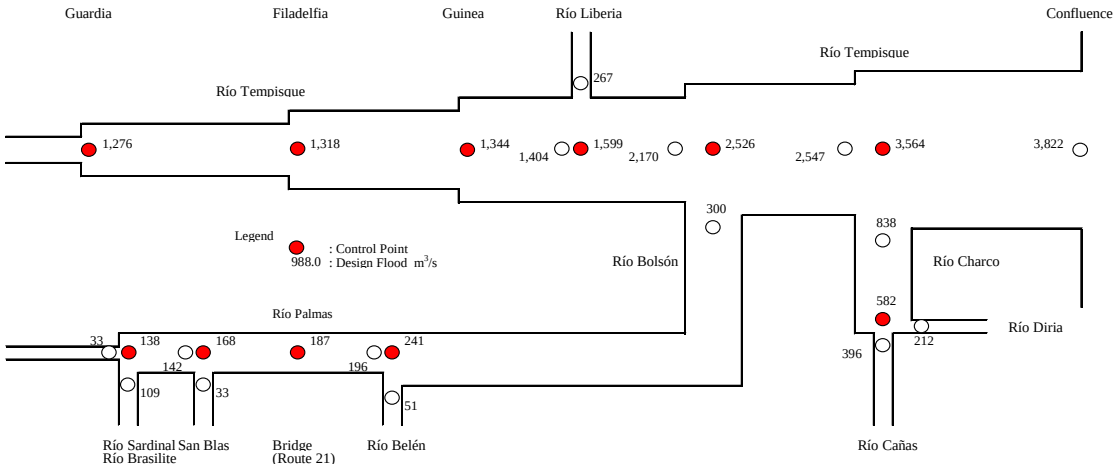
Inundation area map

(4) Objective and areas of the flood protection

The targets of flood protection are the farmlands, communities and infrastructure spreading in the downstream basin of Tempisque River. By the implementation of the protection plan, extent of flooded areas and the impact of floods upon residential life will be reduced.

5.4.2 Improvement plan of river course

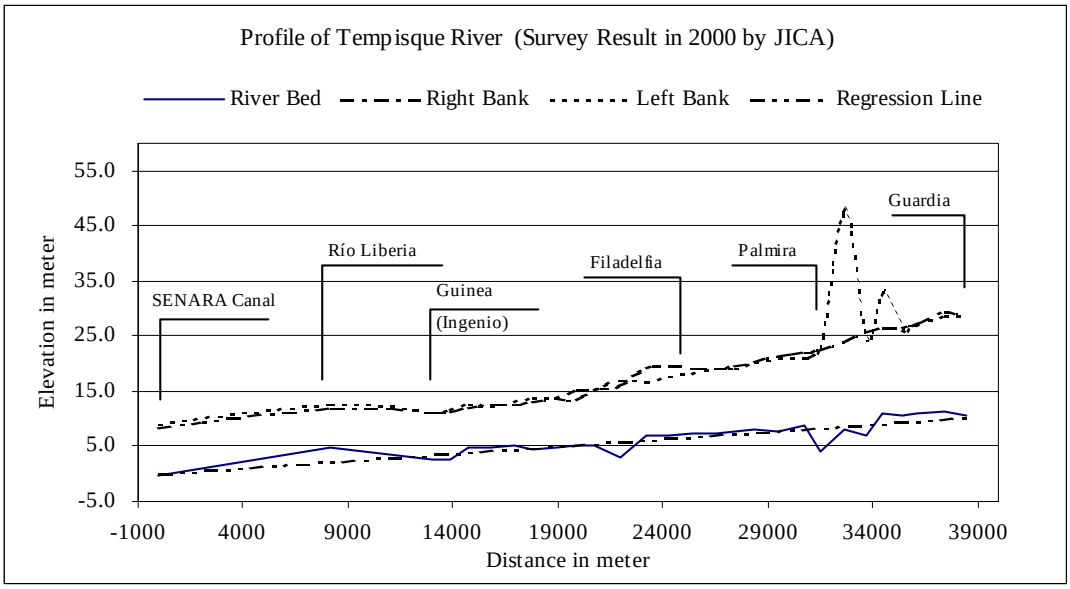
Design flood discharge for the plan is shown below. The discharges of the Tempisque and Liberia rivers are for 10 years return period and that of others are for 5 years return period.



Design discharge of each control point

(1) The Tempisque River

The profile of the Tempisque River, from the SENARA drainage canal to Guardia is shown below.



Profile of the Tempisque river

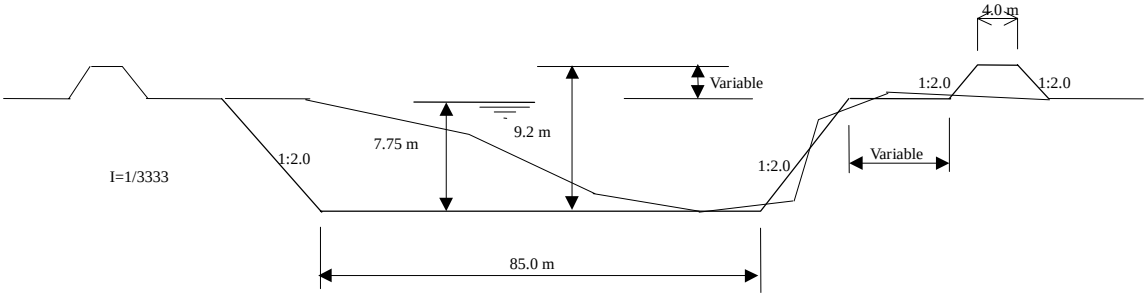
Approximation curve of the riverbed based on the actual height of the riverbed is y = 0.0003X+3.1498 and therefore, the longitudinal slope of the river is 1/3333. Improvement of river course of Tempisque River will be from Guardia to SENARA canal with the planned capacity of the flood discharge of 10 years return period. The existing flow capacities of the respective points, estimated from the

longitudinal slope and river profile, are as indicated below. As for the codes in the chart, C.S.No. stands for “river section No.”, R. and L. for the elevation of the left and right bank respectively, R.B. for the elevation of the riverbed, and $Q_{1/10}$ for the flood of 10 years return period.

Maximum flow discharge

Location	C.S. No.	Elevation (m)			W.D. max	Flow Area	Velocity	Qmax	$Q_{1/10}$
		R	L	R.B.	(m)	(m2)	(m/s)	(m3/s)	(m3/s)
SENARA Canal	37	8.30	9.53	-0.29	8.59	565	1.31	740	1599
Río Liberia	45	12.20	13.46	4.72	7.48	856	1.29	1059	1599
Guinea	51	11.26	11.73	2.77	8.49	389	1.00	388	1344
Filadelfia	61	19.71	17.86	6.98	10.88	957	1.76	1686	1318
Palmira	68	23.18	22.54	18.31	18.31	1535	1.86	2861	1276
Guardia	75	28.31	28.71	17.79	17.79	1274	2.40	3178	1276

The section from Guardia to Filadelfia is capable of discharging the flow of the flood of 10 years return period. However, the flow capacity is deficient from the down stream of the dykes in Filadelfia. At the downstream of Guinea (Ingenio), the improvement works (capable for the flood discharge of 10 years return period) is under construction by SENARA. Therefore, the section requiring improvement is from Filadelfia to Guinea (Ingenio) (9km). The necessary cross section is as indicated below.

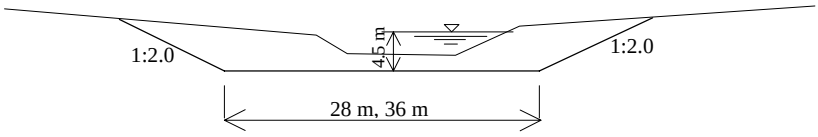


Proposed section of Tempisque river

The hydraulic dimensions are A=779 m2, V=1.725 m/s, R=6.51 m, Q=1344 m3/s. In the plan, the present riverside will be used as the low flow bed and the dike on the left bank will be left as the actual status. In case of the elevation of the right bank is not enough, embankment will be done. Freeboard will be set for 1.0 to 1.5 m.

(2) The Palmas - Bolson River

Based on the basin division map, the design flood discharge of the Palmas River between the confluences with Belén river and Estero Caballos is set as 241 m3/s, and that from the confluences with Estero Caballos to Puerto Ballena is set as 300 m3/s. Based on the topographic map (1:10000) and the results of the topographical survey conducted in this study, the river slope is set at 1/2000. The cross section of the Palmas and Bolson rivers adopted in this study is as indicated below.



Proposed section of Palmas - Bolson River

With the design discharge of 241 m^3/s, the width of low flow bed will be 28 m, and when 300 m^3/s it will be 36 m. The hydraulic dimension of the respective cross sections are as indicated below.

Dimensions of Proposed section of Palmas - Bolson River

Design Discharge m^3/s	Base Width m	Water Depth m	Flow Area m^2	Velocity m/s	Calculated Discharge m^3/s
241	28	4.476	165.4	1.457	241
300	36	4.463	200.5	1.496	300

Moreover, the section between the confluence with Belen River and the confluence with the Sardinal will not be planned for river improvement for the following reasons. The present flood damages of this section characterized by the flooding of the Bambú district of Filadelfia city. The implementation of the plan of raising Route 21 will reduce the damage of the floods up to 20 years return period. Therefore, the river improvement of the up- and mid-stream of the Palmas River for the protection of Bambú district is not highly necessary. Furthermore, the damages to the housings located on the west side of route 21 near Filadelfia city has the possibility to be reduced.

The inundation of lower part of Palmas river, there is no good countermeasures because the ground elevation is absolutory low. The river range of improvement is decided considering that the inundation damage is decreased with reducing the peak flood discharge at lower part coursed by inundation at upper part and the land us at upper part of inundation area is already considered the inundation. According to analysis results, the maximum capacity of the improved section of the river (RBB201 and 301) will be approximately 3.8 MCM for the flood of 5-year return period, and 6.0MCM for the flood of 10 years return period. These figures refer to the amounts of flood regulation at RBB201 and 301. The maximum capacity of RBB401, where the waters of RBB201 and 301 flows in, is 30MCM for the flood of 5 year return period and 38MCM for the flood of 10 years return period. This means that the maximum capacity of RBB401, which is located in the downstream of the improved section increases at a rate of 15% due to the extension of the river improvement section. Therefore, the improvement works in the upper part from river confluence at Saldinal will increase the inundation damage of lower part, so, it is not recommendable.

Furthermore, in case river improvement works are done between the confluences with Belen River and Sardinal River, the scale of the construction works will be as shown below.

The scale of the construction works for the section from Belen River to Sardinal River

Section	Length (km)	Capacity (m3/s)	Width of low flow bed (m)	Depth (m)	Remarks
Belén ～Bridge(R21)	4.0	196	25.0	4.215	
Bridge(R21) ～San Blas	7.0	187	25.0	4.106	One bridge
San Blas ～Sardinal	4.0	142	20.0	3.919	
Total	15.0				

The figures will be 1/5year return period for floods, 1/2000 of earth canal gradient for planned cross sections and 1:2 gradient for the side of the channels.

The coefficient of roughness for hydraulic calculation is 0.035.

The required budget of the construction works (15km of riverbed excavation and construction of one bridge) is approximately US$1,500,000 (excavating 0.3 million m3 of riverbed; US$900,000 construction of one bridge; US$ 600,000) as for the direct cost for construction. Considering the abovementioned, it is determined that the river improvement works of the upstream of the confluence with Belen River has only low benefit/cost performances.

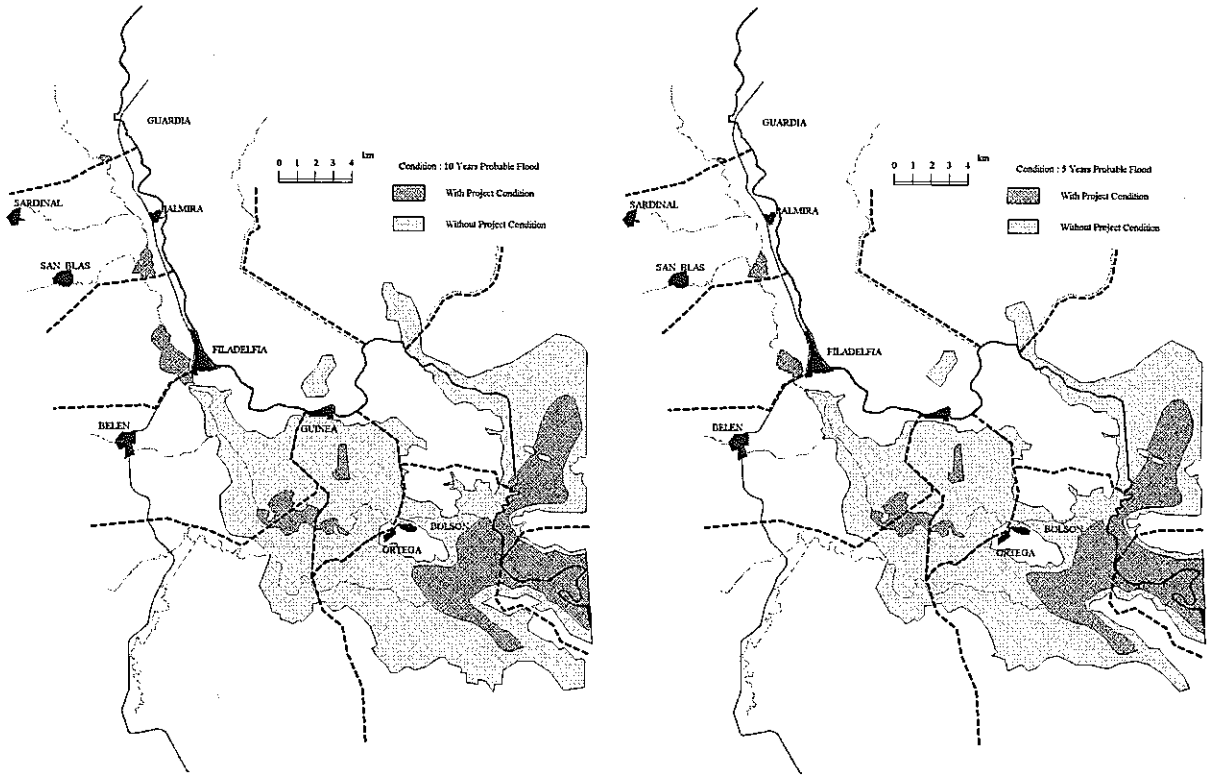
(3) Effect of improvement of river course

The effect of the improvement of the Palmas - Bolson river course (including the improvement of the river course of Tempisque below the point of Guinea done by SENARA) were analyzed with the discharges of the floods with the return periods of 5 and 10 years, and the abovementioned river sections. The results of the calculation are as indicated below.

Effect of improvement of river course

Retarding Basin Block (RBB) No.	Lowest E.L. in RBB (m)	1/10						1/5					
		Without Project		With Project		Difference		Without Project		With Project		Difference	
		Max. W.L. E.L. m	Max. Area ha	Max. W.L. E.L. m	Max. Area ha	Max. W.L. E.L. m	Max. Area ha	Max. W.L. E.L. m	Max. Area ha	Max. W.L. E.L. m	Max. Area ha	Max. W.L. E.L. m	Max. Area ha
101	21.5	23.3	32	23.3	32	0.0	0	23.1	23	23.1	23	0.0	0
201	18.0	19.6	150	19.6	150	0.0	0	19.5	137	19.5	137	0.0	0
301	8.0	13.4	352	13.4	352	0.0	0	12.9	180	12.9	180	0.0	0
401	5.0	9.8	2329	6.3	415	-3.5	-1914	9.4	2106	6.3	390	-3.1	-1716
501	5.0	9.8	1363	6.3	258	-3.5	-1105	9.4	1258	6.2	240	-3.2	-1018
601	4.0	9.8	3060	5.1	220	-4.7	-2840	9.4	3034	5.0	129	-4.4	-2905
701	6.0	9.7	745	6.4	53	-3.3	-692	9.4	666	6.3	45	-3.1	-621
801	2.0	9.7	8224	5.0	3894	-4.7	-4330	9.4	7899	5.0	3837	-4.4	-4062
901	7.5	8.6	339	8.6	336	0.0	-3	8.2	206	8.2	202	0.0	-4
1001	5.0	9.2	483	7.7	226	-1.5	-257	8.4	350	6.2	93	-2.2	-257
1101	2.0	9.7	5887	5.0	1793	-4.7	-4094	9.3	5653	4.9	1730	-4.4	-3923
Total			22964		7729		-15235		21512		7006		-14506

With the implementation of the plan, the impacts of the floods are largely reduced. As described in the figure below, most of the areas still being flooded after implementation are the areas near the confluence of the rivers of Bolson-Charco and Tempisque, and are also frequently flooded at the actual state due to the low elevation.



Expected effect for mitigation of inundation

5.4.3 Plan of raising trunk roads

In order to prevent the isolation of the communities during floods, the raising of the existing trunk roads are planned. The height of the raised roads will be decided corresponding to floods with the return period of 20 years. The range of the plan is as indicated below.

Proposed construction sites

Site	Length（km）	Remarks
Filadelfia - Belén	6	1 bridge
Filadelfia - Corralillo	10	-
Palo Blanco - Guinea	5	-
Corralillo - El Viejo	4	1 bridge
Had El Viejo - Bolsón	3,5	1 bridge
Total	28,5	3 bridges

From the analysis of the floods, the design height of the respective roads with a free board from 1.0 to 1.5 m is as indicated below.

Design Height

Site	Length (km)	W.L. at Flood (E.L. m)	Design Height (E.L. m)
Filadelfia - Belén	6	14.1	15.1 ～ 15.6
Filadelfia - Corralillo	10	10.1	11.1 ～ 11.6
Palo Blanco - Guinea	5	10.1	11.1 ～ 11.6
Corralillo - El Viejo	4	10.1	11.1 ～ 11.6
Had El Viejo - Bolsón	3,5	10.1	11.1 ～ 11.6

5.4.4 Proposals on urbanization control and alert systems

As a part of its soft components, this plan autonomously proposes the following suggestions from the viewpoint of disaster prevention for the agricultural areas. Though the followings shall be effective upon flood protection, they shall be handled as proposals and shall not be included in the plan itself.

(1) Urbanization control considering floods

The existing plans for flood protection of Filadelfia city are summarized as follows;

The plan is of practicing urbanization control against the floods from the Tempisque by establishing four categories of endangered areas. The categorization of the areas are as indicated below.

Area 1: Area endangered by the floods from Tempisque River
Area 2: Area endangered by the floods from Las Palmas River
Area 3: Areas highly endangered at times of dyke break
Area 4: Areas moderately endangered at times of dyke break

Area 3 is the area within 15 meters from the dyke, and existing residences are planned to be relocated while the construction of new ones are restricted. Relocation is also planned for the residences located extremely close to the rivers within Area 1 and 2. Area 4 is the area within 50 meters from the dyke and construction of new residences are recommended to refrain. The roles of the areas at the time of dyke break are defined for Area 3 and 4 in order to protect the residents. The distance from the dykes should be determined considering the impacts of excavation to the weight balance of the dyke and impacts of the existence of structures on seepage faces, along with the consideration of the impacts on the stability of the dyke, when structures are constructed adjacent to the dyke. Generally, it is said that the structure will not influence the dyke as long as it stands outside of the 1:2 gradient line drawn from the base of the dyke. From this point, the regulations set by Filadelfia city on Area 3 and 4 are appropriate, and these regulations should also be kept for the newly constructed dykes.

(2) Alert system

The evacuation of residents are induced by fire department announcing the necessity of evacuation when observing rising of the water level of the river. Automatic alert systems reacting to the water level in required to ensure and speed evacuation. The water level indicator equipped within this study records the datum in the data-logger as digital information. Therefore, utilizing these indicators,

systems automatically sending alerts at times of high water level can be easily constructed. Accordingly, in order to ensure and speed evacuation, it is desirable to equip alert systems linked to water level indicators to the areas near the rivers of the key communities, such as Palmira, Filadelfia, Guinea, Bolsón and Ortega.

5.4.5 O/M plan

O/M of the facilities will be performed by placing a division of irrigation and drainage in the office newly established for the implementation of the project and O/M activities. Necessary personnel will be mainly of the loan employees from MOPT and CRE. Annual plans for the performance of satisfactory maintenance of the facilities will be made and necessary allocations of budget will be granted. Regular or spot inspections will be necessary for the O/M of the constructed facilities. The issues and period of these inspections will be set as indicated below.

Facilities	Main issues of inspection	Period of inspection
Rivers and dykes	Subsidence of the dyke, distortion, seepage, vegetation of the slopes, river bed evolution	Regular inspection before floods Inspection after floods and earthquakes
Roads and bridges	Subsidence of road surface, break down, slide soil, breakage of road shoulders and roadsides, breakdown of slopes, extrusion, breakage of the handrails of bridges	Regular inspection before the rainy season Inspection after deluges and earthquakes

5.5 ENVIRONMENTAL CONSERVATION PLAN

5.5.1 Objective of the Plan and the development strategies

In order to achieve the sustainable agriculture development of small and medium producers, it is necessary to take actions during the execution of the physical works to assure the minimum effect on the natural environment. Furthermore, it shall be determined the measures necessary to avoid the deterioration of the environmental conditions of the zone during the process of increase and improvement of the productive system, that actually determine an integral sustainable development of the Study Area and the surroundings. Therefore, the actions of the Plan of Environmental Conservation shall be focused not only at the Study Area, but also rather to the totality of the hydrographical basin of the Tempisque River.

Since the human activities are the ones that cause the greatest impacts on the environment, the consciousness of the population on their responsibility and of the necessity of active participation in actions tending to preserve the environment surrounding them, constitute a fundamental element to maintain or improve the existing environmental conditions and to make sustainable the productive development proposed in the present Project. Therefore, the project will not be sustainable and there will not have a positive impact if the actions designed for such ends are not carried out based in the consciousness of the community. So, as a first step to be taken, the present Plan recommends first of all to “reinforcing the consciousness of the community in the management of the basin”.

Also, it is important to implement effective measures to the latent problems, for though they are not manifesting today, they could have some impacts over the environment in the future. As an example, presently, the eventual problem of possible overdoses of agrochemicals going with the agriculture production of the basin has not been methodically investigated. Neither has been clarified the incidence of the Tempisque River basin’s residual waters on the contamination of the Nicoya Gulf, nor the possible contamination and over exploitation of some sectors of underground water have been investigated. The monitoring has to continue through the years and actions have to be taken in the face of the eventual problems such as the aforementioned and others that still do not have a judgment concerning the environmental impact towards the future. The Actual Project proposes four actions to be taken, namely “the consciousness of the population in the management of the basin”, “the extension of eco-friendly agriculture techniques”, “the recovery of the maintenance flow of the river” and the “conservation of underground waters”.

However, presently there are not enough information or data to serve as base to design the particular measures, being necessary to carry out previously the systematic environmental monitoring and to analyze and to study the actual conditions of the zone, to adjust the corresponding actions accordingly to the results. In accordance to the above the Plan of Environmental Conservation includes the "monitoring execution", in all such aspects considered fundamental for the fulfillment of the goals of the present Plan.

5.5.2 Development of consciousness on the management of the basin

(1) Objective

The conservation and improvement of the environment require the active and effective participation of the population of the zone and the actions shall start from the initiative of the own local inhabitants. That means, it is necessary to create a consciousness that they are the ones that must protect the environment in order to assure their living conditions. For that, it is required that each one of the local inhabitants acknowledge the importance of defending their surroundings, and that it is difficult to attain the objective only with legal regulations, etc. To maintain the activities of the basin's nature conservation, the reinforcement of consciousness in the management of the basin and the obtaining of the consensus among the distinct organizations, including the public institutions, and the families are required. The actual Plan has as objectives the improvement of the consciousness level in the management of the basin as a whole by the party of the community of the Tempisque River basin.

(2) Contents of Plan

For the reinforcement of consciousness in the management on the basin on the part of the community, it is important to know the change on the level of consciousness caused by the training, motivation and consciousness actions carried out in the framework of the Plan, so the execution of periodical pools and the timely analysis on the type of activities to be carried out based on the results are proposed. Basically, the actions shall constitute in the sensitization of the community in the "acknowledgement of the present conditions on the environment and the necessity to preserve them, and of the minimal alteration of the conditions of the same as consequence on infrastructure works and the productive development actions to be conducted", to which would be aggregated the support of pro-environmental activities generated from the same community.

1) Study on the change of consciousness of the local population (pools)

- To carry out periodically pools in order to know the change in the consciousness of the community. The pools shall be directed to 400 families, applying a significance rate of 95%.

2) Enlightenment activities for inhabitants

- Prepare and distribute the prospects, pamphlets, and/or any other type of material appropriate to divulge and transmit the environmental information to the community. The type of information to be divulged shall be defined based on the results of the pools, on the monitoring and on the progress of the distinct actions proposed in the present Plan that shall be reviewed and eventually renewed at least once a year. The information shall be distributed to the relevant institutions, academic centers, communitarian organizations for the analysis and eventual contribution to the process.
- Training teachers of primary and secondary schools in the environmental issue to widely impart the environmental education since the early years. The issues shall include, among others, the situation and projection of the local environment, measures to be taken, environmental education methodology. At least fours courses a year shall be organized, gathering around 30 participants to development environmental issues of communitarian interest.
- Organize seminaries with environmental issues, mainly directed to the representatives of the community, but also, other members of the community shall participate, in such a way that the environmental formation shall be generalized, and also shall promote the emergence of new community representatives trained by the moment they assume such functions. The seminaries shall be organized on a continuous basis with a frequency of twice a year, gathering around 200

persons. Also it shall be requested the participation of NGOs, including the OET.

3) Support to the environmental conservation activities of the community

- Provide support to the activities to be carried out by the local community, to their initiative in this issue, in events such as reforestation campaigns, cleaning of rivers and channels, recollection of solid waste, improvement of latrines, etc. The support shall consist in advisement, supply of information, mediation, assignment of human and economic resources eventually available for such purpose.

5.5.3 Extension of eco-friendly cultivation techniques

(1) Objective

To the date it has not been verified that the use of agro-chemical is causing a serious impact to the environment .The impact of the change of modalities on farms' management in the framework of the actual Project is neither substantially different to the present. However, it is important to make efforts to minimize the environmental burden produced by the agrochemicals, and to supply the market with safe agricultural products by the reduction on the dosage of chemicals and encouraging and developing the organic cultivation, as a way to maintain the quality of the environment and the quality of life of the community. In this sense, the present Project shall have as objective to extend the sustainable practice of eco-friendly cultivation techniques.

(2) Contents of the plan

The application of eco-friendly cultivation techniques would not be sustainable it there is not a clear interest and initiative on the part of the same producers. In this sense, the promotion of exchange of opinions among the local population is proposed, incorporating the issue of "eco-friendly agriculture" into the sensitization campaign in order to divulge among all producers the importance of said practice, including in the process not only small and medium producers but also large producers.

Additionally, it is necessary to optimize the use of agro-chemicals and to substitute such that could cause problems by safer ones, without deteriorating the profitability of the farming activity, which set up the necessity not only of improving the cultivation techniques, such as the use of agro-chemicals, handling methods, etc, but also of establishing commercialization strategies, taking as advantage the aggregated value of products cultivated with eco-friendly techniques. In this sense, it is proposed to incorporate in the training program of the technical extension and producers, the issue of handling and reduction of agro-chemical dosage and of the organic agriculture, in coordination with the Plan of Reinforcement of Support to Producers. The experts in the management of farms shall offer advice and consultancy on commercialization strategies of agriculture products cultivated under such modality. Such actions shall be included in the component extension of technique of the Plan of Reinforcement of Support to Producers.

5.5.4 Recovery of River Maintenance Flow

(1) Objective

There is no water for 40 days at SENARA Canal in every two years statistically. The reason is that people use water without considering maintaining the river flow downstream in the dry season. It is necessary to recover the river maintenance flow for keeping the purification function of river water, the good offer landscape and the ecosystem in surrounding areas. These functions are inherent in a natural river. An extra ($1.5m^3/s$) of river flow needs to be added to the system. The reasons are as follows.

In the dry season (March and April), the total allocated water rights are the same as the total water flow of the Tempisque River. Recovering the maintenance water flow is a difficult problem in this situation. The limited river flow for conservation of the landscape, preservation of biology and maintaining water quality (under BOD10mg/l、20mg/l) were estimated as follows;

River Flow and required Maintenance Flow in March and April (m3/s)

Section (Section Length)	Edge on upper reaches of the study area ～Guardia (km)	～Guinea (30km)	～Rio Liberia (10km)	～SENARA Canal (5km)	～Palo Verde (5km)
Existing river flow ①	8.8	7.6	3.7	1.7	0.9
Water rights ②	1.2	3.9 (CATSA3.4)	2.0 (Viejo2.0)	0.8 (Pelon0.8)	-
Final river flow ③＝①-②	7.6	3.7	1.7	0.9	0.9
Conservation of the landscape	7.2	7.2	4.0	2.3	1.5
Preservation of biology	0.8	0.8	2.1	1.5	1.5
Keep BOD10mg/l		5.1	5.4	7.2	7.2
Keep BOD20mg/l		2.6	2.7	3.6	3.6

Note: Quantity for conservation of the landscape needs the situation that water surface cover the 60% of river width. Quantity for the preservation of biology needs the situation that crocodiles, frogs, wild bird etc. are inhabitable. BOD10mg/l means anyone don't feel discomfort (River Water Quality Standard in Japan). BOD20mg/l was measured on February in 2001.

Annual average flow of the Tempisque River is approximately 30m^3/s. River flow decreases in the dry the season (March and April), however, water usage does not decrease during this season. It is difficult to satisfy all conditions in short term. Therefore, the aims of the plan were decided as follows;

- To at least maintain river flow for the preservation of the biology.
- Residence should agree to use water conservation measure to reduce the wasteful user of the resource.

The amount of river flow needed for the preservation and planned river flows are as follows;

Required maintenance flow and proposed River Flow in March and April (m^3/s)

Section (Section Length)	Edge on upper reaches of the study area ～Guardia (７km)	～Guinea (30km)	～Rio Liberia (10km)	～SENARA Canal (5km)	～Palo Verde (5km)
Amount of river flow needed for the preservation	**0.8**	0.8	2.1	1.5	1.5
Existing river flow	7.6	3.7	1.7	0.9	0.9
Existing water rights	1.2	1.4	0.6	0.2	
New water rights	-	3.0	-	-	-
Supplemental river flow		(1.5)		-	-
Planning river flow	7.6	3.2	2.6	2.4	2.4

In addition, it is necessary for people in Tempisque River basin to agree on saving water and maintain the river flow.

(2) Contents of the Plan

1) Supplemental Water Flow (1.5m^3/s)

The authority for water rights (4.5m^3/s) should be transferred to SENARA. SENARA will control the water (1.5m^3/s) included in 4.5m^3/s and discharge it into the river. According to this, the minimum amount of river flow needed for the preservation of biology should be kept at the SENARA Canal. The SENARA Canal has no water in every two years at present.

2) Consensus building for river maintenance flow

Campaigns that highlight the need for maintaining the river flow should be carried out. In addition, this campaign should include make people aware of the need for river basin management and activate discussion among the people.

5.5.5 Groundwater Conservation

(1) Objective

Underground water is expected to remain abundant in the Study area. This plan expects (1m3/s) of underground water to be used for irrigation. However, monitoring of the underground water needs to

occur to forecast problems in regards to its sustainable use.

(2) Contents of the Plan

Monitoring of water levels in wells in the Study area should be carried out to ensure the underground water is used sustainable. Details of the monitoring will be described in the monitoring plan section. Hearing for the pumping from existing wells will be carried out also.

Yearly variations of water levels of wells in the Study area should be analyzed. When problems occur (for example: decrease of water level, decrease pumping ability) SENARA should make countermeasures (for example: restriction of the pumping volume, stop the new development).

5.5.6 Monitoring Plan

(1) Objective

If the development impacts seriously on the environment, the countermeasures should be carried out exactly. Monitoring data is important for the countermeasure plan.

(2) Contents of the Plan

1) Monitoring Factors

As the volume of monitoring contents is reflect the monitoring cost directory, selecting the monitoring contents of only the most important and monitored easily, considering the reducing of the work load of implementation agency as much as possible, The following factors are selected for the continues reasonable execution. These factors shall be reviewed at the implementation of the project and it is necessary to confirm the optimum method and factors considering conditions of the budget.

a. Water Quality and Quantity

The condition of surface water in the Study area is represented by the Tempisque River and Las Palmas River. The water quality and flow quantity of both rivers are important as environmental factors. Water levels are measured continuously by ICE, water intake is already controlled by MINAE. Therefore, water quality and flow of river are need to establish as other monitoring factors.

Monitoring points were selected as follows;

- Well in Bolson: Water quality will be monitored, because this point is located in the lower part in the Study area and was the most polluted among the investigated wells in 2001.
- Three points in Tempisque River: Water quality and river flow will be monitored.
- One point in Las Palmas River: Water quality and river flow will be monitored.
- Two points, one in and the other near Palo Verde National Park: Water quality will be monitored, because these points are affected by Arenal Tempisque Development Phase I and II.

The aim of water quality standard for monitoring is shown below.

a) Tentative water quality of drinking water is shown below.

Tentative Water Quality of the existing well (Bolson), used for drinking water

Analysis Parameters	Units	Bolson well			
Note		Maximum in 2001	Drinking water standard of WHO	Drinking water standard of Japan	Tentative water quality
Nitrates	mg/L	18.9±0.7	＜50	＜10	<50
Electric Conductivity	μs/cm	974 ± 1			＜700
pH	± 0.02	7.77 at 21 °C		5.8~8.6	5.8~8.6
Alkalinity	mg HCO_3^-/L	290 ± 8			＜298
Chlorides	mg/L	93 ±4			＜97
Sulfates	mg/L	35±1			＜36
Silica	mg SiO_2/L	120 ± 20			＜140
Sodium	mg/L	77 ± 1		＜200	＜200

Tentative Water Quality of the existing well (Bolson), used for drinking water

Analysis Parameters	Units	Bolson well			
Potassium	mg/L	<1.8			<1.8
Calcium	mg/L (±0.6)	90.5			＜90.5
Magnessium	mg/L (±0.6)	81.6			＜81.6
Total Hardness	mg $CaCO_3$/L	380.3±2.6		＜300	＜383
Total Coliforms	MPN Total coliforms/100 mL	> 1 600		0	＜1 600
Fecal Coliforms	MPN Fecal coliforms/100 mL	> 1 600			＜1 600
Bacilluses	Count /mL	$4.3 * 10^6$		＜100	＜$4.3 * 10^6$
Dimethoate	mg/L	--------			＜Detection limit
Diuron	mg/L	--------			＜Detection limit
Oxifluorfen	mg/L	--------			＜Detection limit
Terbutryn	mg/L	--------			＜Detection limit
Oxadiazon	mg/L	--------			＜Detection limit
Ametryne	mg/L	--------			＜Detection limit

Basically, the aim is that water quality does not become worse than the quality measured in 2001. Main tentative water qualities are shown below.

- Nitrate is not over the WHO standard (50mg/l)
- Electric Conductivity is not over the concentration (700μs/cm), this figure generally indicates that the river is polluted.

  Total Hardness is not over 300 mg $CaCO_3$/L

  Total Coliforms is not over1600 coliforms/100 mL
- Bacilluses is not over the maximum (4.3×10^6 Count /mL) of present pollution.
- Agrochemicals is not detected over the standard limit

When water quality is detected over the above readings, the cause should be analyzed and countermeasures implemented. When high levels of agrochemicals are detected in a well, it should be abandoned. Plans need to be established to prevent polluted surface water (containing high levels of Coliforms or Bacilluses) from entering the wells and contaminating them.

b) Tentative water quality of river is shown below.

Tentative Water Quality of Tempisque River at Guardia

Analysis Parameters	Units	GUARDIA		
Note		Maximum in 2001	River water quality standard (E) of Japan	Tentative water quality
Nitrates	mg/L	1.96±0.34		<2.3
Electric Conductivity	μs/cm	242.1 ± 0.1		<242
pH	± 0.02	7.65 at 20.6 °C	6.0~8.5	6.0~8.5
Alkalinity	mg HCO_3^-/L	73 ± 7		<80
Chlorides	mg/L	40±2		<42
Sulfates	mg/L	19.89±0.44		<20
Silica	mg SiO_2/L	110 ± 20		<130
Sodium	mg/L	60 ± 10		<70
Potassium	mg/L	5.1 ± 0.1		<5.2
Calcium	mg/L(±0.6)	14.2±0.4		<14.6
Magnessium	mg/L(±0.6)	9.2		<9.2
Total Hardness	Mg $CaCO_3$/L	55 ± 1		<56
BOD	mg/L	17 ± 3	<10	<20
D.O.	mg O_2/L	8.1	>2	>2
COD	mg/L	40 ± 10		<50
Turbidity	NTU	9.04±0.01		<9
Settleable Solids	mL/L	< 0.1		< 0.1
Total Suspended Solid	mg /L	50 ± 3		<53

Tentative Water Quality of Tempisque River at Guardia

Analysis Parameters / Note	Units	GUARDIA		
		Maximum in 2001	River water quality standard (E) of Japan	Tentative water quality
Total Coliforms	MPN Total coliforms/100 mL	> 1600		<1600
Fecal Coliforms	MPN Fecal coliforms/100 mL	$1.0 * 10^3$		$<1.0 * 10^3$
Bacilluses	Count /mL	$9.9x10^4$		$<9.9x10^4$
Dimethoate	mg/L	＜0.002		＜Detection limit
Diuron	mg/L	<0.001		＜Detection limit
Oxifluorfen	mg/L	<0.0008		＜Detection limit
Terbutryn	mg/L	<0.004		＜Detection limit
Oxadiazon	mg/L	<0.002		＜Detection limit
Ametryne	mg/L	<0.004		＜Detection limit
Chlorpyrifos	mg /L	<0.0007		＜Detection limit

Tentative Water Quality of Tempisque River at Guinea

Analysis Parameters / Note	Units	GUINEA		
		Maximum in 2001	River water quality standard (E) of Japan	Tentative water quality
Nitrates	mg/L	1.96 ± 0.34		<2.3
Electric Conductivity	µs/cm	6070 ± 10		<6080
pH	± 0.02	7.75 at 20.8 °C	6.0~8.5	6.0~8.5
Alkalinity	mg HCO_3^-/L	83 ± 7		<90
Chlorides	mg/L	21.0±0.6		<22
Sulfates	mg/L	23.6 ± 0.9		<24.5
Silica	mg SiO_2/L	110 ± 20		<130
Sodium	mg/L	19.7 ± 0.4		<20
Potassium	mg/L	5.0 ± 0.3		<5.3
Calcium	mg/L (±0.6)	15.2		<15.2
Magnessium	mg/L (±0.6)	9.7		<9.7
Total Hardness	mg $CaCO_3$/L	72 ± 2		<74
BOD	mg/L	20 ± 3	<10	<20
D.O.	mg O_2/L (± 0.2)	6.6	>2	>2
COD	mg/L	98		<98
Turbidity	NTU	12.5 ± 0.1		<12.6
Settleable Solids	mL/L (±0.6)	< 0.1		< 0.1
Total Suspended Solid	mg /L	<8		<8
Chrome	mg/L (±0.6)	< 0.01		< 0.01
Lead	mg /L	< 0.01		< 0.01
Cadmium	mg/L	< 0.03		< 0.03
Zinc	mg/L	0.1±0.01		<0.1
Total Coliforms	MPN Total coliforms/100 mL	> 1600		<1600
Fecal Coliforms	MPN Fecal coliforms/100 mL	$2.1 * 10^4$		$<2.1 * 10^4$
Bacilluses	Count /mL	$3.2 * 10^6$		$<3.2 * 10^6$
Dimethoate	mg/L	<0.02		＜Detection limit
Diuron	mg/L	<0.0009		＜Detection limit
Oxifluorfen	mg/L	<0.001		＜Detection limit
Terbutryn	mg/L	<0.004		＜Detection limit
Oxadiazon	mg/L	<0.002		＜Detection limit
Ametryne	mg/L	<0.004		＜Detection limit
Chlorpyrifos	mg /L	<0.001		＜Detection limit

Note）Tentative water quality at Canal of Palo Verde and Las Palmas is same as Guinea

Basically, the aim is that water quality does not become worse than the quality measured in 2001. Main tentative water qualities are shown below. Tentative water quality at Canal of Palo Verde and Las Palmas is the same as Guinea

- BOD at Guardia is not over 20mg/l: Water quality at Guardia was affected by pollutants in the

upstream areas

- Electric Conductivity at Guinea is not over the maximum (6080mg/l)
- BOD at Guinea is not over 20mg/l
- Agrochemicals are not detected over the detection limit

When water quality is detected above the previously mentioned figures, the cause should be analyzed and countermeasure plans implemented. When agrochemicals are detected from drainage, treatment pond should be established to prevent the water entering directly into the river system.

c) Tentative water quality of Palo Verde National Park

Tentative Water Quality at the P. V. Bocana in Palo Verde National Park

Analysis Parameters / Note	Units	P.V.Bocana	
		Maximum in 2001	Tentative water quality
Nitrates	mg/L	29 ± 1	<30
Electric Conductivity	mS/cm	14.55 ± 0.01	<15
pH	± 0.02	3.50 at 18.9 °C	6.0~8.5
BOD	mg/L	50 ± 10	<60
D.O.	mgO_2/L (± 0.2)	6.3	>6
COD	mg/L	160 ± 10	<170
Alkalinity	mg HCO_3^-/L	35 ± 8	<43
Chlorides	mg/L	1670 ± 90	<1760
Sulfates	mg/L	7300 ± 400	<7700
Silica	mg SiO_2/L	122 ± 4	<126
Sodium	mg/L	3850 ± 70	<3920
Potassium	mg/L	82 ± 8	<90
Calcium	mg/L	700 ± 10	<710
Magnessium	mg/L	600 ± 100	<700
Total Hardness	mg $CaCO_3/L$	4200 ± 500	<4700
Total Coliforms	MPN Total coliforms/100 mL	>1600	<1600
Fecal Coliforms	MPN Fecal coliforms/100 mL	$3.3 * 10^6$	$<3.3 * 10^6$
Bacilluses	Count /mL	$5.0*10^7$	$<5.0*10^7$
Dimethoate	mg/L	< 0.02	＜Detection limit
Diuron	mg/L	< 0.0009	＜Detection limit
Oxifluorfen	mg /L	< 0.001	＜Detection limit
Terbutryn	mg/L	<0.004	＜Detection limit
Oxadiazon	mg/L	<0.002	＜Detection limit
Ametryne	mg/L	<0.004	＜Detection limit
Chlorpyrifos	mg /L	<0.001	＜Detection limit

Tentative Water Quality at the P. V. Park Office in Palo Verde National Park

Analysis Parameters / Note	Units	P. V. Park Office	
		Maximum in 2001	Tentative water quality
Nitrates	mg/L	140 ± 5	<145
Electric Conductivity	mS/cm	15.56 ± 0.01	<16
pH	± 0.02	7.89 at 19.9 °C	6.0~8.5
BOD	mg/L	29.0 ± 4.4	<33
D.O.	mgO_2/L (± 0.2)	6.0	>6
COD	mg/L	150 ± 20	<170
Alkalinity	mg HCO_3^-/L	670 ± 10	<680
Chlorides	mg/L	3700 ± 200	<3900
Sulfates	mg/L	3600 ± 100	<3700
Silica	mg SiO_2/L	88 ± 3	<91
Sodium	mg/L	2780 ± 90	<2870
Potassium	mg/L	42.7 ± 0.6	<43
Calcium	mg/L	1120 ± 20	<1140
Magnessium	mg/L	800 ± 100	<900
Total Hardness	mg $CaCO_3/L$	6100 ± 100	<6200
Total Coliforms	MPN Total coliforms/100 mL	>1600	<1600

Tentative Water Quality at the P. V. Park Office in Palo Verde National Park

Analysis Parameters	Units	P. V. Park Office	
Note		Maximum in 2001	Tentative water quality
Fecal Coliforms	MPN Fecal coliforms/100 mL	$1.0 * 10^5$	$<1.0 * 10^5$
Bacilluses	Count /mL	$3.6*10^6$	$<3.6*10^6$
Dimethoate	mg/L	--------	＜Detection limit
Diuron	mg/L	--------	＜Detection limit
Oxifluorfen	mg /L	--------	＜Detection limit
Terbutryn	mg/L	--------	＜Detection limit
Oxadiazon	mg/L	--------	＜Detection limit
Ametryne	mg/L	--------	＜Detection limit
Chlorpyrifos	mg /L	--------	＜Detection limit

Basically, the aim is that water quality does not become worse than the quality detected in 2001. Main tentative water qualities are shown below;

- At P.V.Bocana, water was affected by discharge from Tamarindo agricultural development area the, water was acid, pH 3.5 (in 2001); which indicates an advanced degree of pollution. If pH indicates less than 3.5, water treatment facility would be required.
- Cholides, Sulfates, Sodium, Total Hardnes at P.V.Bocana and P.V.Park Office were counted as 1700~3900 mg/l, 3700~7700 mg/l, 4700~6200 mg/l respectively. These values indicate unusually level, as a result, monitoring is necessary.
- Agrochemicals at P.V.Bocana and P.V.Park Office should be under the detection limit.

When water quality measurements are detected over the previously mentioned figures, the cause should be analyzed and countermeasure plans implemented. When agrochemicals are detected from drainage, treatment pond should be established. These values in tables are shown only tentatively and it is recommended the more realistic values shall be decided based on the long term investigation and similar conditions of other country.

b. Underground Water Levels

Monitoring of underground water levels is most important for underground water conservation because the water levels relate to the pumping quantity. Water levels at five wells should be measured in the Study area.

c. Biology in Tempisque River

Concerning the fauna and flora, biological changes in the river are deeply connected with the river condition. River conditions directly affect benthos (for example; aquatic insect) living in the river. Monitoring the benthos can indicate biological changes in the Tempisque river. Therefore, species diversity and the quantity of benthos should be monitored at three points in the Tempisque River ever year.

Hata Pelon de la Altuka and Guardia points are relatively clean. Mayfly taxa and Caddisfly taxa are dominant species in these points. Guinea point is relatively polluted. Blood worms and Chironomid midges are expected to be the dominant species at this point. National Costa Rica University has experience surveying of benthos.

d. Bird Watching

Changes to forest areas and land use directly effects the number of wild birds. Therefore, bird monitoring should be carried out at two areas (Guardia and Corralillo). In Guardia and Corralillo area, species diversity and the quantity of wild birds will be counted at the fixed points, 3 times a year for 10 years. Zanate, Urraca, Copetuda, Palomas, Garzas, Soldatitos, Queques, Pecho Amarillos, Tijos, Garzones, Patos agujas are expected to be found at these locations.

(3) Contents of Action

It is necessary to establish the budget and monitoring system during the first two or three years. The system will be reviewed and evaluated in ten years. Further monitoring is necessary after this time.

a. Water Quality

(a) Monitor the water quality of the existing well at Bolson in April for 10 years. Twenty two items: Nitrates, Electric Conductivity, pH, Alkalinity, Chlorides, Sulfates, Silica, Sodium, Potassium, Calcium, Magnessium, Total Hardness, Total Coliforms, Fecal Coliforms, Bacilluses, Agrochemical (Dimethoate, Diuron, Oxifluorfen, Terbutryn, Oxadiazon, Ametryne, Chlorpyrifos) (from this point on, the above items are referred to as 'basic items')

(b) Monitor the water quality at the three locations along the Tempisque River (Guardia, Guinea, Canal of Palo Verde) and one location along the Las Palmas River (Bolson) twice a year (in April and August), and continue monitoring for 10 years. Monitoring items: in addition to the basic items, include BOD, DO, COD, Turbidity, Settleable Solids, Total Suspended Solid, flow velocity and discharge.

(c) Monitor the water quality at the two locations in and around Palo Verde National Park twice a year (in April and August), and continue monitoring for 10 years. Monitoring items: in addition to the basic items, include BOD, DO and COD. One monitoring location is Palo Verde Bocana, here surface water comes in from the NE. The other location in the Palo Verde National Park is at the Park office.

b. Groundwater Level

Observations will be carried out at 5 wells in the Study area for 10 years (12 times per year). Wells should be examined in block number ①, ②, ③ in the irrigation areas with underground water and block numbers ⑩, ⑫ in irrigation areas with supplementary underground water (refer the Fig.5.5.1). Analysis of underground water will be done using the additional data of Palo Verde.

c. Biology in the Tempisque River

Monitoring the benthos will be carried out at the following 3 points for 10 years (4 times per year including the before season of aquatic insect emergence).

3 points: Hata Pelon de la Altuka (4km up stream from the crossing point National Rout 1 and the Tempisque River), Guardia, Guinea.

d. Bird Watching

The monitoring of wild birds will occur 3 times a year at Guardia and Corralillo for 10 years

5.5.7 Action Plan

The new organization is set up for the management and execution of the whole project. In this new organization an environmental section will be established. The staff is mainly from MINAE. An action plan is formulated to achieve the intended target during the main irrigation construction phase (preparation phase:3 years) and action phase (10 years). The total length of the project is 13 years. However, regular action will be carried out after the 13 years.

(1) Improvement of the Basin Management

Actions	Contents	Implementation schedule
Survey the inhabitants	A questionnaire will be administered to approx. 400 households (significant degree 95%) annually. Its aim is to gauge people attitudes and opinions about the basis.	Once a year in preparation and action phase
Enlightenment (Information)	The environmental information (pamphlets and posters) will be distributed among the population.	Once a year in preparation and action phase
Enlightenment (Training to Teacher)	Environmental education consists of training elementary and high school teachers (approx. 30 teachers) about environmental issues. Issues include understanding present environmental	Four times a year in action phase.

	conditions, anticipating future problems, the need for countermeasures and methods of environmental education.	
Enlightenment (Environmental Seminar)	An environmental seminar is will be held for resident representatives (approx. 200 people). Cooperation from OTS and other NGOs is requested.	Tow times a year in action phase.
Support the environmental activity	More information train (leading, information) and personal are needed to support the local population in activities such as tree planting, the cleaning of rivers and water ways and the improvement of garbage facilities and toilets etc.	

Schedule of the Improvement of the Basin Management

	Preparation phase	Action phase		Remark
	1～3	1～5	6～10	
Questionnaire				1 a year
Enlightenment: Information				
Enlightenment: Teacher training				4 a year
Enlightenment: Environmental seminar				2 a year

(2) Promotion of Environmentally conscious agricultural Practices.

This action plan will be included in the plans for farmer support.

(3) Recovery of River Maintenance Flow

Actions	Contents	Implementation schedule
Supplement 1.5m^3/s	Authority of water right (4.5m3/s) is transferred to SENARA. SENARA will hold the water (1.5m3/s) included in the 4.5m3/s and discharge it into the river for the recovery of river maintenance flow.	After action start
Formulating the agreement to maintain flow.	Campaigns for the awareness and need to maintain the flow of the river. The campaigns highlight the awareness of basin management and should encourage the population thinking about the issues.	After action start

Schedule of the Recovery of River Maintenance Flow

	Preparation Phase	Action Phase		Remark
	1～3	1～5	6～10	
Supplement 1.5m^3/s				
Formulating the consensus of				

(4) Underground water Conservation

Actions	Contents	Implementation schedule
Monitoring	Monitoring the water level of the wells in the Study area will be carried out for managing the underground water for its sustainable use (detail of the monitoring is described in the monitoring plan).	After action starts
Analysis	Yearly variations of water levels in wells in the Study area will be analyzed. If problems arise countermeasures should be implemented.	After action starts

Schedule of the Underground Water Conservation

	Prepareation Phase	Action Phase		Remark
	1～3	1～5	6～10	
Monitoring				
Analysis				

(5) Monitoring

Actions	Contents	Implementation schedule
Budget-making and execution	Budge-making and execution plan will be decided in the preparation phase	Preparation phase
Water quality monitoring	Water quality of the well in Bolson will be monitored in April. Water quality and flow at three points (Guardia, Guinea, Canal of Palo Verde) in the Tempisque River and at one point (Bolson) along the Las Palmas River will be monitored in April and August. Water quality at two points in and near the Palo Verde National Park will be monitored in April and August.	Suitable any time in action phase
Underground water level monitoring	Water levels will be measured at five wells in the Study area, 12 times a year for 10 years. Analysis will be carried out with hearing data from pumping.	Every month in action phase
Biology monitoring in the Tempisque River	Monitoring the benthos will be carried out at the following 3 points for 10 years (3 times per year and before the season of aquatic insect emergence). 3 points: Hata Pelon de la Altuka (4km up stream from the crossing point National Rout 1 and the Tempisque River), Guardia, Guinea.	Four times a year in action phase
Bird watching	The monitoring of wild birds will occur 3 times a year at Guardia and Corralillo for 10 years.	Three times a year in action phase

Schedule of the Monitoring

	Preparation phase	Action phase		Remark
	1～3	1～5	6～10	
Preparation	■			
Water quality and quantity		■	■	1 or 2 imes a year
Ground water evel		■	■	Every month
Biology		■	■	4 times a year
Bird Watching		■	■	3 times a year

5.6 AGRICULTURAL SUPPORTING STRENGTHEN PLAN

5.6.1 The Necessities of Strengthening Activities of agricultural Supporting and planning Conditions

In order to realize the objective of this plan, that is, “to achieve sustainable agricultural development for small and medium-size farmers”, it is necessary to increase the level of self-reliance of the small and medium farmers and improve their farm management by expanding the scale of management by organizing them, as well as by introducing compound farm management through diversification of agriculture. Further, in order to pursue the above, it is also necessary to reorganize and strengthen farmers’ organizations to be able to systematically manage farms of small and medium farmers. It is essential, as well, to assist such organizations by providing extension services for farm management, better production skills and technology, and by assisting financial requirements. Moreover, the important thing is, to support the activities of women’s groups, including single mothers, to maintain the sustainability of development from the viewpoint of establishing favorable environment for the children who will carry the development of coming generations.

In view of the above, the plan for strengthening the support for farmers is composed of the following five components.

Components for Strengthening Support for Farmers

Components	Major Objectives
Support for Strengthening Farmers’ Organizations	Increase the level of self-reliance of small and medium farmers to foster them to be the main body of sustainable development of the Area. Expand the scale of farm management by groups, and aim at the reduction of farming costs. Further, the organizations shall be effective recipients of various supports. They shall carry out the operation of water management in the areas where irrigations are introduced.
Promotion for Management Know-How	Improve basic farm account, management know-how or methods aiming at the improvement of basic ability of farm management. Increase also, the know-how of farm management

	including organizations, marketing promotion in order to meet the expansion of the farm management for the purpose of carrying out compound management through diversification from the long-term viewpoint.
Promotion of Production Skills and Technology	By diffusing production skills for presently growing crops, newly introduced crops for diversification, irrigation agriculture, and through environmental conservation, improve the production and productivity.
Financial Assistance for Farmers	Arrange and assist for the initial investment and operation capital so that the diversification of crops can be achieved smoothly.
Assistance for Activities of Rural Women	Support and strengthen the existing activities of groups of rural women in the Target Area, and expand the activities to other parts, in order to stabilize the basis of their life and improve environment for favorable growth of children

.

The small and medium-scale farmers living in the Target Area have the following characteristics:

- Small and medium farmers are not in the condition of poverty in the strict sense.
- The literacy rate of them is approximately 99.5%, that is, nearly all of them have the education of, at least, the minimum level.
- More than half of them have extra incomes that supersede the agricultural incomes.
- However, many of the small farmers are forced to rely on the extra business because of the low productivity of their lands. Their willingness of farming is rather high if the profitability of agriculture is improved.
- A majority of them are thinking that agriculture is an attractive income sources, and are willing to continue the farming.
- Many of them do not live near or around their farmlands.
- An average land holding of the small farmers in the Target Area is approximately 7 to 8 hectares, and the size is rather limited.
- In general, the farmers are individualistic.

It is necessary to carefully consider these characteristics when plans are prepared for assisting them, particularly in the cases of strengthening farmers' organizations. It should be emphasized that the plans should be implemented based on the agreed consensus of the small and medium farmers upon discussions after clarifying the strong points and weak points of the groups. Particularly, the approaches have to be different between those who have multiple businesses and are not very positive in farming and the farmers who rely on agriculture only and are willing to develop new farm management. However, it also should be understood that those different types of farmers would necessarily come together in farmers' organizations. Again, the assisting activities must be carried out effectively in cooperation with governmental and non-governmental organizations that are already pursuing assistance in the Area.

Almost 1000 small and medium scale farm households exist in the Target Area. Naturally, it is impossible to assist each individual farmer separately, hence the rule should be to strengthen and solidify the farmers' organizations that will be the recipient bodies of assistance services for first three to four years, and, as a rule, the assistance activities shall be expanded the organizations as their basis.

5.6.2 Assistance for the Strengthening Farmers' Organizations

(1) Objectives to Achieve and Strategy for Strengthening Organizations

An appropriate size of land should be 200 hectares in average (the minimum is 100 hectares) to aim at the reduction of production costs, and to develop compound faming management through diversification of crops. For this reason, approximately a total of 60 organizations consisted of about 15 farmers of small and medium size in the area shall engage in agricultural activities.

However, types and activities of those organizations shall be different in managing methods depending

on their crops and on the farmers who form the organizations. As already mentioned, many farmers in the Target Area have extra business, and there are some who are very willing to develop their agriculture and others who are not very willing to do so. Therefore, it is very important that for each organization to have good leaders as the bases of agricultural development. The objectives of the plan to achieve by strengthening and re-organizing the farmers' organizations are those farmers who are with side business to form organizations around their leaders, and acquire by the activities of organizations easily available profits by collectivization. Each farm shall be managed individually at the initial stage.

Later on, higher activities looked from a long-term view may be added as the farmers' organizations grow. Those higher activities are also assisted. The details of activities of the farmers' organizations by stages of their development are described below. Nevertheless, these activities are selected according to the maturity of each organization, types of agriculture, products and the opinions of the consisting members. But it should be noted that not all organizations will, should, or can develop as follows. At the beginning, the objective is the activities of the initial stage.

Initial stage:	Activities focusing on the reduction of agricultural expenditure.
Intermediate stage:	Add the activities aiming at the increase of agricultural incomes to the activities of the initial stage.
Final stage:	Develop farm management by organizations

Further, the types of farm management shall vary, for example: ① the case to continue to manage individual land by the farmer, ② the case to manage the entire farmland of the members and manage jointly or manage by contract. The selection is made depending on the quality of the members or their opinions. Thus, the decisions of the selection for organizing small and medium farmers are made by individual organization, and the type of organization should not be controlled by others. Each organization should have thorough discussions to have consents among its members to be able to strengthen and improve the organization while provided sufficient information and necessary assistance for continuous organizational activities. Accordingly, activities must be concentrated on the formation of organizations and their strengthening for the first three to four years.

The farmers' organizations that are necessary to be formed by zones are as follows:

① Zone A: Jointly attempt the reduction of agricultural expenditure in order to shift the crop to mango production.

② Zone B: Jointly irrigate by the use of underground water

③ Zone C: Jointly irrigate by the use of a pump system

(2) Re-organization and Strengthening of Farmers' Organizations

The period before the adoption of the Project (assumed about one year), and the period during which the construction of This Project has completed and the pump system has started to operate after the initiation of the project (about three years) shall be considered a preparatory period. During these periods the activities to assist the reorganization and strengthening of farmers' organizations as follows:

Also, ① public explanation meetings for people ② detailed surveys of the existing conditions, shall be carried out during the first year, that is, the small and medium farmers who shall be the beneficiaries of the project well understood the project and their preparation for participation in the project is completed by the time when the project is adopted and its implementation is decided.

1) Explanation Meetings for the People

The project descriptions must be explained to all small and medium farmers during the first six months, and reorganization of the existing organizations shall be promoted. Many of the small and medium farmers have belonged in the past, or belong presently to some organization.

Through discussions of the necessity of farmers' organizations, the farmers participate in This Project,

receive required assistance, and then, have a common understanding of the necessity of farmers' organizations by small and medium farmers for the improvement of farm management. Further, the farmers would be assisted to form an organization of which land holding is to be the minimum of 100 hectares. Simultaneously, various consultations must be given.

The inception of full activities of the farmers' organizations shall be four years after water supply has started. The clauses of each organization and objectives of their activities should be internally discussed and be set, members be replaced when necessary, and some organizations shall be reorganized or be merged according to necessity. In order to put into practice the above, the details of assistance that will be given during the preparatory period should be thoroughly explained, so that the farmers will understand that it is neither possible, nor necessary to form solid organizations from the very beginning of the initiation of the project. Consequently, individuals can belong to some organization temporarily, and later can move to other organization, if desired. Reorganization and intensification shall be conducted based on the conditions of the existing organizations, but the locations of farmlands, kinds of crops produced, and the existence of leaders shall be the key points in cases of forming new organizations.

2) Detailed Survey to Find the Existing Conditions

After the public meetings, for the period of approximately six months, while receiving the requests for assistance from farmers' organizations, a detailed survey for each organization shall be conducted. At the time of the survey, consultations of various kinds and guidance shall be given to farmers to form the organizations that will have farmlands of larger than 100 hectares. The guidance shall be different depending on the conditions of actual operation and management of each organization. Sometimes, mediation for reorganization shall be assisted. Also, those small and medium farmers who were not incorporated to any organization shall be mediated to join some organization.

3) Training of Leaders

The training oriented towards leaders of each organization shall be given twice a year. The details of the training include the following subjects, such as, management of organization and improvement of farm management. The training can also function as the place of exchanging information. Simultaneously, the themes to be discussed are selected for the purpose of answering common problems of each organization.

4) Workshops for Strengthening Organizations

Workshops shall be held twice per week for about 3 hours after the farmers finished their day's work during the three-year period between the completion of detailed survey and the completion of construction. At these workshops farmers shall have discussion to form common understanding and to reach consensuses on the matters of their organization. The details of the workshops shall include all the points necessary to form organization and to strengthen the organizations. The method should be talked over until the consents of the organization on each subject are reached. Some specialists on farmers' organizations shall act as moderators:

i. Analyze own management problems and have common understanding of the problem points.
ii. For the purpose of solving the problem points, analyze purposes and understand the objectives to achieve.
iii. Discuss on the methods of achieving their objectives and clarify their obstructs and constraints.
vi. Clarify the role of each individual to achieve organization's objectives and formulate an activity plan.

According to the above procedure, the farmers will decide their activities while forming common understanding for various problems, reach consensus within each organization.

The important points are considered as follows:

- Objectives of activities of each organization.
- Diversification of crops by the production of mango (A zone)

- Vegetable production by the use of underground water (B zone)
- Water distributions by the introduction of pump systems (C zone)

The small and medium farmers of each organization shall select as to what types of the organization to be formed. As stated, the type of organization should not be controlled by someone else because the backgrounds of each organization vary each other. The above points should be fully discussed within each organization and while forming general agreements among its members the assistance for strengthening and developing the organization must be rendered. To do so, it is also important to provide necessary information and to provide continued assistance for organizations' activities from the time of the preparatory stage. Thus, for the four years the activities shall be concentrated on the forming of organizations and on strengthening of them.

5) Capacity Building

The necessary human resources for the above assistance, specialists who have abundant experiences on the fields of farmers' organization, shall be sought from the World Vision or ECADES. Other specialists, for crop production, management skills or the specialists for farmers' financial assistance shall be also added. The total number of the supporting staffs for the first three years shall be about 20 persons. Through public explanation meetings, detailed surveys, and training by specialists, the farmers shall acquire necessary knowledge and skills for their duties for the first six months. After the fourth year, by the time farmers' organizations are strengthened to a certain level, the capacity building will be taken care of by seven specialists. The training by those specialists mainly based on the method of PCM (Project Cycle Management), and each specialist will act as the moderator of the workshops.

(3) Points Need Consideration

. Strengthening or Reorganizing the Existing Organizations

Many of the small and medium size farmers who are possible beneficiaries belong to some of the existing organizations. Through various surveys, 43 farmers' organizations are confirmed to exist or have existed. It is proposed by this project to base on the existing farmers' organizations as main bodies and strengthen them by giving additional functions. From the viewpoint of the improved farm management, the size of the farmland must be larger than 100 hectares. Consequently, some organizations must be reformed along that line. Basically, the formation of new organizations is considered difficult because an organization requires long-time relations and trust among the people. One third of the above 43 organizations have already been broken up, or in the process of dissolution. Nevertheless, unless the organizations have broken down due to grave internal problems, even those organizations will be rebuilt.

Some of the existing organizations include in their members not only farmers, but include the people of other occupations, and the crops that the members are producing are varied. However, each organization has to maintain a certain degree of similarity or cohesion at the time of carrying out activities. Considering the above, it may be judged that to start with some of the associations within asentamientos (collective farmlands) would be the best to intensify the organizations. There are seven large asentamientos in the Target Area and the cases of the asentamientos in, such as, Piragua and Filadelfia, are consisted of separate associations in each asentamiento. However, farmlands of some associations exceed 100 hectares and can easily be able to become a main body for the new system. Those organizations that are not satisfying the requirement of minimum size, that is less than the total of 100 hectares, should try to incorporate and reorganize the farmers who have dropped out in the past without much reasons, or integrate some associations that have broken up in the past, so that the organization can maintain the required 100 hectares.

Cooperatives can relatively easily form organizations holding more than 100 hectares.

Four out of five cooperatives within our area hold more than 100 hectares but about 10% of the lands are already irrigated. On the other hand, there is one cooperative that has no irrigated land and its farmland is less than 100 hectares. This cooperative has to incorporate few small farmers nearby or

has to unite one neighboring organization.

Communal banks are generally made up by the people of different occupations, for example, farmers, small business people, cattle raisers and agricultural laborers. Thus, those groups should be reorganized only with landholding or land using small and medium farmers. Some members of the communal banks are groups of women who are attempting to start small enterprise or some have already initiated business. It is desirable that those groups be incorporated into the component of "assistance for rural women".

The group of farmers considered most difficult to organize is the independent farmers who do not belong to or have never belonged to any organization. They have to form new organizations, but this may require a long time with some difficulties. The total number of independent farmers is unknown. Neither government organizations nor non-governmental organizations have records and statistics. However, it is known from the information of MAG that there are a considerable numbers of independent farmers exist in the Target Area. It is recommended that these people be organized after the implementation body of the project has had sufficient experiences with organizations of other groups.

There are certain possibilities of reincorporating some farmers or rebuilding some organizations because the introduction of irrigation could be the incentive and attractive power for strengthening and reorganizing the farmers. Yet, it may appropriate to limit the number of one organization to between 15 and 20 utmost, except for cooperatives that are consisted of many more numbers of people. Otherwise, as the number of members increases the composition of the organization becomes more complex and its management tends to be difficult.

. Strategy for Maintaining Self-Reliance and Towards Development

The formation and management of farmers' organization may be the way of increasing self-reliance and development of small farmers. On the other hand, it is not easy to organize those farmers because of the special characteristics and their tendencies, and because of the present situation of farm management. In general, formation of an organization requires clear incentives and a strong sense of belonging of all group members toward their organization. With this plan, the reduction of production costs and increase of incomes by expanding productivity through the use of irrigation by collectivization can be strong incentives and create good motivation for the farmers. Therefore, attempt must be made, by the introduction of a participatory method, to assist the formation of organizations so that the farmers themselves shall be able to think, understand, and make necessary plans.

Also, the farmers' organizations proposed in this plan shall have various functions in order to increase agricultural production in the future. But, it is impossible to implement complex activities at the beginning of the project. Only, those activities that are appropriate for the ability of the farmers should be carried out at the initial stage of the project. Through the above activities, an assisting method in which the farmers themselves become able to bring about independently a higher level of economic activities shall be introduced.

To mention, the strengthening of farmers' organizations, and various training and practices for the farmers shall start immediately after the inception of the project, and the entire system must be ready at the time of completion of the construction of irrigation. Thus, when the construction has completed, each organization has to be able to smoothly carry out their activities. Attention has to be given to the fact that many existing organizations are facing stagnant activities or experiencing suspension of activities from small missteps or troubles. To avoid the same or similar mistakes, the training for strengthening organizations must be carried out repeatedly and continually. Moreover, the assistance of government organizations and NGOs should come from the side but must be continued for a long time until the organizations become solid and the development by themselves become possible.

5.6.3 Extension of Management Know-How

(1) Objectives of the Plan and Development Strategy

The achievement of objectives of this plan is to increase managerial ability of the small and medium farmers by the diffusion of the basic management knowledge. The other objective is to diffuse necessary know-how for the development of compound management from a long-term view by the expansion of the scale of management through organizing small and medium farmers and by diversifying crops. The subjects of diffusion are farmers' organizations, and expansion activities are focused on the training of the leaders and staffs in charge of organizations concerned. Also, seminars are held for the small and medium farmers of the area, and the consultations of various problems on management shall be given as well. All of these are held and given continually.

The details of the diffusions are listed below. The objective of this project is set to the basic management skills, such as, accounting, at an early stage, but a high-level management strategy shall also be included at the stage where the maturity of each organization become sufficiently increased and the direction of compound management has become clear.

Initial stage: Improve basic management skills. Diffusion of general basic knowledge, such as, cost management, balance calculation and accounting. All organizations (including individual farm household) are subjects.

Intermediate stage: The step towards moving to compound management.

Expand the necessary knowledge and managing method to shift towards compound management by the diversification of crops, such as, reduction of cost, increase in profits, reinvestment, and market expansion. The above shall be targeted only those organizations whose level of maturity is high and who are willing to develop the compound management.

Final stage: The stage of developing the compound management. Expand sophisticated management know-how, such as, solidifying and stabilizing the managing foundation by each crop, avoidance of risks of markets, and building of new management strategy. The target of this level shall only be the organizations that are successfully developed compound management.

(2) Details of the Plan

The training for expansion of management know-how shall be carried out focused on the following activities.

1) Training for the leaders of each organization and the staffs in charge of organizations concerned

The training for management know-how shall be given to the leaders of each organization and the staffs in charge in the form of class courses.

Initial stage: Basic courses: 30 people for 3 days, will be held about 4 times per year. Basic courses focused on general management knowledge for, such as, cost management, balance calculation and accounting.

Intermediate stage: Intermediate courses: 30 people for 3 days, will be held 2 times per year. (The total: 4 times of trainings including 2 trainings of basic courses). The subjects for intermediate course are: reduction of cost, increase in profits, reinvestment, market expansion which are necessary knowledge and management skills to shift to compound management by diversifying crops.

Final stage: Advanced course for about 30 people for 3 days. Shall be held once per year (the total will be 4 courses including 2 basic courses and 1 intermediate course). The subjects of the advance course shall include solidifying and stabilizing the managing foundation by each crop, avoidance of risks of

markets, and building of new management strategy. The target of this level shall only be the organizations that are successfully developed compound management.

2) Seminars for Small and Medium Farmers in the Area

One-day seminar for approximately 200 people of the small and medium farmers and the staffs of the organizations concerned on management know-how shall be held once a year. The course will focus on common problems in the area, such as general trends of markets, problem points of farm management and their countermeasures.

3) Consultation for Various Problems on Farm Management

Open a window to handle various problems that each organization might face, and give consultation to deal with such problems. This window shall also accept the consultation on financial matters such as how to get credit loans.

(3) Human Resources on Diffusion of Management Know-How

The specialists required for the seminars on management know-how need to have different qualifications each other depending on the subjects of the seminars and consultation. Hence, specialists from institutes and/or universities may be called on depending on necessities. Two full-time specialists shall be required for the diffusion of management know-how. And those specialists will be responsible for the coordination of training, and instruction of general managing knowledge, such as, basic accounting for farming or how to handle market data. Those specialists may also be dispatched from PRODAPEN and other existing NGOs. They shall attend some external specialist training courses at least once a year. They, at the same time, shall study for one to two years at the existing melon, vegetable or mango farms that are applying advanced management so that they will be able to learn their managing methods, and acquire the knowledge on problems of management.

5.6.4 Diffusion of Production Skills

(1) Objectives to Achieve and Development Strategy

The objective of this plan is to spread the production skills and technology to meet the introduction of irrigation and diversification of crops.

Many small and medium farmers in the Area are not necessarily devoted to farming by themselves but have extra business besides agriculture. Their method of farming is by hiring various contracts and let them do actual labor. Consequently, it is more useful to train leaders of farmers' organizations for expansion of crop production skills rather than giving training to individual small and medium farmers. Further, the present situation of the extension service system is far small for the required human and financial resources. However, because it is considered very difficult to augment staffs of ASA (agricultural extension service agency) due to national policy, it may be necessary that the project implementation body augment the necessary human resources. In addition, a consideration should be given to the possibility that as the stage of diversification progresses, different types of production skills and technology become necessary.

Under these circumstances, in order to achieve the objectives it is necessary to strengthen the capacity of extension service system, and continuously improve the ability of service staffs.

Augmentation of Extension Service System

The Project shall augment the number of the extension service staffs while maintaining a good coordination with the ASA. One staff for each five organizations shall be required, that is, about 10 staffs should be increased. Because one staff covers about 1,000 hectares, securing their transportation is important point. Also, equipment and materials, such as, an audio-visual equipment have to be added.

Skill Training of Extension Service Staffs

The training for skills for crop production shall be carried out regularly about twice a year. Although in addition to production skills, the extension service people need to have the knowledge on farm management and organization management, this should be dealt with upon the coordination with the specialists for farm management and organization management.

(2) Details of the Plan

1) Details of Activities

The method of diffusion of production skills and technology shall be based on V&T, and extension service staffs visit each organization and give instructions. In addition to the visits, training for improving production skills and technology shall be given once or twice per year for the leaders of each farmers' organization. The details of the services are; to improve production skills for traditional crops and to practice organic farming with reduction of agro-chemicals (farming with environmental conservation). The diffusion of these shall be implemented through discussions with the specialists for farm management and strengthening organizations. Also, important point is that because the activities by the extension service people have strong relations with farmers, they must build up good relationships with the farmers. For this reason, the extension service staffs should join the activities of the specialists in charge of strengthening organizations, and actually participate in the activities of strengthening organization and reformation of them at the time of forming farmers' organizations.

2) Reinforcement of Extension Service System

While maintaining coordination with ASA, the Project Implementation Body augments necessary staffs. Also, supply the necessary materials and equipment (audio-visual equipment, bikes, etc.).

3) Human Resources for Diffusion of Production Skills and Technology

Dispatch the candidates for extension service to the agricultural enterprises that are applying advanced skills and technology for sugarcane, melon and vegetable and train about 10 service people. The training for those service staffs must be given continually because the quality of the service staffs must always be improved for the diffusion of new skills.

5.6.5 Financial (Credit) Assistance for Farmers

(1) Objectives of the Plan and Development Strategy

There is a possibility that the small and medium farmers in the Area do not have sufficient capital to shift the crops or plant new crops when this plan is put into practice because a majority of them are facing lack of farming capital. The existing farmers financial systems are covering this Area. So, by utilizing these capitals it may be possible to cover the lack of capital of the target farmers. However, many farmers do not understand the details of the points that they have to pay attention to or the procedures of requesting credit loans, or the method of repayments. Therefore, the objective of the financial assistance for farmers is set to the improvement of farmers' ability to utilize farmers' credits by themselves. Guidance shall be also given to farmers' organizations to mediate appropriate financial institutes and loans, and procedures for repayments.

Again, the credits are required because farmers lack their own capital. But they have to try to manage themselves in the near future while using credits for the time being. This training shall be given to the farmers to let them understand the importance of managing their farms with own capital. The instructions are given to have knowledge of how to make plans for returning the provided credits recognizing the risks of farm management, and the way to manage by own capital.

(2) Details of Assisting Activities

The assistance for finance for farmers shall include the following activities.

1) Training for Leaders of Each Organization

The training for leaders of each organization shall be given in the form of class courses with a total of about 60 leaders. Roughly 3 times of one-day training be given for the first year. The details of the

training are, the matters to be strictly obeyed in using credit loans or qualification for loan approval, necessary procedures for requesting loans, and how to prepare for repaying the loans.

2) Training for Small and Medium Farmers in the Area

One-day seminar for the small and medium farmers and the staffs of the organizations concerned is given with a total of about 200 people once per year. The details are focused on how to use loans for farmers, and how to breakaway from credits and manage their farms by own capital. The important point is to improve farmers' basic tendency to rely on utilizing credit loans.

3) Consultation on Finance for Agriculture

Open a window to deal with diverse problems in relation to finance for farmers, and give consultation according to the needs of the farmers. This window shall also mediate the necessary loans to meet their actual needs.

(3) Human Resources for Assisting Activities for Farming Capital

One full-time specialist for farmers' finance is required. In general, the staff will provide consultation for mediating finance for farmers. The financial specialist shall be assisted by extension service people who have management know-how when the specialist holds such training. The specialist shall have an experience of working with an NGO or a financial institute.

5.6.6 Support for Activities by Rural Women

(1) Objectives of the Plan and Its Strategy

In order to achieve the objectives of sustainable development of agriculture of small and medium farmers, it is important to maintain a favorable growing environment of the people who shall carry a future development of agriculture. For the above reason, the activities of groups of rural women, many of who are single mother, should be supported. The objectives of the support for the activities of rural women in the Area are to prompt their consciousness (self-awareness・and self-development), to increase their abilities (vocational education・implementation of training), and to achieve economic self- reliance (increase of incomes・improve their life).

The activities by rural women are being carried out by their own initiative. Assistance will be given to the on-going activities by the existing women' groups. The importance is the process to gradually expand the extent of those activities. Accordingly, the assistance shall be given to the women's groups who have organized themselves for certain purpose and have already started their activities or those who are trying to start their activities. Those activities are encouraged. Their progresses shall be publicized as important information, so that such activities may induce the participation of other women in the Area who are in similar situations.

The groups that will be supported first are selected from those groups who have already organized and have started their activities. An appropriate size of the organizations to be selected is of ten to twenty members and who need assistance. About five organizations will be selected at first and be assisted.

The method of assistance is as follows:

a. The main body is women. All decisions are made by the women. Assistance must come from the side.
b. As a principle, direct financial assistance shall not be given.
c. Assistance shall be in the form of discussions, training, and practice.

Further, a team of specialists who are gathered from IDA, PRODAPEN, and NGOs (ODRES, ECADES, and World Vision) shall provide the assistance for women's activities.

(2) Details of Assisting Activities

1) Assistance for Rural Women for Their Self-Awareness and Self-Development

The self-evaluation of many rural women is very low, and they often believe that they only have

limited ability. It is essential that women recognize themselves first, and then gradually lead them to think by themselves what they do and how they do certain things. These trainings shall be provided by the form of workshops. The women shall develop themselves through discussions among members of their groups, while building consensus among themselves they will build up the objectives and plans for their activities. By these workshops, their organizations will be strengthened and the details of their activities shall be clarified. The workshops shall be held for a period between seven to ten days (but because it may be impossible to hold the workshop everyday consecutively, two to three weeks may be required to complete the entire workshop), and the session will last for three hours each day.

a. Self-empowerment and establishment of self (for about 2 days)
b. Setting up of objectives (for about 2 days)
c. Method of achieving the objectives
d. Confirmation of requirements for achieving the objectives (Necessary technical training, vocational training, capital, etc. for a half day)
e. Plan for annual activities (for one day)
f. Confirmation of the organization (directors, rules, operation method for a half day)

The outputs of the workshops shall be an annual activity plan, and the workshops will be held continually once per year.

2) Support for Vocational Education・Training

The necessities, details and method of vocational education and training are decided through discussions within each woman's group. As a rule, existing public institutes, such as, INA will be utilized, but dispatch of instructors or visits to developed examples may be other methods to be used. As a part of assisting activities, circulation of information of public institutes on the schedule of education and training, or introduction of instructors may be included.

3) Assistance for Increase of Incomes and Improvement of Life

Open a consultation window to discuss about all possible problems on income increase and life improvement by the activities of rural women. Provide useful information, introduce or mediate necessary specialists depending on problems. Assistance also may be possible from the specialists of strengthening farmers' organizations and management know-how when the problems are difficult beyond the ability of the rural women's assistance team.

(3) Human Resources for Assisting the Activities of Rural Women

Form a rural women assistance team consisted of six people for the assistance of the activities of women's groups. The team members are called from IDA, PRODAPEN, NGO (ODRES, ECADES, World Vision, etc.). Each specialist will participate in an external training or seminar on women's affairs once a year and continually. Besides, special fields, such as organization and management, shall be handled by coordinating with other specialists.

5.6.7 Assistance System

(1) Necessity of Independent Assistance Organization

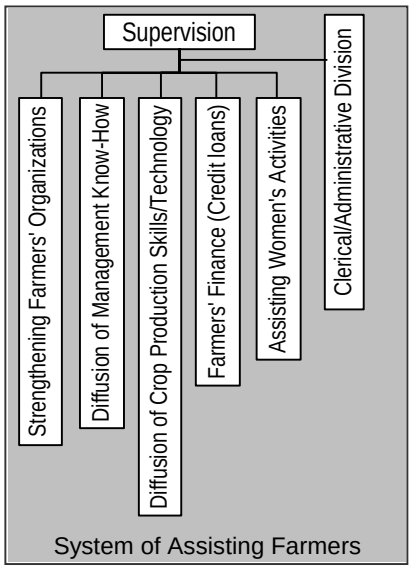
At present, each related organization and institute is providing assistance for farmers according to the following share of duties.

The Roles of Each Organization and Institute for Assistance to Farmers

Organization/ Institute	Roles of Assistance	Strength-ening	Management Know-how	Pro-duction Skills	Fi-nance	Rural Women
SENARA	Construct irrigation, operation / maintenance; set-up water management organizations	○				
MAG (ASA)	Confirm landholding, diffuse production skills/technology		○	○		

IDA・PRODAPEN・NGO(World Vision)	Set-up farmers' organizations; carry out strengthening and operation of them; prepare training, mediate credit loans	○			○	○
CNP・INA	Provide production skills, trainings of various kinds		○	○		○
ECADES	Dispatch specialists, open courses and training for farmers' organizations	○	○		○	○
MINAE	Conserve environment, water rights					
MOPT	Construction of public facilities other than irrigation, maintenance/management					

The assisting activities required for the components of This Plan are dispersed across multiple institutes and organizations concerned. Thus, if attempts are made to implement the above only by reinforcing the existing organizations, it may be difficult to keep pace with each other due to the differences of objectives, or various issues of budgets. To build a solid system of assistance for the farmers, it is proposed to set up a new organization that is specialized for small and medium farmers' affairs by the temporarily assigned staffs from the organizations concerned as the nucleus and by reinforcing other necessary human resources when required. That is, a new office to assume the implementation and administration of the entire project has to be established. Several divisions in charge of assisting the farmers need to be set up in the office.



System of Assisting Farmers

(2) Scale of Assisting System

The size of the organization for farmers' assistance shall be a total of about 30 staffs.

Supervisor (Director) (will be responsible for the entire activities of assisting the strengthening of farmers)

1 person: Shall be assigned to one of the temporarily transferred staffs from an organization concerned.

Clerical/Administrative Division: (operation of the organization, general management of office equipment, etc.)

1 person: Shall be assigned to one of the temporarily transferred staffs from an organization concerned.

Division for Strengthening Farmers' Organizations:

About 7 staffs: Call on a temporary staff from IDA and

PRODAPEN, and other staffs having the experiences of working with farmers, from other NGOs such as World Vision. When not available, train some staffs.

Division for Diffusion of Management Know-How:

About 2 staffs: Call on specialists from PRODAPEN and other NGOs.

Division for Diffusion of Crop Production:

About 10 staffs: Call on the staffs with experiences, and transfer them temporarily to advanced farm enterprises to build their capacity.

Division for Farmers' Finance (Credit Loans):

1 person: Call on a specialist who has experience of banking business.

Division for Assisting Women's Activities:

About 6 staffs: Staffs from IDA as nucleus, call on specialists on women's affairs from PRODAPEN, NGOs (ODRES, ECADES, and World Vision, etc.) and form a team to support rural women.

The first years (about 3 years) of the construction of pump systems are considered a preparatory period, and the first 6 months of this preparatory period shall be utilized for acquiring necessary knowledge and skills for strengthening of farmers' organizations through the explanation meetings, detailed surveys, and training for specialists. The activities of strengthening farmers' organizations shall be carried out with 20 staffs assisting the specialists. Also, the time of the temporary transfer of the technical specialists shall be set as one year after the completion of the preparatory period.

(3) Required Facility and Equipment

The above activities require the following facility and equipment.

Facility: Office (about 200 ㎡), a garage/storage (bout150 ㎡)

Equipment: Motor bikes (about 20 each), four-wheel vehicle (1 each), pick-up truck (1 each) Other office equipment (a copy machine, personal computers, audio-visual equipment, etc.)

5.6.8 Action Plan

The activity plan of This Project considers the first year (about 1 year is considered) as the period required for the adoption of The Project, and the period (about 3 years) until after the completion of the construction and the start of operation of the pump system as a preparatory period. And in 10 years after the completion of the construction is set as the year of achieving the objectives. However, periodical activities shall continue even after the 10th year.

(1) Assistance for Strengthening Farmers' Organizations

Activities	D e t a i l s	Execution Period
Explanation Meetings for Farmers	While explain the details of the entire project, promote formation of farmers' organizations. A total of about 15 times of meetings including 3 times each of 「explanation of project」, 「additional explanation and hearing of farmers' opinion」, 「integration of the general opinions」 are to be held. The locations of the meetings should be easily accessible for the farmers. Also, bus transportation shall be provided.	First 6 months of preparatory period
Detailed Surveys of Farmers' Organizations	While accept the requests for assistance from farmers' organizations, detailed surveys are carried out. As a principle, survey shall be conducted by visits by the specialists of strengthening farmers' organizations.	About 6 months after the explanation meetings
Training of leaders	Twice per year of the training for leaders be held. The method shall be one-day class courses. The contents of the training change depending on the progress of the training.	Continue every year from the time of preparation period.
Workshops for Strengthening of Organizations	Continuously hold workshops of about 3 hours for 1 to 2 times per week. The details of the workshops will include all the required points of forming and strengthening organizations, and each subject shall be continued until agreements are reached in the organization.	Continue 3 to 4 years of preparatory period.
Continuous assistance such as a Consultation Window	After the start of activities of organizations, specialists will visit each organization every month, and monitor problems faced, give consultation and continuously assist the management of organizations.	Continue after the start of activities.
Capacity Building	The required human resources shall be temporarily transferred from the organizations concerned, such as IDA. Also, experienced specialists from NGOs shall be called on. Further, the specialists for crop production, management know-how, and farmers' finance shall be added. All of these staffs shall be also trained for public meetings, detailed surveys and organizing farmers.	First 12 months of preparatory period.

Activity Schedule for Assistance to Strengthen Farmers' Organizations

	Preparatory Period	Activity Period		Remarks
	1 - 4 years	1 - 5 years	6 - 10 years	
Public Meeting for Explanation				
Detaild Survey on Farmer's Organization				
Training of Leaders				4 times/year
orkshops for strengthening Organizations				
Assisting Services/Window for				
Capacity Building of Human Resources				

(2) Diffusion of Management Know-How

Activities	Details	Execution Period
Basic Training: Management Know-How	3-day training of 4 times a year shall be held for about 30 staffs as a basic course. The courses are composed of basic general management knowledge, such as, cost management, calculation of balance, and accounting	After the start of activities by farmers' organizations
Intermediate Training: Management Know-How	Intermediate course of about 3-day training for about 30 people are held 2 times per year. (adding 2 times of basic course, a total of about 4 times of training.) Intermediate course includes mainly the necessary knowledge and method of management to shift to crop diversification and to compound management, such as cost reduction, increase in profits, reinvestment, and market expansion.	Start around 5th year of inception of the activities.
Advanced Training: Management Know-How	3-day course for about 30 people of once-a-year training. (will be four times of training, adding 2 times of basic courses, and one intermediate course.) The advanced course will include a high-level management know-how, such as, solidify and stabilize the management foundation by crop, avoid risks that occur by the expansion of market, and building a new management strategy.	Start around 8th year of inception of the activities
Seminars for Small/ Medium Farmers in the Area	For 200 people including both small/medium farmers and peoples from the organizations concerned; a one-day seminar on management know-how shall be held once a year. The subjects shall include common problems of the Area, such as, general trends of market, problem points of farm management and their countermeasures.	Start from the 2nd year of inception of the activities.
Consultation for Various Problems on Management	Open a window for consultation to deal with the problems that each organization might face. This window, in addition to the problems on management, shall deal with the consultation for obtaining credit loans.	From the 2nd year of Inception of the Activities.
Capacity Building of Human Resources	Call on the specialists for compound management of farms from PRODAPEN and other NGOs, and dispatch them for a temporarily to some of the enterprises of melon, vegetable and mango producers that are applying advanced method of management, for about 1 year for training to learn problems of management. They will participate also, in external training for specialists at least once a year.	For one year after the completion of preparatory period. (External training shall be once a year)

Activity Schedule for Diffusion of Management Know-How

	Preparatory Period	Activity Period		Remarks
	1 - 4 years	1 - 5 years	6 - 10 years	
Basic Training				4 times/year (2 times/year from 5th
Intermediate Training				2 times/year(1 year from 8th year)
Advanced Training				Once/year
Seminars				Once/year
Management Consultation				
Capacity Building				
Capacity Building (external training)				Once/year

(3) Diffusion of Production Skills/Technology

Activities	Details	Execution Period
V&T	Extension Service staffs shall visit each farmers' organization and give instruction. As a rule, 2 visits per week for each organization.	After completion of Preparatory period.
Technical training for farmers	Provide crop production technical training for leaders of each organization of 1～2 times per year. Details of the training include; production skills for traditional crops, introduction and production skills for shifting the crops and organic production with reduced agrochemicals. Diffusion of these skills and technology are discussed upon coordination with specialists of farm management and organizations.	After completion of preparatory period. 1～2 times per year.
Capacity Building (temporary dispatch)	Dispatch about 10 candidates for extension service staffs to farming enterprises of applying advanced method of production for sugarcane, melon, and vegetable.	For 1 year after the completion of preparatory period
Capacity Building (external training)	Diffusion of new skills/technology requires improvement of the quality of the extension service staffs. Continually provide technical training for extension service people.	Once per year after the completion of preparatory period

Activity Schedule for Diffusion of Production Skills/Technology

	Preparatory Period	Activity Period		Remraks
	1 - 3 years	1 - 5 years	6 - 10 years	
V&T				
Training for Production skills				1 - 2 times/year
Capacity building (temporary dispatch				
Capacity building (external training)				once/year

(4) Assistance for Farmers' Finance

Activities	Details	Executing Period
Leaders' Training	Hold 3 times/year of one-day training for leaders. The method of the training shall be in class courses on; qualification and items to be respected in applying credits from financial institutes, procedures needed for requesting credits, or plan for repaying.	The last 1 year of preparatory period, and thereafter, as necessity arises.
Training for Small/ Medium Farmers	Approximately 200 farmers shall be trained for basic understanding on agricultural finance.	Every year from the last one year of preparatory period
Window for Consultation and continuous assistance	Along with mediation for financial institutes, monitor the conditions of repayment of loans, and conduct consultation as required.	Continually given after the inception of activities.

Activity Schedule for Assistance for Farm Finance

	Preparatory period	Activity period		Remraks
	1 - 4 years	1 - 5 years	6 - 10 years	
Leaders Training				3 times/year
Training for small/medium farmers				once/year
Window for Consultation/assistance				

(5) Assistance for the Activities of Rural Women

Activities	Details	Execution Period
Assistance for Self-Awareness/Self-Development	The rural women shall pursue self-development through setting objectives and preparing plans by themselves. The training will be in form of workshops for the duration of 7 to 10 days of 3-hour/day sessions. The training requires 2～3 weeks each because it may be difficult to continue everyday consecutively.	Once a year
Assistance for Vocational Education/Training	The necessities, contents and methods of the vocational education and training shall be determined by the women's groups upon discussions. In principal, public institutes such as, INA shall be utilized, but also dispatch of instructors or visits to the places that are applying advanced methods may be considered. The assisting activities include provision of information on the schedules of education and training of public institutes and mediation of necessary instructors.	From the time of completion of workshops.
Assistance for Income Increase/ Life Improvement	Open a window for consultation to deal with all the problems arise in connection with income increase and life improvement. And offer them assistance by providing useful information, introducing or mediating specialists.	From the time of completion of workshops.
Capacity building: External seminars	Form a team of 6 staffs to assist the women's activities centered around temporarily dispatched staffs from IDA, and calling on the specialists of PRODAPEN and NGOs (ODRES, ECADES, World Vision.) Each specialist shall participate in external training or seminars on women's affairs once per year continually. For the assistance for special fields, such as, organization and management, shall be provided on coordination with other specialists.	Once a year

Activity Schedule for Assistance to Rural Women's Activities

	Preparatory period	Activity period		Remarks
	1 - 4 years	1 - 5 years	6 - 10 years	
Self Development Workshops				once/year
Assistance for Vocational Training				
Increase of incomes/Life Improvement				
Capacity Building:Participation in Seminar				once/year

5.7 PROJECT IMPLEMENTATION

5.7.1 Project Cost Estimation

(1) Project Cost Components and Conditions of Calculation

The project cost for irrigation and drainage, and flood protection are composed by the costs of works execution, land acquisition, administration, consulting services, material contingency and operation and maintenance (O/M). The project costs for environmental conservation and farmers support are composed by activities expenses, material contingency and O/M costs. The estimation is made by calculation under the following conditions. The precision of the calculation is +10%. Price contingency corresponding to price rise is indicated below for reference.

1) The base prices of labor, materials, equipments and machinery are based in the unit prices table of a report of analogous construction works. The market prices of 2001 was used for those items that were not included in this table.

2) The requirements for unit work will be referred to the technical spec of the construction works of the west canal by SENARA.

3) The prices of domestic construction materials will be the prices at site. The imported materials will have the addition of prices fixed at the delivery in Puntarenas port, domestic transportation and importation taxes.

4) The work cost will be calculated in the partitions of local and foreign currency.

5) The applied exchange rate will be that of the official exchange rate at the end of February 2002, which is US$ 1.00 =¢ 340.3. The consulting services fees will be 3% of the engineering work costs. The rate of price rise for price contingency will be 10.9% fore home currency and 1.6% for foreign currency, which are the averages of 1997-2001.

6) The target year for the accomplishment of project objectives is set at 10 years after the completion of construction works. With the total period of 4 years, for the project to be accepted (presumed as 1 year) and for the completion of construction (presumed as 3 years), regarded as the period for preparation

(2) Project Cost

The estimated costs computed from the abovementioned conditions are as summarized below.

Plan for Irrigation and Drainage

(Unit: US $ 1,000)

	Pumping system					
	Pump station	Water pipe	Main canal	Secondary canal	Drainage canal	Total
Construction cost	7,928	3,250	2,566	812	475	15,031
Land acquisition	1	20	133	68	92	314
Over head	793	325	257	81	48	1,503
Consulting service	238	98	77	24	14	451
Physical contingency	793	325	257	81	48	1,503
Total	9,752	4,018	3,289	1,067	677	18,802
O/M cost (per year)	519	33	26	8	5	590

Note: The costs of electricity and costs for facility management (1% of the construction costs) are indicated as O/M costs.

(Unit: US $ 1,000)

	Small scale ground water system (50 systems)				
	Well construction	Pumping facility	Terminal pipe		Total
Construction cost	1,770	970	500		2,740
Land acquisition					
Over head	177	97	50		274
Consulting service	53	29	15		82
Physical contingency	177	97	50		274
Total	2,177	1,193	615		3,370
O/M cost (for first year)	15	175	5		195

Note: The costs of electricity and costs for facility management (1% of the construction costs) are indicated as O/M costs.

Replacement cost

(Unit: US $ 1,000)

	Pumping equipments	Remarks
Pumps for river water	637	
Pumps for groundwater	700	

The period of replacement shall be 15 years.

Flood protection

(Unit: US $ 1,000)

Short term	Bolson River improvement	Tempisque river improvement	Raising of road	Total
Construction cost	1,492	10,239	3,391	15,121
Land acquisition	21	145	48	214
Over head	149	1,024	339	1,512
Consulting service	45	307	102	454
Physical contingency	149	1,024	339	1,512
Environmental measures		28		28
Total	1,856	12,767	4,218	18,841
O/M cost (per year)	22	154	51	227

Note: The costs for O/M equipment will be included in the annual reparation costs, through sub-contract, and the office will not own these equipments.

Plan of environmental conservation

The plan of environmental conservation is summarized as follows. The annual cost is estimated as US$ 92,000.

Costs for the plan of environmental conservation (Unit: US$1,000)

	Preparation period (4 years)			Period for project activities (10 years)			Total		
	Activities Expense	O/M Cost	Total	Activities Expense	O/M Cost	Total	Activities Expense	O/M Cost	Total
Improvement consciousness for basin management	36	2	38	166	38	204	202	40	242
Extension of eco-friendly agriculture	Included in the extension of cultivation techniques (Farmers support)								
Preserving river flow				0	18	18	0	18	18
Conservation of groundwater				100	5	105	100	5	105
Execution of monitoring	0	9	9	329	66	395	329	75	404
Total	36	11	47	595	127	722	631	138	769

Note: Activity expenses include physical contingency cost (10% of activity expense).

Agricultural supporting Plan

The Farmers Support Project is summarized as follows. The annual costs are estimated in US$ 293,000 for short term plan and in US$ 175,000 for the medium and long term plan.

Costs for the plan of farmers support (unit: US$1,000)

	Preparation period (4 years)			Period for project activities (10 years)			Total		
	Activities Expense	O/M Cost	Total	Activities Expense	O/M Cost	Total	Activities Expense	O/M Cost	Total
Activities of farmer's organizations	155	432	587	94	504	598	249	936	1,185
Extension of management techniques	0	0	0	149	144	293	149	144	293
Extension of cultivation techniques	0	0	0	525	722	1247	525	722	1247
Agricultural credit	3	0	3	20	72	92	23	72	95
Support for activities of women in rural areas	30	130	160	100	432	532	130	562	692
Equipment	126	3	129	0	13	13	126	15	141
Office	0	61	61	0	204	204	0	265	265
Total	314	626	940	888	2091	2979	1202	2716	3918

5.7.2 Project implementation and O/M

This study also proposes suggestions in issues outside of the responsibilities of SENARA in order to achieve sustainable agricultural development for the small and medium-scale farmers.

It is important to understand and utilize the total scheme as an integrated agricultural development. From this viewpoint, the implementation and O/M for the project is planned as follows.

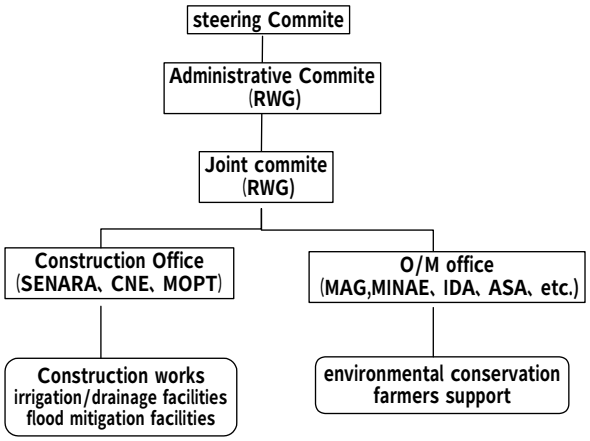
(1) The necessity of establishing a new project office

This project is proposing to achieve "sustainable agricultural development for small and medium-scale farmers" through the improvement of farming of the small and medium-scale farmers, and therefore, the establishment and strengthening of farmers organization plays an important roll. For this reason, solid and continuous supportive activities are planned. However these activities far exceeds the scopes of services of SENARA and the individual relevant government agencies. Yet, these activities need to be implemented in uniformly with issues such as equipment of infrastructures (construction facilities for irrigation/drainage and flood protection) and environmental conservation. Thus, the establishment of a new "project office", which consists of the "constriction office" focusing mainly on the contracting and implementation of infrastructure constructions, and the "implementation, operation and maintenance office" (O/M office) focusing on supporting activities shall be established. The staffs of this office will consist of loan employees from the relevant agencies (SENARA, MOPT) along with talents developed through the implementation of the project such as extension officers and workshop moderators. Furthermore, the activities for environmental conservation and farmers support does not need to be limited in the Study Area, and may be done broadly around the basin of Tempisque River, involving relevant agencies of other areas.

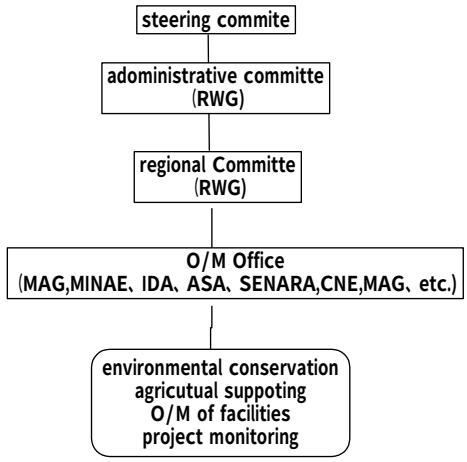
(2) Structure and functions of the project office

The project office consists of the construction office and O/M office, and is managed by supervisor and support staff. The construction office is divided into the irrigation/drainage section and the flood protection section, and is in charge of designing, construction and O/M. There will be a significant number of staffs in construction office during the construction period. However, the project office will be closed after the construction has completed and the staffs of the office will be inherited to the O/M office, which will remain afterwards. The O/M office will be loaned employees from MAG, MINAE, IDA, ASA, etc., and is divided into the nature conservation section and the farmers support section. After the completion of construction, the office will take in the division of facility O/M. The farmers support section will reinforce the staff by developing new staffs and will continue necessary activities regarding the observation results of the project progression. Activities such as the evaluation of the project, done 10 years after the completion of construction, will also be done mainly by the O/M

office.



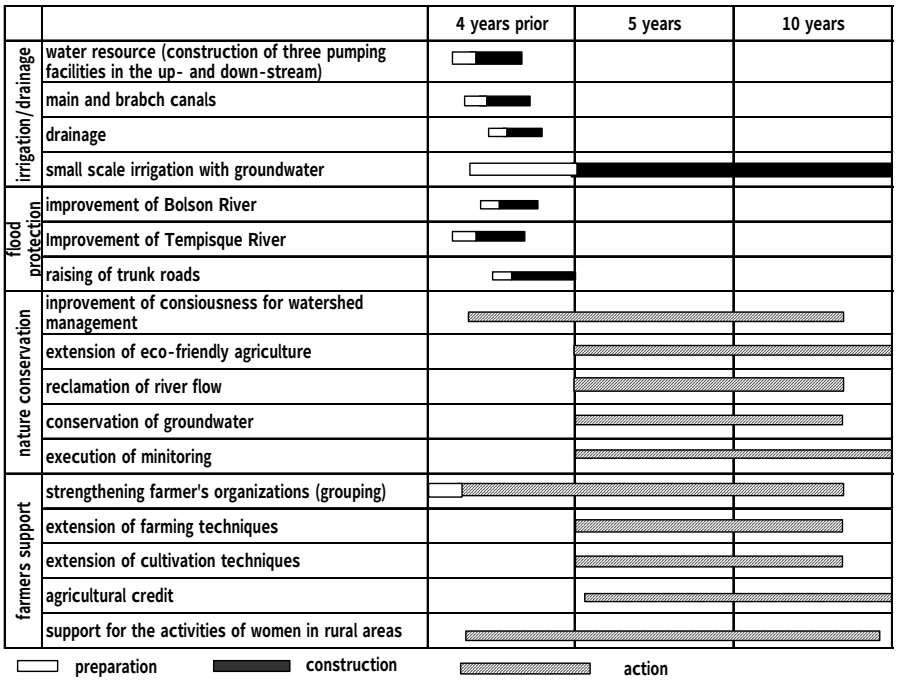
Impremention organization (construction perid)



Impremention organization (O/M period)

5.7.3 Implementation Schedule

The schedule of implementation will be as indicated below. The construction works for irrigation/drainage and flood protection will be completed in three years, and the target year of the project will be set at 10 years after the completion of construction



5.7.4 Disseverment schedule

The disseverment schedule for the projects implementation will be as indicated below.

(Unit: US$1.000)

		4 years prior	5 years	10 years	Total	Remarks
Irrigation/ Drainage	Pump system	18,802			18,802	
	O/M for pump system	531	2,950	2,950	6,431	
	Small scale irrigation with groundwater		1,685	1,685	3,370	
	O/M for irrigation with groundwater		293	780	1,073	
	Sub total	19,333	4,928	5,415	29,676	
	Price contingency	225	412	937	1,574	
Flood protection	Improvement of Bolson River	1,858			1,858	
	Improvement of Tempisque River	12,751			12,751	
	Raising of trunk roads	4,222			4,222	
	O/M costs	170	1,135	1,135	2,440	
	Sub total	19,001	1,135	1,135	21,271	
	Price contingency	399	94	196	689	
Nature conservation	Improvement of consciousness for watershed management	36	83	83	202	
	Extension of eco-friendly agriculture	0			0	Included in extension of cultivation techniques
	Reclamation of river flow	0	0	0	0	Included in O/M costs
	Conservation of groundwater	0	50	50	100	
	Execution of monitoring	0	165	165	329	
	O/M costs	11	64	64	138	
	Sub total	47	361	361	769	
	Price contingency	1	30	62	93	
Farmers support	Strengthening farmer's organizations (grouping)	155	59	35	249	
	Extension of farming techniques	0	66	83	149	
	Extension of cultivation techniques	0	263	263	525	
	Agricultural finance	3	10	10	23	
	Support for activities of women in rural areas	30	50	50	130	
	Materials and equipment	126	0	0	126	
	O/M costs	625	1,045	1,045	2,715	
	Sub total	939	1,493	1,486	3,917	
	Price contingency	13	121	252	387	
Total		39,320	7,917	8,397	55,634	
Total of price contingency		639	659	1,451	2,749	

The required finance for the project is proposed to be procured from IBD.

5.8 PROJECT APPRAISAL

This project appraisal mainly consists of financial and economic analysis of the feasibility of the project, as those on technological, environmental and social aspects were already carried out in the previous chapters.

Firstly the financial and economic analysis on the total project will be carried out to see the feasibility of its implementation. In order to appraise the potentials for sustained development of the small and medium-scale farmers, the changes of economic balances of the small and medium size farms of the respective zones, brought by the introduction of irrigation system and new crops will be analyzed. Furthermore, the impact of the burden of the small and medium-scale farmers for the project cost on the economy of the farmers will be analyzed in different rates of burden, along with analyzing the changes of income of the farmers after implementation of the project with the matrix of national household income distribution.

The dollar unit is only used for the calculation of the financial and economic appraisal with the end February 2002 exchange rate of 347.3 colons for one dollar.

5.8.1 Financial and Economic Appraisals

(1) Conditions

The life of the facilities and the project life are set at 30 years. In calculation of the financial and economic appraisal, however, the project life is set at 25 years after the installation of major facilities taking into account of BID's long-term loan of 25 years.

We assume that such external conditions as population growth, price, national policy, urban economic activities follow the present trends. Shadow rates are used to calculate the economic price. We anticipate the following situation change would take place if the targets of the project are to be achieved.

- Cooperative movement and diversification of crops would increase the rate of intense farming by small and medium farmers.
- An irrigation system would be introduced to a part of the fields of sugarcane and pasture owned by small and medium-scale farmers to ease water shortage during the dry season.
- The idea of basin management would permeate through the minds of the populace in the basin, and natural environment would be sustained in good condition.
- People would go easy on water and some sign of recovery on the volume of river flow would be seen.
- Agriculture with less fertilizer and agrochemical would become a norm, and its impacts on water quality would be eased.
- The habitat of flora and fauna in the basin would be sustained in good condition.
- Rural women groups would work actively, members' income would increase, and the social environment for bringing up children would be improved.
- The basis of the farm management of the small and medium farmers would stabilize, and the goal of sustainable agricultural development would be attained.

(2) financial appraisal

1) Calculation of benefit

a. Agricultural production (irrigation and drainage, environmental, and supporting farmers)

Calculation of benefit of agricultural production is based on the following major crops.

Crop balance per hectare used for the calculation of benefit

Crop	Current and planned state	With/without irrigation	Production cost/ha (colons)	Gross income/ha (colons)	Benefit/ha	
					Colons	US$
Sugarcane	Current l state	Without irrigation	309,799	390,000	80,201	231
		With irrigation	366,370	520,000	153,630	442
	Planned state	Without irrigation	264,333	455,000	190,667	549
		With irrigation	313,640	650,000	336,360	968
Rice (rainy season crop)	Current l state	Without irrigation	256,978	307,700	50,722	146
		With irrigation	293,159	374,000	80,841	233
	Planned state	Without irrigation	228,868	323,000	94,132	271
		With irrigation	259,457	442,000	182,543	526
Pasture	Current l state	Without irrigation	181,810	133,200	-48,610	-140
		With irrigation	566,415	570,857	4,442	13
	Planned state	Without irrigation	209,377	166,500	-42,877	-123
		With irrigation	660,866	713,571	52,705	152
Mango	Current l state	Without irrigation	431,300	624,000	192,700	555
	Planned state	Without irrigation	702,200	1,008,000	305,800	881
Vegetables	Current l state	With irrigation	1,155,285	1,664,000	508,715	1,465
	Planned state	With irrigation	1,006,439	1,768,000	761,561	2,193
Melon	Planned state	With irrigation	1,864,129	4,320,000	2,455,871	7,071

The following costs are not included in the project costs.

Item	Contents	Costs	
		Colon/ha	US$/ha
Costs for crop conversion	Pasture to sugarcane	50,700	146
	Conversion to melon	680,000	1,958
	Conversion to mango	520,000	1,497
O/M costs of groundwater usage (will O/M costs of groundwater systems will not be allocated for they will be owned by the farmer's organizations)		66,300 (annual)	191 (annual)
Organization running costs	1,440,000 colons (annual cost per organization)	72,000,000 (as total)	207,314 (as total)

For the net profits, the net profits of the current state will be used for the time right after the introduction of the pumping system, and were premised to increase gradually to reach the level of planned profits with irrigation in ten years along with the increase of the effect of conservation of the environment, and supporting farmers. The change of the planted area and irrigated area in the plan are shown below.

Changes in planted/irrigated areas

Crop	At implementation				10 years after implementation				Changes of planted area
	Planted area	Irrigated area			Planted area	Irrigated area			
		Normal year	1/5year probability	1/10year probability		Normal year	1/5year probability	1/10year probability	
Pasture	6,875	800	580	510	5,125	0	0	0	-1,750
Sugarcane	3,885	1,520	1,110	970	4,335	2,590	2,000	1,790	450
Rice (rainy season crop)	1,545	1,010	1,010	1,010	1,695	1,360	1,360	1,360	150
Melon	0	0	0	0	600	600	600	600	600
Mango	40	0	0	0	640	0	0	0	600
Vegetables	260	210	210	210	1,310	1,310	1,310	1,310	1,050
Total	12,605	3,540	2,910	2,700	13,705	5,220	4,670	4,450	1,100

Note: the irrigated area indicated in the table corresponds to the planted area and does not describe the actual irrigated area.

We have assumed that scarcity of river water would occur in March and April of dry years. We calculate the benefits based on the weighted average of 70% in normal year, 20% in 1/5 year, and 10% in 1/10 year.

The annual benefits are estimated as are shown in the following two tables. The benefit is calculated at 491 thousand dollars just after the completion of the construction works, and at 10,672 thousand dollars at ten years after completion.

Benefit calculation: at implementation

(Units: area=ha, benefit=US$1,000)

Crop	Stage of project	With/without irrigation	Net profit without (US$/ha)	Current state		Plan					
						Normal year		1/5year probability		1/10year probability	
				Area	Income	Area	Income	Area	Income	Area	Income
Sugarcane	At first	Without	231	3,885	897	2,365	546	2,775	641	2,915	673
		With	442			1,520	672	1,110	491	970	429
	10 years after	Without	549								
		With	968								
Rice (rainy season crop)	At first	Without	146	1,545	226	535	78	535	78	535	78
		With	233			1,010	235	1,010	235	1,010	235
	10 years after	Without	271								
		With	526								
Pasture	At first	Without	-140	6,875	-962	6,075	-850	6,295	-881	6,365	-891
		With	13			800	10	580	7	510	7
	10 years after	Without	-123								
		With	152								
Vegetables	At first	With	1,465	260	381	260	381	260	381	260	381
	10 years after	With	2,193								
Mango	At first	Without	555	40	22	40	22	40	22	40	22
	10 years after	Without	881								
Melon	10 years after	With	7,071								
			Total	12,605	564	12,605	1,095	12,605	974	12,605	934
			Weighed average of planned income		1,055		70%		20%		10%
			Benefit		**491**						

Benefit calculation: 10 years after implementation

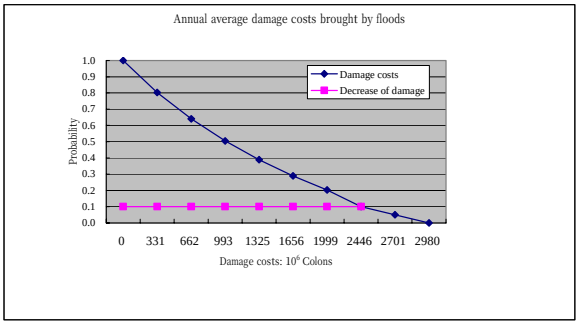
(Units: area=ha, benefit=US$1,000)

Crop	Stage of project	With/without irrigation	Net profit without	Current state		Plan					
						Normal year		1/5year probability		1/10year probability	
			(US$/ha)	Area	Income	Area	Income	Area	Income	Area	Income
Sugarcane	At first	Without	231	3,885	897						
		With	442								
	10 years after	Without	549			1,745	958	2,335	1,282	2,545	1,397
		With	968			2,590	2,508	2,000	1,937	1,790	1,734
Rice (rainy season crop)	At first	Without	146	1,545	226						
		With	233								
	10 years after	Without	271			335	91	335	91	335	91
		With	526			1,360	715	1,360	715	1,360	715
Pasture	At first	Without	-140	6,875	-962						
		With	13								
	10 years after	Without	-123			5,125	-633	5,125	-633	5,125	-633
		With	152								
Vegetables	At first	With	1,465	260	381						
	10 years after	With	2,193			1,310	2,873	1,310	2,873	1,310	2,873
Mango	At first	Without	555	40	22						
	10 years after	Without	881			640	564	640	564	640	564
Melon	10 years after	With	7,071			600	4,243	600	4,243	600	4,243
			Total	12,605	564	13,705	11,318	13,705	11,071	13,705	10,983
			Weighed average of planned income		11,235		70%		20%		10%
			Benefit		**10,672**						

b. Flood protection

We estimated average annual flood damage based on the actual costs of damages caused by Hurricane Mitch in 1998 and Cyclone Floyd in 1999 estimated by the CNE.

Mitch's excess probability is estimated at 1/5, Floyd at 1/10, and damage in probability one is estimated at null. Approximate values that are derived from a fractional equation are introduced for the costs of damages of other probability and the annual average cost of damage.



The actual costs of damage on facilities sensitive to flood damages, such as farmlands, settlements, roads, and public infrastructure are estimated as are shown in the following table.

	Farmlands	Settlements	Public infrastructure
Damage cost per unit	495US$/ha	3,600US$/house	26,000US$/unit
Damage costs floods of 1/5year probability	16,000ha	400 houses	76 units
Damage costs floods of 1/10year probability	23,600ha	478 houses	106 units
Damage costs floods of 1/20year probability	25,000ha	524 houses	117 units
Damage costs floods of 1/30year probability	26,000ha	535 houses	120 units

The following table shows the damage alleviation plan.

Category	Probability of flood	Current state of damage	Planned state of damage	Target of reduction	Measures
Farmland(ha)	1/5	16,000(15,000)	2,000(2,000)	14,000	Improvement of Bolsón River (16.5km)
	1/10	23,600(15,000)	2,500(2,500)	21,100	Improvement of Tempisque River (13km)
Infrastructure	1/10	106 units	0	106 units	Raising of trunk roads (28.5km)

The annual average benefit is estimated at 2.56 million dollars.

Rough estimation of short-term benefit of flood protection

Item		Probability (Possibility)		Total
		1/5(20.0%)	1/10(10.0%)	
Farmland	Reduced damage (ha)	21,000	24,000	
	Cost per unit of damage (US$/ha)	495	371	
	Damage cost (US$1,000)	1,381	86	
	Average reduction of damage cost (US$1,000/year)	1,083	67	1,151
Settlements	Reduced damage (houses)	400	75	
	Cost per unit of damage (US$/house)	3,582	3,582	
	Damage cost (US$1,000)	424	26	
	Average reduction of damage cost (US$1,000/年)	332	21	353
Public infrastructure	Reduced damage (unit)	76	30	
	Cost per unit of damage (US$/unit)	24,144	24,144	
	Damage cost (US$1,000)	1,335	83	
	Average reduction of damage cost (US$1,000/year)	1,047	65	1,112
Total average reduction of damage cost (US$1,000/year)		2,462	153	2616

Item		Probability (Possibility)		
		1/5(20%)	1/10(10%)	Balance
Farmland	Reduced damage (ha)	14,000	21,100	7,100
	Cost per unit of damage (US$/ha): 100%convert	450	336.55553	
	Damage cost (US$1,000)	2,441	2,875	434
	Average reduction of damage cost (US$1,000/year)	**1,089**	**1,126**	**37**
Settlements	Reduced damage (houses)	220	461	241
	Cost per unit of damage (US$/house)	3,254	3654.3959	
	Damage cost (US$1,000)	716	882	166
	Average reduction of damage cost (US$1,000/year)	**337**	**345**	**8**
Public infrastructure	Reduced damage (units)	76	106	30
	Cost per unit of damage (US$/unit)	28,736	26123.395	
	Damage cost (US$1,000)	2,184	2,780	596
	Average reduction of damage cost (US$1,000/年)	**1,072**	**1,089**	**17**
Total average reduction of damage cost (US$1,000/year)		**2,498**	**2,561**	**63**

2) Financial appraisal

a. Agricultural production

In the analysis, we presume that the benefits of the tenth year after the completion of the construction works will continue to be generated. We set the total period of cash-flow calculation at 29 years, i.e., the preparation and construction period of four years and repayment period of 25 years. We estimate FIRR, and B/Cs at the discount rates of 12% and 6%. In the financial analysis, As to the conservation works of the environment and supporting works for farmers, we only include their project costs as the necessary conditions of attaining the increased agricultural production.

The benefits of irrigation are generated partially when a part of irrigation water are provided during the construction period, so corresponding benefits and costs are added. We presume that the present net profits with irrigation are generated in the first year after the construction period is over, and the profits presume to increase gradually to reach the level of planned profits with irrigation in ten years. We presume that the change of crops from pasture to sugar cane, melon, and mango would take place in ten years between the fifth and fourteenth year, and the costs are added. To facilitate understanding, these conversion costs are subtracted from the benefits. Groundwater utilization requires formation of farmers' organizations, which is assumed to be started during the construction period of irrigation system and to achieve the target in ten years. The costs are separately added. The farmers' households share the O/M costs of groundwater irrigation system and operation costs of farmers' organization, so they are deducted from the benefits.

Calculation of accountance

Unit: US$1,000 Plans of irrigation/drainage, environmental conservation, farmers support

Project period: 28 years

Total cost 49,299

Total benefit 157,147

B/C 1.38 Discount rate: 12%
2.41 Discount rate: 6%

FIRR 15.77%

Years		Project costs								Benefit					
After implementation	After completion of short-term construction works	Irrigation development plan			Environment conservation plan		Farmers support plan		Total	Agricultural income	Other expenses			Total	Benefit-Costs
		Pump irrigation systems		Ground water							Cropping	Ground water	Organization		
		Construction costs	O/M costs	Construction costs	Activity costs	O/M costs	Activity costs	O/M costs			Conversion costs	O/M costs	Running costs		
0							92	208	299					0	-299
1		7,521			12	3	92	208	7,835					0	-7,835
2		9,401	177		12	4	64	209	9,867	147			-6	141	-9,726
3	0	1,880	354	337	12	4	67	209	2,863	295			-12	282	-2,581
4	1		590	337	60	13	101	209	1,310	491	-174	-20	-21	277	-1,033
5	2		590	337	60	13	86	209	1,295	1,622	-174	-39	-41	1,368	73
6	3		590	337	60	13	86	209	1,295	2,753	-174	-59	-62	2,459	1,164
7	4		590	337	60	13	86	209	1,295	3,885	-174	-78	-83	3,550	2,255
8	5		590	337	60	13	87	209	1,296	5,016	-174	-98	-104	4,640	3,345
9	6		590	337	60	13	87	209	1,296	6,147	-174	-117	-124	5,731	4,436
10	7		590	337	60	13	87	209	1,296	7,278	-174	-137	-145	6,822	5,527
11	8		590	337	60	13	88	209	1,297	8,409	-174	-156	-166	7,913	6,617
12	9		590	337	60	13	88	209	1,297	9,540	-174	-176	-187	9,004	7,708
Target ye 13	10		590		60	13	88	209	960	10,672	-174	-195	-207	10,095	9,136
14	11		590		60	13	88	209	960	10,672	-174	-195	-207	10,095	9,136
15	12		590		60	13	88	209	960	10,672		-195	-207	10,269	9,310
16	13		590		60	13	88	209	960	10,672		-195	-207	10,269	9,310
17	14		590		60	13	88	209	960	10,672		-195	-207	10,269	9,310
18	15	637	590	70	60	13	88	209	1,667	10,672		-195	-207	10,269	8,603
19	16		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
20	17		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
21	18		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
22	19		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
23	20		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
24	21		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
25	22		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
26	23		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
27	24		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
28	25		590	70	60	13	88	209	1,030	10,672		-195	-207	10,269	9,240
Total		19,439	15,281	4,140	1,536	334	2,515	6,054	49,299	216,329	-1,915	-3,998	-4,269	206,148	157,147

FIRR is estimated at 15.8%, B/C (12%) at 1.38, B/C (6%) at 2.41. The result of the sensitivity analysis with 10% cost increase and 10% benefit decrease is given in the following matrix.

Analysis of financial sensitivity

	Original case	10% decrease of benefit
Original case	15.77%	14.51%
10% increase of cost	14.63%	13.40%

b. flood protection

Financial analysis is carried out for the period of 28 years, i.e., three years of construction period and 25 years of repayment period. The full benefits are assumed to be generated after the completion of construction works. In some areas where the improvement works finish in the second year the benefits and O/M costs are generated from that year.

ntance Plan of flood protection

Project period: 28 years, Total cost: 24,412 Total benefit: 65,883

Years		Project costs			O/M	Total cost	Benefit			Total benefit	$1000 Benefit-cost
							Agricultural production	Settlement	Public infrastructure		
After implementation	After construction	Colon	US$	Total			1/10	1/10	1/10		
1		539	913	1,452	0	1,452				0	-1,452
2		3,016	5,107	8,123	0	8,123				0	-8,123
3	0	3,437	5,819	9,256	170	9,426	1,126	345	545	2,016	-7,411
4	1				226	226	1,126	345	1,089	2,560	2,334
5	2				226	226	1,126	345	1,089	2,560	2,334
6	3				226	226	1,126	345	1,089	2,560	2,334
7	4				226	226	1,126	345	1,089	2,560	2,334
8	5				226	226	1,126	345	1,089	2,560	2,334
9	6				226	226	1,126	345	1,089	2,560	2,334
10	7				226	226	1,126	345	1,089	2,560	2,334
11	8				226	226	1,126	345	1,089	2,560	2,334
12	9				226	226	1,126	345	1,089	2,560	2,334
13	10				226	226	1,126	345	1,089	2,560	2,334
14	11				226	226	1,126	345	1,089	2,560	2,334
15	12				226	226	1,126	345	1,089	2,560	2,334
16	13				226	226	1,126	345	1,089	2,560	2,334
17	14				226	226	1,126	345	1,089	2,560	2,334
18	15				226	226	1,126	345	1,089	2,560	2,334
19	16				226	226	1,126	345	1,089	2,560	2,334
20	17				226	226	1,126	345	1,089	2,560	2,334
21	18				226	226	1,126	345	1,089	2,560	2,334
22	19				226	226	1,126	345	1,089	2,560	2,334
23	20				226	226	1,126	345	1,089	2,560	2,334
24	21				226	226	1,126	345	1,089	2,560	2,334
25	22				226	226	1,126	345	1,089	2,560	2,334
26	23				226	226	1,126	345	1,089	2,560	2,334
27	24				226	226	1,126	345	1,089	2,560	2,334
28	25				226	226	1,126	345	1,089	2,560	2,334
		6,992	11,839	18,831	5,820	24,651	29,276	8,970	27,770	66,016	41,365
		NPV:12%=				15,743				15,726	-17
		NPV: 6%=				18,939				29,169	10,230
									B/C:12%=	**1.00**	**FIRR**
									B/C: 6%=	**1.54**	**12.0%**

FIRR is estimated at 11.8%, B/C (12%) at 0.99, B/C (6%) at 1.53. The result of the sensitivity analysis with 10% cost increase and 10% benefit decrease is given in the following matrix.

	Original case	10% decrease of benefit
Original case	12.0%	10.2%
10% increase of cost	10.4%	8.9%

(3) Economic Appraisal

The economic appraisal is examined by conforming to the conditions set for the financial appraisal.

1) Method

Financial costs are converted into economic costs by the following process.

Process 1: Compensation cost is excluded as a transfer item.

Process 2: Project costs are divided into foreign currency potion and domestic currency potion. Unskilled labor cost in the construction costs are assumed to be insignificant and negligible. Economic Wage Rate (EWR) for the agricultural labor is to be estimated.

Process 3: The costs are expressed in dollar term, so the amount of domestic currency potion is multiplied by the colon's Standard Conversion Factor (SCF) to dollar.

Financial benefits are converted into economic benefits by the following process.

The prices of sugar and paddy are regulated, so the crops are divided into two categories, sugar and paddy, and others. Border prices are estimated for sugar and paddy in dollar term, and for the rest, the prices are multiplied by the colon's Standard Conversion Factor (SCF) to dollar if their prices are expressed in colon.

2) Coefficients, rates, and economic prices

SCF is estimated at 0.998, EWA at 0.5. Economic price of sugarcane at factory gate is estimated at 11 dollar per ton, and economic price of paddy at mill gate is estimated at 122 dollar per ton.

3) Economic benefit

a. Agricultural production

The economic benefit is estimated at 179 thousand dollars just after the completion of the construction works, and at 10,009 thousand dollars after ten years.

Benefits from agricultural production (Pre-E/F; Pre-F/S) ha 1000$

						70%		20%		10%	
	Stage	Irrigation	Net profit ($/ha)	Current state		Plan					
						Normal		1/5		1/10	
				Area	Income	Area	Income	Area	Income	Area	Income
Sugarcane	+1	0	-155	3885	-600	2365	-365	2775	-429	2915	-450
		1	-100			1520	-152	1110	-111	970	-97
	+10	0	81			1745	141	2335	188	2545	205
		1	277			2590	717	2000	554	1790	495
Rice (rain-fed)	+1	0	-283	1545	-438	535	-152	535	-152	535	-152
		1	-291			1010	-294	1010	-294	1010	-294
	+10	0	-179			335	-60	335	-60	335	-60
		1	-96			1360	-131	1360	-131	1360	-131
Pasture	+1	0	-36	6875	-244	6075	-216	6295	-224	6365	-226
		1	117			800	94	580	68	510	60
	+10	0	-19			5125	-98	5125	-98	5125	-98
		1	256								
Vegetables	+1	1	2126	260	553	260	553	260	553	260	553
	+10	1	2852			1310	3737	1310	3737	1310	3737
Mango	+1	0	763	40	31	40	31	40	31	40	31
	+10	0	1088			640	696	640	696	640	696
Melon	+10	1	7245	0	0	600	4347	600	4347	600	4347
				12605	**-699**	13705	-502	13705	-558	13705	-576
					+1	Average	-521	Net profit	**179**		
						13,705	9,348	13,705	9,233	13,705	9,192
					+10	Average	9,310	Net profit	**10,009**		

b. The annual average benefit is estimated at 2.56 million dollars. It breaks down into 1.13 million dollars for agricultural production, 0.35 million dollars for houses, and 1.09 million dollars for public infrastructure.

4) Economic appraisal

a. Cultural production

EIRR is estimated at 14.7%, B/C (12%) at 1.27, B/C (6%) at 2.23. The cash flow of the plan is shown

Economical cash-flow

											0.998		便 益				$1000
		Agricultural production					Environmental conservation		Agricultural production		Total costs	Agricultural production	Environmental conservation	GW O/M	Organizatoin management	Total	B-C
Years		Colon	US$	Total	O/M	GW	Activity costs	O/M	Activity costs	O/M							
0				0	0	0	0	0	92	207	299.1505					0	-299.1505
1		2,666	4,537	7,204	0	0	12	3	92	207	7,518					0	-7,518
2		3,722	5,671	9,394	177	0	12	4	64	208	9,858	54			-6	48	-9,811
3	0	744	1,134	1,879	353	336	12	4	67	208	2,859	107			-12	95	-2,764
4	1				589	336	60	13	101	208	1,307	179	-174	-20	-21	-36	-1,343
5	2				589	336	60	13	86	208	1,292	1,271	-174	-39	-41	1,017	-275
6	3				589	336	60	13	86	208	1,292	2,363	-174	-59	-62	2,069	777
7	4				589	336	60	13	86	208	1,292	3,455	-174	-78	-83	3,121	1,829
8	5				589	336	60	13	87	208	1,293	4,548	-174	-98	-104	4,172	2,879
9	6				589	336	60	13	87	208	1,293	5,640	-174	-117	-124	5,226	3,933
10	7				589	336	60	13	87	208	1,293	6,732	-174	-137	-145	6,277	4,984
11	8				589	336	60	13	88	208	1,294	7,824	-174	-156	-166	7,329	6,035
12	9				589	336	60	13	88	208	1,294	8,917	-174	-176	-187	8,381	7,087
13	**10**				589		60	13	88	208	958	10,009	-174	-194	-207	9,434	8,476
14	11				589		60	13	88	208	958	10,009	-174	-194	-207	9,434	8,476
15	12				589		60	13	88	208	958	10,009		-194	-207	9,608	8,650
16	13				589		60	13	88	208	958	10,009		-194	-207	9,608	8,650
17	14				589		60	13	88	208	958	10,009		-194	-207	9,608	8,650
18	15	252	384	636	589	70	60	13	88	208	1,664	10,009		-194	-207	9,608	7,943
19	16				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
20	17				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
21	18				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
22	19				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
23	20				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
24	21				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
25	22				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
26	23				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
27	24				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
28	25				589	70	60	13	88	208	1,028	10,009		-194	-207	9,608	8,580
		7,385	11,727	19,112	15,250	4,132	1,533	333	2,511	6,043	48,913	201,233	-1,911	-3,990	-4,260	191,072	142,458
									NPV:12%=		21,138					26,867	**5,729**
									NPV: 6%=		29,432					65,777	**36,345**
													B/C:12%=			**1.27**	**EIRR**
													B/C: 6%=			**2.23**	**14.7%**

in the following table.

The result of the sensitivity analysis with 10% cost increase, 10% benefit decrease, and combined case is given in the following matrix.

	Original case	B: -10%
Original case	14.7%	13.5%
C: +10%	13.6%	12.4%

b. Aviation of flood damage

EIRR is estimated at 12.0%, B/C (12%) at 1.00, B/C (6%) at 1.55. the cash flow of the plan is given below.

Reduction of flood damage

Years		0.998				Total cost	B1	B2	B3	Total Benefit	$1000
		Project costs					Agricultural productivity	Settlement	Public infrastructure		Benefit-Cost
After implementation	After construction	Colon	US$	Total	O/M		1/10	1/20	1/20		
1		484	1,184	1,668	0	1,668				0	-1,668
2		3,489	5,920	9,409	0	9,409				0	-9,409
3	0	2,791	4,735	7,526	170	7,696	1,124	344	543	2,011	-5,685
4	1				226	226	1,124	344	1,087	2,555	2,329
5	2				226	226	1,124	344	1,087	2,555	2,329
6	3				226	226	1,124	344	1,087	2,555	2,329
7	4				226	226	1,124	344	1,087	2,555	2,329
8	5				226	226	1,124	344	1,087	2,555	2,329
9	6				226	226	1,124	344	1,087	2,555	2,329
10	7				226	226	1,124	344	1,087	2,555	2,329
11	8				226	226	1,124	344	1,087	2,555	2,329
12	9				226	226	1,124	344	1,087	2,555	2,329
13	10				226	226	1,124	344	1,087	2,555	2,329
14	11				226	226	1,124	344	1,087	2,555	2,329
15	12				226	226	1,124	344	1,087	2,555	2,329
16	13				226	226	1,124	344	1,087	2,555	2,329
17	14				226	226	1,124	344	1,087	2,555	2,329
18	15				226	226	1,124	344	1,087	2,555	2,329
19	16				226	226	1,124	344	1,087	2,555	2,329
20	17				226	226	1,124	344	1,087	2,555	2,329
21	18				226	226	1,124	344	1,087	2,555	2,329
22	19				226	226	1,124	344	1,087	2,555	2,329
23	20				226	226	1,124	344	1,087	2,555	2,329
24	21				226	226	1,124	344	1,087	2,555	2,329
25	22				226	226	1,124	344	1,087	2,555	2,329
26	23				226	226	1,124	344	1,087	2,555	2,329
27	24				226	226	1,124	344	1,087	2,555	2,329
28	25				226	226	1,124	344	1,087	2,555	2,329
		6,765	11,839	18,603	5,808	24,412	29,217	8,952	27,714	65,883	41,472
		NPV:12%=				15,931				15,726	-205
		NPV: 6%=				19,049				29,169	10,120
									B/C:12%=	**0.99**	**EIRR**
									B/C: 6%=	**1.53**	**12.0%**

The result of the sensitivity analysis with 10% cost increase and 10% benefit decrease, and combined case is given in the following matrix.

Sensitivity analysis

	Original case	B: -10%
Original case	12.0%	10.4%
C: +10%	10.5%	9.0%

5.8.2 Farm Management Analysis

(1) Objective of analysis

The proposed development plan in the study is aiming to "achievement of sustainable development of small and medium scale framers" and suggests the agricultural management for 3 zones expecting the establishment of the foundation of self-development with public supporting for the small and medium scale farmers who are in the financially and economically week conditions. Therefore, the objectives the farm management analyses are to check on the questions such; how do the small-scale farmers improve their farm management with their small-scale farmlands? how much credit will be required for the small-scale farmers who do not have their own money enough? the proposed farming improvement plan can be applied for the small-scale framers? from the viewpoints of financial maters. Especially, at the initial stage of agricultural improvement, for instance converting the crops from cattle raising to mango, increase of agricultural input and decrease of agricultural income will be occurred and, in this conditions, it is necessary to see that the small-scale farmers, who do not have enough self-fund, are able to improve their farm management with paying the interest using the present credit system including agro-credit or not. And also the obtaining the indicators for if it is possible to charge to the small-scale farmers for the investment cost of irrigation facilities construction is one of objective of the analyses.

(2) Analysis conditions

The farm management for 3 zones is analyzed and common conditions for all zones are shown below. The specific conditions for each zone will be described at the each section respectively.

- Farm size: The average farm size of small-scale farmers is estimated as 7.3 ha, but, for seeing the possibilities of small-scale farmers with bad conditions, the farm size of model farmer is set as 5 ha.
- Family labor: In the project evaluation, the cost of family work is included in the agricultural cost. In the farm management analysis, the cost of family work is excluded. When the working time of family labor is increased, the family labor will work more, and, when the time is decreased family will get more luxury time, so those are not influence to the cost.
- Cost/benefit: The other factors for cost/benefit are flowed the same conditions as those of the project evaluation. Therefore, the productivity at initial stage is the same as that of present and the effect of the project is going to be appeared gradually and 100 % of effect will be appeared after 10 years.
- Organization cost: The activities of framers' organization make necessary conditions for getting proposed benefit and each farmer has to pay for their organizations 72,000 colons/year additionally.
- Other costs: With assumption of that the agricultural net benefit at present might be necessary for the expenditure of others than agriculture (for instance living expense), the present agricultural net benefit will be reduced from family budget.
- Credit conditions: In the study are, some of small-scale farmers might have the fund for the initial investment. However, for seeing the farmers in the severe conditions in this analysis, it is assumed that all the new requirements for farm management will be borrowed from the credit. Basically, long-term loan will be applied for initial investment and short time lone will be applied for running cost.
  The conditions of long-term lone (as same as conditions of agro-credit of IDA)
  Interest: 8 % per annum, unredeemable period: 5 years, payment term: 15 yeas, payment on a per capita basis.
  The conditions of short-term lone (as same as conditions of city banks)
  Interest: 24% per annum (2% per month), payment term: within 1 years
- Supporting conditions: It is necessary to implement the strengthen of agricultural supporting plan on time for organizing the small and medium scale farmers and improving their farming practice on the schedule. For the implementation of the plan, approximant 100,000 colons/year for each farmer of the cost will be required, but, these cost will not be charged to farmers.

The farm management conditions is analyzed for seeing the balance of cost/benefit of farming with 5 ha, but not for seeing the income/expenditure of farm household, so, present income/expenditure of

others than agriculture is not considered. Instead of the other factors, present agricultural net benefit is assumed for necessary expenditure for farm household.

(3) Farm management analysis

1) Zone A (conversion from cattle raising to mango)

a) Financial analysis for 1 ha of mango

Conditions for analysis:

Following the conditions of the project financial/economic evaluation, The basic conditions are set as shown below.

- The conversion from cattle raising to mango is carried out with purchasing the nursery tree and without the irrigation.
- The yield of mango is no harvest for first 2 years (0, 1st fiscal year), is started to increase from 3 years later (2nd fiscal year) as shown below, and become to possible to harvest 100 % at 11 years later (10th fiscal year).

Increasing condition for the Yield of Mango

Fiscal year	0	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
% of yield	0%	0%	21%	42%	56%	69%	83%	88%	92%	96%	100%

- Unit price of wages: 300 colons/hr, harvesting cost: 2.5 colon/mango, contract labor: 3,000 colon/day, farm gate price: 30 colon/mango
- Based on the payment period for long-term agricultural credit (interest: 8 % per annum, unredeemable period: 5 years, payment term: 15 yeas, payment on a per capita basis), the analysis period is set as for 21 years (by 20th fiscal year)

Financial analysis for 1 ha

Financial analysis for the case of conversion from cattle raising to mango for 1 ha is shown in next page. In the first 2 years show the loss with no harvest but, after 4th fiscal year, stable benefit can be obtain and FIRR for 20th fiscal year is 15.3 %.

Financial analysis of mango (for 1 ha, unit:1000 colon)

fiscal year	Time of labor (ha)	wages	harvesting wages	contract labor	inputs	organization fee	Total Cost	Benefit	yield (pieces)	B-C	
0	140	42	0	17	461	0	520	0		-520	
1	**264**	79	0	0	80	14	174	0		-174	
2	**264**	79	0	0	80	14	174	210	7,000	36	
3	**264**	114	35	12	293	14	469	420	**14,000**	-49	
4	311	140	47	12	293	14	506	560	18,667	54	
5	357	166	58	12	293	14	543	700	23,333	157	
6	**404**	191	70	12	393	14	681	840	**28,000**	159	
7	439	205	74	12	393	14	698	882	29,400	184	
8	474	219	77	12	393	14	716	924	30,800	208	
9	509	233	81	12	393	14	733	966	32,200	233	
10	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
11	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
12	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
13	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
14	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
15	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
16	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
17	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
18	**544**	247	84	12	443	14	801	1,008	**33,600**	207	
19	**544**	247	84	12	443	14	801	1,008	**33,600**	207	FIRR=
20	**544**	247	84	12	443	14	801	1,008	**33,600**	207	15.3%

Reducing the present benefit of cattle raising land (with – without), FIRR is 12.0 %.

Conversion from Pasture to Mango

financial analysis (for 1 ha unit: 1,000 colons)

fiscal year	Mango		Pasture		Mango - Pasture		
	working time	net income	working time	net income	working time	benefit	
0	140	-520	243	24	-103	-544	
1	**264**	-174	243	24	21	-198	
2	**264**	36	242	25	22	12	
3	**264**	-49	241	25	23	-74	
4	311	54	240	25	71	29	
5	357	157	239	26	118	131	
6	**404**	159	238	26	166	133	
7	439	184	237	26	202	158	
8	474	208	236	27	238	182	
9	509	233	235	27	274	206	
10	**544**	207	234	27	310	180	
11	**544**	207	234	27	310	180	
12	**544**	207	234	27	310	180	
13	**544**	207	234	27	310	180	
14	**544**	207	234	27	310	180	
15	**544**	207	234	27	310	180	
16	**544**	207	234	27	310	180	
17	**544**	207	234	27	310	180	
18	**544**	207	234	27	310	180	
19	**544**	207	234	27	310	180	FIRR=
20	**544**	207	234	27	310	180	12.0%

b) Farm model

in the A zone, some part of cattle raising land will be convert to the mango. The land use in this zone will be changed with this conversion as shown below. The number of the small and medium scale farmers is estimated as 324 farm household and average cropping area per farmer is also estimated as shown in the table.

Clopping area of Zone A (ha)

	Cattle raising	Sugarcane	Rice	Mango	Vegetables	Others	Total
At present	4,935	720	125	10	70	280	6,140
	80%	12%	2%	0.2%	1%	5%	100%
Proposed	4,335	720	125	610	70	280	6,140
	71%	12%	2%	10%	1%	5%	100%

Cropping area per farmer

At present	15.2	2.2	0.4	0.0	0.2	0.9	18.9
Proposed	13.4	2.2	0.4	1.9	0.2	0.9	18.9

A model farm household for the analysis is set as follows:

Present cropping area: cattle raising 4ha, sugarcane 1 ha
Proposed cropping area: cattle raising 3ha, sugarcane 1 ha, mango 1 ha

c) Basic dimensions and present balance of agriculture

The basic dimensions of cattle raising and sugarcane at present and 10 years later are summarized as shown below.

Agricultural balance for 1 ha (non-irrigation unit:1,000 colon)

	At initial		10 years later	
	Cattle raising	Sugarcane	Cattle raising	Sugarcane
Family labor (hr)	243	0	234	0
Production cost	109	310	139	264
Gross income	133	390	167	455
Net income	24	80	27	191
Organization fee	14			
Net income reducing organization fee	10	70	13	177

Note) the family labor is based on estimation

Agricultural balance of model farmer at present is as shown in the right table and it is estimated they earn approximant 177,000 colon of agricultural net income annually (note: this model farmer has another job(s) getting other income, so, this table does not show the household income).

Agricultural income of model farm at present (1,000 colon)

	Cattle raising	Sugarcane	total
Planted area	4ha	1ha	5ha
Family labor	972hr	0hr	972hr
Production cost	436	310	745
Gross income	533	390	923
Net income	97	80	177

d) The working time of family labor

The working time of family labor will be increased with conversion of 1 ha from cattle raising to mango except the first year. As for the working time of the family labor, it will be changed based on the family conditions. As the increased time is short (around 1 hr for 1 day) for the small-scale farmer with small-scaled land, it is assumed that the family will work more.

The working time of family labor
(Cattle raising 3 ha, mango 1ha, unit: hr)

fiscal year	pasture	mango	total	increased time
0	972		972	0
1	729	140	869	-103
2	729	264	993	21
3	726	264	990	18
4	723	264	987	15
5	720	311	1,031	59
6	717	357	1,074	102
7	714	404	1,118	146
8	711	439	1,150	178
9	708	474	1,182	210
10	705	509	1,214	242
11	702	544	1,246	274
12	702	544	1,246	274
13	702	544	1,246	274
14	702	544	1,246	274
15	702	544	1,246	274
16	702	544	1,246	274
17	702	544	1,246	274
18	702	544	1,246	274
19	702	544	1,246	274
20	702	544	1,246	274

e) Agricultural Balance

Agricultural balance for cattle raising (3 ha), sugarcane (1 ha) mango (1ha) is shown below. The production cost includes the organization fee. The production cost of mango at first year includes the cost for preparation works for 1ha. For first 2 years, the production costs is larger than gross income but the net income will be 2.5 times bigger than that at present after 11 years later.

Agricultural balance (cattle raising: 3 ha, sugarcane: 1 ha, mango: 1ha, unit: 1,000colon)

fiscal year	production cost					gross income				net income
	cattle raising	sugarcane	mango	org. fee	total cost	cattle raising	sugarcane	mango	total	
0	436	310	0		745	533	390	0	923	177
1	327	310	571	72	1,279	400	390	0	790	-490
2	327	310	145	72	854	400	390	0	790	-64
3	337	305	145	72	859	411	397	210	1,018	159
4	347	300	440	72	1,159	422	404	420	1,246	87
5	357	295	478	72	1,201	433	412	560	1,405	203
6	367	290	515	72	1,244	444	419	700	1,563	319
7	377	285	652	72	1,386	455	426	840	1,721	335
8	387	279	670	72	1,408	466	433	882	1,782	373
9	397	274	687	72	1,431	477	441	924	1,842	411
10	407	269	705	72	1,454	488	448	966	1,902	449
11	418	264	772	72	1,526	500	455	1,008	1,963	436
12	418	264	772	72	1,526	500	455	1,008	1,963	436
13	418	264	772	72	1,526	500	455	1,008	1,963	436
14	418	264	772	72	1,526	500	455	1,008	1,963	436
15	418	264	772	72	1,526	500	455	1,008	1,963	436
16	418	264	772	72	1,526	500	455	1,008	1,963	436
17	418	264	772	72	1,526	500	455	1,008	1,963	436
18	418	264	772	72	1,526	500	455	1,008	1,963	436
19	418	264	772	72	1,526	500	455	1,008	1,963	436
20	418	264	772	72	1,526	500	455	1,008	1,963	436

f) Cash balance considered the other expenditure

The net income at preset might be required for other expenditure. Therefore, it is assumed that 177,000 colons of the present net income will be paid from agricultural benefit. Furthermore, though the increased amount of production cost is considered in the agricultural balance, this amount is required before harvesting (before getting the gross income) and it is necessary to prepare in some way if farmer does not have self-fund. In here, this amount is considered as the cost of the investment required for the new farm management. However, as this cost is already calculated in the net income of the agricultural balance, the same amount will come to be excess budget for next year. Based on above conditions, the balance considering the other expenditure is shown below. The table shows the luck of fund from first year to 4th year. This table is only for showing the lack of fund and is not showing the farm cash flow.

Cash balance considered the other expenditure
(Cattle raising: 3 ha, sugarcane: 1 ha, mango: 1ha, unit: 1,000colon)

fiscal year	net income	other expenditure	increased production cost for next year	excess budget	annual balance	accumulated surplus from 2nd year
0	177	177	534		-534	
1	-490	177	0	534	-133	292
2	-64	177	5	0	-247	274
3	159	177	300	5	-313	-116
4	87	177	42	300	168	168
5	203	177	42	42	26	310
6	319	177	142	42	42	368
7	335	177	23	142	278	683
8	373	177	23	23	196	917
9	411	177	23	23	234	1,188
10	449	177	73	23	221	1,397
11	436	177	0	73	332	1,729
12	436	177	0	0	259	1,988
13	436	177	0		259	2,247
14	436	177	0		259	2,506
15	436	177	0		259	2,765
16	436	177	0		259	3,024
17	436	177	0		259	3,283
18	436	177	0		259	3,542
19	436	177	0		259	3,801
20	436	177	0		259	4,060

g) Cash balance considered the loan and repayment

Lone and repayment schedule
(Cattle raising: 3 ha, sugarcane: 1 ha, mango: 1ha, unit: 1,000colon)

fiscal year	Long-term lone					Short-term lone				
	lone	interest 8%	repayment		balance	lone	interest 24%	repayment		balance
			proncipal	interst				proncipal	interst	
0	534								534	
1	176	43		43	710					
2	303	57		57	1,013		0	0	0	
3	394	81		81	1,407		0	0	0	
4		113		113	1,407		0	0	0	0
5		113	36	113	1,371	67	0	0	0	67
6		110	47	110	1,324	115	16.08	67	16.08	115
7		106	68	106	1,256		27.6	115	27.6	0
8		101	94	101	1,163		0	0	0	0
9		93	94	93	1,069		0	0	0	0
10		86	94	86	975		0	0	0	0
11		78	94	78	881		0	0	0	0
12		70	94	70	787		0	0	0	0
13		63	94	63	694		0	0	0	0
14		55	94	55	600		0	0	0	0
15		48	94	48	506		0	0	0	0
16		40	94	40	412		0	0	0	0
17		33	94	33	319		0	0	0	0
18		25	94	25	225		0	0	0	0
19		18	94	18	131		0	0	0	0
20		10	58	10	73		0	0	0	0
21		6	46	6	26				0	0
22		2	26	2	0					

If farmers have their self-fund enough they have no problem, but if do not have self fund sufficiently it is necessary to get lone for the investment. In here, the required fund from first year to 4th year will be prepared from long-term lone and other necessary fund will be prepared from short term lone.

Total farm management balance
(Cattle raising: 3 ha, sugarcane: 1 ha, mango: 1ha, unit: 1,000colon)

fiscal year	expenditure					income				annual balance	balance (accumulated surplus)
	production cost	others	increase of cost	repayment	total	agricultural income	lone	execs budget	total		
0	745	177	534	0	1,457	923	534	0	1,457	0	0
1	1,279	177	0	43	1,499	790	176	534	1,499	0	0
2	854	177	5	57	1,093	790	303	0	1,093	-0	-0
3	859	177	300	81	1,417	1,018	394	5	1,417	-0	-0
4	1,159	177	42	113	1,491	1,246	0	300	1,546	55	55
5	1,201	177	42	148	1,569	1,405	67	42	1,514	-55	-0
6	1,244	177	142	157	1,720	1,563	115	42	1,720	-0	-0
7	1,386	177	23	173	1,759	1,721	0	142	1,864	104	104
8	1,408	177	23	194	1,803	1,782	0	23	1,804	1	105
9	1,431	177	23	187	1,818	1,842	0	23	1,864	47	152
10	1,454	177	73	179	1,883	1,902	0	23	1,925	42	194
11	1,526	177	0	172	1,875	1,963	0	73	2,035	160	354
12	1,526	177		164	1,868	1,963	0	0	1,963	95	449
13	1,526	177		157	1,860	1,963	0	0	1,963	102	551
14	1,526	177		149	1,853	1,963	0	0	1,963	110	661
15	1,526	177		142	1,845	1,963	0	0	1,963	117	778
16	1,526	177		134	1,838	1,963	0	0	1,963	125	903
17	1,526	177		127	1,830	1,963	0	0	1,963	132	1,035
18	1,526	177		119	1,823	1,963	0	0	1,963	140	1,175
19	1,526	177		112	1,815	1,963	0	0	1,963	147	1,322
20	1,526	177		69	1,772	1,963	0	0	1,963	190	1,513

Though it is necessary to borrow the money from the short-term lone for 5th and 6th year For the repayment of interest, after the 8th year, the accumulated surplus is increasing in stably.

h) Conclusion

The analysis results are summarized below;

- in case of the small scale farmer with 5 ha (cattle raising 4 ha, sugarcane 1ha) converting 1 ha from pasture to mango, the annual net income from the agriculture will increase 2.5 times bigger than that of present in 10 years later (the working time of family labor is also increase around 1 hr/day).
- It is necessary to prepare the fund of 1,230,000 colon for first 4 years and 180,000 colon for 6th and 7th year and If farmer does not have the self-fund it is possible to manage using the log-term and short-term lone.
- Keeping the present expenditure level, preparing the increased production cost, repaying the lone, the accumulated surplus can be gotten from 8th years.
- As annual balance for few years show losses, it is necessary to prepare the fund when the farmer does not have self-fund, especially for first 4 years, it is necessary to get long-term lone with low interest (if applying the short-term lone, management will be bankrupt with payment of high interest)
- If the farmers have advantages such as having the self-fund, controlling the other expenditure, managing more large scale farm, the farmers can manage the farming with more profitable.

For the conditions of achievement to above, the systematic management by farmers' organization and supporting such as technical extension, management guidance, mediation to access to agro-credit, etc. by public institution are indispensable. And, incase of the small and medium scale farmers who do not have sufficient abilities in technically and financially, it is impossible to improve the farm management with farmers' individual activities without any relation to those conditions. Though the each farmland is managed individually, reducing the production cost and increasing the agricultural benefit based on the systematic management are expected and the

calculation will be quite different from the case of individual management. The benefit of mango is 8 times bigger than that of cattle raising and the benefit will be increased with large size cultivation land of mango. However, as the risk also come to high such as further big investment is required, it is necessary to decide the conversion area reasonably based on the conditions of each farmers.

At the farmers' level, the earlier establishment of the circumstance for the improvement family budget, re-investment to the farm management with early occurring of surplus is essential for raising up the project sustainability and farmers' self development. For this, in zone A, it is necessary to prepare the agro-credit with same loaning conditions as that of IDA and to guide and help the farmers for being able to access and use the credit effectively.

The farm model in here is set in this analysis based on the conditions of the small-scale land and fund less situation. When actual farmers are going to make a plan to convert, it is necessary to formulate the financial plan considering the respective conditions of each farmer.

2) Zone B

There are high potential of groundwater in zone B and the farm management is expected to be improved using the groundwater irrigation system with deep wells. At first the financial feasibility is analyzed for 1 ha of each farming (cattle raising, sugarcane and vegetables), then, the farm management balance in case of converting to vegetables for the model small-scale farmer who has disadvantage comparing with the average small and medium scale farmers in the area is evaluated.

a) Financial analysis for 1 ha of groundwater irrigation system

Conditions for analysis:

Based on the conditions of the project financial/economic evaluation, the basic conditions are set as shown below.

- The cost of construction and O/M for 1 ha is applied the 0.1% of the total costs shown in section 5.8.1 considering the total irrigation are of ground water irrigation system is around 1,000 ha. Considering the economic life of pump is 15 years, the replacement cost at 15th years is included.
- The family labor is considered for cattle raising. For the sugarcane and vegetables, the all labor costs are included based on the contact labor cost.
- For the conversion from pasture to vegetables the small land preparatory work is considered (50,700 colon/ha).
- For the vegetables double cropping is applied, so, the cost/benefit of 2 ha is calculated for 1 ha/year.
- Unit price of wages: 300 colons/hr, harvesting cost: 2.5 colon/mango, contract labor: 3,000 colon/day, farm gate price: 30 colon/mango
- Based on the payment period for long-term agricultural credit (interest: 8 % per annum, unredeemable period: 5 years, payment term: 15 yeas, payment on a per capita basis), the analysis period is set as for 21 years (by 20th fiscal year)

Financial analysis for 1 ha

Financial analysis for the groundwater irrigation system of 1ha of cattle raising is shown in next page.

With instillation of groundwater irrigation system, irrigating the pastureland, 10 % of working time of the family labor is increased and the net income will be 4 times bigger than that of present in the future. However, in case of the facility investment is charged to the farmer, the FIRR comes to – 3 % and it is not recommendable financially.

Financial analysis of cattle raising with groundwater irrigation system (for 1 ha, unit:1000 colon)

fiscal year	with groundwater irrigation system								non-irrigation		with - without	
	Time of labor (ha)	irrigation facility	O/M Cost	production cost	organization fee	total cost	gross income	net income	Time of labor (ha)	net income	Time of labor (ha)	increased benefit
0		1,170				1,170	0	-1,170	243	10	-243	-1,181
1	324		68	**469**	14	551	**571**	20	243	10	81	9
2	318		68	482	14	564	587	23	242	11	76	12
3	311		68	494	14	576	603	26	241	11	70	15
4	305		68	506	14	589	618	30	240	11	65	19
5	298		68	519	14	601	634	33	239	12	59	22
6	292		68	531	14	613	650	37	238	12	54	25
7	285		68	544	14	626	666	40	237	12	48	28
8	279		68	556	14	638	682	44	236	13	43	31
9	272		68	569	14	651	698	47	235	13	37	34
10	266		68	**581**	14	663	**714**	50	234	13	32	37
11	266		68	581	14	663	714	50	234	13	32	37
12	266		68	581	14	663	714	50	234	13	32	37
13	266		68	581	14	663	714	50	234	13	32	37
14	266		68	581	14	663	714	50	234	13	32	37
15	266	243	68	581	14	906	714	-193	234	13	32	-206
16	266		68	581	14	663	714	50	234	13	32	37
17	266		68	581	14	663	714	50	234	13	32	37
18	266		68	581	14	663	714	50	234	13	32	37
19	266		68	581	14	663	714	50	234	13	32	37
20	266	-162	68	581	14	501	714	212	234	13	32	199
FIRR (the cost irrigation facility is charged to farmers)								-3%	-			

Financial analysis for the groundwater irrigation system of 1 ha of sugarcane is shown below.

Financial analysis of sugarcane with groundwater irrigation system (for 1 ha, unit:1000 colon)

fiscal year	with groundwater irrigation system							net income with non-irrigated	increased benefit
	irrigation facility	O/M Cost	production cost	organization fee	total cost	gross income	net income		
0	1,170				1,170	0	-1,170	66	-1,237
1		68	**366**	14	448	**520**	72	66	6
2		68	361	14	442	534	92	78	14
3		68	355	14	436	549	113	91	22
4		68	349	14	430	563	133	103	30
5		68	343	14	425	578	153	115	38
6		68	337	14	419	592	173	128	46
7		68	331	14	413	607	194	140	54
8		68	325	14	407	621	214	152	62
9		68	319	14	401	636	234	164	70
10		68	**314**	14	395	**650**	255	177	78
11		68	314	14	395	650	255	177	78
12		68	314	14	395	650	255	177	78
13		68	314	14	395	650	255	177	78
14		68	314	14	395	650	255	177	78
15	243	68	314	14	638	650	12	177	-165
16		68	314	14	395	650	255	177	78
17		68	314	14	395	650	255	177	78
18		68	314	14	395	650	255	177	78
19		68	314	14	395	650	255	177	78
20	-162	68	314	14	233	650	417	177	240
FIRR (the cost irrigation facility is charged to farmers)							12.9%	-0.8%	

With instillation of groundwater irrigation system, irrigating the sugarcane, the net income will be 1.5 times bigger than that of present in the future. The FIRR with charging the facility investment cost to the farmers comes to 12.9 % and it cannot be said that is infeasible financially. However, comparing with the benefit of present non-irrigated sugarcane, the FIRR comes to – 0.8 % and it means better to continue the sugarcane planting without irrigation system.

Financial analysis for the groundwater irrigation system of 1 ha of vegetables is shown below.

Financial analysis of vegetables with groundwater irrigation system (for 1 ha, unit:1000 colon)

fiscal year	with groundwater irrigation system							increased benefit from non-irrigated sugarcane	in case of 50% of gross income of vegetable is		
	irrigation facility	O/M Cost	production cost	organization fee	total cost	gross income	net income		gross income	net income	increased benefit
0	1,170				1,170	0	-1,170	-1,237		-1,170	-1,237
1		68	**2,311**	14	2,392	**3,328**	936	870	**1,664**	-728	-794
2		68	2,277	14	2,359	3,351	992	913	1,872	-487	-566
3		68	2,244	14	2,326	3,374	1,048	957	2,080	-246	-337
4		68	2,211	14	2,293	3,397	1,104	1,001	2,288	-5	-108
5		68	2,178	14	2,260	3,420	1,160	1,045	2,496	236	121
6		68	2,145	14	2,227	3,444	1,217	1,089	2,704	477	350
7		68	2,112	14	2,194	3,467	1,273	1,133	2,912	718	578
8		68	2,079	14	2,161	3,490	1,329	1,177	3,120	959	807
9		68	2,046	14	2,128	3,513	1,385	1,221	3,328	1,200	1,036
10		68	**2,013**	14	2,095	**3,536**	1,441	1,265	**3,536**	1,441	1,265
11		68	2,013	14	2,095	3,536	1,441	1,265	3,536	1,441	1,265
12		68	2,013	14	2,095	3,536	1,441	1,265	3,536	1,441	1,265
13		68	2,013	14	2,095	3,536	1,441	1,265	3,536	1,441	1,265
14		68	2,013	14	2,095	3,536	1,441	1,265	3,536	1,441	1,265
15	243	68	2,013	14	2,338	3,536	1,198	1,022	3,536	1,198	1,022
16		68	2,013	14	2,095	3,536	1,441	1,265	3,536	1,441	1,265
17		68	2,013	14	2,095	3,536	1,441	1,265	3,536	1,441	1,265
18		68	2,013	14	2,095	3,536	1,441	1,265	3,536	1,441	1,265
19		68	2,013	14	2,095	3,536	1,441	1,265	3,536	1,441	1,265
20	-162	68	2,013	14	1,933	3,536	1,603	1,427	3,536	1,603	1,427
FIRR (the cost irrigation facility is charged to farmers)							85.5%	75.0%	15.8%		

For the converting to the vegetable, the irrigation system is required indispensably. The net income comparing that of sugarcane is increased as nearly 6 times bigger and farm management is improved essentially. In case of initial gross income of vegetables is reduced to 50 % for difficulties of vegetable cropping, the FIRR comes to 15.8 % and farm management will be improved finally.

From above analyses for 1 ha, its can be said that the cattle raising should be done with non-irrigated condition and that the ground water irrigation system for sugarcane looks not bad for improvement, however, if the present income of sugarcane is considered, irrigation system for sugarcane cannot be said that it is effective. Therefore, groundwater irrigation system shall be installed for mainly vegetables, which is the most profitable crop. In case of without charging the facility investment to the farmers, even for the cattle raising, the good improvement of farm management is expected, so, the effect will be high for the project which is one of the governmental projects for poverty mitigation.

b) Farm model

In this zone, some part of pasture and sugarcane will be converted to vegetables with installation of groundwater irrigation system. With this, the general land-use pattern and of average household will change as are shown below. The number of household in the zone is estimated as around 90.

Cropping area of Zone B (ha)

	Cattle raising	Sugarcane	Rice	Mango	Vegetables	Others	Total
At present	450	320	410	30	0	0	1,210
	37%	26%	**34%**	2.5%	**0%**	0%	**100%**
Proposed	200	270	410	30	300	0	1,210
	17%	22%	34%	2%	25%	0%	100%

Cropping area per farmer

At present	4.9	3.5	4.5	0.3	0.0	0.0	13.3
Proposed	2.2	3.0	4.5	0.3	3.3	0.0	13.3

A model farm household for the analysis is set as follows:

Present cropping area: cattle raising 3ha, sugarcane 2 ha
Proposed cropping area: cattle raising 2ha, sugarcane 2 ha, vegetables 1 ha
(the planting area of vegetables is 2 ha with double cropping)

c) Basic dimensions and present balance of agriculture

The basic dimensions of vegetable at present and 10 years later are summarized as shown in right table.

Agricultural balance of vegetable for 1 ha
(with-irrigation unit:1,000 colon)

	At initial	10 years later
Family labor (hr)	0	0
Production cost	1,155	1,006
Gross income	1,664	1,768
Net income	509	762
Organization fee	14	
Net income reducing organization fee	495	748

Note) the family labor is not considered

Agricultural income of model farm at present (1,000 colon)

	Cattle raising	Sugarcane	Total
Planted area	3ha	2ha	5ha
Family labor	729hr	0hr	729hr
Production cost	327	620	946
Gross income	400	780	1,180
Net income	73	160	233

Agricultural balance of model farmer at present is as shown in the left table and it is estimated they earn approximant 233,000 colon of agricultural net income annually (note: this model farmer has another job(s) getting other income, so, this table does not show the household income).

d) The working time of family labor

The working time of family labor will be decreased from that of present (729 hr) with conversion of 1 ha from cattle raising to vegetables. Considering this reduced time will be leisure time for the family, the reduce of cost is not considered (As for the working time of the family labor, it will be changed based on the family conditions).

e) Agricultural Balance

Agricultural balance for cattle raising (2 ha), sugarcane (2 ha) vegetable (2 ha) is shown below. The production cost includes the O/M cost and the organization fee. For first year, the production costs is larger than gross income but the net income will be 1,819,000 colon equivalent to 8 times bigger than that at present after 11 years later.

The working time of family labor
(Cattle raising 2 ha, unit: hr)

fiscal year	pasture	increased time
0	486	-243
1	486	-243
2	484	-245
3	482	-247
4	480	-249
5	478	-251
6	476	-253
7	474	-255
8	472	-257
9	470	-259
10	468	-261
11	468	-261
12	468	-261
13	468	-261
14	468	-261
15	468	-261
16	468	-261
17	468	-261
18	468	-261
19	468	-261
20	468	-261

Agricultural balance (cattle raising: 2 ha, sugarcane: 2 ha, vegetables: 2ha, unit: 1,000colon)

fiscal year	production cost							gross income			
	cattle raising	sugarcane	vegetable	irrigation facility	O/M Cost	organization fee	total cost	cattle raising	sugarcane	vegetable	total
0	218	620	51	1,170		72	2,131	266	780	0	1,046
1	218	620	2,311		68	72	3,288	266	780	3,328	4,374
2	225	609	2,277		68	72	3,251	274	794	3,351	4,419
3	231	599	2,244		68	72	3,215	281	809	3,374	4,464
4	238	589	2,211		68	72	3,178	289	823	3,397	4,509
5	245	579	2,178		68	72	3,142	296	838	3,420	4,554
6	251	569	2,145		68	72	3,105	303	852	3,444	4,599
7	258	559	2,112		68	72	3,069	311	867	3,467	4,644
8	265	549	2,079		68	72	3,033	318	881	3,490	4,689
9	272	539	2,046		68	72	2,996	326	896	3,513	4,734
10	278	529	2,013		68	72	2,960	333	910	3,536	4,779
11	278	529	2,013		68	72	2,960	333	910	3,536	4,779
12	278	529	2,013		68	72	2,960	333	910	3,536	4,779
13	278	529	2,013		68	72	2,960	333	910	3,536	4,779
14	278	529	2,013		68	72	2,960	333	910	3,536	4,779
15	278	529	2,013	243	68	72	3,203	333	910	3,536	4,779
16	278	529	2,013		68	72	2,960	333	910	3,536	4,779
17	278	529	2,013		68	72	2,960	333	910	3,536	4,779
18	278	529	2,013		68	72	2,960	333	910	3,536	4,779
19	278	529	2,013		68	72	2,960	333	910	3,536	4,779
20	278	529	2,013		68	72	2,960	333	910	3,536	4,779

f) Cash balance considered the other expenditure

As the same manner as for zone A, considering 233,000 colon of the net income at present is assumed as for the necessary other expenditure, the increased amount of production cost is considered as the cost of the investment required for the new farm management, the same amount will come to be excess budget for next year. The balance considering the other expenditure is shown in the right tables. The table shows approximately 2,490,000 colon of the luck of fund at first year (This table is only for showing the lack of fund and is not showing the farm cash flow).

Cash balance considered the other expenditure
(Cattle raising: 2 ha, sugarcane: 2 ha, vegetables: 2ha, unit: 1,000colon)

fiscal year	net income	other expenditure	increased production cost for next year	excess budget	annual balance
0	-1,084	233	1,172		-2,490
1	1,087	233		1,172	2,026
2	1,168	233			935
3	1,250	233			1,016
4	1,331	233			1,098
5	1,412	233			1,179
6	1,494	233			1,260
7	1,575	233			1,342
8	1,657	233			1,423
9	1,738	233			1,505
10	1,819	233			1,586
11	1,819	233			1,586
12	1,819	233			1,586
13	1,819	233			1,586
14	1,819	233			1,586
15	1,576	233			1,343
16	1,819	233			1,586
17	1,819	233			1,586
18	1,819	233			1,586
19	1,819	233			1,586
20	1,819	233			1,586

Lone and repayment schedule
(Cattle raising: 3 ha, sugarcane: 1 ha, mango: 1ha, unit: 1,000colon)

fiscal year	Long-term lone				
	lone	interest 8%	repayment		balance
			proncipal	interst	
0	2,490				2,490
1		199		199	2,490
2		199		199	2,490
3		199		199	2,490
4		199		199	2,490
5		199	166	199	2,324
6		186	166	186	2,158
7		173	166	173	1,992
8		159	166	159	1,826
9		146	166	146	1,660
10		133	166	133	1,494
11		120	166	120	1,328
12		106	166	106	1,162
13		93	166	93	996
14		80	166	80	830
15		66	166	66	664
16		53	166	53	498
17		40	166	40	332
18		27	166	27	166
19		13	166	13	0

g) Cash balance considered the loan and repayment

If farmers have their self-fund enough they have no problem, but if do not have self fund sufficiently it is necessary to get lone for the investment. In here, the required fund at first year will be prepared from long-term lone.

Total farm management balance (with long-term lone)
(Cattle raising: 3 ha, sugarcane: 1 ha, mango: 1ha, unit: 1,000colon)

fiscal year	expenditure					income				annual balance	balance (accumulated surplus)
	production cost	others	increase of cost	repayment	total	agricultural income	lone	execs budget	total		
0	2,131	233	1,172		3,536	1,046	2,490		3,536	0	
1	3,288	233		199	3,720	4,374		1,172	5,547	1,827	1,827
2	3,251	233		199	3,684	4,419		0	4,419	736	2,562
3	3,215	233		199	3,647	4,464		0	4,464	817	3,379
4	3,178	233		199	3,611	4,509		0	4,509	898	4,278
5	3,142	233		365	3,740	4,554		0	4,554	814	5,092
6	3,105	233		352	3,691	4,599		0	4,599	909	6,000
7	3,069	233		339	3,641	4,644		0	4,644	1,003	7,004
8	3,033	233		325	3,591	4,689		0	4,689	1,098	8,102
9	2,996	233		312	3,541	4,734		0	4,734	1,193	9,294
10	2,960	233		299	3,492	4,779		0	4,779	1,287	10,582
11	2,960	233		285	3,478	4,779		0	4,779	1,301	11,882
12	2,960	233		272	3,465	4,779		0	4,779	1,314	13,196
13	2,960	233		259	3,452	4,779		0	4,779	1,327	14,523
14	2,960	233		246	3,439	4,779		0	4,779	1,340	15,864
15	3,203	233		232	3,668	4,779		0	4,779	1,111	16,975
16	2,960	233		219	3,412	4,779		0	4,779	1,367	18,342
17	2,960	233		206	3,399	4,779		0	4,779	1,380	19,722
18	2,960	233		193	3,385	4,779		0	4,779	1,394	21,116
19	2,960	233		179	3,372	4,779		0	4,779	1,407	22,522
20	2,960	233		0	3,193	4,779		0	4,779	1,586	24,109

Though it is necessary to borrow 2,490,000 colons at first year, from the second the accumulated surplus is increasing in stably.

h) In case of applying shot-term lone

For the converting to vegetables, short-term lone can be also applied.

Lone and repayment schedule
(Cattle raising: 3 ha, sugarcane: 1 ha, mango: 1ha, unit: 1,000colon)

fiscal year	short-term lone				
	lone	interest 24%	repayment		balance
			proncipal	interst	
0	2,490				2,490
1	1,062	598	2,490	598	1,062
2	382	255	1,062	255	382
3	0	92	382	92	0

Total farm management balance (with short-term lone)

fiscal year	expenditure					income				annual balance	balance (accumulated surplus)
	production cost	others	increase of cost	repayment	total	agricultural income	lone	execs budget	total		
0	2,131	233	1,172		3,536	1,046	2,490		3,536	0	
1	3,288	233	0	3,088	6,609	4,374	1,062	1,172	6,609	0	0
2	3,251	233	0	1,317	4,801	4,419	382		4,801	-0	0
3	3,215	233	0	474	3,922	4,464			4,464	543	543
4	3,178	233	0	0	3,412	4,509			4,509	1,098	1,640
5	3,142	233	0	0	3,375	4,554			4,554	1,179	2,819
6	3,105	233	0	0	3,339	4,599			4,599	1,260	4,080
7	3,069	233	0	0	3,302	4,644			4,644	1,342	5,422
8	3,033	233	0	0	3,266	4,689			4,689	1,423	6,845
9	2,996	233	0	0	3,229	4,734			4,734	1,505	8,350
10	2,960	233	0	0	3,193	4,779			4,779	1,586	9,936
11	2,960	233	0	0	3,193	4,779			4,779	1,586	11,522
12	2,960	233	0	0	3,193	4,779			4,779	1,586	13,108
13	2,960	233	0	0	3,193	4,779			4,779	1,586	14,694
14	2,960	233	0	0	3,193	4,779			4,779	1,586	16,280
15	3,203	233	0	0	3,436	4,779			4,779	1,343	17,624
16	2,960	233	0	0	3,193	4,779			4,779	1,586	19,210
17	2,960	233	0	0	3,193	4,779			4,779	1,586	20,796
18	2,960	233	0	0	3,193	4,779			4,779	1,586	22,382
19	2,960	233	0	0	3,193	4,779			4,779	1,586	23,968
20	2,960	233	0	0	3,193	4,779			4,779	1,586	25,554

In this case, it is necessary to get lone for first 3 years but the accumulated surplus at 20 the fiscal year is slightly bigger than that of applying the long-term lone.

i) Case of gross income of vegetable is reduced to 50 % for 1 time for 2 years

The vegetable cropping is influenced from conditions such as natural and marketing and the case of gross income of vegetable is reduced to 50 % for 1 time for 2 years is studied as shown below.

Agricultural balance (Case of gross income of vegetable is reduced to 50 % for 1 time for 2 years)
(Cattle raising: 2 ha, sugarcane: 2 ha, vegetables: 2ha, unit: 1,000colon)

fiscal year	production cost							gross income				net income
	cattle raising	sugarcane	vegetable	irrigation facility	O/M Cost	organization fee	total cost	cattle raising	sugarcane	vegetable	total	
0	218	620	51	1,170		72	2,131	266	780		1,046	-1,084
1	218	620	2,311		68	72	3,288	266	780	1,664	2,710	-577
2	225	609	2,277		68	72	3,251	274	794	3,351	4,419	1,168
3	231	599	2,244		68	72	3,215	281	809	1,687	2,777	-438
4	238	589	2,211		68	72	3,178	289	823	3,397	4,509	1,331
5	245	579	2,178		68	72	3,142	296	838	1,710	2,844	-298
6	251	569	2,145		68	72	3,105	303	852	3,444	4,599	1,494
7	258	559	2,112		68	72	3,069	311	867	1,733	2,911	-158
8	265	549	2,079		68	72	3,033	318	881	3,490	4,689	1,657
9	272	539	2,046		68	72	2,996	326	896	1,756	2,978	-18
10	278	529	2,013		68	72	2,960	333	910	3,536	4,779	1,819
11	278	529	2,013		68	72	2,960	333	910	1,768	3,011	51
12	278	529	2,013		68	72	2,960	333	910	3,536	4,779	1,819
13	278	529	2,013		68	72	2,960	333	910	1,768	3,011	51
14	278	529	2,013		68	72	2,960	333	910	3,536	4,779	1,819
15	278	529	2,013	243	68	72	3,203	333	910	1,768	3,011	-192
16	278	529	2,013		68	72	2,960	333	910	3,536	4,779	1,819
17	278	529	2,013		68	72	2,960	333	910	1,768	3,011	51
18	278	529	2,013		68	72	2,960	333	910	3,536	4,779	1,819
19	278	529	2,013		68	72	2,960	333	910	1,768	3,011	51
20	278	529	2,013		68	72	2,960	333	910	3,536	4,779	1,819

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Cash balance considered the other expenditure
(Case of gross income of vegetable is reduced to 50 % for 1 time for 2 years)
(Cattle raising: 2 ha, sugarcane: 2 ha, vegetables: 2ha, unit: 1,000colon)

fiscal year	net income	other expenditure	increased production cost for next year	excess budget	annual balance	accumulated surplus from 2nd year
0	-1,084	233	1,172		-2,490	
1	-577	233		1,172	362	362
2	1,168	233			935	1,297
3	-438	233			-671	626
4	1,331	233			1,098	1,723
5	-298	233			-531	1,192
6	1,494	233			1,260	2,453
7	-158	233			-391	2,061
8	1,657	233			1,423	3,485
9	-18	233			-252	3,233
10	1,819	233			1,586	4,819
11	51	233			-182	4,637
12	1,819	233			1,586	6,223
13	51	233			-182	6,041
14	1,819	233			1,586	7,628
15	-192	233			-425	7,203
16	1,819	233			1,586	8,789
17	51	233			-182	8,607
18	1,819	233			1,586	10,193
19	51	233			-182	10,011
20	1,819	233			1,586	11,597

Total farm management balance (with long-term lone)
(Case of gross income of vegetable is reduced to 50 % for 1 time for 2 years)
(Cattle raising: 3 ha, sugarcane: 1 ha, mango: 1ha, unit: 1,000colon)

fiscal year	expenditure					income				annual balance	balance (accumulated surplus)
	production cost	others	increase of cost	repayment	total	agricultural income	lone	execs budget	total		
0	2,131	233	1,172		3,536	1,046	2,490		3,536	0	0
1	3,288	233			3,521	2,710		1,172	3,883	362	362
2	3,251	233			3,485	4,419			4,419	935	1,297
3	3,215	233		0	3,448	2,777			2,777	-671	626
4	3,178	233		0	3,412	4,509			4,509	1,098	1,723
5	3,142	233		497	3,872	2,844			2,844	-1,028	695
6	3,105	233		479	3,817	4,599			4,599	782	1,477
7	3,069	233		461	3,763	2,911			2,911	-852	625
8	3,033	233		443	3,708	4,689			4,689	981	1,606
9	2,996	233		425	3,654	2,978			2,978	-676	930
10	2,960	233		406	3,599	4,779			4,779	1,180	2,109
11	2,960	233		388	3,581	3,011			3,011	-570	1,539
12	2,960	233		370	3,563	4,779			4,779	1,216	2,755
13	2,960	233		352	3,545	3,011			3,011	-534	2,221
14	2,960	233		334	3,527	4,779			4,779	1,252	3,473
15	3,203	233		316	3,752	3,011			3,011	-741	2,731
16	2,960	233		298	3,491	4,779			4,779	1,288	4,020
17	2,960	233		280	3,473	3,011			3,011	-462	3,558
18	2,960	233		262	3,455	4,779			4,779	1,324	4,882
19	2,960	233		244	3,437	3,011			3,011	-426	4,456
20	2,960	233		0	3,193	4,779			4,779	1,586	6,042

In case of gross income of vegetable is reduced to 50 % for 1 time for 2 years, annual balances of some years come to less but accumulated surplus is increasing gradually. In this case, short-term lone cannot be applied because farm management will come to bankrupt with repayment of the interest.

j) Conclusion

The analysis results are summarized below;

- In case of the small scale farmer with 5 ha (cattle raising 3 ha, sugarcane 2 ha) converting 1 ha from pasture to vegetable, the annual net income from the agriculture will increase approximately 8 times bigger than that of present in 10 years later (the working time of family labor is also decreased).
- It is necessary to prepare the fund of 2,490,000 colon for the first year. If farmer does not have the self-fund it is possible to manage using the log-term or short-term lone.
- Keeping the present expenditure level, reducing the working time of family labor, preparing the increased production cost, repaying the lone, the accumulated surplus can be gotten from 2nd years.
- As annual balance for few years show losses, it is necessary to prepare the fund when the farmer does not have self-fund, especially for first 4 years, it is necessary to get long-term lone with low interest (if applying the short-term lone, management will be bankrupt with payment of high interest)
- In case of gross income of vegetable is reduced to 50 % for 1 time for 2 years, the farmer can manage their farm with applying the long-term lone.

For the installation of groundwater irrigation system, it is necessary to apply the small-scale groundwater irrigation project with establishment of farmers' organization. With effective function of this organization, it is necessary to improve getting the public support on such technical extension, management guidance, assist to access for agro-credit, and, it is impossible for individual farmers to

install the groundwater irrigation system without belonging to any organization. Furthermore, when the small and medium scale farmers who do not have sufficient technique and finance are going to install the groundwater irrigation system, it is necessary to change their agriculture to more profitable, especially the cattle raising should be convert to other agriculture. If groundwater irrigation system can be use for vegetables, the facilities cost can be charged to the farmers. Based on the due considerations and discussions on these point, the optimum crop and the farmers' charge for facilities should be decided. On the other hand, as the vegetable farming has always high risk influencing from the conditions such as marketing, climate, disease/pest, to intend the vegetable farming with big area is quite risky for the small and medium farmers who are on the week management foundation at present and it is necessary to decide the converting area without unreasonable scale based on the conditions of each farmer.

At the farmers' level, the earlier establishment of the circumstance for the improvement family budget, re-investment to the farm management with early occurring of surplus is essential for raising up the project sustainability and farmers' self development. For this, in zone A, it is necessary to prepare the agro-credit with same loaning conditions as that of IDA and to guide and help the farmers for being able to access and use the credit effectively.

3) Zone C (installation of river pumping irrigation system)

In this zone, with instillation of irrigation system with river pumping station at the Tempisque river, some part of rain fed pasture and sugarcane will be irrigated in the dry season, the rain fed paddy field will be irrigated supplementary in the rainy season, and some part of pastureland will be converted to sugarcane. Though the production amount can be increased with installation of irrigation system, considering the increase of production cost such water fee and others, facilities investment cost (charge of the project cost), it is not always to lead the improvement of farm management depending on the crops.

a) Water fee and charge of the construction cost of irrigation facilities

in the Costa Rica, as the water fee will be set by public institution, it is not always to cover the total O/M cost required (sometimes covering more than O/M cost). In here, the water unit cost for 1,000 m^3 is estimated from the total O/M cost and total amount of irrigation water discharge, based on this water unit cost, the annual water fee for each crop is calculated.

The calculation of water unit cost for 1,000 m^3

Annual O/M cost		Total irrigation water volume (1,000 m^3)	Water fee for 1,000m^3 (colon)
US$	colon		
590,000	204,907,000	67,928	3,017

Water fee for each crop

Crop	Annual water requirement (1,000 m^3)	Water fee (colon/ha)
Sugarcane	24.3	73,300
Pasture	18.8	56,700
Paddy rice (rainy season)	14.2	42,800
Vegetable	15.2	46,000
Melon	15.4	46,500

For the groundwater system, one system is installed for one organizations with 10 to 20 of farmers and it is quite clear the construction cost for 1 ha. For the river pumping irrigation system, as the beneficiaries is more than 500 farmers and irrigation water requirement for 1 ha is different depending on the crops, the construction cost for 1 ha is not clear. Furthermore, assuming the development lone from the international funding agency such as IDB, the repayment will be occurred from 3 years later of starting the irrigation operation. Before discussing the charge of irrigation construction cost (charge to the farmers or not), for the purpose of seeing the possibilities the farmers can pay or not, the irrigation construction cost is analyzed for the investment cost at farmers' level. Based on the implementation plan, the total irrigation construction cost is borrowed

at initial stage of the project and, distributing the repayment amount for each crop based on the irrigation water requirement, the charge of construction cost for farmers is estimated. For the interest, it will be depending on the negotiation with fund agency, but, as for in case of agricultural development project, the interest may be 2 to 4 % per annum, 3 % of interest is assumed for this analysis.

Lone and repayment plan and charge of construction cost for each crop

fiscal year for the project	fiscal year for the irrigation	construction cost (US$1,000)	loan and repayment (US$1,000)				charge amount for water per 1,000 m3 (1,000 colon)	construction charge for crops (1,000 colon/ha)				
			lone	interest 3%	amount	total repayment and replacement cost		sugarcane	pasture	paddy in rainy season	vegetables	melon
1		7,521	7,521	0	7,521	0	0	0	0	0	0	0
2		9,401	9,401	226	17,148	0	0	0	0	0	0	0
3	0	1,880	1,880	514	19,542	0	0	0	0	0	0	0
4	1			586	20,128	0	0	0	0	0	0	0
5	2			604	20,732	0	0	0	0	0	0	0
6	3			622	21,354	0	0	0	0	0	0	0
7	4			641	21,297	698	3,566	87	67	50	54	55
8	5			639	20,380	1,556	7,957	193	150	112	121	123
9	6			611	19,290	1,701	8,698	211	164	122	133	134
10	7			579	18,200	1,669	8,531	207	161	120	130	132
11	8			546	17,110	1,636	8,364	203	157	118	128	129
12	9			513	16,021	1,603	8,196	199	154	115	125	126
13	10			481	14,931	1,570	8,029	195	151	113	122	124
14	11			448	13,841	1,538	7,862	191	148	111	120	121
15	12			415	12,751	1,505	7,695	187	145	108	117	119
16	13			383	11,661	1,472	7,528	183	142	106	115	116
17	14			350	10,571	1,440	7,361	179	139	103	112	114
18	15	637		317	9,482	1,407	7,193	175	135	101	110	111
19	16			284	8,392	2,011	10,283	250	194	145	157	159
20	17			252	7,302	1,342	6,859	167	129	96	105	106
21	18			219	6,212	1,309	6,692	163	126	94	102	103
22	19			186	5,122	1,276	6,525	159	123	92	99	101
23	20			154	4,032	1,243	6,358	154	120	89	97	98
24	21			121	2,943	1,211	6,191	150	117	87	94	95
25	22			88	1,853	1,178	6,023	146	113	85	92	93
26	23			56	763	1,145	5,856	142	110	82	89	90
27	24			23	109	677	3,460	84	65	49	53	53
28	25			3	0	112	574	14	11	8	9	9

b) Farm model

The land use in this zone is changed as shown below. The number of small and medium scale farmers in this zone is estimated as 549 and average land use for each farmers is shown below.

Cropping area of Zone C (ha)

	Pasture	Sugarcane	Rice	Mango	Vegetables	Others	Total
At initial	1,490	2,845	1,010	0	85	0	5,430
	27%	52%	**19%**	0%	**2%**	0%	**100%**
proposed	590	3,345	1010	300	185	0	5,430
	11%	61%	19%	6%	3%	0%	100%

Cropping area per farmer

At initial	2.7	5.2	1.8	0.0	0.2	0.0	9.9
Proposed	1.1	6.1	1.8	0.6	0.3	0.0	9.9

A model farm household for the analysis is set as follows:

Present cropping area: cattle raising (non-irrigated) 4ha, paddy rice (non-irrigated) 1 ha
Proposed cropping area: cattle raising (non-irrigated) 1ha, sugarcane (non-irrigated) 1 ha, sugarcane (irrigated) 2 ha, paddy rice (irrigated) 1 ha
(note: paddy rice is only for rainy season)

c) Basic dimensions and present balance of agriculture

The basic dimensions of cattle raising and sugarcane at present and 10 years later are summarized as shown below.

Agricultural balance for 1 ha (non-irrigation unit:1,000 colon)

	At initial (present: non-irrigated)			10 years later (non-irrigated)		
	Cattle raising	sugarcane	rice	Cattle raising	sugarcane	rice
Family labor (hr)	243			234		
Production cost	109	310	257	139	264	229
Gross income	133	390	308	167	455	323
Net income	24	80	51	27	191	94
Organization fee	14	14	14	14	14	14
Net income reducing organization fee	10	66	37	13	177	80
	At initial (irrigated)			10 years later (irrigated)		
	Cattle raising	sugarcane	rice	Cattle raising	sugarcane	rice
Family labor (hr)	324			266		
Production cost	469	366	293	581	314	259
Gross income	571	520	374	714	650	442
Net income	102	154	81	132	336	183
Water fee	57	73	42	57	73	42
Organization fee	14	14	14	14	14	14
Net income reducing water fee and organization fee	31	67	25	62	249	126

Agricultural balance of model farmer at present is as shown in the right table and it is estimated they earn approximant 148,000 colon of agricultural net income annually (note: this model farmer has another job(s) getting other income, so, this table does not show the household income).

Agricultural income of model farm at present (1,000 colon)

	Cattle raising	Rice	total
Planted area	4.0ha	1.0ha	5ha
Family labor	972hr		972hr
Production cost	436	257	693
Gross income	533	308	841
Net income	97	51	148

d) The working time of family labor

The working time of family labor will be decreased from that of present (972 hr) with conversion of 1 ha from cattle raising to vegetables. Considering this reduced time will be leisure time for the family, the reduce of cost is not considered (As for the working time of the family labor, it will be changed based on the family conditions

The working time of family labor
(Cattle raising 2 ha, unit: hr)

fiscal year	pasture	difference
0	972	0
1	243	-729
2	242	-730
3	241	-731
4	240	-732
5	239	-733
6	238	-734
7	237	-735
8	236	-736
9	235	-737
10	234	-738
11	234	-738
12	234	-738
13	234	-738
14	234	-738
15	234	-738
16	234	-738
17	234	-738
18	234	-738
19	234	-738
20	234	-738

e) Agricultural Balance

Agricultural balance for cattle raising (non-irrigated: 1 ha), sugarcane (non-irrigated: 2 ha) sugarcane (irrigated: 1 ha) rice (supplementary irrigated: 1ha) is shown below. The production cost includes the water fee and the organization fee. For first year, the production costs is larger than gross income but the net income will be 740,000 colon equivalent to 5 times bigger than that at present after 11 years later.

Agricultural balance (cattle raising: non-irrigated 1 ha, sugarcane: non-irrigated: 2 ha, sugarcane: irrigated: 1 ha, rice: supplementary irrigated: 1ha, unit: 1,000colon)

fiscal year	production cost							gross income					net income
	cattle raising non-irrigated	sugarcane non-irrigated	sugarcane irrigated	rice irrigated	water fee	organization fee	total cost	cattle raising non-irrigated	sugarcane non-irrigated	sugarcane irrigated	rice irrigated	total	
0	436	101	51	257		72	917	533			308	841	-76
1	109	620	366	293	115	72	1,575	133	780	520	374	1,807	232
2	112	609	361	289	115	72	1,559	137	794	534	382	1,847	289
3	116	599	355	286	115	72	1,542	141	809	549	389	1,887	345
4	119	589	349	282	115	72	1,526	144	823	563	397	1,928	401
5	122	579	343	278	115	72	1,510	148	838	578	404	1,968	458
6	126	569	337	274	115	72	1,493	152	852	592	412	2,008	514
7	129	559	331	271	115	72	1,477	155	867	607	419	2,048	571
8	133	549	325	267	115	72	1,461	159	881	621	427	2,088	627
9	136	539	319	263	115	72	1,444	163	896	636	434	2,128	684
10	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
11	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
12	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
13	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
14	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
15	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
16	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
17	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
18	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
19	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740
20	139	529	314	259	115	72	1,428	167	910	650	442	2,169	740

f) Cash balance considered the other expenditure

As the same manner as for zone A, considering 148,000 colon of the net income at present is assumed as for the necessary other expenditure, the increased amount of production cost is considered as the cost of the investment required for the new farm management, the same amount will come to be excess budget for next year. The balance considering the other expenditure is shown in the right tables. The table shows approximately 883,000 colon of the luck of fund at first year (This table is only for showing the lack of fund and is not showing the farm cash flow).

Cash balance considered the other expenditure
(cattle raising: non-irrigated 1 ha, sugarcane: non-irrigated: 2 ha, sugarcane: irrigated: 1 ha, rice: supplementary irrigated: 1ha, unit: 1,000colon)

fiscal year	net income	other expenditure	increased production cost	excess budget	annual balance	charge of construction cost			annual balance reducing charge
						sugarcane 1ha	paddy 1ha	total	
0	-76	148	658		-883	0	0	0	-883
1	232	148		658	743	0	0	0	743
2	289	148			141	0	0	0	141
3	345	148			197	0	0	0	197
4	401	148			254	87	67	154	100
5	458	148			310	193	150	343	-33
6	514	148			367	211	164	375	-9
7	571	148			423	207	161	368	55
8	627	148			480	203	157	361	119
9	684	148			536	199	154	354	182
10	740	148			592	195	151	346	246
11	740	148			592	191	148	339	253
12	740	148			592	187	145	332	261
13	740	148			592	183	142	325	268
14	740	148			592	179	139	317	275
15	740	148			592	175	135	310	282
16	740	148			592	250	194	444	149
17	740	148			592	167	129	296	297
18	740	148			592	163	126	289	304
19	740	148			592	159	123	281	311
20	740	148			592	154	120	274	318

g) Cash balance considered the loan and repayment

If farmers have their self-fund enough they have no problem, but if do not have self fund sufficiently it is necessary to get lone for the investment. In here, the required fund at first year will be prepared from long-term lone.

Lone and repayment schedule
(unit: 1,000colon)

fiscal year	Long-term lone				
	lone	interest 8%	repayment		balance
			proncipal	interst	
0	883				883
1		71		71	883
2		71		71	883
3		71		71	883
4		71		71	883
5		71	59	71	824
6		66	59	66	765
7		61	59	61	706
8		56	59	56	647
9		52	59	52	588
10		47	59	47	530
11		42	59	42	471
12		38	59	38	412
13		33	59	33	353
14		28	59	28	294
15		24	59	24	235
16		19	59	19	177
17		14	59	14	118
18		9	59	9	59
19		5	59	5	0

Total farm management balance(cattle raising: non-irrigated 1 ha, sugarcane: non-irrigated: 2 ha, sugarcane: irrigated: 1 ha, rice: supplementary irrigated: 1ha, unit: 1,000colon)

fiscal year	expenditure						income				annual balance	balance (accumulated surplus)
	production cost	others	increase of cost	repayment	charge	total	agricultural income	lone	execs budget	total		
0	917	148	658	0	0	1,723	841	883		1,723	0	0
1	1,575	148	0	71	0	1,795	1,807		658	2,466	671	671
2	1,559	148	0	71	0	1,779	1,847		0	1,847	68	739
3	1,542	148	0	71	0	1,764	1,887		0	1,887	124	863
4	1,526	148	0	71	154	1,902	1,928		0	1,928	25	888
5	1,510	148	0	129	343	2,135	1,968		0	1,968	-168	720
6	1,493	148	0	125	375	2,147	2,008		0	2,008	-139	581
7	1,477	148	0	120	368	2,120	2,048		0	2,048	-72	509
8	1,461	148	0	115	361	2,093	2,088		0	2,088	-5	504
9	1,444	148	0	111	354	2,065	2,128		0	2,128	63	567
10	1,428	148	0	106	346	2,038	2,169		0	2,169	130	698
11	1,428	148	0	101	339	2,027	2,169		0	2,169	141	839
12	1,428	148	0	96	332	2,016	2,169		0	2,169	152	991
13	1,428	148	0	92	325	2,005	2,169		0	2,169	163	1,154
14	1,428	148	0	87	317	1,995	2,169		0	2,169	174	1,328
15	1,428	148	0	82	310	1,984	2,169		0	2,169	185	1,513
16	1,428	148	0	78	444	2,113	2,169		0	2,169	55	1,568
17	1,428	148	0	73	296	1,962	2,169		0	2,169	207	1,775
18	1,428	148	0	68	289	1,951	2,169		0	2,169	218	1,992
19	1,428	148	0	64	281	1,940	2,169		0	2,169	229	2,221
20	1,428	148	0	0	274	1,870	2,169		0	2,169	298	2,519

Though it is necessary to borrow 883,000 colons at first year and annual balance for 6^{th} to 9^{th} come to less, from the second year the accumulated surplus is increasing in stably.

h) In case of applying shot-term lone

Short-term lone can be also applied.

Lone and repayment schedule (unit: 1,000colon)

fiscal year	short-term lone				
	lone	interest 24%	repayment		balance
			proncipal	interst	
0	883				883
1	212	71	883	71	212
2	90	17	212	17	90
3		7	90	7	0

Total farm management balance (with short-term lone)

fiscal year	expenditure						income				annual balance	balance (accumulated surplus)
	production cost	others	increase of cost	repayment	charge	total	agricultural income	lone	execs budget	total		
0	917	148	658	0	0	1,723	841	883		1,723	0	0
1	1,575	148	0	953	0	2,677	1,807	212	658	2,678	0	0
2	1,559	148	0	229	0	1,938	1,847	90	0	1,937	0	0
3	1,542	148	0	97	0	1,791	1,887	0	0	1,887	97	97
4	1,526	148	0	0	154	1,832	1,928	0	0	1,928	96	193
5	1,510	148	0	0	343	2,006	1,968	0	0	1,968	-38	155
6	1,493	148	0	0	375	2,023	2,008	0	0	2,008	-15	140
7	1,477	148	0	0	368	2,000	2,048	0	0	2,048	48	188
8	1,461	148	0	0	361	1,977	2,088	0	0	2,088	111	299
9	1,444	148	0	0	354	1,955	2,128	0	0	2,128	173	473
10	1,428	148	0	0	346	1,932	2,169	0	0	2,169	236	709
11	1,428	148	0	0	339	1,926	2,169	0	0	2,169	242	951
12	1,428	148	0	0	332	1,920	2,169	0	0	2,169	249	1,200
13	1,428	148	0	0	325	1,914	2,169	0	0	2,169	255	1,454
14	1,428	148	0	0	317	1,908	2,169	0	0	2,169	261	1,715
15	1,428	148	0	0	310	1,901	2,169	0	0	2,169	267	1,983
16	1,428	148	0	0	444	2,036	2,169	0	0	2,169	133	2,116
17	1,428	148	0	0	296	1,889	2,169	0	0	2,169	280	2,395
18	1,428	148	0	0	289	1,883	2,169	0	0	2,169	286	2,681
19	1,428	148	0	0	281	1,876	2,169	0	0	2,169	292	2,973
20	1,428	148	0	0	274	1,870	2,169	0	0	2,169	298	3,271

In this case, it is necessary to get lone for first 3 years but the accumulated surplus at 20 the fiscal year is slightly bigger than that of applying the long-term lone.

i) Conclusion

The analysis results are summarized below;

- In case of the small scale farmer with 5 ha (cattle raising 4 ha, rice 1ha) converting 3 ha from pasture to sugarcane and irrigating sugarcane 2 ha and supplementary irrigating rice 1 ha in the rainy season, the annual net income from the agriculture will increase 5 times bigger than that of present in 10 years later (the working time of family labor is also decreased).
- It is necessary to prepare the fund of around 883,000 colon for the first year. If farmer does not have the self-fund it is possible to manage using the log-term or short-term lone.
- Keeping the present expenditure level, reducing the working time of family labor, preparing the increased production cost, repaying the lone, the accumulated surplus can be gotten from 2nd years.

For the achievement of above situation by the small and medium scale farmers with week management foundation, systematical management by farmers organizations and the public support on such technical extension, management guidance, assist to access for agro-credit, are indispensable, and, it is impossible for individual farmers to improve with self effort alone. The result shows, even the farmers with small-scale farmland can pay the construction charge if improving their farm management through converting to more profitable crop, irrigating a part of their land and taking the systematic management with farmers' organization. Furthermore, when the small and medium scale farmers who do not have sufficient technique and finance are going to install the irrigation system, it is necessary to change their agriculture to more profitable, especially the cattle raising should be convert to other agriculture. Based on the due considerations and discussions on these point, the optimum crop and the farmers' charge for facilities should be decided. On the other hand, as the improvement of farm management has always a risk and it is necessary to decide the methodologies without unreasonable scale based on the conditions of each farmer.

At the farmers' level, the earlier establishment of the circumstance for the improvement family budget, re-investment to the farm management with early occurring of surplus is essential for raising up the project sustainability and farmers' self development. For this, in zone A, it is necessary to prepare the agro-credit with same loaning conditions as that of IDA and to guide and help the farmers for being able to access and use the credit effectively.

4) Other cases

The objective of this plan is "achievement of sustainable agricultural development for the small and medium scale farmers" and for the small and medium farmers who is in the week situation technically and finically, based on the crops of which farming techniques already established in the area, of which the marketing is comparatively stable, it is shown in the plan that how to improve the farm management. How to develop the small-scale farmers with small land and fund? Are they able to pay the construction charge? The purpose of farm management analysis is to check the those points. For confirming the framing balance at small-scale farmers' level, adding to the model farm of each zone, following case of farming balance are analyzed and comparison is shown below.

Summary of results of farm management analysis

Case		non-irrigated					river pumping irrigation system						groundwater irrigation system
		case 1	case 2	case 3	case 4	case 5	case 6	case 7	case 8	case 9	case 10	case 11	case 12
		cattle raising	cattle raising	sugarcane	convert to sugarcane	A zone model	pasture irrigated	sugarcane irrigated	rice supplemental irrigated	convert to sugarcane irrigated	convert to vegetable irrigated	C zone model	B zone model
management area		5.0 ha	50.0 ha	5.0 ha	5.0 ha	5.0 ha	5.0 ha	5.0 ha	5.0 ha	5.0 ha	5.0 ha	5.0 ha	5.0 ha
planting at present	pasture	5.0 ha	50.0 ha		4.0 ha	4.0 ha	5.0 ha			5.0 ha	5.0 ha	4.0 ha	3.0 ha
	sugarcane			5.0 ha	1.0 ha	1.0 ha		5.0 ha					
	rice								5.0 ha			1.0 ha	2.0 ha
proposed planting													
non-irrigated	pasture	5.0 ha	50.0 ha		3.0 ha	3.0 ha	3.0 ha			3.0 ha	2.0 ha	1.0 ha	2.0 ha
	sugarcane			5.0 ha	2.0 ha	1.0 ha		3.0 ha			1.0 ha	2.0 ha	2.0 ha
	rice												
	mango					1.0 ha							
irrigated	pasture						2.0 ha						
	sugarcane							2.0 ha		2.0 ha	1.0 ha	1.0 ha	
	rice								5.0 ha			1.0 ha	
	vegetable										2.0 ha		2.0 ha
agricultural net income (1000colon)	at present	121	1,215	401	177	177	121	401	254	121	121	148	233
	10 years	78	1,288	881	391	436	161	1,027	630	537	1,960	740	1,819
	increase rate	0.6	1.1	2.2	2.2	2.5	1.3	2.6	2.5	4.4	16.1	5.0	7.8
time of family labor (hr)	at present	1,215	12,150		972	972	1,215			1,215	1,215	972	729
	10 years	1,168	11,680		701	1,246	1,232			701	467	234	468
	deference	-47	-470		-271	274	17			-514	-748	-738	-261
long-term lone (1000 colon)	total lone	77	23	1,810	308	1,055	808	413	502	720	514	834	2,490
	accumulated surplus at 20th year	247	3,202	6,599	2,705	1,720	1,002	4,976	2,570	1,976	21,202	3,385	24,109
	occurring year of accumulated surplus	2nd year	2nd year	2nd year	3rd year	7th year	3rd year	3rd year	3rd year	3rd year	3rd year	3rd year	1st year
short-term lone (1001 colon)	total lone	443	32	684	1,049	*	919	1,001	1,948	1,234	1,252	1,389	3,934
	accumulated surplus at 20th year	75	3,011	6,508	2,707	*	1,495	5,082	2,686	2,359	21,385	3,865	25,554
	occurring year of accumulated surplus	12th year	4th year	6th year	7th year	*	3rd year	8th year	8th year	5th year	3rd year	4th year	4th year
covering rate of other		45%	90%	100%	100%	100%	45%	100%	80%	100%	100%	100%	100%
covering rate of		-	-	-	-	-	0%	100%	30%	100%	100%	100%	100%
evaluation of effect		low	middle	high	middle	middle	low	high	low	high	high	high	high

note)* in case 5 short-term lone cannot applied. ** vegetable is applied for double cropping.

the reason of evaluation

Case			evaluation of effect	reason
non-irrigated	case 1	cattle raising	low	agricultural income come to low
	case 2	cattle raising	middle	the increase rate of agricultural income is low. Other expenditure is constrained.
	case 3	sugarcane	high	accumulated surplus at 20th year is large
	case 4	convert to sugarcane	middle	agricultural net income can be increased with low investment
	case 5	A zone model	middle	the increase rate of agricultural income is high. Accumulated surplus comes late.
river pumping irrigation system	case 6	pasture irrigated	low	the increase rate of agricultural income is low. Other expenditure is constrained. Construction cost charge cannot be paid.
	case 7	sugarcane irrigated	high	the increase rate of agricultural income is high. Construction cost charge can be paid.
	case 8	rice supplemental irrigated	low	Other expenditure is constrained. Construction cost charge cannot be paid.
	case 9	convert to sugarcane irrigated	high	the increase rate of agricultural income is high. Construction cost charge can be paid.
	case 10	convert to vegetable irrigated	high	the increase rate of agricultural income is high. Construction cost charge can be paid. accumulated surplus at 20th year is large.
	case 11	C zone model	high	the increase rate of agricultural income is high. Construction cost charge can be paid.
groundwater irrigation system	case 12	B zone model	high	the increase rate of agricultural income is high. Construction cost charge can be paid.

Following conclusions can be said from this comparison study.

Non-irrigated:

- For the farmer with insufficient fund and small-scale farmland, it is difficult to improve the farm management if the farmer continues his cattle raising farming. Comparing the results of case 1 and case 2, if the farmer has middle scale of farmland the improvement can be expected with cattle raising farming.
- If the small-scale farmer is going to continue the sugarcane farming without irrigation, the improvement of the farm management using systematic management based on the farmers' organizations can be expected effectively.
- The conversion from cattle raising (pastureland) to sugarcane of mango is profitable in case of that irrigation system cannot be installed. As the annual net income of mango farming is higher than that of sugarcane farming, if the farmer has the margin of fund, converting to mango is more profitable than converting to sugarcane. However, the accumulated surplus at 20^{th} year of the sugarcane is bigger than that of mango.

Irrigated:

- For the farmer with insufficient fund and small-scale farmland, it is difficult to apply the irrigation for pastureland basically. Intensive cattle raising with irrigation is difficult for the small-scale farmers with disadvantage technically and financially.

- It is effective for the small-scale farmer to apply the irrigation to sugarcane and the farmer can pay the charge of construction cost. This will be considered for the farmland where cannot be converted to vegetable from the reason such as topographic condition. Converting from pasture to sugarcane with irrigation is also effective according to the result of case 9.
- The supplemental irrigation for paddy rice in the rainy season is not so effective if considering the charge of the construction cost. However, from the viewpoints of effective use of the river pumping irrigation system in the rainy season, the benefit, especially for stability of production, is not so bad with reducing the construction charge. It shall be considered for the farmers who is able to captivate only rice from the reason such as soil condition.
- The converting to vegetable is quite effective and if conditions such as soil, topography, organizations are suitable the farmer is better to convert to the vegetable positively. For the groundwater irrigation system, it shall be irrigate the vegetable basically.
- Except pastureland, irrigating in dry season is effective and it is possible to pay the construction cost charge. The charge of construction cost shall be considered based on this point.
- This farm management analysis is carried out for the small farmers with disadvantage for the self-development. Therefore, depending on the conditions of such as self-fund it is possible to improve the farm management more effectively. And it is not impossible for the small-scale farmers with business mind to improve their faming for further intensive and developed agriculture by self-effort.

5.8.3 Farm Household Budget Analysis

(1) Ideal type model of the small-scale farmers

Though the farm model was set for the small-scale farmers with disadvantages in the farm management analysis for confirmation how to improve their farming, in the farm household budget analysis, the purpose of analysis is to estimate the change of family budget conditions between at present and after implementation of the project for average small-scale farmers in the area. Therefore, the ideal type farm model is set as shown below.

a) Family size

It is assumed that an average household has 4 members, a couple with two children.

b) Average farm land tenure

The inquiry survey studied 300 samples out of 1,000 farmers' households in the study area stratified them into two groups, small farmers and medium and big farmers. The small farmer households consist of 87 per cent of the total. The same survey also shows that 73 per cent of the sample of 590 households of agro-producers are mainly growing one of the three major items of produce, i.e., sugar cane (67%), paddy (19%), and cattle (14%).

Another statistics provided by ASA-Filadelifia, shows around 75 per cent of the farmer's households in the area produce one of the three major produce, i.e., sugarcane (58 %), paddy (20 %) and cattle (22 %). And, 76 per cent of the group are categorized as small farmers. Their ratios of distribution of three crops are sugar cane (60 %), paddy (21 %) and cattle (19 %).

The second statistics does not contradict with the first. The image of an ideal type of small farmer's household is brought out from the second statistics. First, its activity ranges over the three major types of produce. Second, the scale of its holding is based on a weighted average of the holding kept by the group.

It holds 4.8ha of pasture, 4.3ha of sugar cane field and 1.0ha of paddy field, 10.2ha in total, out of which 3.5ha are on lease. And, 4.8ha of pasture can keep 4.3 heads of cattle in average (0.8/ha).

(2) Present Situation of Ideal Type of Family in this Analysis:

The gross and net incomes from the agricultural land holding

In present situation all the necessary water are rain-fed. The gross income from the mixed farming is estimated at 2,642 thousand colons a year and net income is estimated at 211 thousand colons a year, if all the manual labor required are carried out by hired hand.

Unit net income for 1 ha (1000colon)

	Pasture	Sugarcane	Paddy
Cost	182	310	257
Gross income	133	390	308
Net income	-49	80	51

Agricultural net income (1,000colon)

	Pasture	Sugarcane	Paddy	Total
Planted area	4.8 ha	4.3 ha	1.0 ha	10.1 ha
Cost	873	1,332	257	2,462
Gross income	639	1,677	308	2,624
Net income	-233	345	51	162

Manual Labor Cost

In the present business environment of agriculture in the area[1], it requires 552 man-hours (m-h) a year in average to cultivate sugarcane (128m-h/ha), 33 man-hours a year to manage the paddy fields (32m-h/ha), 1,207 man-hours a year for maintaining the pasture for cattle raising (250m-h/ha). The figures total up 1,792 man-hours a year. It costs the owner 542 thousand colons, if he only acts as a manager of the farm and hires laborers for all the manual labor required.

Required labor wages				
	Pasture	Sugarcane	Paddy	Total
Unit Working time(man・hr/ha)	250	128	32	
Planting area (ha)	4.8	4.3	1.0	10.1
Working time（man・hr）	1,200	552	32	1,784
Labor wages(1,000colon）	360	166	10	535

A side job other than agriculture or agriculture as a side job

A head of a household of a small farmer can be a full time farmer with a side job, or a man of some other trade who does farming as the side business (we shall exclude this case). If the head of the household decides to devote on this mixed farming doing all the manual labor by his family members, firstly his net income from the farming will increase by 542 thousand colons a year (+157%). Secondly, he can afford to look after his back yard vegetable gardens or a chicken farm: and to do other maintenance works of his house, if he lives on a piece of land in the countryside. Thirdly, he can give more personal care to his children than the case with the person with side jobs. Their children may help some of the cattle raising work as their part time work under his guidance. This is the opposite of the second case. In reality, people are between the two extremes. If he finds another job, he will surely take it as far as his holding of time allows and the family situation can be compromised. [2]

Other household income

National statistics show that a household has two income sources. The value of the second one is 30-40 per cent of the major one in average in the lower income group. In our study area the spouse can have opportunity to find odd jobs in her community or nearby, like ironing, or dress making, to augment income, so, 35 per cent of the net income from agriculture is counted.

1 Activities such as mechanized harvesting and transportation of sugarcane and paddy are outsourced.

2 Reciprocity of giving hand to the neighbor in need of labor is also found

The net income compared with the national income distribution statistics

Its annual net disposable income, 838 thousand colons ranked to the fourth in decimal division of the national household income distribution. (The first two divisions consist of those below poverty line.)

Farm household income (1,000colon)

Agricultural Net income	Family labor	Other income	Equipment fee	Total
162	535	244	-103	838

national household income distribution（1999）

（unit：1,000colon）

Rank	1	2	3	4	5	6	7	8	9	10	Average
Income	184	423	629	815	1,010	1,243	1,553	2,015	2,836	5,553	1,618

The Household Expenditure

We classify the household expenditure into the following categories; food, clothes, building house, maintenance of household, health, transport and communication, recreation and education, and others.

Classification of Consumption

	Country	Central Region	Chorotega Region
Food	40.1	37.9	48.2
Cloths	9.4	9.2	9.2
Housing	12.1	12.6	10.6
Household	10.9	10.8	10.3
Health	3.7	4.0	3.0
Transport & Communication	11.6	13.1	7.9
Recreation & Education	4.4	4.6	4.0
Others	7.8	7.8	6.8
total	100.0	100.0	100.0

Source: INEC, 1988

In the present situation, on the one hand, under present local situation of agro-processing industry, producers of three kinds of major produce have to buy them at markets for their household's requirement. On the other hand, There are chickens, eggs, fruits and some vegetables that can be raised and grow in the back yard, if they live in their farmhouse. The percentage of expenditure on food could be reduced to the national level. We presume that the distribution of household expenditure follows the national average instead of the regional average of Chorotega. This means he could use more percentage of earned money to other categories than the food than the other regional fellows who follow different occupations could in the same income bracket. The average annual costs that were required for buying the basic necessities of rural household were amounted to around 470 thousand colons in 2000.

(3) With Project Situation and Setting of Ideal Type of Family in this Analysis:

The expected changes in the situation

In a short term, 'with project' situation, 0.4 hectare of meadow will be converted into sugarcane field and 0.1 to paddy field. 46 percent of sugarcane fields in average and 67 per cent of paddy field is estimated to have irrigated water. Annual irrigation water rate is estimated at 91,500 colons. The increase of productivity will come not only from irrigation but also from a cooperative movement, which our project will specifically plan to train the members.

The gross and net incomes from the agricultural land holding

The gross income from the mixed farming is estimated at 3.7 million colons a year and net income is estimated at 1.4 million colons a year, if all the manual labor required are carried out by the family hands.

Agricultural income at initial						
	Non-irrigated			Irrigated		Total
	Pasture	Sugarcane	Paddy	Sugarcane	Paddy	
Planting area (ha)	4.3	2.6	0.3	2.2	0.7	10.1
Cost (1000 colon)	782	803	85	809	196	2,675
Gross income (1000 colon)	573	1,011	102	1,148	251	3,084
Net income (1000 colon)	-209	208	17	339	54	409
Water fee (1000 colon)				161	28	189
Organization fee (1000 colon)						72
Net income (1000 colon)						148

Agricultural income at 10 years later						
	Non-irrigated			Irrigated		Total
	Pasture	Sugarcane	Paddy	Pasture	Sugarcane	Paddy
Planting area (ha)	4.3	2.6	0.3	2.2	0.7	10.1
Cost (1000 colon)	900	685	76	693	174	2,527
Gross income (1000 colon)	716	1,179	107	1,435	296	3,733
Net income (1000 colon)	-184	494	31	743	122	1,206
Water fee (1000 colon)				161	28	189
Organization fee (1000 colon)						72
Net income (1000 colon)						945

Manual Labor Cost

It requires 532 man-hours (m-h) a year in average to cultivate sugarcane (111m-h/ha), 35 man-hours a year to manage the paddy fields (35m-h/ha), 1,075 man-hours a year for maintaining the pasture for cattle raising (250m-h/ha). The figures total up 1,643 man-hours a year. It costs the family 493 thousand colons, if its head only acts as a manager of the farm and hires laborers for all the manual labor required.

Other household income

Monetary contribution of the housewife is not counted, as future intensification of agriculture will require her attention more to agriculture production as well as non-financial aspect of well being of household itself.

Farm household income (1,000colon)

Agricultural net income	Family labor	Other income	Equipment fee	Total
945	493		-95	1,342

The net income in the national household income distribution

With the entire farm work done by the family members, its net disposable income ranked to the sixth in decimal division of the national household income distribution in ten years after the plan is initiated.

The household expenditure

With the increase of the net income, the distribution of household expenditure would approach the pattern of the regional average of the Central Region. More percentage and amount of money would be spent on other items than the food than the present situation.

Increase in the ability of shouldering income tax or a part of the project cost

The net income from the agriculture of the ideal type farm household rises from at 28.5 per cent from the bottom (poverty zone: up to 20.6 per cent) to 48 per cent in the national income distribution. (A percent gap corresponds to about 26,000 colon to 28,000 colon in the area of the distribution pattern.) This signifies the increase in the ability of shouldering income tax or a part of the project cost.

5.8.4 Results of Project Evaluation

For the agricultural production plan combined the irrigation/drainage, agricultural supporting and natural conservation and for the flood protection plan, the following can be said.

- Through the Chapters 5.1 to 5.6, the technical feasibility are studied and practicable plans were formulated.
- In the Chapter 5.7, implementation plan including O/M plan, implementation organization and disbursement schedule were studied and realizable plans were formulated.
- In the Chapter 5.8, financial and economical feasibilities were analyzed and more than 12 % of internal rate of return were obtained respectively.
- In the Chapter 5.8, the proposed farm management was analyzed and the methods of improvement of the farm management for small-scale farmers with disadvantaged conditions were shown.
- In the Chapter 5.8, the averaged small-scale farmers' household budged was analyzed and it was confirmed that the household budged will be improved with increasing the farm income for the averaged small-scale farmers through the implementation of the Project.

From the above considerations and entire viewpoints, it is judged that those plans are feasible.

The following are the aspects to be duly considered at the time of implementing the project.

- It is indispensable to give the technical supports to the small and medium scale farmers as is shown in the plan if one expects continuous positive effects of this agricultural development project.
- It is expected that there are some small and medium scale farmers who need loan from a bank for the initial investment to crop conversion, for example. In this case, such loan condition as interest rate affects the farmers' future income, so providing easier term of loan as has been done by IDA would be essential.
- If loan requirements are well organized, the beneficiaries could share even the initial investment cost of irrigation system.

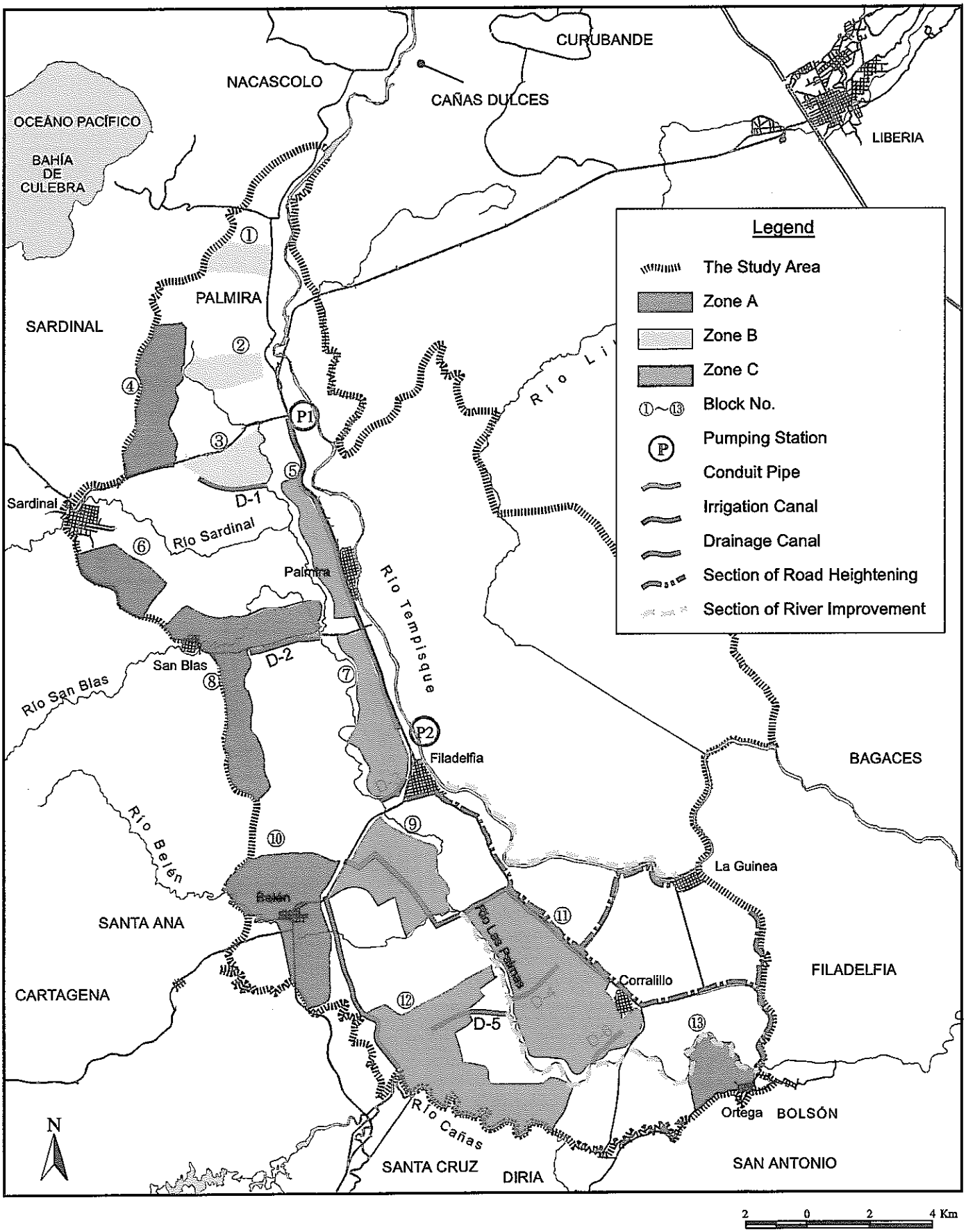


FIG.5-1 IRRIGATION/DRAINAGE AND FLOOD PROTECTION PLANS

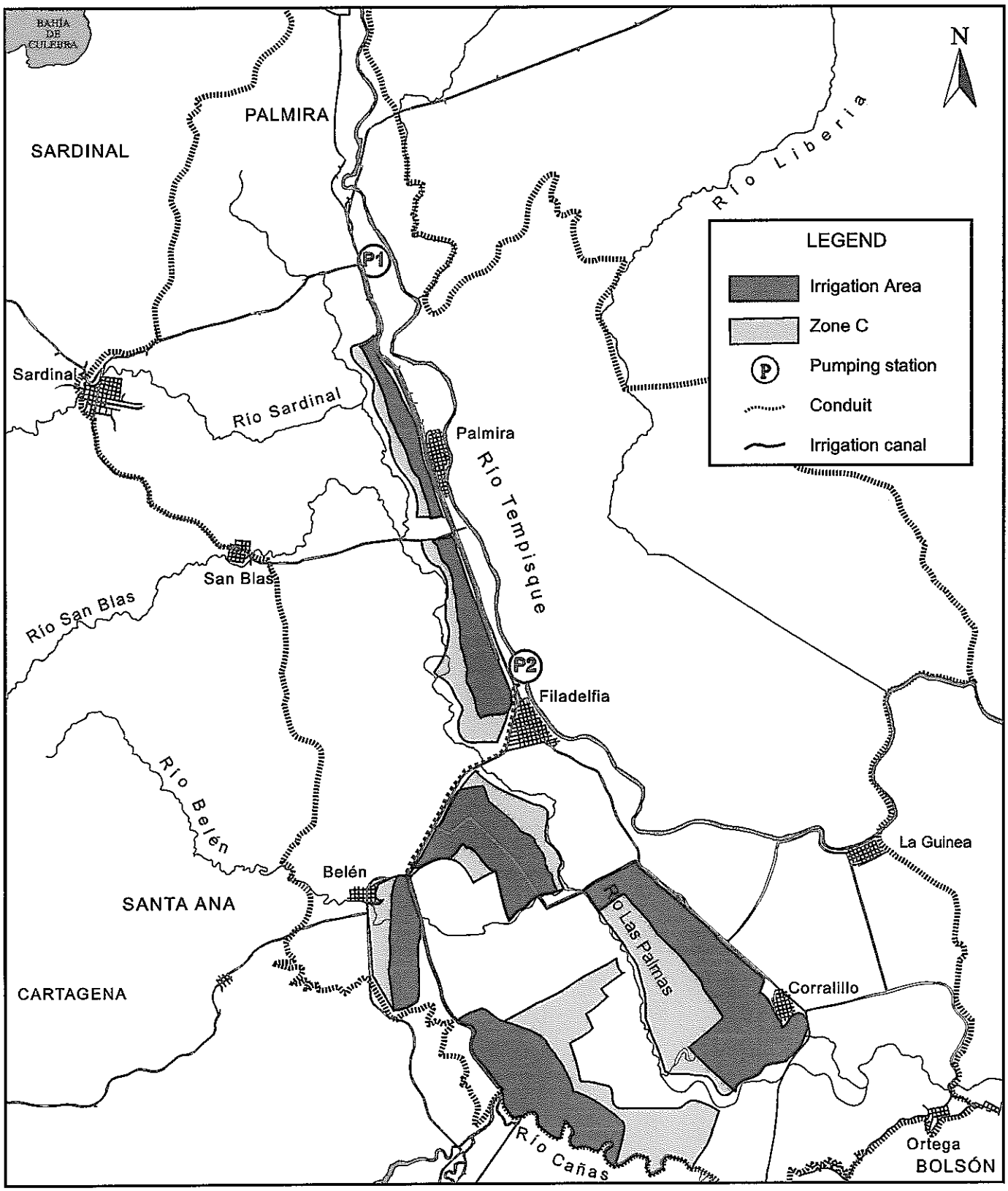


FIG.5-2 IRRIGATION AREA OF RIVER PUMPING SYSTEM

CHAPTER 6

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 6 ENVIRONMENTAL IMPACT ASSESSMENT

6.1 PROCEDURES FOR THE PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

SETENA, organism belonging to MINAE, is responsible for assessing the environmental impact of all projects in Costa Rica. SETENA heads the commission conformed by the representatives of the relevant institutions, meeting twice a week to sustain discussions concerning the distinct projects (FEAP; EIA and monitoring). The member institutions are as follows:

1. MAG, 2. MOS, 3. ICE, 4. AyA, 5. SENARA, 6. MINAE, 7. MOPT

The IEE (Initial Environmental Examination), referred to by JICA, corresponds to the Preliminary Environmental Assessment (FEAP) in Costa Rica. Although the basic environmental information required by the FEAP of Costa Rica are less demanding than those of Japan, for example, the ones related to contamination and social environs, it may be said that in general terms they cover sufficiently the necessary aspects, and it can be affirmed that the FEAP of Costa Rica and the IEE of Japan are almost equivalent.

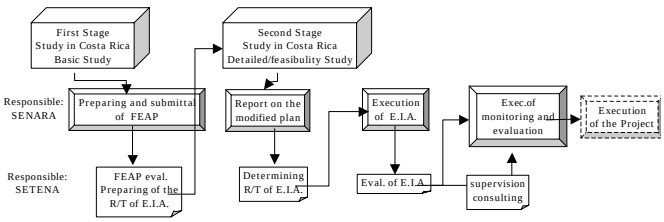
The procedures of FEAP are the following. The executing organism submits and explains the FEAP to the commission, and the ministries conforming the commission review the form in their respective field and they all discuss about the resolution to be issued. The commission evaluates the impact of the project to the environment, and decides on the necessity of an EIA. When such necessity is acknowledged, the commission prepares and delivers the corresponding specifications. The preparing of the FEAP, the execution of the EIA and the monitoring are responsibility of the executor of the project. In the case of the present Project, the executor is SENARA.

At the present Study, the FEAP was submitted and explained by SENARA to SETENA in February 2001, according to the Development Plan prepared in the first stage of the study in Costa Rica. Later, on March of 2001, SENARA received the answer from SETENA concerning the basic aspects, including the terms of reference of the EIA. The Development Plan was reviewed during the second stage of the study in Costa Rica, for that SETENA was consulted about the necessity to modify and to submit for the second time the FEAP, and the possible steps to be followed were confirmed.

- At the present Study the procedures for the submittal of the FEAP were concluded and the guidelines for the execution of the EIA have been defined. Therefore, once the contents of the Plan are defined, it is necessary to inform about them to SETENA.
- SETENA shall review once more the terms of reference of the EIA according to the definitive contents of the Plan, and shall communicate it to SENARA:
- SENARA shall carry out the EIA according to the terms of reference defined by SETENA and shall submit the report.

Therefore, after the submittal of the Final Report of the present Project, it shall be necessary to inform SETENA through SENARA, the modified aspects of the Project, in order that SENARA executes the EIA according to the terms of reference defined by SETENA.

Here are presented the results of the initial environmental assessment carried out by the Study Team (it does not refers to the FEAP), as a way of reference, and the impact of the Project on the environment has been analyzed.



6.2 Initial Environmental Evaluation

At the Appendix the document of the FEAP and its Appendix are presented. The environment basic main information of FEAP include the following (details are summarized in the chart below):

- The PA is located in zones qualified as highly risky, from the point of view of vulnerability of seism, volcanic irruptions, flood, fault breakage in surface, accordingly to information of the National Commission of Emergencies.
- The PA corresponds to the zone of water intake, accordingly to information of the Water Department of MINAE.
- Superficial water bodies (rivers, damps, etc) that could potentially be affected by the Project are found in the PA and of the AID.
- There are Protected Areas legally established inside the PA and of the AID.
- There are endemic species, menaced or in danger of extinction inside de PA and the AID, that could be affected by the Plan.
- Superficial waters of the PA are contaminated.
- There are zones with archeological value in the PA according to information of the National Museum.

Table: Basic Environmental Information

Bisc Environmental Information	Yes	No	Unknow
The existing conditions on air quality (emission and noise) in the PA are adequate. For example: The air is clean, artificial noise and upsetting odor cannot be perceived.		X	
Climate conditions at the project area are: Precipitation not more than 3.000mm per year	X		
No blowing of strong winds > 30km/hour	X		
Mist not frequent	X		
The predominant topography at the PA is: Less than 15%	X		
Between 15 and 40%		X	
More than 40%		X	
The activity requires to carry out earth works:			
The volume to be removed oscillates between 100 and 500 cubic meters		X	
The volume to be removed oscillates between 501 and 2000 cubic meters		X	
The volume to be removed is more than 2000 cubic meters	X		
The PA is located inside zones geologically qualified as highly risky, from the point of view of vulnerability to seism, volcanic eruptions, tsunamis, flood, potential liquefaction, fault breakage in surface, according to information available in the National Committee of Emergencies.	X (flood)		
The PA is located inside a zone of water bearings recharge zone, of springs protection, or underground water wells, according to information available in the National Service of Underground, Irrigation and Drainage Water (SENARA), or also in a superficial waters intake, according to information available at the Water Department of MINAE.	X		
According to the available data, the underground water level under the PA, is deeper than 10 meters (according to data available in the SENARA).	X		
There are superficial water bodies (lake, lagoon, creak, river, spring, estuary, etc) in the PA and in the AIID that could potentially be affected by the Project.	X		
The quality of the superficial water bodies located in the AIID of the Project, can be considered as little contaminated by the color, smell and general appearance.		X	
Are there Areas Protected by law, or Conservation Areas legally established inside the PA and the AIID of the Project?	X		
Are there wood patches inside the PA?	X		
Are there endemic species menaced or in danger in the PA and the AIID that could be affected by the Project?	X		
The PA is located in a development zone accordingly to the established for the activity in conformity to the planning programs established by the Regulation Plan, Plan for the Use of Soil, Environmental Master Plan, or other in force.	X		
In the PA and in the AIID there are human settlements that could directly and indirectly be affected by the activity of the Project.	X		
In the PA and the AIID there are tourism or recreational zones.		X	
In the PA and in the AIID there are recreation zones (parks), educational centers, hospitals, graveyards and other important infrastructure works.	X		
Inside the PA there are possible areas of archeological interest, or of historic or cultural heritage accordingly to data supplied by the National Museum.	X		
In the AIID there are other significant environmental projects.	X		
The project shall shut out or isolate sectors of urban nucleus, neighborhoods (quarters or districts) or shall create barriers hindering the cultural cohesion and continuity of the neighborhood.	X		
The development of the project shall produce a negative impact on the landscape.		X	

Therefore, based on the initial environmental assessment it is concluded that the present Project shall require an Environmental Impact Assessment . Actually, the answer of SETENA, received on May 2001 in relation to the FEAP submitted on March 2001, demanded the preparing of the EIA:

6.3 ANALYSIS ON THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The environmental impact assessment is carried out by SETENA accordingly to Costa Rica's legislation, following the terms of reference defined by said institution. Here, the environmental impact has been analyzed from the technical point of view.

The details of the analysis on environmental impact is in the Appendix. Following, only the results of the study of this analysis is presented.

6.3.1 Aspects to be studied concerning environmental impact

The aspects to be analyzed on environmental impact have been selected as indicated in the following chart, according to the profile of the Project.

The aspects to be studied in the EIA.

Notes: XX are very important aspects, and X are the necessary aspects.

Dimensions	Factors of impact Aspects to be studied	Installation of pumps	Water channels	Elevation of the roads' gradient	Improvement of the river bed	Amplification of agriculture land
Social Environment	Secondary Sector (sand pits)	—	—	—	XX	—
	Segmentation of the zone	—	X	—	—	—
	Road Transport (during the execution of works)	X	XX	XX	X	—
	Adjustment of water concessions	X	X	—	—	—
	Draining during the execution of works	X	X	X	X	—
	Deterioration of the landscape	X	X	X	X	—
	Loss of cultural heritage	—	X	X	—	—
	Impact on the river bed of the low basin	X	—	—	XX	—
Natural Environment	Impact on the underground waters	—	—	—	—	X
	Change on hydrologic conditions	X	—	—	X	—
	Flora	X	X	X	X	X
	Fauna	—	X	—	XX	—
	Aquatic fauna	—	—	—	XX	—
	Destruction of the ecosystem	—	—	—	XX	—
	Quality of Water	—	—	—	—	X
	Noise	XX	X	XX	X	—

6.3.2 Results on the environmental impact analysis

Following, the evaluation of each aspect shall be detailed. The aspects requiring monitoring are the "impact on underground water", "aquatic fauna" and the "destruction of the ecosystem". On the other hand, "aquatic fauna" is mentioned as an aspect requiring mitigation measures of environmental impact.

1) Secondary sector (sand pits)

Although it is correct that there is a possibility of reduction in the volume of resources presently being extracted by the sand pit due to the improvement of the river bed , such does not constitute in a social problem for it is considered that the Project Executor shall take a compensation measure.

2) Segmentation of the zone

Concerning the possibility that the channels to be installed segment the communication of the local community, such does not constitute a social problem for the construction of bridges on convenient intervals over the channels are considered.

3) Road Transportation (during the execution of works)

Concerning the possibility that the installation of pumps, channels, elevation of the gradient of the roads and the works to improve the river bed increase the volume of traffic of construction vehicles affecting the present traffic, such shall not be a social problem for the impact to be produced during the execution of works could be reduced, by the regulation of traffic in determined hours.

4) Adjustment of the water concessions

The concession of waters shall need to be readjusted, because of the construction of new pump stations and new channels. Such negotiations shall be carried out with previous and due conversation and coordination among the interested parts, so it shall not constitute a social problem.

5) Drainage during the execution of works

It is probable that the execution of the construction works of pumping installations, channels, elevation of the road gradients and the improvement of river beds deteriorate the environmental sanitation of the construction sites due to the discharge of residue, sewage, etc. proceeding from the workers' lodgings. However, such shall not constitute a social problem for they can be solved by taking proper disposal measures during the execution of works.

6) Landscape deterioration

The execution of construction works of pumping installation, channels, elevation of the roads gradient and improvement of river bed, implies changes in the landscape. However, such shall not constitute a social problem for there are no viewpoints or landscape to be protected in the surroundings.

7) Loss of cultural heritage

There are no cultural heritage buried in the zones whose topography shall be affected by the execution of construction works of channels and the elevation of gradient of roads so the works shall not cause a social problem. It is said that there are cultural heritage buried at approximately 50 m from the Tempisque River dyke. Such are mainly ceramic pottery that, in the eventuality of being found during the execution of works, the concerned study could be concluded at a short time, so it shall not constitute a social problem, including the suspension of works.

8) Impact on the river bed of the low basin

The flow to be taken from the intake (pumping) is of 3,0m3/s. The SENARA Channel upstream of the PNPV which flow exhausts during the dry season, could recover with the Project, 1.5m3/s as maintenance flow, so its execution does not constitute a natural problem, on the contrary the impact shall be positive.

9) Impact on underground waters

The design flow to be used for irrigation is of 1,0m3/s. The existing recharge in the Area of Study is estimated in approximately 287km2; without including the slope, it is of around 116 million of m3 . The intake flow of all wells reach 54 million of m3. Supposing that there would be an irrigation recharge (of superficial and underground waters) of approximately 10 million m3, it is considered that it is possible to use between 1,0 and 1,5 m3 /s in the whole Area of the Study, even when the uncertain factors, as for example, the circulation of exceeding underground water are considered. Therefore, the execution would not carry an environmental impact, such as the exhausting of underground waters, etc. However, the monitoring of said resources is considered to check the situation.

10) Change in the hydrologic conditions

It is possible that the execution of construction works for pumping installations, as also the

improvement of the river bed cause a change in the hydrological conditions of the low basin, and so, a change in the flora along the river. However, the SENARA Channel, upstream of the PNPV which flow exhausts at the dry season, could recover 1,5 m3/s as maintenance flow with the Project, so its execution shall not constitute a natural problem, on the contrary, the impact would be positive.

11) Flora

The existence of species of flora in danger of extinction at the zones affected by the execution of construction works for installation of pumps, channels, elevation of the gradient of roads and improvement of river bed, as also the amplification of the agricultural horizon have not been identified. Although it is correct that the trees of Tempisque and Guanacaste were identified , the population is numerous at the zone, so it shall not constitute a grave environmental problem.

12) Fauna (without including the aquatic fauna)

Besides the lizards, the existence of species in danger of extinction at the zones affected by the execution of construction works for installation of pumps, channels, elevation of the gradient of roads and improvement of river bed, as also the amplification of the agricultural horizon have not been identified. The lizards could move by themselves avoiding any danger, so it shall not constitute a grave environmental problem.

13) Aquatic fauna

The Project proposes to improve the river bed by the excavation of the Tempisque River bed over an extension of 9 km at La Guinea. The lizards inhabiting in the river and that are classified as menaced species would displace themselves looking for a new habitat during the works, so it shall not constitute a serious environmental problem. On the other hand, at the Tempisque River there are bivalves (Polymesoda radiata) that, although do not correspond to the specie in danger of extinction, its distribution is limited between the South of Mexico and Panama. For this specie, measures to mitigate the impact during the works for improvement of the river bed are proposed. Additionally, the amplification of agriculture land would increase the application of agrochemicals and fertilizers. Since on this aspect there are factors unknown scientifically, monitoring to take the necessary measures shall be carried out.

14) Destruction of the Ecosystem

Concerning the impact on the flora and fauna at the zones affected by the Project, it is not considered that the destruction of the ecosystem shall be produced by the change of habitat and of the alimentary chain. However, the amplification of the agricultural horizon implies in increasing the use of agrochemicals and fertilizers. Since the relationship between the applied dose of such products and the destruction of the ecosystem are scientifically unknown, monitoring is required ant the necessary measures shall be taken.

15) Quality of water

It is probable that the amplification of agricultural land affect the quality of water in the basin by the increase in the use of agrochemicals and fertilizers. Therefore, monitoring to take the necessary measures shall be carried out.

16) Noise (during the execution of works)

It is probable that the execution of construction works for the installation of pumps, channels, elevation of the gradient of roads and improvement of river bed, have an impact on the lives of the local community, on the cattle and wild fauna at the zone, by the production of noise due to the movement of construction machines and vehicles. However, such shall not constitute an environmental problem for such could be technically solved during the execution stage.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The Arenal Tempisque Irrigation Project (PRAT) that constitute the framework of the present Project had been designed in 1978 as a project of national importance with the objective the increasing the production through the introduction of irrigation. Phases I and II of the PRAT have been concluded and for the Phase III it is foreseen the irrigation is put into service from May 2003. PRAT has substantially contributed to the increase of the agriculture production and to the development of the regional economy, thanks to the huge efforts made by SENARA and the relevant institutions, so is true that the levels of economic development achieved in Cañas and other benefited zones have improved in a surprisingly way compared to the situation before its implementation. The actual Project constitutes the Phase IV of PRAT. However, the present is distinct from the other three phases because the water sources for irrigation are very limited to cover the vast existing cultivation area, constituting a great disadvantage to carry out the agriculture development. Due to this reason, in the actual Project, the irrigations plan consistent in the increment of agricultural production optimizing the use of the river flow available in the sources has been developed, under conditions to make feasible the implementation of the Project.

The superior goal of a agricultural development project is to improve the capacity of the benefited farmers and to open the way for the sustainable management of the farms by their own effort. In other words, the different components integrating the agriculture development project shall be the means to direct the achievement of the superior goal. In our Project, all included components, such as the Plan of Support to Farmers, Plan of Irrigation and Drainage, etc., are designed under said philosophy. However, to achieve the development of human resources among the farmers, the “how to implement” the Project having the beneficiaries farmers as protagonists of the development constitute a determinant factor, so it is expected that SENARA and other concerned institutions assume a great responsibility. The implementations of the present Project shall allow to the institutions accumulate extremely valuable experiences in the field of participatory development, an indispensable modality to carry out future projects of agricultural and rural development.

The main beneficiary population of the present Project shall be the small and medium farmers that suffer from great economic and technical limitations to drive forward the agricultural development by their own means, and the benefited area shall be the area presently without irrigation at the medium basin of the Tempisque River. The Area of the Project can be divided into three great zones according to the conditions of soil and availability of water. The development plan has been designed for the respective zone, and constitute in the following:

For all zones: To all zones, the improvement on the management of farms by grouping small and medium farmers is proposed with the purpose of developing the articulated administration of farms through the diversification of crops and partial intensification of the production.

Zone A: Said zone is characterized by the fact that irrigation shall have very limited effects, so at this zone the impulse to diversify crops by the partial re-conversion of pasture without irrigation to handle and the improvement on the model of farm management are proposed.

Zone B: Considering that the irrigation with water pumped from the river is not profitable in this zone, irrigation of part of the farming land with underground water, the impulse to diversify crops by the partial re-conversion of sugar cane to vegetables, and the improvement of the model of farm management are proposed.

Zone C: At this zone the irrigation of part of the agriculture land with water pumped from the river, the impulse to diversify crops by the partial re-conversion of pasture and sugar cane to vegetables and melon during the dry season, and to carry out supplementary irrigation of rice during the rainy season, and so improving the model of farm management are proposed.

In order to put into practice the development plan of the respective zones, the following four components were designed in the present Project.

Component 1: Irrigation and drainage

Due to the lack of water sources to cover the integrity of the cultivation areas, the construction of an irrigation system consistent in pumping water from the Tempisque River is proposed to supply Zone C that presents relatively favorable conditions. The installations are designed with a capacity to pump and conduit 3,0 m3 /s of the new concession. Also the irrigation system with underground water shall be constructed in the zone presenting high potential of water bearings. However, the exploitation of such source shall be carried out with due precaution, for which the necessary monitoring shall be executed.

Component 2: Flood Prevention

The Flood Prevention Plan shall not have as objective to control completely the floods at the zone, but to mitigate the damage to agriculture land from flood for a return period of 10 years. Every year, the small and medium farmers of the zone suffer from flood damage, and the fact of defending small and medium farmers from flood of such magnitude shall substantially contribute to stabilize the agriculture income and to improve the farm management of such population. Concretely, the Plan shall constitute in the improvement of the embankments of the Tempisque and Palmas Rivers, as also the elevation of the grade line of roads to assure the evacuation routes and to improve the conditions of access during flood.

Component 3: Environmental Conservation

The sensitization of local population is proposed to be carried out, as also the monitoring in environmental issues to make it possible the sustainable improvement of farm management of small and medium farmers.

Component 4: Reinforcement of Agricultural Support

The service of institutional support is required to be reinforced in order to improve the modality of farm management of small and medium farmers. Most of all, it is indispensable to restructure and reinforce the peasant organizations. The support service shall additionally include the extension of cultivation techniques, know how on farm management, credit management, as also the support to peasant women.

On such manner, the present Project includes plans and actions reaching different fields and such shall be systematically coordinated among them. It is very possible that the impact of the Project does not manifest at a hundred per cent if the institutions of the public sector (SENARA, MOPT, MINAE, CNE and IDA) undertake isolated actions without any coordination. So, the creation of a new inter-institutional Project Unity for its implementation is recommended. Additionally, it is recommendable to invite the farmers to participate in this Project, even before the approval of its implementation by the Central Government, and in such a way, to prepare the foundations of a development where farmers shall have a primordial role and, later, to reinforce and reorganize the peasant organizations with the purpose of implementing efficiently the Project and to obtain the expected results.

The implementation cost of the Project, including the construction works, is estimated in approximately US$ 40 million. The FIRR of the Project surpasses the level of 12% indicating that it satisfies the criteria applied by the multi-lateral banks such as the IDB to grant the financing. Moreover, the feasibility that even small and medium farmers without resources of their own would be able to increase their agricultural income by the improvement of the methods for farm management with the resources of the system of credit for agriculture in force has been envisaged.

It is worth reminding that, after carrying out the initial environmental assessment it has been concluded that the implementation of the actual Project EIA. Accordingly to the environmental impact study carried out in the actual Study, the feasibility of executing the Project without causing negative impacts to the local environment has been envisaged.

Taking into account everything set forth previously, the conclusion is that the proposed Project is feasible and it has as objective "the achievement of a sustainable agriculture development for small and medium scale farmers"

7.2 Recommendations

With the purpose of understanding the nature of the actual Project and the implementation of the same, the following recommendations are set forth.

1. The present Project has as main objective the achievement of "the sustainable agriculture development of small and medium farmers" and it has been designed to improve farm management, mainly of small and medium farmers, through the diversification of crops and a complex system of farm management. Each component of the Project shall be completely discussed taking into account such philosophy. (Example: if the Project had been conceived only to increase the agricultural production at the region, a different conclusion would be obtained).
2. The present Project requires to be implemented in the participatory modality. The participatory development consists in the fact that small and medium farmers identify the problems related to the management of their farms, look for and put into practice the solution to such problems. So, the present Project shall be considered as a plan to support the efforts of small and medium benefited farmers to improve the management of their farms. The beneficiaries and all governmental authorities of Costa Rica must fully understand that it is not a project that intends to supply irrigation water freely or to support the agricultural production to small and medium farmers without a strong consciousness of self-management and that are only waiting to receive external assistance.
3. The peasant organizations shall be consolidated as the promoting body of the participatory development, and the implementation of the components of the present Project shall be set up on the acknowledgement of the own benefited ones that they are important to conduct the agricultural development.
4. To develop the agriculture in the Area of the Project, the achievement of the diversification of crops and the management of greater areas of cultivation are required, for such small and medium farmers shall be grouped and the administrative scale shall be extended. Such process requires time and the reinforcement of support services is necessary to reorganize and consolidate the peasant organizations.
5. The models of farm management set forth in the present Study are only examples and the option to choose the most proper model for each one on the farmers stay on their own hands. Here are set forth also the distinct methods of support, but the contents may vary accordingly to the eventual changes of the market.
6. Given the limited availability of exploitable water at the Project Area; it is extremely difficult to totally irrigate the agricultural land, and for this reason, to think about how to utilize effectively the water is a requirement. A project intending to drive forward a forced exploitation of water resources, shall not be sustainable both from the technical and economical point of view, but rather could be very problematical towards the future.
7. At the beginning of the Project, SENARA shall exercise a strong control on the distribution of water through the irrigation system. At the same time, however, the diffusion of the necessary techniques of operation shall be required so that in the future, the benefited farmers become capable of carrying out the operation and maintenance of the installations.
8. The construction of the irrigation system with underground water shall be carried out analyzing permanently the results of the monitoring and verifying that the development does not cause a great negative impact at the underground level
9. For the agriculture under irrigation, SENARA shall be initially be responsible for the distribution of water to the parcels. However, when the Water users associations (WUA) reach a certain grade of maturation in the future, the possibility of supplying water to each WUA shall be studied.

10. The actions to prevent flood proposed in the present Document have as main objective the mitigation of the damage by flood at the agricultural land of small and medium farmers, and form part of the actions taken against flood in the region. The flood control in the regional sphere shall be analyzed taking as reference the guidelines set forth in the present Study.
11. At the Plan of Flood Prevention measures to protect the valuable species of the zone according to the EIA are recommended. Also it considers necessary the study of preventive measures for environmental deterioration, accordingly to the results of the EIA.
12. In order to divulge the eco-friendly agriculture, the propagation of cultivation techniques to replace as much as possible the use of highly residual or toxic agro-chemicals are recommended.
13. The main benefited population of the present Project shall be the small and medium farmers suffering from great economic and technical limitations to drive forward the agricultural development by their own efforts, and the benefited area shall be the area presently without irrigation at the medium basin of Tempisque River. SENARA as one of the executing organisms of the present Project shall continue the negotiation with MINAE, the institution responsible for the river water management, in order to obtain the new concession of the Tempisque River and to obtain water to supply the maintenance flow.
14. The present Project attributes importance to the social aspect, but such may not be an excuse to disdain the financial and economical profitability. A project is not sustainable if due importance is not attributed to its profitability.
15. The monitoring items are selected only indispensable items based on the present situation for minimizing the execution costs and it should be reviewed at implementation stage considering the budget conditions. When it is reviewed, considering the conditions of budget and execution agencies, the practicable plan should be formulated.
16. It is recommended that The values shown for standard of evaluation concerning the water qualities in monitoring plan should be set as more realistic values, based on the long-term investigations and observations, considering the conditions of Costa Rica (especially the Study Area) and other countries situated in the similar conditions.
17. In the proposed plan, as the first step for the maintenance and improvement of river environment, supplement of 1.5 m^3/s of water for maintenance flow in dry season was suggested. However, this water amount is minimum requirement to maintain the ecological system, and, for the purpose of further improvement of river environment, continues activities is required for the improvement of inhabitant consciousness for basin control and the activation of their activities.