

SUMMARY

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PROFILE OF THE STUDY

The name of study: The Study on Rural Development Project
for the Middle Basin of Tempisque River
Study period: November 2000 to September 2002
Counterpart agency: Servicio Nacional de Aguas Subterráneas,
Riego y Avenamiento (SENARA)

Background of the Study

In Guanacaste province, which is one of the main agricultural production areas, the Arenal Tempisque Irrigation Project (proposed irrigation area: 59,960 ha) was planned in 1978, Phase I of the Project was completed in 1985, and, the Phase II of the Project completed the construction in 1999. 18,000 ha of irrigation area (beneficiaries: 850 farmers) were improved by the Project. As the Phase III of the Project, the phase 2 construction of the west main canal (between the Piedras and the Cabuyo rivers) was commenced at the end of 2000 and it will be finished at the middle of 2003. Around 10,000 ha (beneficiaries: 125 farmers) of irrigation land will be improved additionally.¹

This Study was proposed at the moment of the implementation of the Phase III and it can be considered as the Phase IV of the Project. However, as the expected water source at the initial plan has been decreased and the international/national environment surrounding the agriculture has been changed extraordinary, the formulation of the sustainable integrated agricultural development plan, which includes the improvement of food self sufficiency, the strengthen of international competitive power of agriculture, the correction of regional difference from other area, and environmental conservation, are required to the Study. Considering these conditions, the Government of Costa Rica requested to the Government of Japan for technical cooperation of the study on “the Rural Development Project for the Middle Basin of Tempisque River” and, in response to this request, the government of Japan dispatched the study team through the Japan International Cooperation Agency (JICA).

Objectives of the Study

- (1) Based on the request of the government of Costa Rica, for the 35,000 ha of the area at the middle basin of the Tempisque river in the Guanacaste Province, considering the environmental conservation of the national park in the upper and lower areas, for the purpose of the establishment of irrigation and drainage agriculture, establishment of countermeasure for rural flood protections and promoting the sustainable agricultural development of the small and medium scale farmers, to reevaluate the existing development plan (Arenal Tempisque Irrigation Project) and formulate the preliminary development plan, to conduct a feasibility study on the proposed project in the preliminary plan.
- (2) For the Costa Rican counterpart personnel, to carry out the technology transfer on the methodology of the study and the procedure and thinking way for the formulation of the development plan.

Study Area

The plan shall be formulated the area that covers approximately 35,000 ha along the Middle Basin of Tempisque River including Liberia, Santa Cruz and Carrillo cantons in the Guanacaste province.

¹The Phase 2 expanding construction works of the south main canal (between the Cañas and the Abangares rivers) and the construction of irrigation canal networks in Lajas/Abangares sub-districts are planned as Phase V. The detailed design is carrying out now by SENARA.

Scope of the Study

The Study consisted of Phase 1 study (evaluation of existing plan and formulation of preliminary development plan) and Phase 2 study (execution of feasibility study) and was carried out from 2000 to 2002. This report was prepared as the final report of feasibility study (F/S) describing the proposed development plan based on the entire study results.

SUMMARY OF THE RESULTS

【BACKGROUND】

General Conditions of Costa Rica

General

Costa Rica is located at latitude 10°00' North and longitude 84°15' West and lays adjacent to Nicaragua on the Northeast, Panama on the Southeast, Pacific Ocean on the West, and the Caribbean Sea on the East. The territorial area of Costa Rica is 51,100 km² consisting of 7 Provinces, 81 Cantons and 463 Districts. According to the national census performed in 2000, the general indexes are summarized below.

The general index of Costa Rica

Population: around 3.5 millions, population density: 67.4 person/km ² , distribution: 44 % for the urban, 56 % for the rural	
Literacy rate: 95 %	Life expectancy: 79.8 years (women), 74.1 years (men), Infant mortality rate: 11.8 per 1,000 life births
Unemployment rate: 6.0%, economic active population: about 1,383,000, (458,000 persons for women)	
Main exporting products: banana, coffee, meat, sugar, electronic parts, pineapple, medicines, decorations plants, synthetic rubber for packing, women garments, fish, tires, glass containers, polyester fiber	
GDP growth rate: 8 % (1999), GDP growth rate per capital: 5.5%, inflation control rate: 10.1%	
Average monthly income: 54,183 colons (1999), poverty rate: 20.6%, extreme poverty rate: 6.7%	

Agricultural and Livestock Sector

GDP share of agricultural sector in the industrial structure of Costa Rica, showing 26% in 1960 (commercial sector 20%, service sector 19%, industrial sector 14%), 18% in 1980 and 11% in 1999, has been decreased. In spite of decreasing the GDP share, the production of agricultural sector was increased 38% comparing with 1991 (1991 price) and it still is one of the major sectors for creating the job opportunities for employer (19.73% of total labor force). The main products are coffee, bananas and the non-traditional products (especially flowers, melons, marine products and pineapple).

General Conditions of Chorotega Region

Chorotega region is almost same area as the area of Guanacaste province, located in the northeast of the country and its feature is a vast area with low population density. In spite of covering 20% of the Costa Rican territory, the population in this area is about 8% of the total population in 1999. Before 1950, the social and productive development in the low flat land of Guanacaste was preceded based on economic activities represented by the traditional big cattle farms. After 1950, the big cattle farms were revitalized with opening of cattle meat and sugar cane market of USA, on the other hand, the productions of rice, cotton and sorghum for domestic market were also revitalized. However, after 1990, the agricultural and livestock sector as the most major industrial sector by that time was changed place by service sector (truism) gradually. But, The Chorotega region is one of the major rice production areas in Costa Rica and there is 45.3 % of rice planted area in 1989-1999. 45.8 % of the national sugar production and more than 50% of the total sugar cane are produced and processed in the Guanacaste.

There are many protection areas for natural environment, reforestation is done very well, government and local people are promoting positively the conservation of natural resources in region; those are also ones of the feature of the Guanacaste Province. However, the water resource is scarce and the inundation has occurred The local people are harmed by inundation every year.

The largest poverty population (35.5 % of total employments) exists in the Chorotega region and many of people have been out flowing to other regions from old time. The income level is the lowest in the all country and the low in come employment index is the highest (17.9 % in 1999).

Arenal Tempisque Irrigation Project (PRAT)

PRAT Phase I - Phase II

With the water source from discharge water of Arenal-Corobicí-Sandillal Hydroelectric Power Station (ARCOSAN), Arenal Tempisque Irrigation Project (PRAT) was planed Phase I and Phase II of the project have been implemented.

Summary of project

Phase	Cost (Million US\$)	Irritation canal (km)	Drainage canal (km)	Road (km)	Area (ha)	Beneficiaries
I	19.80	79.31	23.13	68.46	6,371	168
II	38.46	154.92	66.32	162.37	13,011	632
TOTAL	58.26	234.23	89.45	230.83	19,382	800

Source: SENARA

PRAT Phase III and Phase IV

Phase III is planned to cover the western part of the irrigation area; Cabuyo, Tempisque and South Zapandí, with 15,500 ha, and Phase V is Planned to cover the Lajas and Abangares with 7,500 ha.

Phase	Sub District	Main Canal	Canal Extension (km)	Area (ha)	No. of Beneficiaries*
III	Cabuyo/Tempisque/South Zapandí	CO-II	18	15,500	105
V	Lajas/Abangares	CS-II	32	7,500	250
TOTAL			50	23,000	355

* Beneficiary includes 100 farmers (approximately 1,000 ha) settled by IDA San Ramon

Phase IV

In the recent survey done by SENARA and ICE, it was concluded that the irrigation water using the discharge of ARCOSAN hydroelectric power station is not sufficient for all expected area. Therefore, the government of Costa Rica requested the implementation of this study; “The Study on Rural Development Project for the Middle Basin of Tempisque River”, targeting 35,000 ha of the middle basin of Tempisque river (Guanacaste Province) to Japan International Cooperation Agency (JICA) with the objectives of establishing agricultural irrigation system, regional flood control and sustainable development of small and middle-scale farmers, considering environmental conservation of the areas including the upper stream of Tempisque river and the national park of down stream. This study is of revising the existing development plan (Arenal-Tempisque Irrigation Project), drafting a new development plan and conducting its F/S. The development plan shall be proposed in this report, by Study team and Counterpart personals of the government of Costa Rica. The proposed project in the study becomes to be the Phase IV of the PLAT.

[THE STUDY AREA]

General Description

3.1.1 Administration

The Study Area includes 3 cantons of 11 cantons in the Guanacaste Province and covers partly 7 districts of each canton.

Provincia	Canton	District:
Guanacaste	Liberia	(2/5) : Nacascolo, Liberia
	Carrillo	(4/4) : Palmira, Sardinal, Belén, Filadelfia
	Santa Cruz	(1/9) : Bolson

Population:

Guanacaste Population: 264 thousand Increasing rate: 1.9 % (3.4% for the urban, 1.0% for the rural)	Estimation of 7 district Population: 67 thousand Increasing rate: 2.0 % Population density: 45.2 person/km ²
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The ratio of the households below the poverty line was 38.4 % (national average: 25.9 %) in 1993 and it was 35.5 % (do.23.5 %) in 1999 decreasing with an annual rate of 1.3 % (do.3.3 %). Comparing with the national level, The Guanacaste Province ranks the highest in the level of poverty.

Natural Conditions

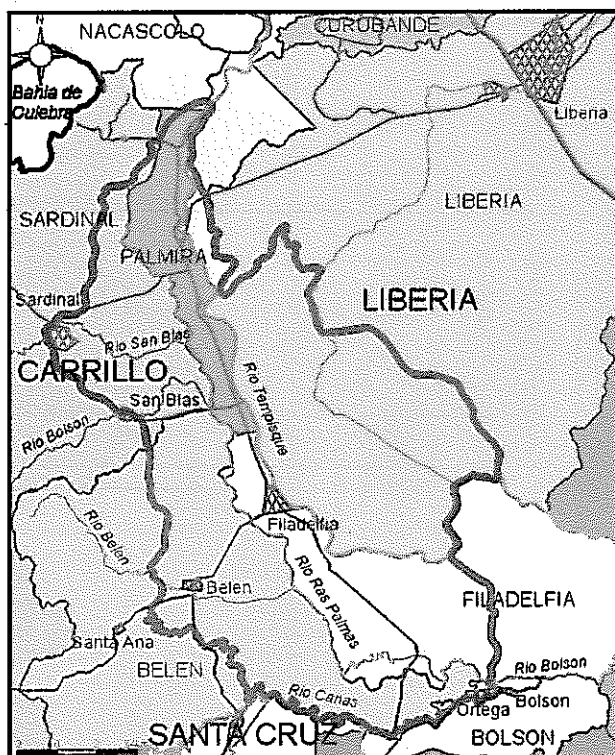
Soil

Most of the Study Area's soil is classified into the Mollisol, Vertisol and Inceptisol order. Mollisol is good in physically and chemically and is appropriate to grow sugar cane, rice, melon, watermelon, etc. Vertisol is no good in physically but well in chemically and is destined of rice and pasture production. Inceptisol is medium in chemically and not well in physically with small stones and is mainly used for pasture.

According to the classification of potential land use in Costa Rica, in the Study area, the class II² (58%), class III³ (11%) and class IV⁴, do 99% of the land can be used for agriculture.

Meteorology

Distribution of the annual rainfall in the Tempisque basin is 1,800 to 2,100mm in the foot of the southern and northern mountains (southern mountain side of Orosi volcano and the northeastern mountain side of the Nicoya peninsula) and 1600mm in the middle basin, it is 200 to 500 mm less than that of the mountainsides. The average annual rainfall in the Study Area is 1,520 mm (average for the basin: 1,770 mm). Climate in the Study Area is divided into the rainy and the dry seasons. The



Administrative division

Area of each soil order within the Study Area

Type	Area (ha)	Percentage (%)
Mollisol	9,943	28
Vertisol	13,114	37
Inceptisol	8,348	24
Alfisol	2,984	9

² The soil does not undergo any limitation as long as it is used for agricultural, livestock, and forestry activities in good relation with the local ecosystem. Yet, certain crops may cause some reduction in productivity.

³ The soil can grow some crops that do not require the usage of any agrochemical, but required to be managed intensively. Besides, soil conservation measures must be taken.

⁴ The soil requires a great level of conservation treatment and its production is limited to long-lasting or semi long-lasting crops.

rainy season is from May to November and the monthly rainfall of that duration counts over 100 mm. Other months count less than 100mm of monthly rainfall and are defined as the dry season. No obvious difference can be seen on temperature through the year.

Monthly rainfall in the Study Area (mm/month)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
0.9	2.9	2.9	20.5	250.3	210.5	138.1	180.3	327.4	276.1	101.1	5.9	1,516.9

Climate in the Study Area

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature ()Min	20.3	20.6	21.3	22.3	22.6	22.6	22.3	22.1	22	21.9	21	20.3	21.6
Temperature ()Max	34.1	35.1	36.3	36.8	35	32.5	32.6	32.7	32.2	31.9	32.1	32.9	33.7
Temperature ()Ave	27.1	27.9	28.9	29.6	28.9	27.5	27.5	27.3	27.1	26.9	26.7	26.7	27.7
Relative Humidity (%)	69.5	66.2	65.7	68.4	80.5	87.1	82.8	86.2	89.7	88.9	84.3	78.8	79
Evaporation (mm)	9.7	11.3	11.6	10.8	7.7	5.2	5.9	5.7	4.8	4.5	5.2	7	2711.5
Wind Velocity (km/h)	18.4	20.3	19.2	15.7	10.1	7.4	10.1	9.2	6.6	6.3	8.2	14.3	12.2

*Wind velocity is from data of Liberia meteorological station. Other items are form Tempisque meteorological station.

Hydrology

The Study Area extends over the midstream basin of the Tempisque River. The Tempisque River originates at the mountain foot of the Orosi Volcano and flows down to the gulf of Nicoya in the Pacific Ocean. Basin area comprises 3,405 km² down to the junction with the Bebedero river. The river length is 138 km with 1,487 m of difference the elevation.

Conditions of Runoff (at Guardia)

Basin Area (km ²)	Average Annual rainfall (mm)	Total Volume of rainfall (MCM)	Annual average runoff (MCM)	Runoff ratio
955.0	1,681	1,605	832.4	0.52

Flowing condition of the Tempisque River

Guardia (Rio Tempisque, A=955.0 km², 0741901 ICE, 1951-2000) unit; m³/s

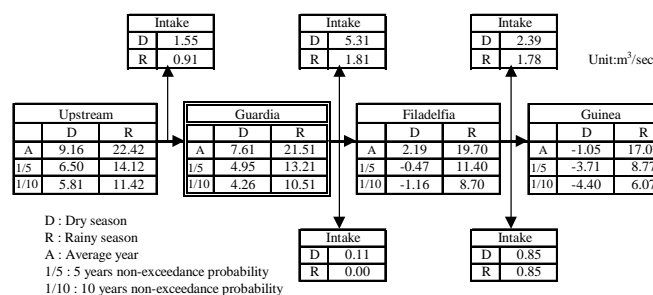
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Ave.	16.80	12.12	9.02	7.61	14.72	30.83	21.51	26.73	48.18	63.07	43.28	22.27	26.34
1/5NE	10.94	7.89	5.87	4.95	9.04	18.93	13.21	16.42	29.59	38.73	28.17	14.49	16.52
1/10NE	9.42	6.79	5.05	4.26	7.19	15.06	10.51	13.06	23.53	30.80	24.25	12.48	13.53

Note: NE; non exceedance (being less) probability,

The peak flood discharge and minimum discharge for each return period (at Guardia)

Return Period	1/2	1/5	1/10	1.20	1/30	1/50	1/100	1/200
Peak Flood Discharge (m ³ /s)	442	889	1,267	1,692	1,964	2,335	2,892	3,515
Minimum Discharge (m ³ /s)	6.19	4.56	3.79	3.21	2.92	2.59	2.20	1.86

26 water rights are set up on the main river course of Tempisque River, for utilization of surface flow. The maximum discharge of such water rights accounts 12.16 m³/s for the dry season and 5.5 m³/s in the rainy season. The water rights that are set up exceeded the available discharge during the low water season of the Tempisque River.



Groundwater Recharge

There is high potential of groundwater in the study area. Groundwater recharge in the area comes from natural recharge and return of irrigation water and, in the right bank of the Tempisque river, the average annual groundwater recharge is estimated as 62 to 116 MCM (2.0 to 3.7 m³/s).

Natural Environment

Natural Environment of the Tempisque River Basin

The form of forests of the Tempisque river basin is Bio-climatologically varieties (mountainous rain forests – low mountain rain forests – low mountain wet forests – tropical rain forests – tropical wet forests – tropical dry forests), and rich of biodiversity. There are three nature conservation systems⁵ for the Tempisque basin, including the Guanacaste conservation area. A part of the Guanacaste conservation area, which is located in the upper stream of the area is designated as a World Heritage (natural heritage) in Dec. 1999. In the lower stream of Tempisque river is the Palo Verde National Park registered to the Ramsar Convention

Water Quality

There big different amount of the seasonal river discharge between the dry and rainy seasons and the filth density of the rive water in dry season is 2 to 3 times higher than that in rainy season. Some of water polluted with colon bacillus is observed but the problems of water pollution for agriculture use is not observed. There are 2 agricultural waste water treatment plant in the project area of Phase I and II, the agrochemicals is not detected at the at entrance point. Some of wells in the study area are polluted by bacillus; the water can be drinkable with boiling.

Agrochemicals

The agrochemicals used in and around the study area are some 30 types of herbicides, 20 types of insecticides, and 10 types of fungicides.

Assumed Annual selling amount of Principal Agrochemicals in and around the Study Area (Unit: t)

	Herbicides	Insecticides	Fungicides
Sugar Cane	108.9	24.2	0
Rice	71.5	43.3	39.3
Melon	10.0	38.5	56.0
Vegetables	1.0	1.6	7.3
Mango	1.2	2.3	3.5
Total	192.6	109.8	106.1

Palo Verde National Park

Environmental problems impact caused by existing irrigation development in and surrounding areas indicated by the Palo Verde National Park are sermonized below:

For natural environment; Deforestation and Rupture of Forest Areas, Pollution of Water, Soil Erosion, Use of Agrochemicals, Problems concerning Wildlife (extinction, immigration, diseases and intoxication), Recharging of Water Resources.

For social environment; Intoxication of People Using Agrochemicals, Accidents Caused by Crocodiles, Field Fire

As there are long distance between the proposed project area of the study and the Palo Verde, it is difficult to consider that the big impact from the proposed project, as same impact as at present can be occurred. However, from the viewpoints of science, as there are several obscure points for the Tempisque river flowing into Palo Verde National Park, it shall be necessary to carry out the monitoring.

River Maintenance Flow

With water use in the Tempisque river, no water flow for approximately 40 days may occur at SENARA canal once every two years. At now, there is no serious impact in this situation, it can no be said absolutory no problem will be occurred in the future if this phenomenon is continued.

⁵ Costa Rica has The National Conservation Areas System (SINAC; Sistema Nacional de Areas de Conservacion) legislated in 1998 and there are 11 conservation areas (CA) in the country.

Flooding Condition

Most of the Study Area is categorized in potential flood damage zone according to the Guanacaste inundation potential hazard map (MAPA DE AMENAZA POTENCIAL DE INUNDACION, GUANACASTE) and some of area is inundated every year.

Flow Capacity of River

The flow capacity of Tempisque river is estimated as 300m³/s at Guinea (equivalent to flood of 3 year return period), 1,100 m³/s at Filadelfia (do 10 year return period) and 1,700 m³/s at Palmira. For the tributaries; the Palmas-Bolsón and Cañas-Charco rivers, the flow capacity of these rivers can be estimated as 100 to 300m³/sec.

Flooding Damage

The flooding damages are mainly on houses and farmlands and, secondly, damage of basic infrastructure is counted such as roads, bridges, domestic water supply and sewerage facilities. At the flood time, the information of refuge, climate and so on are informed to the related local residents through the substructures of CNE, and as local residents take refuge voluntarily with the increasing of water level of the river, human damage by flood has been found scarcely in the Study Area.

Socio-Economic Conditions

Rural Society in the Study Area

In and around the Study Area, public services and social infrastructure are sufficiently provided by the government and with regard to the living standards of the dwellers, the line of poverty is overcome when it comes to income, housing, holdings and food intake, etc. Nevertheless, this does not mean that there are not any inhabitants with scarce economic resources. Indeed, agricultural workers or single-mother families do not acquire enough income to support their families. Thus this must be improved.

Settlement Project and Society of Settlers

Though agriculture in Costa Rica has been developed mainly large-scale farmers, the government has been implementing the settlement project to distribute the land for landless people since 1961 with legislations of the Organization Law (Law No.2825).

In the Study Area, there are 12 *parcelas* (distributed land lot for settlers) with more than 400 adjudicated *parceleros* (settlers). Few of them are living in the settlement; many are still residing in the urban areas and commute to the land for work. The average size of a *parcela* is 7.4 ha. Most of them do not have irrigation facilities and is used for the seasonal sowing of rice or sugar cane using rainwater.

Farmers' Organizations

In the study area, already there are 43 of farmers' organization and many of them are not adequately active. But, one third of them are doing their activities adequately.

Agriculture

Land Use

Land use in the Study Area				
	Right bank of Tempisque River (ha)	Left bank of Tempisque River (ha)	Total (ha)	Notes
Agricultural Land	20,000	10,400	30,400	
- Rangeland	9,275	1,360	10,635	
- Sugarcane	5,950	6,150	12,100	
- Rice	3,000	2,370	5,370	
- Melon	1,230	400	1,630	
- Mango	110	120	230	
- Vegetables	155		155	Watermelon, Chili
- Others	280	-	280	Corn, Beans
Urban Area, housing	1,100	100	1,200	
Roads, riverbed	620	220	840	
Swamp, Forest, others	1,860	700	2,560	Including 50 ha of Fishpond
Total	23,580	11,420	35,000	

Agricultural Production

Planted area of main crops within the Study Area (ha)											
Zone	Rice (Rainy season)	Rice (Dry season)	Rice (Total)	Sugar cane	Melon	Corn	Mango	Water- melon	Beans	Chili	Pasture
Right Bank of Tempisque River	3,000	340	3,340	5,950	2,020	200	110	80	80	25	9,275
Left Bank of Tempisque River	2,370	850	3,220	6,150	850		120				1,360
Total	5,370	1,190	6,560	12,100	2,870	200	230	80	80	25	10,635

(Source: MAG)

Main crops production within the Study Area (tons)											
Zone	Rice (Rainy season)	Rice (Dry season)	Rice (Total)	Sugar cane	Melon	Corn	Mango	Water- melon	Beans	Chili	
Right Bank of Tempisque River	10,873	1,070	11,943	362,950	59,600	221	715	950	65	325	
Left Bank of Tempisque River	9,800	4,692	14,492	437,990	18,120		900				
Total	20,673	5,762	26,435	800,940	77,720	221	1,615	950	65	325	

(Source: MAG)

Yield of main crops within the Study Area (ton/ha)											
Zone	Rice (Rainy Season)	Rice (Dry season)	Rice (Total)	Sugarcane	Melon	Corn	Mango	Water- melon	Beans	Chili	
Right Bank of Tempisque River	3.62	3.15	3.58	61	29.5	1.11	6.50	11.9	0.82	13.0	
Left Bank of Tempisque River	4.13	5.52	4.50	71	21.3		7.50				
Average	3.85	4.84	4.03	66	27.1	1.11	7.02	11.9	0.82	13.0	

(Source: MAG)

Pasture area and cattle in the Study Area			
Zone	Area (ha)	Number of Feeding Cattle	Feeding Capacity (head/ha)
Right Bank of Tempisque River	9,275	7,230	0.78
Left Bank of Tempisque River	1,360	1,220	0.90
Total	10,635	8,450	0.79

(Source: MAG)

Farming Conditions

In this study, farmer is classified into 3 types; small scale farmer (with less than 20 ha of land tenure), middle scale farmer (with 20 to 200 ha), large-scale farmer (more than 200 ha, including big enterprise)

Number farms according to size and area of plowed land

Farm Scale	Number of Farm	Total Area (ha)	Average (ha/farm)
Small-scale Farm	830	6,100	7.3
Medium-scale Farm	134	6,680	49.9
Large-scale Farm	30	17,620	587.3
Total	994	30,400	30.6

The farmland of all small-scale farmers in the Study Area is in the right bank of the Tempisque River. The major products of small-scale farmers differ in these areas. Sugar canes and rice along with a portion of vegetables are grown in the plains, while stocks are raised in the undulate areas with production of small amounts of frijoles and maize for domestic consumption.

Irrigation and Drainage Conditions

In this area, without irrigation, the shortage of water with only 100 mm of rainfall in the dry season (November to May) troubles cultivation of yearly harvested crops. For sugar cane, the prospect of harvest is only 60% when cultivated without irrigation in the dry season. The source of water used in the dry season in the Study Area is the river waters of Tempisque, Cañas and Liberia, etc., and groundwater. There are approximately 30 wells in this area, set with rights of water. The total flow of pumping reaches 1,030 liters per second.

Irrigation conditions in the study area Unit: Hectare

Area	Irrigated land		Seasonal crop land	Total
	Rivers	Underground water		
Left bank of Tempisque river	6,700	40	3,300	10,400
Right bank of Tempisque river	1,545	1,230	17,225	20,000
Total	8,245	1,630	20,525	30,400

Current State of Water Management

In the project area of PRAT, SENARA manages the irrigation system up to the entrance of the fields of each farmer. The farmers are paying the water fee (administration, O/M, water rights) to SENARA. Irrigation associations are seen for some of the parts of area, and in cases of these associations charges of water management are returned.

Supporting Systems for Farmers

Technical Supporting

The Chorotega Regional Direction of the MAG supplies technical advice and assistance mainly to small and medium-scale farmers in cooperation with the Regional Offices of CNP, INA, IDA, SENARA and IMAS etc. The main target area of the ongoing project "PRODAPEN" is the Nicoya peninsula including Carrillo canton, which occupies most of the Study.

Agricultural Credit

In many cases, farmers are unable to engage in production activities unless they are provided with some credits from financial institutions. Presently, there are cases that farmers reduce their production sizes, totally give up production, or to rent their land, for reasons such as difficulties and complexity of the loan procedures and high interest rates.

【BASIC CONCEPT】

Change of Concept from Initial Project

The conditions surrounding the PRAT have been change such as; “As it is necessary to enforce the international competitiveness of the agriculture, the supporting to small and medium-scale farmers is required urgently”, “As there are so many uncertain factors in the international market in the future, it is necessary to guide the diversification of agriculture”, “In the Guanacaste, it is necessary to correct the regional differences with the other regions through the bottom-up of the low-income inhabitants”, “expected water amount of the water source at initial project become to be insufficient for irrigation of all proposed area”. For above conditions, the Phase 4 project (the right bank of the Tempisque River) aims to rural integrated development⁶ objecting “achievement of the sustainable agricultural development of the small and medium-scale farmers”. Therefore, focusing on the small and medium scale farmers for main beneficiaries and proposed project area is non-irrigated area of small and medium scale farmers in the right bank of the Tempisque river. Furthermore, with a formulation of development plan including a flood protection plan considering the environmental impact, through the improvement of the farm management for the small and medium scale farmers, development objective will be achieved.⁷

Subject and Development Direction in the Study Area

1. *Improvement of agricultural productivity, especially for the small and medium-scale farmers, is required for the low flat lands of Costa Rica.*
2. *Development with minimizing impact on natural environment is required for the area located surrounding conservation areas.*
3. *Enlightenment for the inhabitants concerning conservation and rational use of natural resources*
4. *Improvement of farming practice in order to improve the productivities of small and medium-scale farmers.*
5. *Development capable of accepting various approaches of agriculture, such as the coexistence of full-time and part-time farmers is required.*
6. *It is necessary to enlarge and improve the farming scale by grouping small and medium-scale farmers.*
7. *Suitable support is required for women in rural area in order to contribute the improvement of home environment.*
8. *Installation irrigation/drainage facilities and the enlargement of farm size through grouping of small and medium-scale farmers are required.*
9. *The increase of employment opportunity for agricultural laborers is necessary.*
10. *Recovering of river maintenance flow with effective use of river water is required.*
11. *The mitigation of inundation damage is required in order to enable stable farming of the small and medium-scale farmers.*
12. *Ensuring security for the life of local residents is required.*

⁶ For the achievement of this purpose, it will be the basic condition that the policies of the water rite of the Tempisque river shall be decide AyA of MINAE.

⁷ It is important to shows the methodology for small and medium-scale farmers, who has insufficient power on both financially and technically, that to improve the present agriculture by self-effort based on the existing technique and crops known already, but, it is not the purpose of this study to show the high progressive agriculture witch small and medium-scale farmers cannot adopt at present.

Basic Components of Development

Present Subjects	Basic Component
1.Improvement of the productivity of small and medium-scale farmers 6.Enlargement of farming scale and crop diversification 9.Increase of employment opportunity for agricultural laborers based on the productive activities through the year	Irrigation/Drainage Plan
11.Mitigation of inundation damages on farmlands 12.Ensuring security for living	Flood Protection Plan
2.Minimization of impact against the natural environment 9.Securing of river maintenance flow 3.Enlightenment for the inhabitants concerning conservation and rational use of natural resources	Environmental Conservation Plan
3/4.Improvement of cultivation and farming techniques of the small and medium-scale farmers 5.Various approaches of agriculture by the small and medium-scale farmers 6.Enlargement of farming scale by grouping 7.Supporting to women in the rural areas	Strengthen of Agricultural Supporting Plan

Basic concept of Development

Target Year

The target year of this plan is set considering 3 years for the required construction and 10 years after the completion of the construction. Therefore, the target year of this plan will be 13 years after commencement of the project⁸. Development target other than that of flood protection is achieved after 10 years the completion of the construction

Irrigation and Drainage

1. Irrigation water source: based on the results of alternative study as shown below, the Tempisque rive (Pumping up, maximum 3 m³/s⁹) and groundwater (around 1 m³/s in peak time) is set for water source

Alternatives of water source

Alternatives		Environmental Impact	Economic efficiency	Adopted /not adopted
Newly development of river water	A. La Cueva Dam	Large	Low	not adopted
	B. Piedras Dam	Large	Low	not adopted
	C. Brasilito Dam	Large	Low	not adopted
Transfer of water rights of the Tempisque river	D. Head works/ at upper stream	Large	Low	not adopted
	E. Head works/ at lower stream	Moderate	Medium	not adopted
	F. 1 Pumping station	Slight	High	not adopted
	G. 2 Pumping stations	Slight	High	Adopted
H. Groundwater irrigation system		Slight*	High	Adopted

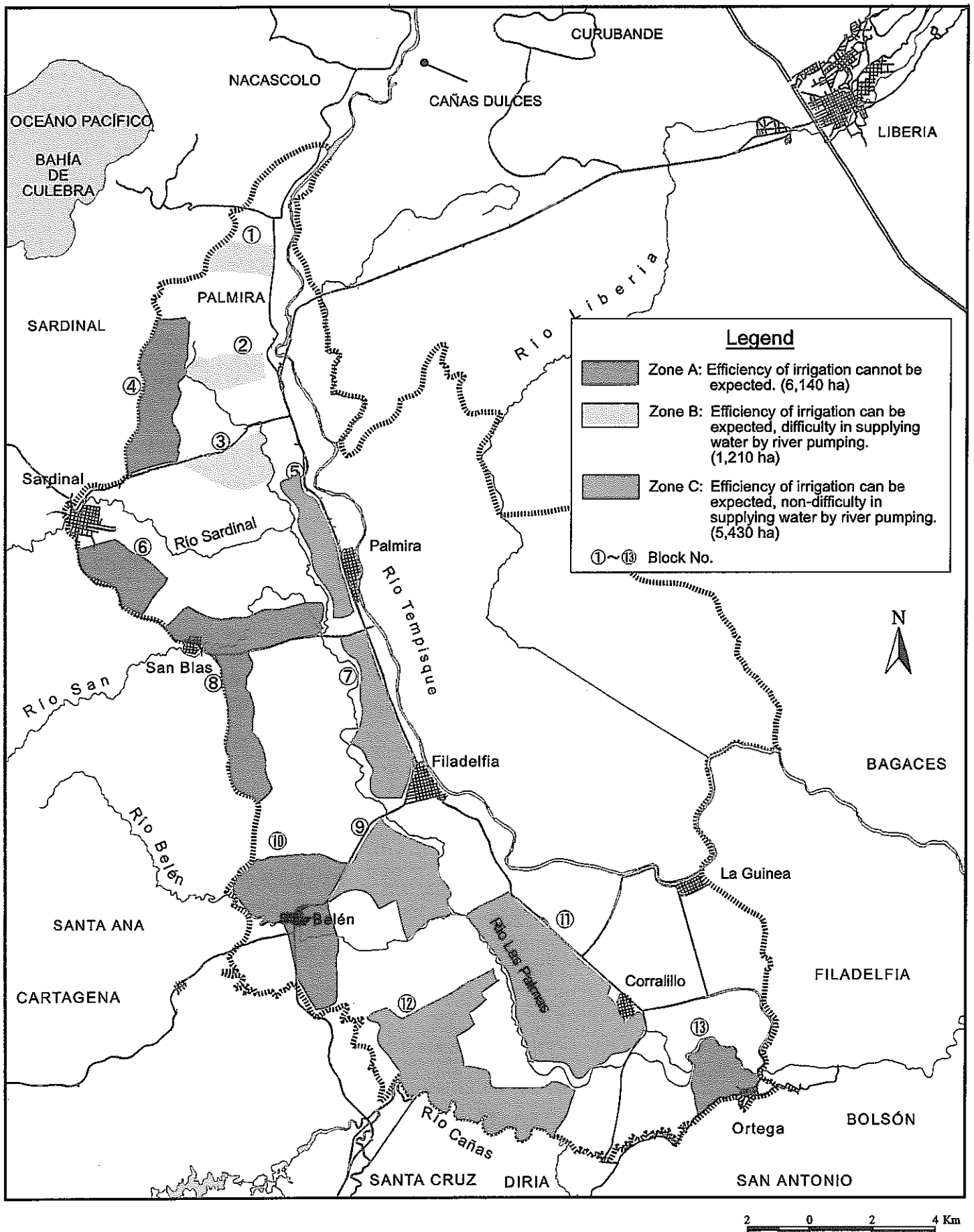
*: Groundwater will be developed considering the potential and influential area of respective wells.

2. Sustainable agricultural Development of Small and Medium-Scale Farmers (study of irrigation areas)

the farm land of small and medium scale farmers is classified in to 3 zones and irrigation system is installed considering conditions of each zone.

⁸ It is 14 years including preparation period.

⁹ With transferring the water right



ZONING OF SMALL AND MEDIUM SCALE FARMERS

Zone	Development strategy	Block	Farm land
A	The conversion from pasture; mainly to mango	No. 4, 6, 8, 10, 13	6,140 ha
B	Intensive diversified farming with groundwater irrigation system	No. 1, 2, 3	1,120 ha
C	Development of diversified and the large-scale farming with river pump irrigation	No. 5, 7, 9, 11, 12	5,430 ha

Flood Protection Plan

For contributing the “achievement of the sustainable agricultural development of small and medium scale farmers”, focusing on the mitigation of damages where of frequent inundation area, River improvement works on Tempisque River (for flood of 10 year of return period) and Bolsón – Palmas River (do 5 year) is planned. Furthermore, Raising of main roads (do 20year) is planned for securing access roads connecting communes.¹⁰

Environmental Conservation Plan

Improvement of consciousness of the locals mainly through environmental education will be achieved, and accumulation of information necessary for the enforcement of radical countermeasures will be done through the establishment of monitoring systems.

Development objectives

Improvement of consciousness for watershed management	Establishment of systems for extension and enlightenment Establishment of systems for supporting nature conservation organizations
Extension of environmental conservation type agriculture	Research and extension of environmental conservation type agriculture
Recover and improvement of river maintenance flow	Replenishment the 1.5 m ³ /s of maintenance flow for the Tempisque river
Conservation of groundwater	Implementation of systematic surveys, measures for the enlightenment of issues concerning groundwater, administrative control, monitoring of groundwater
Operation of monitoring	Establishment and operation of a simplified monitoring system for acquiring the overall status, accumulation of basic data

Strengthen of Agricultural Supporting Plan

In addition to the abovementioned plans, extension of agricultural techniques along with support for farmer’s organizations are necessary to achieve sustainable agricultural development for the small and medium-scale farmers. Also, groups of women of the farm areas shall be supported in order to strengthen and spread its activities to the whole area.

Development targets

Strengthening farmers’ organizations (Grouping farmers)	Reorganization and strengthening of the existing organizations of small and medium-scale farmers within the Study Area. The organizations shall be reorganized into about 60 new organizations and the average size of the respective organizations will be about 15farmers with the farming scale of about 200ha (more than 100ha at least)
Extension of management techniques	Improvement of management abilities necessary for the enhancement and diversification of farming of the small and medium-scale farmers through the extension of fundamental knowledge for management.
Extension of cultivation techniques	Extension of cultivation techniques for the improvement of farming, which will correspond to the installation of irrigation and diversification of crops.
Agricultural finance	Enabling the use of agricultural credits by the small and medium-scale farmers for the improvement of farming.
Support for women activities in farm areas	Achievement of economic independence of the women in farm areas through encouraging their consciousness of and improving their skills.

¹⁰ For the comprehensive approaches combined with the soft side such as restriction of land use in consideration of floods through urbanization control and alert systems, the only basic ideas will be shown but those are excluded from the proposed project.

【DEVELOPMENT PLAN】

Land Use PLAN

The project area is approximately 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.

Land use plan for each zone

Zone A (large efficiency of irrigation cannot be expected)								blocks: No. 4, 6, 8, 10, 13	
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.									
Land use	Pasture	Sugar cane	Rice	Melon	Mango	Vegetables	Others*	Total	
At present	4,935	720	125	0	10	70	280	6,140	
Proposed	4,335	720	125	0	610	70	280	6,140	
Balance	-600	0	0	0	600	0	0	0	
Zone B (efficiency of irrigation can be expected but has difficulty in supplying water by pumping)								blocks: No. 1, 2, 3	
the improvement of farming shall be achieved through the conversion of pasture and sugarcane to vegetables by using groundwater irrigation.									
Land use	Pasture	Sugar cane	Rice	Melon	Mango	Vegetables	Others*	Total	
At present	450	320	410	0	30	0	0	1,210	
Proposed	200	270	410	0	30	300	0	1,210	
Balance	-250	-50	0	0	0	300	0	0	
Zone C (efficiency of irrigation and easy of supplying water)								blocks: No. 5, 7, 9, 11, 12	
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.									
Land use	Pasture	Sugar cane	Rice	Melon	Mango	Vegetables	Others*	Total	
At present	1,490	2,845	1,010	0	0	85	0	5,430	
Proposed	590	3,345	1,010	300	0	185	0	5,430	
Balance	-900	500	0	300	0	100	0	0	

Agricultural management plan

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 within 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.

Farming plans

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. For 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.

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.

Diversified farming through diversification of crops

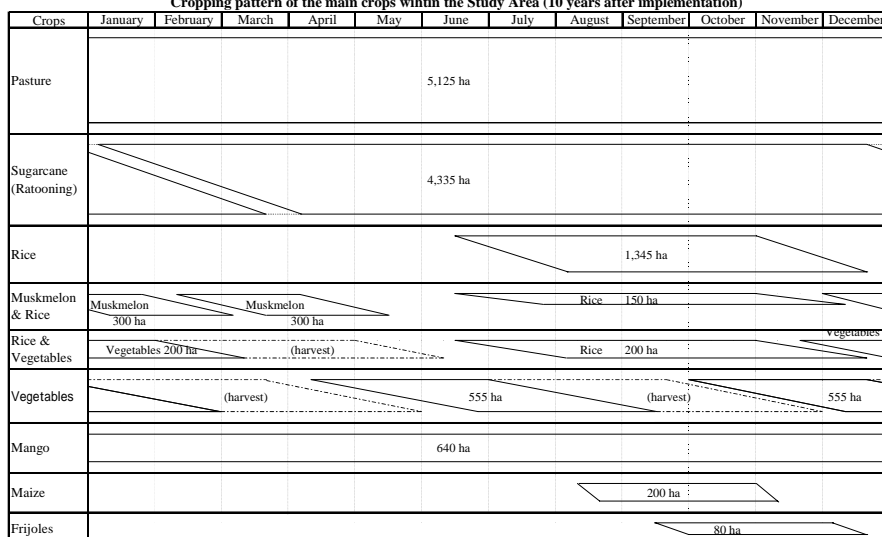
Groups mainly cultivating pasture and mango	Within the pasture areas with unfavorable conditions of soil and topography that have difficulty for conversion to crops such as sugarcane and vegetables, approximately 10% of the area shall be converted to mango. However, organizational measures based on conversion 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 within 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.

Cropping Plan

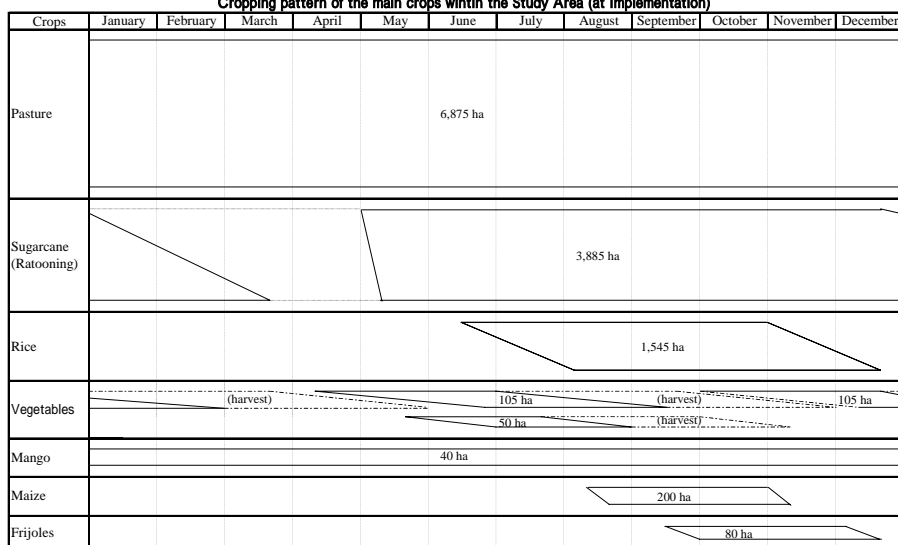
Cropping pattern

The same cropping pattern as that of present is applied at initial and the proposed cropping pattern will be realized 10 years later

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



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



Planting Area

The same planting area as that of present is applied at initial and 10 years after, approximately 1,750ha of the pastures owned by the small and medium-scale farmers shall be converted to sugarcane and mango and the sugarcane shall be converted to vegetables and melon

Cropping area of the main crops within the Study Area (ha)

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

Irrigation and Drainage Plan

Method of irrigation

The irrigation water is the maximum 3.0 m³/s and 1.0 m³/s from the Tempisque River and groundwater, respectively. The ground water irrigation system is installed using for 10 years gradually.

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.

Irrigation area

At initial of the project, irrigation will be started for blocks No. 5, 7, 9, 11 and 12 using river 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.

Propose irrigation area (ha)

Crop	Sugarcane	Pasture	Rice (rainy season)	Vegetables	Melon	Mango	Total
At initial	1,520	800	1,010				3,330 ** (2,320)
10 years after	2,590	0	1,360	650 * (450)	300	0	4,900 (3,540)

Note: *rainy season, ** total for dray season

Irrigation water

Irrigation water plan (m³/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

Note: 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.

Available water of the Tempisque River

The water right of the usable water for irrigation of the Tempisque River is set as 3 m³/s. However, in

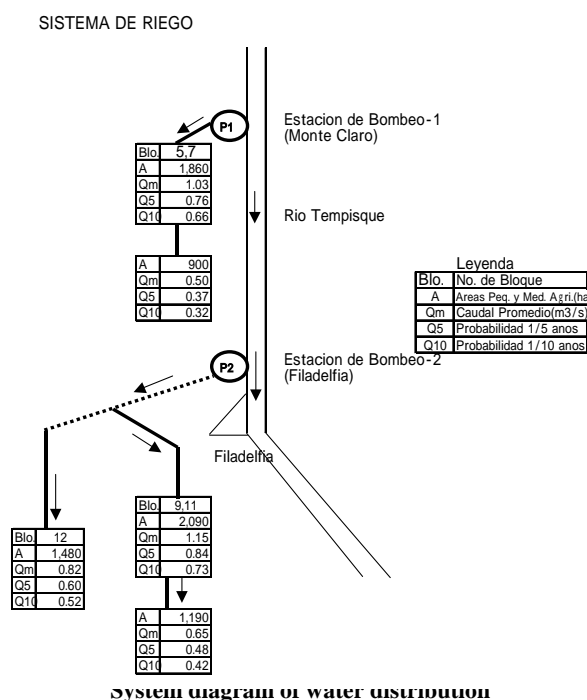
the dry season of drought years, the intake from the river is decreased in adjustment with the other water rights reducing the irrigation area of sugarcane and pasture.

Irrigation Water Distribution Method Area irrigated with river water from pumping system

For the prevention of expansion of the social difference on the income of small and medium scale farmers, irrigation water is distributed for all of the small and medium farmers. The farmers hold the farmland less than 200 ha (average small scale farmer: 7.3 ha, medium: 49.9 ha) and based on the holding scale of are, 0.55 l/s of irrigation water is distributed. The limitation of water distributing for one farmer is 55l/s considering 100 ha of farmland. Though the water fee is collected by SENARA at initial stage, the management of water users association is expected in the future.

Area irrigated with groundwater system

As for the groundwater irrigation system, with application from the farmers' organization to implementation agency, installing the 5 systems for a year, 50 of groundwater irrigation system is installed for 10 years. Irrigation area is 1,000 ha based on the groundwater potential and irrigation water amount is 14 MCM (average 0.4 m³/s, maximum 1.0 m³/s).



Ground water irrigation system plan

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		

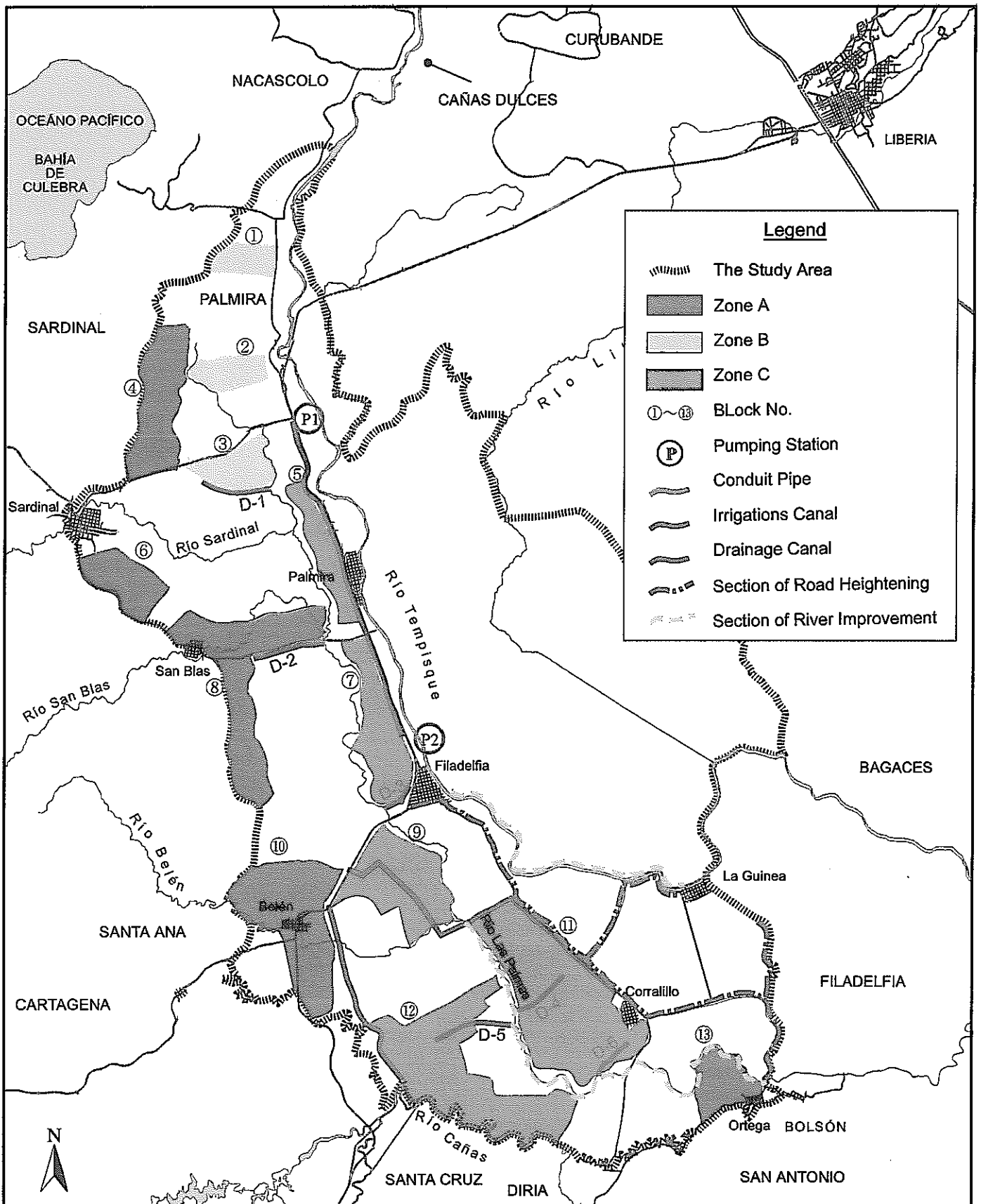
River Pumping facilities

Pumping facilities

Name of facility	Location	Irrigation area (ha)	Design discharge (m ³ /s)	Motor capacity
Up-stream pump	Near Finca Monte Claro	1,860 ha	1.0	450 kw
Down-stream pump	North on Filadelfia City	3,570 ha	2.0	920 kw

Canal facilities

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
Down-stream pump system	Branch channel	5.65	0.5 ~ 0.3
	Total	33.00	



IRRIGATION/DRAINAGE AND FLOOD PROTECTION PLANS

Groundwater irrigation facilities

Scale of facility for 1 system

	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 100 ~ 50mm

Drainage canals

Drainage Plan

Route	D-1	D-2	D-3	D-4	D-5	D-6	Total
Drainage area (ha)	220	280	210	250	300	200	1,460
Design discharge (m ³ /s)	5.7	7.3	5.4	6.5	7.8	5.2	37.9
Length (km)	1.8	2.3	1.7	2.2	2	1.8	11.8

Flood protection

Planning Concept

This plan aiming the prevention of farmland (mitigation of inundation damage) which largely inference to the farm management of small and medium scale farmers and the perfect flood control are not recommended.

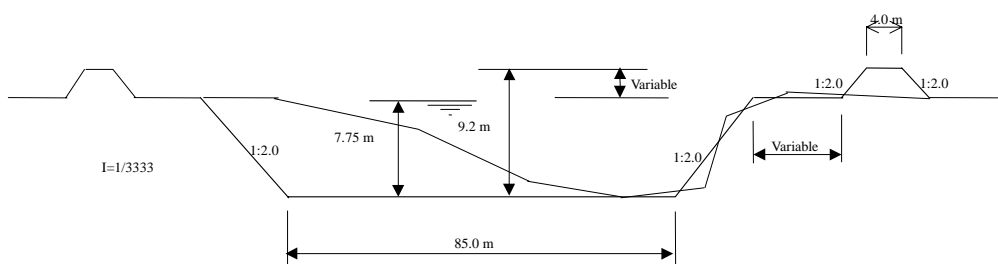
Improvement plan of river course

The maximum flowing capacity (Q_{max}) and flood discharge for 10 year return period (Q_{10}) is shown below.

Maximum flow discharge

Location	C.S. No.	Elevation (m)			W.D. max (m)	Flow Area (m ²)	Velocity (m/s)	Qmax (m ³ /s)	Q _{1/10} (m ³ /s)
		R	L	R.B.					
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

As the flow capacity is insufficient the down stream from Filadelfia for the flood of 10 years return period, the section requiring improvement is from Filadelfia to Guinea (Ingenio) (9km).¹¹



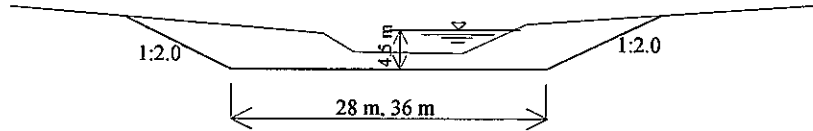
Proposed section of Tempisque river¹²

¹¹ For the area at down stream from Guinea, as SENARA has the improvement plan, it is not include to proposed plan

¹² 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.

The Palmas - Bolson River

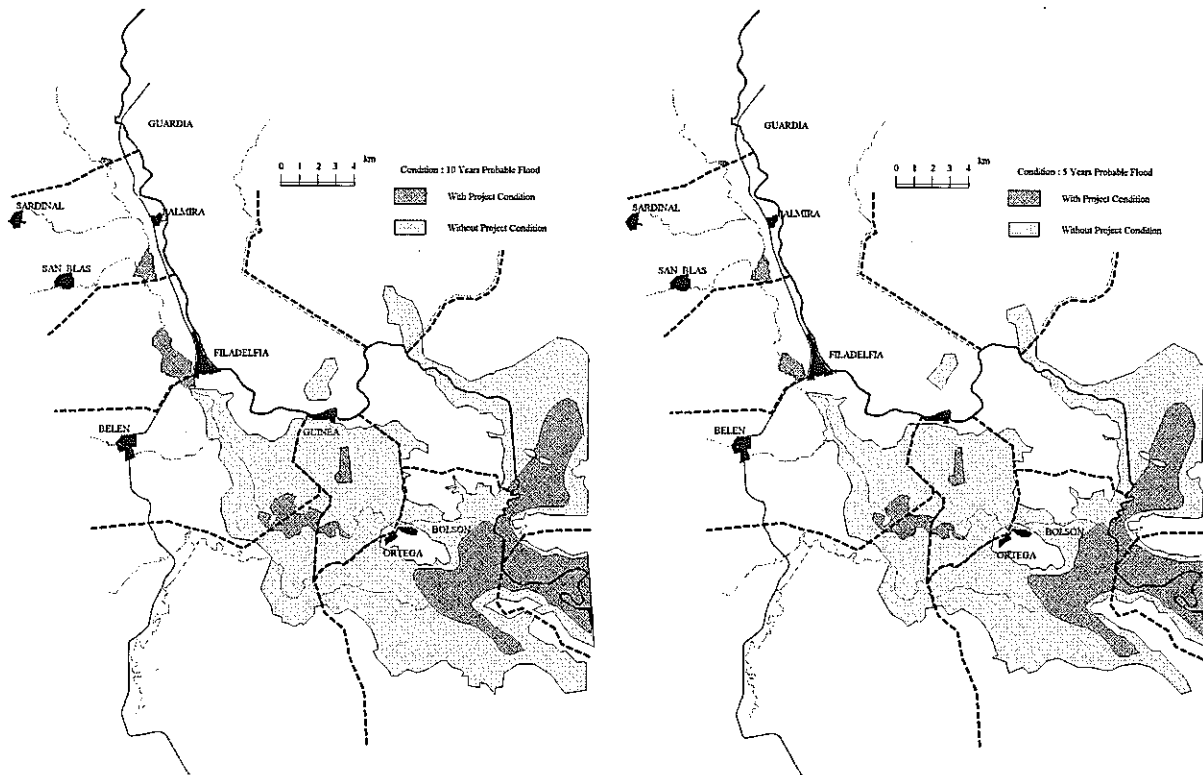
Based on the basin division map, the design flood discharge of the Palmas River between the confluences with Belén river and Estero Caballos is set as 241 m³/s, and that from the confluences with Estero Caballos to Puerto Ballena is set as 300 m³/s.¹³



Proposed section of Palmas - Bolson River¹⁴

Effect of improvement of river course

With implementation of plan, 3.3 to 4.7 m of inundation water level and 15,200 ha of inundation area for the flood of 10 year return period is reduced (3.1 to 4.4 m and 14,500 ha for 5 years return period. 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.



Area of inundation mitigated

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.

¹³ the treatment of surplus soil will be dropped surrounding area

¹⁴ With the design discharge of 241 m³/s, the width of low flow bed will be 28 m, and when 300 m³/s it will be 36 m.

Proposed construction sites					
Site	Length (km)	W.L. at Flood (E.L. m)	Design Height (E.L. m)		Remarks
Filadelfia Belén	6	14.1	15.1 ~ 15.6		1 bridge
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		1 bridge
Had El Viejo Bolsón	3,5	10.1	11.1 ~ 11.6		1 bridge
	28,5				3 bridges

Environmental Conservation Plan

Objective of the Plan and the development strategies

In order to achieve the sustainable agriculture development of small and medium scale farmers, it is necessary not only to take actions during the execution of the physical works to assure the minimum impact on the natural environment, but also, to establish the countermeasure for preventing the environmental destruction from the agricultural producing activities and these efforts are indispensable for the sustainable integrated development in and around the study area. Therefore, the environmental conservation plan is considered not only for the study area but also for the entire area of the Tempisque river basin.

Development of consciousness on the management of the basin

Objective: 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

Contents : Study on the change of consciousness of the local population (pools), Support to the environmental conservation activities of the community

Extension of eco-friendly cultivation techniques

Objective: to extend the sustainable practice of eco-friendly cultivation techniques

Contents : Enlightenment activities for inhabitants on eco-friendly cultivation, Extension of cultivation techniques

Recovery of River Maintenance Flow

Objective: to improve the river maintenance flow required for maintaining the biological system

Contents : to supplement 1.5m³/s for river maintenance flow, Consensus building for river maintenance flow

Groundwater Conservation

Objective: to grasp the behavior of groundwater (in case the problem found out, it is necessary to make a countermeasure)

Contents : monitoring and hearing on wells, analysis, formulation of countermeasure

Monitoring Plan

Objective: to evaluate the environmental impact of development and, in case the problem found out, countermeasure is carried out

Contents :

Water Quality and Quantity	Domestic well (1 well), Tempisque river (3 sites), Palmas river (1 site), Paro Verde (2 site)
Groundwater Levels	5 wells
Biological environment	Tempisque River
Bird Watching	2 site

Agricultural supporting strengthen plan

The activity of the strengthening of farmers' organization is carried out for first 4 years (preparation period: 1 year, construction period: 3 years) and after that it is continued for necessary support.

Assistance for the Strengthening Farmers' Organizations

Objective: establish/strengthen 60 organizations consisted of about 15 farmers with average 200 hectares of farmland.

Contents : public hearing, detailed survey, leader training, workshop, Capacity Building

Extension of Management Know-How

Objective: improvement of management ability through extension of basic management knowledge for small and medium scale farmers

Contents : leader and staff training, seminar, management consulting, Capacity Building

Extension of farming technology

Objective: Extension of farming technology for the irrigation scheme and crop diversification

Contents : extension of V&T, strengthen of institutions, Capacity Building

Assistance for agro-Credit

Objective: activation of use of agro-credit (mediation, guidance)

Contents : leader training, small farmer training, service for agro-credit, Capacity Building

Support for Activities by Rural Women

Objective: of rural women: promote the Awareness, improve the ability, economical participation to family budget, establishment of economic independence of single mother

Contents : workshop, women's vocational education and training, support to increasing of income/improve the living

Project Implementation

Project Cost

The project cost includes by the costs of construction, land acquisition, administration, consulting services, and physical contingency. Exchange rate is US\$ 1.00 = ₡ 340.3 (2002, end of February).

Cost of Irrigation/drainage and Flood protection plans (unit : US \$ 1,000)

	Irrigation/drainage			Flood protection			
	River pumping system	Groundwater irrigation s (50systems)	Total	Palmas-Borson river improvement	Tempisque river improvement	Heightening of trunk road	Total
Project cost	18,802	3,370	22,172	1,856	12,767	4,218	18,841
O/M cost (annual)	590	195	785	22	154	51	227
Replacement of Pump*	637	700	1,337	*every 15 years.			

Environmental conservation plan (Unit: US\$1,000)

	Preparation (4 years)	Project (10 years)	Total
Improvement consciousness for basin management	38	204	242
Extension of eco-friendly agriculture	Included in the extension of cultivation techniques		
Preserving river flow		18	18
Conservation of groundwater		105	105
Execution of monitoring	9	395	404
Total	47	722	769

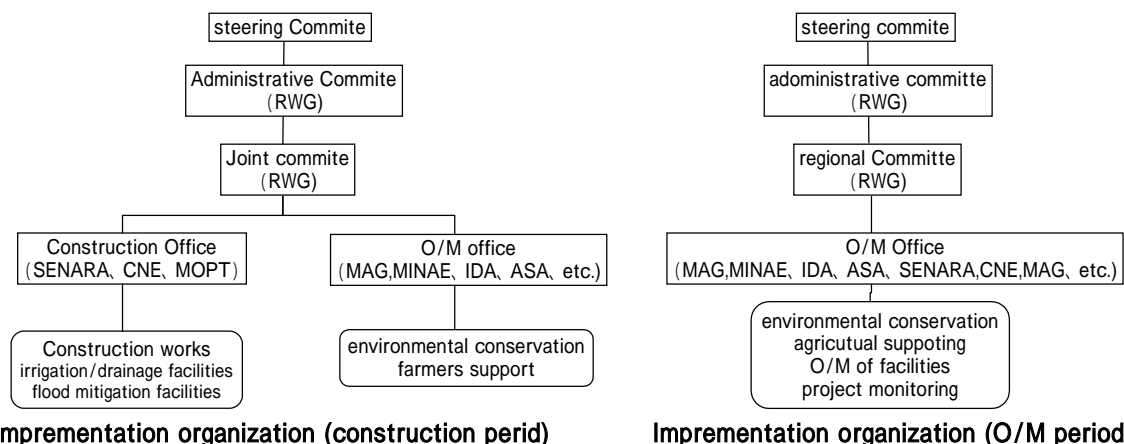
*10% of physical contingency is considered

Agricultural supporting Plan (unit : US \$ 1,000)

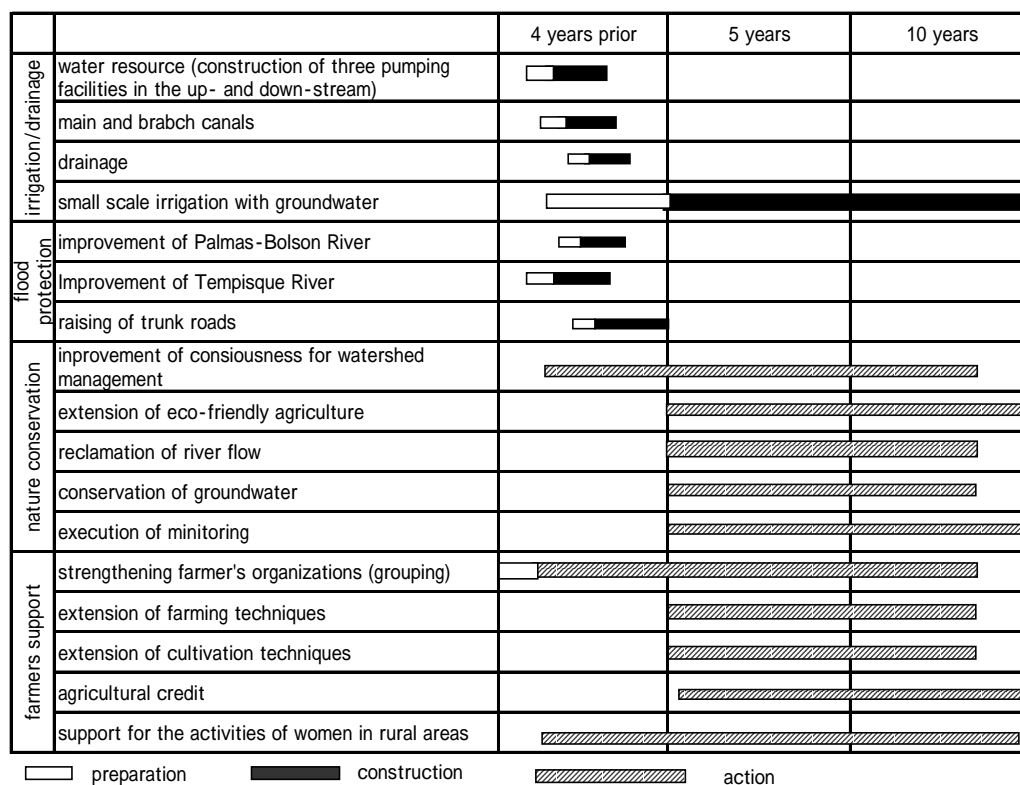
	Preparation (4 years)	Project (10 years)	Total
Activities of farmer's organizations	587	598	1,185
Extension of management techniques	0	293	293
Extension of cultivation techniques	0	1,247	1,247
Agricultural credit	3	92	95
Support for activities of women in rural areas	160	532	692
Equipment	129	13	141
Office	61	204	265
Total	940	2,979	3,918

Project implementation and O/M

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 proposed as follows.



Implementation Schedule



Disbursement schedule

Period	Irrigation/Drainage	Flood protection	Environmental conservation	Farmers Supporting	Total Project Cost
4 years prior	19,333 (225)	19,001 (399)	47 (1)	939 (13)	39,320 (639)
5 years	4,928 (412)	1,135 (94)	361 (30)	1,493 (121)	7,917 (659)
10 years	5,415 (937)	1,135 (196)	361 (62)	1,486 (252)	8,397 (1,451)
Total	29,676 (1,574)	21,271 (689)	769 (93)	3,917 (387)	55,634 (2,749)

Note: ():price escalation

Project Evaluation

Conditions of Financial and Economic Analysis

Exchange rate is US\$ 1 = 347.3 colon. Though the life of the facilities and the project life are set at 30 years, the calculation of the financial and economic evaluation will be carried out considering BID's long-term loan of 25 years (unredeemable for five years, repayment for 20 years) after the completion of major construction works. The benefits of flood protection plan and irrigation/drainage will be appeared at initial stage of the project, but other benefits will be increased gradually for 10 years and 100 % of benefits will be appeared 10 years after. Furthermore, in drought year, it is assumed that the irrigation area is decreased and a weighted average of benefit (70% for average year, 20% for 5 year return period, 10% for 10 year return period) is calculated.

The result of Financial and Economic Analysis

Financial Internal Rate of Return (FIRR)

	Irrigation/drainage, environmental conservation, Framers Supporting		Flood protection	
	Original Case	10% benefit decreased	Original Case	10% benefit decreased
Original Case	15.77%	14.51%	12.00%	10.20%
10% cost increased	14.63%	13.40%	10.40%	8.90%

Economic Internal Rate of Return (EIRR)

	Irrigation/drainage, environmental conservation, Framers Supporting		Flood protection	
	Original Case	10% benefit decreased	Original Case	10% benefit decreased
Original Case	14.70%	13.50%	12.00%	10.40%
10% cost increased	13.60%	12.40%	10.50%	9.00%

Farm Management Analysis

Objective of analysis

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.

Analysis conditions

- Farm size: The farm size of model farmer is set as 5 ha.
- Organization cost: The farmer has to pay for their organizations 72,000 colons/year additionally.
- Other costs: The present agricultural net benefit will be reduced from family budget.
- Credit conditions: 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 results of Analysis

For Zone A, in case of converting 1 ha from pasture to mango without irrigation system, the annual net income from the agriculture will increase 2.5 times bigger than that of present in 10 years later. Approximately 1,810 colon of fund is necessary. the accumulated surplus can be gotten from 8th years.

For Zone B, In case of converting 1 ha from pasture to vegetable with ground water irrigation system, the annual net income from the agriculture will increase approximately 8 times bigger than that of present in 10 years later. Approximately 2,490,000 colon of fund is necessary. the accumulated surplus can be gotten from 2nd years. Farmers can pay the charge of construction cost.

For Zone C, In case of 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. Approximately 883,000 colon is necessary the accumulated surplus can be gotten from 2nd years. Farmers can pay the charge of construction cost.

Following conclusions can be said from this comparison study.

Non-irrigated:

- It is difficult to improve the farm management if the farmer continues his cattle raising farming. 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.

Irrigated:

- For the farmer with insufficient fund and small-scale farmland, it is difficult to apply the irrigation for pastureland basically.
- It is effective for the small-scale farmer to apply the irrigation to sugarcane and the converting from pasture to sugarcane with irrigation is also effective.
- The supplemental irrigation for paddy rice in the rainy season is not so effective if considering the charge of the construction cost. But the benefit is not so bad with reducing the construction charge.
- The converting to vegetable is quite effective and if conditions 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.

Farm Household Budget Analysis

Ideal type model of the small-scale farmers

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.

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

Average farmland tenure: 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 (0.9/ha).

Change of ideal type model farmers

Item	Present (without project)	10 years later (with project)
Planting area	Cattle raising: 4.8ha, (meat cattle 4.3head) Sugarcane: 4.3ha, Paddy rice: 1.0ha	Cattle raising: 4.3ha, (meat cattle 4.5head) Sugarcane: 2.6ha (non-irrigated), 2.2ha (irrigated) Paddy rice: 1.0ha (supplemental irrigation)
Agricultural income	Gross income: 2,624,000 colons, Net income: 162, 000 colons	Gross income: 3,733,000 colon Net income: 945,000 colon
Working time, labor wages	Annual 1,784 man-hr (Equivalent to wages 535,000 colons)	Annual 1,634man-h (Equivalent to wages 493,000 colons)
Equipment fee	103,000 colon	95,000 colon
Other income	244,000 colon	Not consider
Net Income	838,000 colon (162+535+244-103)	1,342,000 colon (945+493-95)
Income ranking ¹⁵	Ranking 4	Ranking 6
Expenditure	470,000 colon	470,000 colon
Annual surplus	368,000 colon	872,000 colon

The net income of 10 years later is 1.6 times bigger than that of at present. If converting to vegetables the net income will be more or less 8 times bigger.

Results of Project Evaluation

- The technical feasibility is studied and practicable plans were formulated.
- Implementation plan including O/M plan, implementation organization and disbursement schedule were studied and realizable plans were formulated.
- Financial and economical feasibilities were analyzed and more than 12 % of internal rate of return were obtained respectively.
- The proposed farm management was analyzed and the methods of improvement of the farm management for small-scale farmers with disadvantaged conditions were shown.
- The averaged small-scale farmers' household budgeted was analyzed and it was confirmed that the household budgeted would 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.

【 ENVIRONMENTAL IMPACT ASSESSMENT 】

Procedures for the Preliminary Environmental Impact Assessment

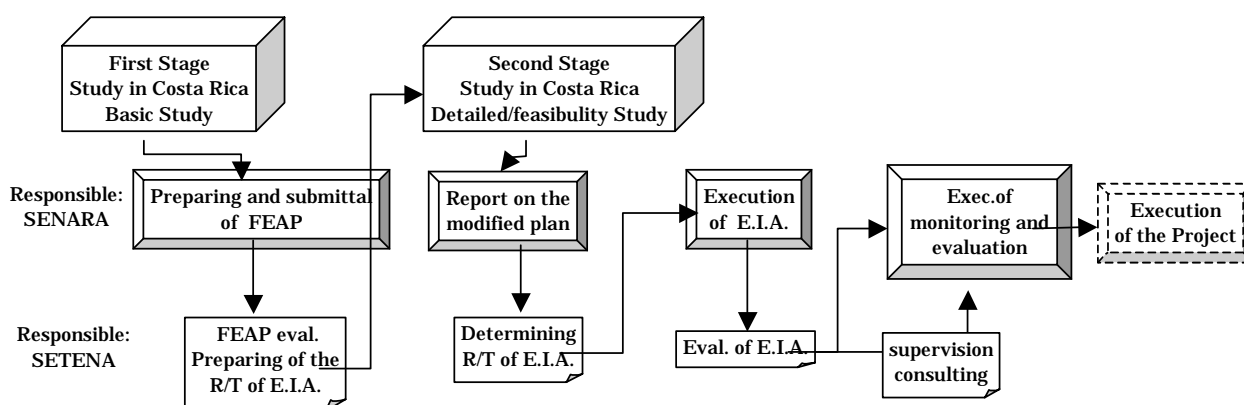
SETENA belonging to MINAE, is responsible for assessing the environmental impact of all projects in Costa Rica.

In this Study, the FEAP was submitted and explained by SENARA to SETENA in February 2001, later, on March of 2001, SENARA received the answer from SETENA concerning the basic aspects, including the terms of reference of the EIA. From now, the procedure will be preceded based on following manner.

- SENARA informs the final plan to SETENA.
- SETENA shall review the terms of reference of the EIA and notice to SENARA.
- SENARA shall carry out the EIA according to the terms of reference defined by SETENA and shall submit the report.

¹⁵ 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



Study on the Environmental Impact Assessment (EIA)

According to the results of IEE carried out by the study team, it is necessary to execute EIA for the implementation of the proposed project. The environmental impact was studied from the social and technical sides.

The aspects to be studied in the EIA.

Dimensions	Factors of impact Aspects to be studied	Installation of pumps	Water channels	Elevation of the roads' gradient	Improvemen t of the river bed	Amplification of agriculture land
Social Environmen t	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 Environmen t	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	-

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

It was judged that the mitigation countermeasure is necessary concerning “Aquatic fauna” and the required items for monitoring are “Impact on underground waters” “Aquatic fauna” “Destruction of the Ecosystem”. These are included in to the proposed project.

【CONCLUSIONS AND RECOMMENDATIONS】

Conclusions

The Arenal Tempisque Irrigation Project (PRAT) has been contributing for the increase of the agricultural production and the development of regional economy. The Proposed project in the study, as the Phase IV of the PRAT, aims to “the achievement of the sustainable agricultural development of the small and medium scale farmers” and the achievement methods with maximum/effective use of limited resources are shown in the plan, the contents of all project component are consisted for realization of this objectives. Through the implementation of the proposed project, the all institutions concerned represented by SENARA will get a significant experience concerning the participatory development which is indispensable for the agricultural and rural development in future.

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 international funding agency such as the IDB to grant the financing. Furthermore, in the improvement of the farm management at farm level, even small-scale farmer, who has not sufficient self-fund, improving his farm management under the conditions of present agro-credit system, can increase his agricultural income and can pay the charge of initial construction cost. According to the results of IEE, EIA is necessary to carried out for the implementation of the proposed project and from the results of the study concerning the EIA, it is judged that the proposed project is practicable without giving any serious impact on rural environment.

Taking into account everything set forth previously, the conclusion is that the proposed Project with the objective of “the achievement of a sustainable agriculture development for small and medium scale farmers” is feasible.

7.2 Recommendations

For the understanding and implementing the proposed project, the following are recommended.

1. The proposed Project has as main objective “the achievement of the sustainable agriculture development of small and medium scale farmers” and it has been designed to improve farm management, focusing on the small and medium scale farmers and this point should be understood sufficiently.
2. The proposed Project requires to be implemented in the participatory activities and it is necessary to recognize those the self efforts of the small and medium scale farmers as beneficiaries are needed and the proposed project might to be supporting project for the improvement of the farm management.
3. The peasant organizations shall be consolidated as the promoting body of the participatory development, and the implementation of the other components shall be set up on the acknowledgement of the own benefited ones that they are important to conduct the agricultural development.
4. Even the project is focusing on the social aspect, the project must be feasible in financially and economically. If this point is ignored the project cannot be sustainable.
5. As it is quite difficult to irrigate the all farmland in this area with limited water resources, the effective use of the valuable water resources should be considered. Technically and economically unreasonable development of the water resources is not sustainable, furthermore, it has high risk for becoming to be big problem in the future.
6. For the achievement of crop diversifications and agricultural complex management, expiation of the management scale with forming the group is necessary for the small and medium scale farmers. For this, strengthening the supporting activities concerning the establishment/strengthen of farmers’ organizations, it is necessary to form the farmers’ group taking enough time.

7. The farm management shown in the study is only a sample and the farmers should think by themselves how to improve their management for each farming.
8. At the initial stage of the project, strong guidance of SENARA is required for the operation of the irrigation facilities. However, the technical training should be done for transferring the operation of the irrigation facilities in the future.
9. For the agriculture under irrigation, SENARA shall initially be responsible for the distribution of water to the farmers. However, when the farmers' organizations reach a certain grade of maturation in the future, the possibility of supplying water to each organization shall be studied.
10. For the irrigation system with water source of groundwater, the system should be improved with inspecting the results of monitoring always and confirming that there is no serious impact to natural environment.
11. The flood protection plan proposed in the study is focusing on the mitigation of flood damage for the conservation of agricultural land of the small and medium scale farmers and this is one of the flood protection countermeasures for the rural area. For the regional flood protection, further study should be carried out referring to the concept shown in this study.
12. Based on the study of EIA, the countermeasure of protection for the precious species in the area was considered in the flood protection plan. After exciting the EIA by SENARA, based on the results, further protecting countermeasures for environmental deterioration should be studied if necessary.
13. In order to extend the eco-friendly agriculture, it is recommend extending the agriculture changing the agro-chemicals form the one with strong residuary or toxicity to the other as much as possible
14. For the agricultural development with self-efforts, the proposed project is focusing on the small and medium scale farmers who have constraints of finance and technique and benefited area is the non-irrigated land of the right bank of the Tempisque river. SENARA, which is one of the implementation agencies, is required to do the effort for, to continue the discussion with MINAE (river control agency), to obtain a new water right of the Tempisque river, and, to create the river maintenance flow.
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 m³/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.