Annex G   Agricultural Land Development

Annex G. Agricultural Land Development

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G.1 Vegetation and Topography of Uncultivated Land and Grassland or Pasture

The profile of land is following.

The profile of land is divided into six areas from the lay of the land; large river area, banks area, low lying area, swamp area, wet woods area and small river area.
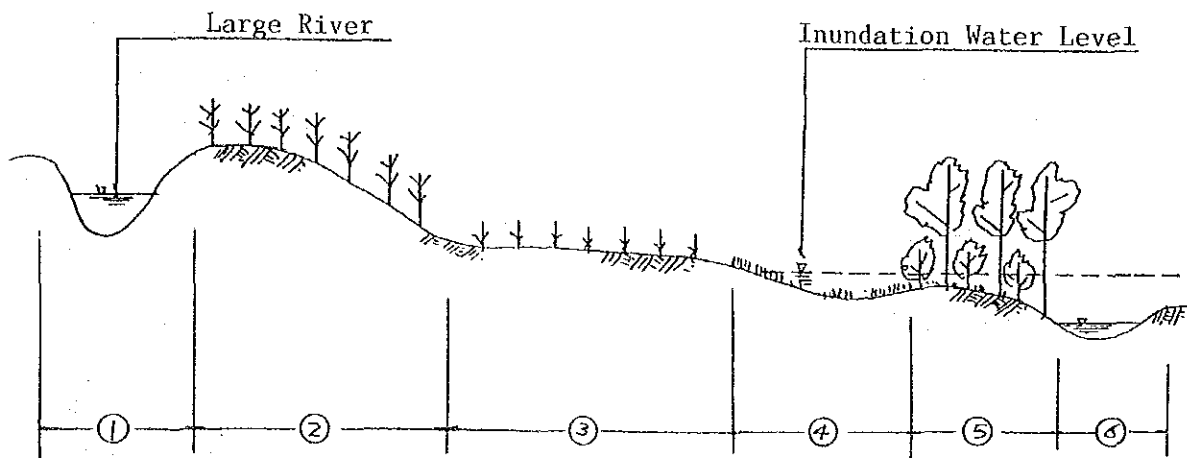
① Large river area
② Banks area
③ Lowland area
④ Swamp area
⑤ Wet woods area
⑥ Small river area

Fig. G.1.1 Profile of Land

There are a few areas that have not clear boundary between a uncultivated land and a grassland or pasture, and the former is considered to be a swamp, it's environs area and a wet woods area, the latter is to be grassland in the present conditions.

G.1.1 Uncultivated Land

There are many uncultivated lands (wet woods area) on the banks of large and small river that are meandering, and on the skirts of Navigable Canal skirts the coast.

River's meandering has formed a convex area and a hollow area one after the other. The convex area has been formed the tropical wet woods zone and the hollow area has been inundated with water and formed a swamp land that tropical aquatic plants grow thick. There are a tropical wet woods area and a partial jungle area on the skirts of Navigable Canal along the coast.

G.1.1.1 Vegetation

(1) Coastal Area

Weed and shrubbery grow wild on a coastal sand dune having a good drainage condition, but being charged with salt, and on a hilly land with a well drainage, a forest area is formed and Guavas trees are growing there.

(2) Navigable Canal Skirts' Area

This zone is mainly covered with tropical wet woods that a good many Palm tree grow. And a partial mangrove forest is seen on the Navigable Canal between the Rio Blanco river-mouth and the Rio Toro river-mouth.

This Navigable Canal was completed through the connecting with some swamps one after the other by means of the excavation work. Especially the wider sections were swampy area in the old days. On the excavation work of canal, the excavated soil was abandoned around the place that was dug and then the banks of the artificial canal became a little higher. There is a swamp area submerged through the year on the west side bank of the Navigable Canal. Such section is extending mainly between the Rio Blanco river-mouth and

the Rio Toro river-mouth, and there are peculiar plant and a animal group to the tropical zone.

(3) Swamp Area

Swamp zone is lying in a weed land having a sub-meregence once in a few year or sub-meregence through the year, and in a Palm tree land.

1) Weed Land

There are grasses growing in the grater parts of the land and the delta zone which is inundated with water two or three times in a year. The predominant species of grasses are Gamolote, Cana Brava, and they grow to four or five meters in height.

2) Palm Forest (Yolillos) Land

This Palm forest is call "Yolillo" in Costa Rica, small Palm-tree forest. This Palm-trees exist in the inundation zone and grow thick as like grasses. Sangrillo trees and Poponjoche trees mingle among other trees on a little eminence land.

3) Border of Swamp Land

Betel-nut Palm-trees (Palma Real) with a height of four or five meters exist as a thick forest at the border of swamp land and mingle among other high trees on the banks of small and medium rivers. As being apart from the border, the sight get out in tropical wet woods zone being in a well drainage.

There are two forests group, a forest of low trees and a forest of medium trees, in the border of swamp land.

a) Forest of Low Trees

There are trees and shrubs with a height of five meters to fifteen meters in this forest, and these trees make a border to

the swamp land and are found in a submerged land through the year. There are plenty trees of different types, Sangrillo, Paponjoche, Guabas, Guaitil, Guacimo Blanco, Alcanfor, Palma Coquito (Chile Coconut Palm tree) and so on. Cacao trees exist on a area between the coast and the swamp land and the area belong to the semi-swamp land and is blessed with soil and growing conditions.

b) Forest of Medium Trees

Large number of Gavilan trees, from twenty meters to thirty meters in height, exist in this forest. Those forestall aspect is a mingling forest with other tree species on the different conditions of circumstances. And this fact shows this zone is a transits one from the swamp land or semi-swamp land zone to the low land zone uninundated.

And, Cativo trees forest exists between the zone of 10 meters in altitude and the delta zone at river mouth. Cativo tree is seen only in Costa Rica or Nicaragua, grows sixty or seventy meters in height at the no-salty soil zone, puts forth white flowers and it's resin is used to stop the pain.

Cativo and Nispero (European quince) trees grow on a well drain area. Nispero tree puts forth white flowers, and it's fruits are used for food.

(4) Forest Area of High trees

This forest area is divided into two groups. The first group is widely spreaded over an area from Rio Chirripo to the river mouth of Tortuguero, and exists from zero meter zone to seven hundred meters zone above mean sea level. The second group is spreaded over an area from Rio Reventazon to Rio Jimenez river on the alluvial soil area.

1) First Group Area

Many cedro trees mingle with other trees, and falcons live in this forest area. As a feature of this forest, there are many species of trees. Predominant species of trees are following;

Laurel : Growing quickly, being not easily affected by various conditions and high utility value.

Alcafor: Being made medicine for stopping the pain from it's resin.

Cedro Amargo : Using for construction materials

Roben Sabana : Using for construction materials

Tabacon : Using for construction materials

Caobilla: Being used as a substitute for American mahogany, high utility.

2) Second Group Area

The forest's soil is alluvial, and since the drainage condition is well, this area is good for development of agriculture and forestry. Predominant species of tree are following;

Laurel   : Which see 1)

Jabillo : Existing in the torrid zone between South America and North America, materials for canoe.
Ceibo   : A foliage plant, putting forth rose-pink flowers.
Caimito : Having sweet fruits, and using for food.

Tamarindo : Having fruits, succulent, sweet-flavored and using for food.

Aimendro: Putting for white flowers, it's fruit is used for food.

Quino : Picking Quina's resin or cortex.

The forest area has about 98,000 ha now, and amounts to 40.5 % of the whole Atlantic Region. The function of the forest against the soil erosion by rainfall is good on the area that a forest has been kept up well. Research workers on the forest soil have estimated that an annual volume of soil erosion has been amounted to sixty or eighty cubic meters per hectare.

G.1.1.2 Animals

Capture of the animals is prohibited in the Atlantic region.

(1) Navigable Canal and It's Environs, and Swamp

This area is covered with tropical wet woods and is inhabitable for animals. Principal animals are following;

Birds   : Tucan, Falcon
Monkeys   : Mono Congo, Mono Colorado, Mono Carablanca,
                Mono Tamarin
Butterflies : A species of Morpho Cypris (a native of Colombia)
Amphibian   : Little alligators (in swamp zone)
             : Large alligators (in navigable canal)
             : Large black lizards (in navigable canal and it's
                environs)

The forest between Moin and Parismina has been lost it's forest type as a tropical wet woods zone, because the forest has been cutting down frequently and changing to a meadow due to a shrewd commercialism. It is necessary that the area is restored to the original state for animals that inhabit in this forest, and then by the restoration, the improvement and protection of the tropical wet wood will be performed exactly.

(2) <u>Low-lying Area</u>

Rare animals inhabit at the forest of medium trees in the low-lying area. Principal animals are following;

Tolomuco, Perro de Agua, Cabro de Monte, Garza de Sol, Monja Caribianco

It is not necessary to improve the natural wood in low-land zone. However, the technical management should be enforced for useful trees. generally the management seems all right for the trees. Since three trees - Caobilla, Cativo and Sangrillo - are high and useful trees, some planed managements will be made on this three species of trees.

(3) <u>Forest Area of High Trees</u>

As this area connects to the mountainous forest of which interior is dense, it can readily be imagined that the dangerous animals sometimes comes to the forest area of high trees from the mountain. The dangerous animals is showed below;

Puma, Tiger, Manigordo
Leon Brenero, Danta

There are many useful trees for construction materials - Laurel, Pilon, Cedro Amargo and Cetera - , and it is needed to conserve those trees in good condition so as to keep to the qualified time for cutting down.

G.1.2 <u>Meadow and Pasture Land</u>

There are a lot of meadow being submerged three or four times in a year on the banks of small rivers, and pasture land not being submerged on the banks and a little eminence in low land zone.

G.1.2.1 Vegetation

(1) Swamp (Floating Meadow)

Weedy land has been formed by cutting down the trees of low height forest where lie in the border of swamp land and it's environs. A greater part of the weed is grasses, and aquatic plants swarms in a partial hollow land where is water station for graze cattle.

(2) Banks and Low Lying Area (Pasture Land)

Since this area is unsub-merged in a year, the pasture lands have steady production of grass. There are many pasture lands with planted palm tree or orange trees here and there. On the other hand, feeding grass is introduced but the area is small and limited.

G.1.2.2 Animals (including insects)

There are not found a special species on animals in this area.

G.2 Present Status of the Drains and Farm Road

The abandoned farm area has not been found. The greater part of the settlement land of IDA was the abandoned banana plantation of United Fruits Company in a old age. The old banana plantation and it's environs have been incorporated to the settlement land, and was allowed mainly to small scale farmers. However, the land consolidation which I.D.A. authorities have carried out, is only the minimum arrangement of road due to the luck of construction funds. And then, a farmer who has been allowed a land of poor consolidation such as a land without farm road and drainage canal, is obliged to work away from home in a banana plantation, etc., and after getting enough funds, he can undertake to build his house and can make arrangements of farming. As the grater part of North Bataan area is like a abandoned farm, we have studied the situation.

The abandoned farm means that a rightful person for farming does not exist and the farm itself has been abandoned already.

The farm like a abandoned farm means that the farm land has been abandoned, however it's rightful person exists now and if it's agricultural conditions are arranged, he will come back for farming.

G.2.1 North Bataan Zone

Number of farm lots allotted   : 122
Number of farm lots under farming   : 73
Number of farm lots under no farming : 49

G.2.1.1 Farm Road

A line of a horse tramcar from Cuatro Mill as to Matina in a old age, has been changed into a trunk road, and runs through the south-west of north Bataan zone. Two roads are diverged from the trunk road. A bridge is constructed by round timbers and paving wooden boards. And it seems that the bridge had been built in an old banana plantation age, a severe caution is needed on passing of the bridge. A trunk road is paved with gravel, and cars are able to go around without hindrance, however branch road is not paved with gravel, and cars are not able to go around after rainfall. Allotment of farm lands for settlers has been completed already, however, all allotment lands cannot face the road. It is the present condition that some settlers are able to arrive at their farm lands only along banks of canals. Since roads network have not been arranged so as to enable all lots to face a road, the matter is one of reason that there are many lots under no farming in this zone. The greater part of road ditches are covered with grasses and filled with soil, and then it's fiction is lost now. This is a cause of the poor drainage in a area around a road. Accordingly, there are rice fields using the stagnant rain water around a road in low lying area. There are many farms like an abandoned farm from the end of the trunk road (Cuatro Millas) to the north-east or the north-west of this zone.

Present conditions of roads are following;

Table G.2.1   Road Consolidation in North Bataan Zone

Zone	Area (Unit: ha)	Total Length of Road (Unit: Km)					Road Consolidation Density (Unit: Km/1000ha)
		First Class	Second Class	Third Class	Fourth Class	Total	
		Width	Width	Width	Width		
		8m	Over 6m	From 4m to 6m	Below 4m		
BATAAN NORTE	2,420	—	—	7.2	8.7	15.9	6.6

Road consolidation density in North Bataan Zone is 6.6 km per 1000 ha and it is over the mean road consolidation density 4.9 km per 1000 ha in Zone B. However, the length of road with more than 4 m in width, which car is able to go around, is only 3.0 km per 1000 ha and it is below the mean road density of all Bataan area 3.3 km per 1000 ha.

A numbers of lots obliging to use banks of small rivers as a access road amount to thirty-three. And, among them there are few farm land, not a few forest land being planted trees such as Cedro Amargo, Tamarido in spite of their bad access conditions.

G.2.1.2 Drainage Canal

The small rivers and canals (artificial) in the Study Area have been studied on the drainage conditions.

Drainage canal density which is index of arrangement on drainage condition is only 4.1 km per 1000 ha and is below a half of the small river one. And the fact shows that the practical use of farm lands is not so much progress in Bataan Norte zone, because the drainage canal density in a region that practical use of farm lands is much advanced, is commonly over river density.

The mean river-density on all Bataan zone is 4 km per 1000 ha, and the mean river-density on Bataan Norte zone is over the former density by a large amount. And drainage canal density on Bataan Norte zone is almost equal to the mean drainage canal density on all Bataan zone. It

is thought that Bataan Norte zone will be inundated by heavy rains in view of these facts. A banana plantation is situated on the higher part of Bataan Norte zone, and has drainage canal density of 350 to 600 km per 1000 ha that is able to drain surface flow by rainfall intensity of about 50 mm per hour. On the other hand, as being situated on the most lower part from the banana plantation Bataan Norte zone is unavoidably inundated by drainage discharge flowing down from higher part.

Table G.2.2   Drain Arrangement in North Bataan Zone

Zone	Area (Unit: ha)	Length of Drain Arrangement (Unit: Km)			Index of Drainage Arrangement (Unit: Km/1000ha)		
		Small River	Canal	Total	Inland River	Canal	Total
Bataan Norte	2,420	21.2	10.0	31.2	8.8	4.1	12.9

G.3 Land Consolidation in Existing Settlement Area (especially on Bataan and Marry Land)

G.3.1 Bataan Zone

The present condition of land consolidation in four zones (Sara, Luzon, Goshen Santa Marta y Damasco and Bataan) have been studied.

The result is following;

In comparison with before and after settlement, the well drainage area decrease in Sara and Luzon because new roads have been built and the function of side ditches of road has been lost.

In any settlement in Bataan zone, poor drainage areas are 80 to 85 percentage after settlement.

Table G.3.1 Farm Land Situation in Bataan Zone

Zone	Before Settlement (Unit: %)			After Settlement (Unit: %)		
	① Well Drainage Area	② Poor Drainage Area	③ Like Abandoned Farm Land	① Well Drainage Area	② Poor Drainage Area	③ Like Abandoned Farm Land
Sara	30	70	100	20	30	20
Luzon	30	70	100	20	30	20
Goshen, Santa Marta Damasco	15	85	100	15	85	50
Bataan Norte	15	85	100	15	85	50

G.3.1.1 Road

Present conditions of roads are following;

In a zone that is continuous to a banana plantation, the road density is very high, and going away from a banana plantation, it becomes low, and a road quality also becomes to be low.

One-third of Sara zone and the greater part of Luzon zone are continuous to a banana plantation. The former road density is 14.5 km per 1000 ha, the latter road density amounts to 18.6 km per 1000 ha, and then the farm lands in both zones are well arranged in order in spite of the poorness of drainage condition. However, road density of Bataan Norte zone is the lowest, 6.6 km per 1000 ha only, and also the road quality is low and a road with over six meters in it's width does not exist.

Table G.3.2 Road Consolidation in Bataan Zone

Zone	Area (Unit: ha)	Total Length of Road (Unit: Km)					Road Consolidation Density (Unit: Km/1000ha)
		First Class Width 8m	Second Class Width Over 6m	Third Class Width From 4m to 6m	Fourth Class Width Below 4m	Total	
Sara	968	—	14.0	—	—	14.0	14.5
Luzon	458	—	8.5	—	—	8.5	18.6
Goshen, Santa Marta Y Damasco	1,678	—	7.2	3.5	5.7	16.4	9.8
Bataan Norte	2,421	—	—	7.2	8.7	15.9	6.6
Total	5,525	—	29.7	10.7	14.4	54.8	9.9

G.3.1.2 Drainage Canal and Small River

The drainage facilities are classified into four as shown below;

1) Principal drainage canal   2) Secondary Canal
3) Ditch   4) Small River

Principal drainage canal density is 10 km per 1000 ha, secondary canal density is 100 km per 1000 ha, and those values are ordinary in a drainage system of a banana plantation. While, ditch density ranges from 240 km per 1000 ha to 490 km per 1000 ha according to the land conditions.

Drainage systems on a banana plantation are arranged for the purpose of the excluding of surface runoff discharge from the farm through ditch, and of declining of the ground water table through lateral canal.

Farm lands in the lowland zone doesn't necessitate the drainage system like a banana plantation, however, it is thought that drainage canal density of about 30 km per 1000 ha adding together principal and secondary canal is necessitated for farming. However,Goshen Santa Marta y Damasco zone or Bataan Norte zone have not a enough drainage density as a farm land in low lying area.

The cause of poor drainage in Sara and Luzon zones is that the cross section of most lateral canal is insufficient.

Table G.3.3　Drain Arrangement in Bataan Zone

Zone Items / Drain Class	Sara 968(ha) Length of drain (Unit:Km)	Sara (*) km/1,000ha	Luzon 458(ha) Length of drain (Unit:Km)	Luzon (*) km/1,000ha	Goshen, Santa Marta Y Damasco 1,678(ha) Length of drain (Unit:Km)	Goshen (*) km/1,000ha	Bataan Norte 2,421(ha) Length of drain (Unit:Km)	Bataan Norte (*) km/1,000ha	Total 5,525(ha) Length of drain (Unit:Km)	Total (*) km/1,000ha
① Principal Canal	12.95	13.4	1.98	4.1	6.58	3.9	10.00	4.1	31.35	5.7
② Secondary Canal	10.23	10.6	10.00	21.8	2.00	1.2	—	—	22.23	4.0
③ Ditch	4.64	4.8	2.45	5.3	1.70	1.0	—	—	8.79	1.6
④ Small River	15.7	16.2	0.55	1.2	14.50	8.6	21.2	8.8	51.95	9.4
⑤ Total	43.52	45.0	14.98	32.4	24.70	14.7	31.2	12.9	114.32	20.69

(*) Drainage Canal Density

Table G.3.4　Drainage Canal Density in Bataan Zone

Unit : kms/1,000 ha

Drain Zone	Principal Canal	Secondary Canal	Farm Drainage	Total
Sara	13.4	10.6	4.8	28.8
Luzon	4.1	21.8	5.3	31.2
Goshen, Samta Marta Y Damasco	3.9	1.2	1.0	6.1
Bataan Norte	4.1	—	—	4.1
Banana Plantation	10.0	100.0	240 ~ 490	350 ~ 800

① Principal Drainage Canal

6.0 m

2.5m

1:1.0

1.0m

② Secondary Canal

3.0m

0.6m

1.5m

③ Ditch Canal

1.0m

0.6-0.8m

0.2m
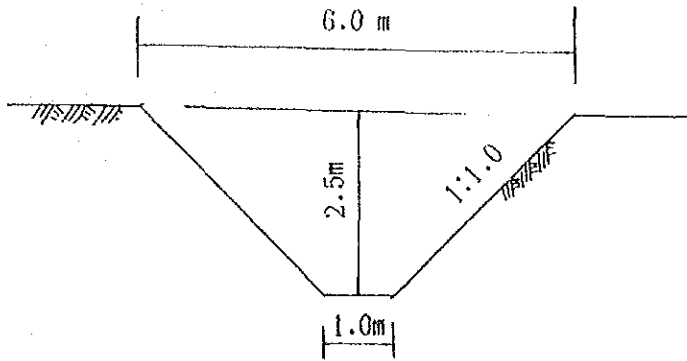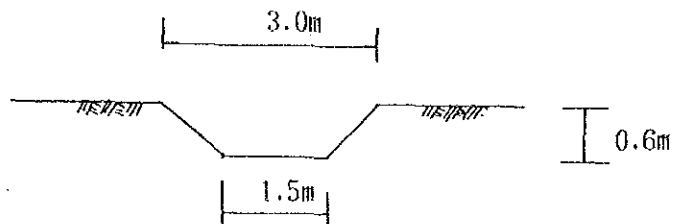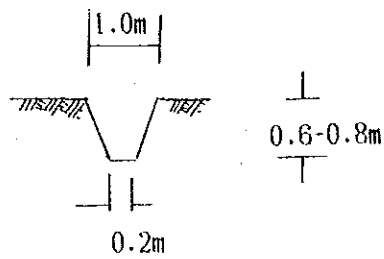
Fig. G.3.1 Section of Existing Drainage Canals in Sara Zone

G.3.2 Marry Land Zone

Marry Land Zone was covered with tropical wet woods by fifty years ago. A banana plantation was established by United Fruits Company in 1937. However, the banana plantation was invaded by SIGATOKA virus, and then abandoned in 1952. Trespassers were found out in the abandoned banana plantation area in 1979, and the government paid attention to the utilization on the abandoned farm land, and decided to use this area as a settlement in 1983. Since the settlement was begun in 1984, three years was gone, the area of 68 ha (83 lots) have been allowed.

    Zone area   : 2153 ha
    Allotment numbers   : 224 lots
    Mean allotment area :   9 ha

The road construction of 59.4 km in length, over the planned length of 41 km , has been already carried out and the road has 7 m width and 14 m site width.

Whereas, since drainage canals in farm land are not planned, inundated area is being forms. Thus, road side ditch of 30 km in length is under planning to improve the present drainage conditions.

G.3.2.1 Road

All allotment lands are facing to the roads, and then road density is 27.6 km per 1000 ha. And there are reservation area of 133 ha in the zone. Excepting this area (133 ha) from the zone area, road density becomes to 29.4 km per 1000 ha.
    The present condition of bridges is following;

    Arrangement numbers   : Seven bridges
    Bridge width   : 2.5 meters to 3.0 meters
    Bridge length   : 2.5 meters to 8.0 meters
    Bridge structure   : Wooden bridge (placing planks or rails on
                              the bridge girders of round timbers)

Table G.3.5 Existing Road in Marry Land Zone

Zone	Area (Unit: ha)	Total Length of Road (Unit: Km)					Road Consolidation Density (Unit: Km/1000ha)
		First Class Width 8m	Second Class Width Over 6m	Third Class Width From 4m to 6m	Fourth Class Width Below 4m	Total	
Marry Land	2,153	--	59.4	--	--	59.4	27.6

G.3.2.2 Drainage Canal and Small River

There are two rivers (Rio Corona and Rio Chiqueron) in this zone. The half stretch of both rivers were repaired by the present banana company and then Canal Corona and Canal Chiqueron were completed.

The arrangement of secondary canal and ditch is not planned even now. As the road system in this zone is already perfected, a partial ill drain will be improved by utilizing of the road side ditches.

Table G.3.6   Drain Arrangement in Marry Land Zone

Name of River	River Improvement Section (Unit : km)	River Unimprovement Section (Unit : km)	Total	Meandering Index (*) of River Unimprovement Section	
				Planned Length of River Channel (Unit:kms)	Meadering Index (*)
Rio Corona	(Canal Corona) 2.95	(Rio Corona) 4.00	6.95	2.28	1.75
Rio Chiqueron	(Canal Chiqueron) 2.20	(Rio Chiqueron) 3.30	5.50	1.83	1.80
Nameless River	3.50	--	3.50	--	--
Total	8.65	7.30	15.95	4.11	1.78

(*) Meandering Index = $\dfrac{\text{River Unimprovement Section}}{\text{Planed Length on River Channel}}$

On the assumption that meandering index before river improvement was equal to the present meandering index of river unimprovement section, each river channel length before river improvement might be about 5.2 km in Canal Corona and about 4.0 km in Canal Chiqueron.

It is thought that river meandering index shows a rate of outflow after river improvement. If lower stretch of both rivers are improved the outflow per an unit length of river become twice as much as outflow before river improvement.

① Canal Corona (Length : 2950 m)
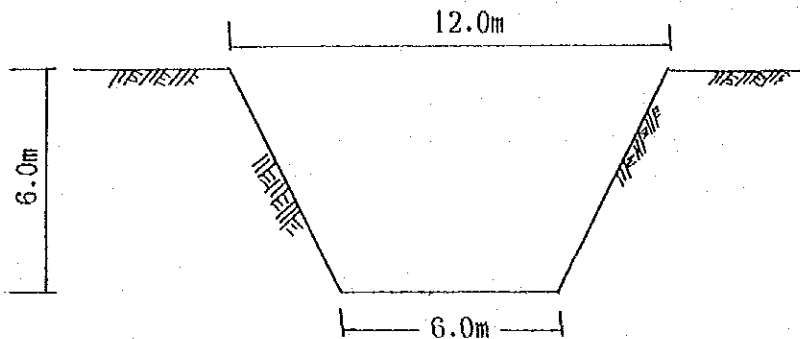
② Canal Chiqueron (Length : 2200 m)
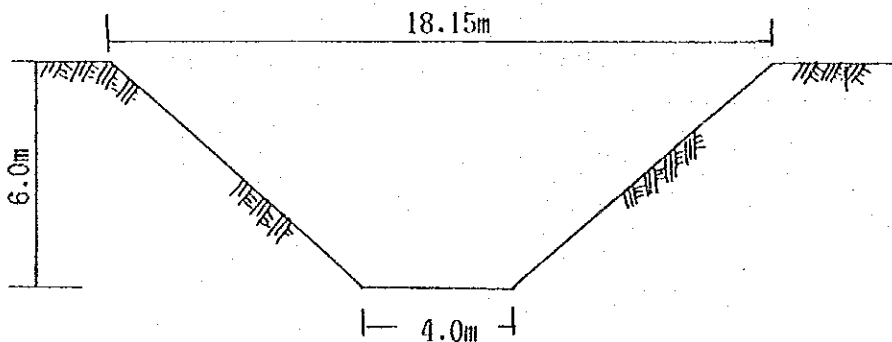
Fig. G.3.2 Section of Principal Drainage Canal
in Marry Land Zone

G.3.2.3 Reservation Land

There are three areas of reservation land at the north of the Study
Area, two areas are in along the right banks of Rio Corona and the rest
in along the right banks of Rio Reventazon. These sections are
denominated A zone, B zone and C zone from the east to the west. The
area of each block is following;

A zone   area: 70 hectares
B zone   area: 12 hectares
C zone   area: 51 hectares
            Total: 133 hectares

A zone is situated on the end of Rio Corona river meandering, where
is lowest part of Marry Land. B zone is submerged two or three times in
a year, situating on the end of Canal Corona (beginning of Rio Corona).
C block is situated on the bottom along Rio Reventazon river and is
suffered from ill drain always.

It is desirable that those blocks are used as a community forest
zone, under forestry management for a growing of useful trees, and as a
green tract of land.

(A) Block
Reservation Land Area = 70 Ha

LEGEND

Reservation Land

allotment land

boundary line

$S = \dfrac{1}{10000}$

(B) Block
Reservation Land Area = 12 Ha
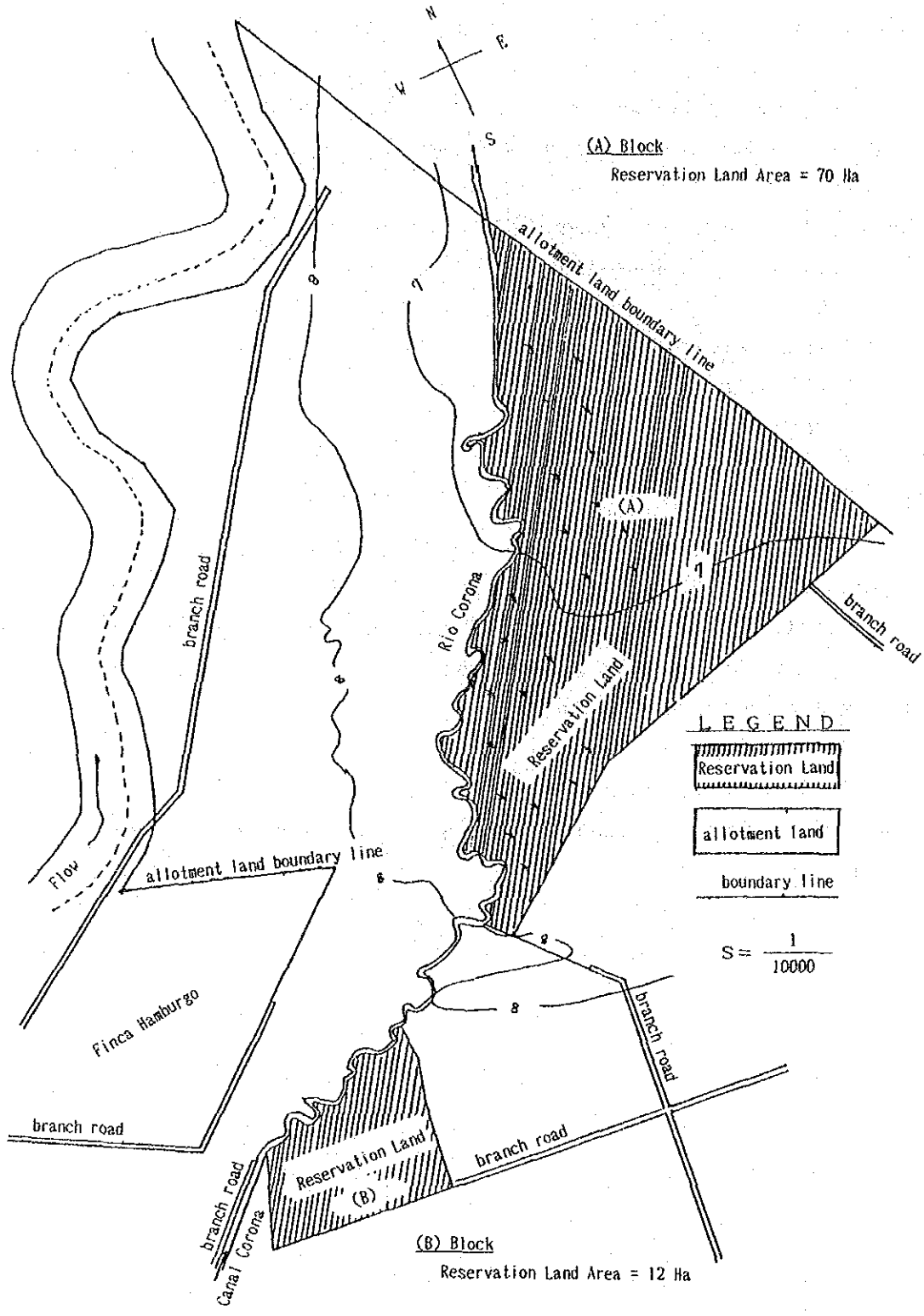
Fig. G.3.3 Reservation Area (Block A and B)
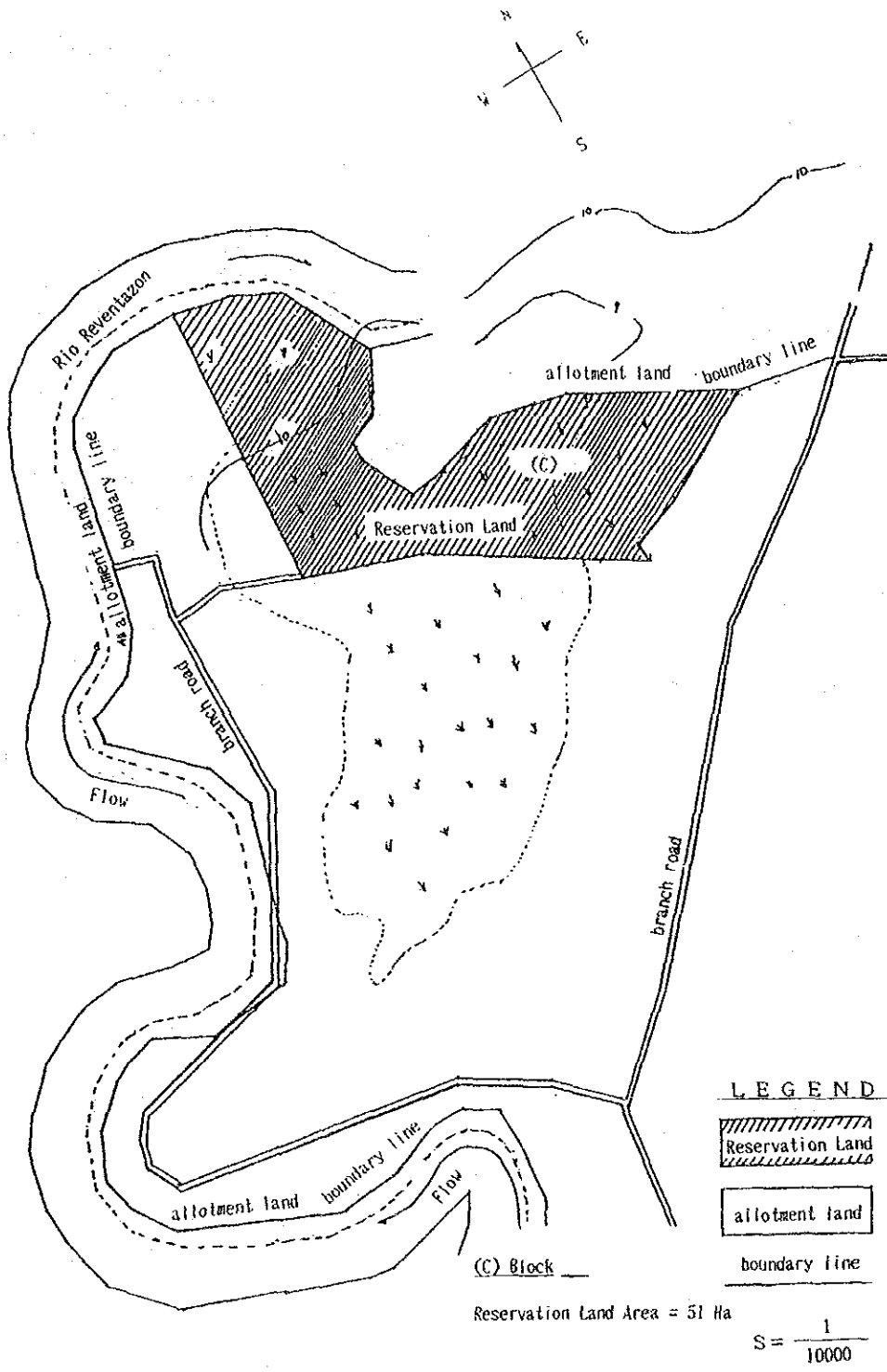
Fig. G.3.4 Reservation Area (Block C)

G.4 Construction Equipment used in the Settlement Project

There is a case of the settlement project on Marry Land zone. Construction machines and many earth-workers were occupied in the road construction.

Principal Construction Machines are shown below:

For excavation: D 6 and D 4 bulldozers

                           I.D-690 Backhoe (2 m^3 bucket)

For hauling: Wagon (Type is unknown)

For felling: Automotive Saw (Type is unknown)

G.5 Planning on Drainage at Farm Land

G.5.1 Size of Farm Block

A unit area of field block is 10 ha, and then the size of a farm block is determined to be 50 ha from a landowner ship condition.

G.5.2 Plan of Drainage Canal

G.5.2.1 Design Rainfall

Rainfall intensity formula is hereunder.

$$I = \frac{229}{t + 4.0} = \frac{229}{4 + 4.0} = 28.6 \ (\text{mm/hour})$$

here   I = rainfall intensity (five-year probability)

             t = duration of rainfall = 4.0 hour

G.5.2.2 Dimension of Drainage Canal in Ordinal Farm Land

(1) Surface Runoff and Secondary Canal Section

1) Surface Runoff

$$Q_s = \frac{f.r.A}{3.6} = \frac{0.45 \times 28.6 \times 1.0}{3.6} = 3.6 \ (m^3/sec/km^2)$$

2) Secondary Canal Section and Capacity (Excluding on the case of banana plantation)

Secondary Canal Section

without scale

A = 5.44 m²

P = 6.31 m

R = 0.86 m
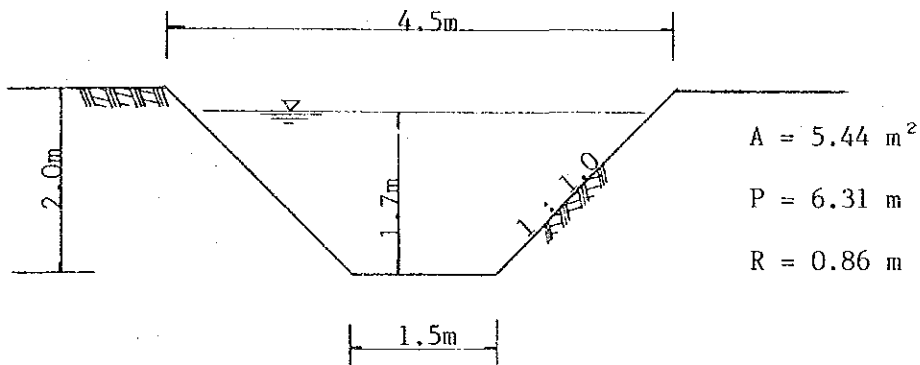
Calculation on Secondary Canal Capacity

Manning's Formula is subject to the calculation, hereunder:

$$V = \frac{R^{2/3}\, I^{1/2}}{n} = \text{(m/sec)}$$

$$R = \frac{A}{P} \qquad I = \text{Gradient} = \frac{1}{1500}$$

$$n = 0.030$$

$$V = \frac{R^{2/3}\, I^{1/2}}{n} = \frac{(0.862)^{2/3} \times \left(\frac{1}{1500}\right)^{1/2}}{0.030} = 0.67 \text{ (m/sec)}$$

$$Q = AV = 5.44 \times 0.67 = 3.7 \text{ (m}^3\text{/sec)} > Q_s$$

(2) Surface Runoff and Lateral Canal Section

<u>Farm Drain Section</u>

<u>without scale</u>

A = 1.12 m²

P = 2.86 m

R = 0.392 m
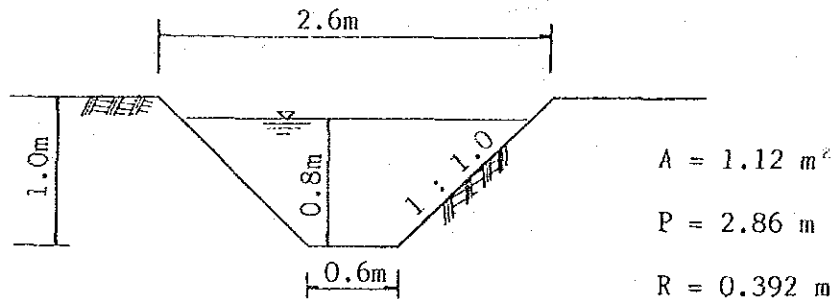
$$Q_s = \frac{f.r.A}{3.6} = \frac{0.45 \times 28.6 \times 0.1}{3.6} = 0.36 \ (m^3/sec/km^2)$$

$$V = \frac{R^{2/3} I^{1/2}}{n} = \frac{(0.392)^{2/3} \times (\frac{1}{2000})}{0.030} = 0.40 \ (m/sec)$$

$$Q = AV = 1.12 \times 0.40 = 0.45 \ (m^3/sec) > Q_s$$

(3) Surface Runoff and Ditch Section

1) Case of Perennial Crops

Ditch is situated at intervals of forty meters, and a drainage area is 0.8 ha (100 m x 80 m = 8,000 m^2)

$$Q_s = \frac{f.r.A}{3.6} = \frac{0.45 \times 28.6 \times 0.008}{3.6} = 0.03 \ (m^3/sec/km^2)$$

$A = 0.72 \ m^2$ $P = 2.80 \ m$ $R = 0.257 \ m$

$$i = \frac{1}{1000}$$

$$V = \frac{(0.257)^{2/3} \times (\frac{1}{1000})^{1/2}}{0.030} = 0.43 \ (m/sec)$$

$$Q = AV = 0.72 \times 0.43 = 0.31 \ (m^3/sec) > Q_s$$

Ditch Section

without scale
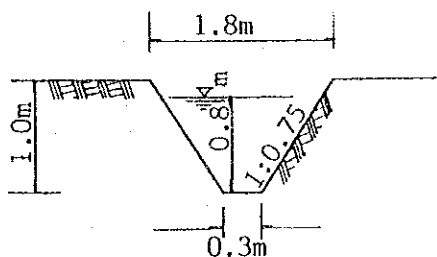
$A = 0.72 \ m^2$

$P = 2.80 \ m$

$R = 0.26 \ m$

2) Case of Annual Crops

Ditch is situated at intervals of forty meters, and a drainage area is 0.4 ha (100 m x 40 m = 4000 m^2).

$$Q_s = 0.02 \quad (m^3/sec)$$

$$A = 0.08 \; m_2, \; P = 0.75 \; m, \; R = 0.107, \; i = \frac{1}{1000}$$

$$V = \frac{(0.107257)^{2/3} \times (\frac{1}{1000})^{1/2}}{0.030} = 0.24 \; (m/sec)$$

$$Q = AV = 0.02 \; (m^3/sec) \geqq Q_s$$

Ditch Section

without scale
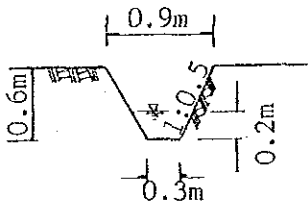
$$A = 0.08 \; m^2$$

$$P = 0.75 \; m$$

$$R = 0.107 \; m$$

G.5.2.3 Dimension of Drainage Canal in Banana Plantation

(1) Surface Runoff and Lateral Canal Section

1) Surface Runoff

A lateral canal is situated at intervals of one hundred m, and a drainage area is 5.0 ha.

$$Q_s = \frac{f.r.A}{3.6} = \frac{0.6 \times 28.6 \times 0.05}{3.6} = 0.24 \ (m^3/sec)$$

2) Lateral Section and Capacity

Lateral Canal Section

without scale

$$A = 3.15 \ m^2$$

$$P = 6.01 \ m$$

$$R = 0.52 \ m$$
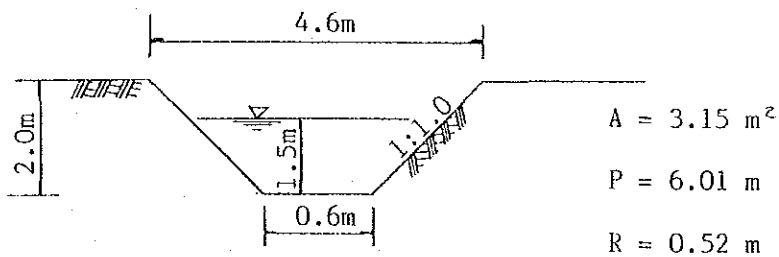
$$V = \frac{R^{2/3} \, I^{1/2}}{n} = \frac{(\frac{1}{2000})^{1/2}}{0.030} = 0.48 \ (m/sec)$$

$$Q = AV = 3.15 \times 0.48 = 1.51 \ (m^3/sec) > Q_s$$

(2) Surface Runoff and Ditch Section

1) Surface Runoff

A ditch is situated at intervals of 40 m, and drainage is 0.2 ha (40 x 50 m)

$$Q_s = \frac{f.r.A}{3.6} = \frac{0.6 \times 47 \times 0.002}{3.6} = 0.016 \ (m^3/sec)$$

2) Ditch Section and Capacity

without scale

A = 0.55 m²

P = 2.01 m

R = 0.274 m
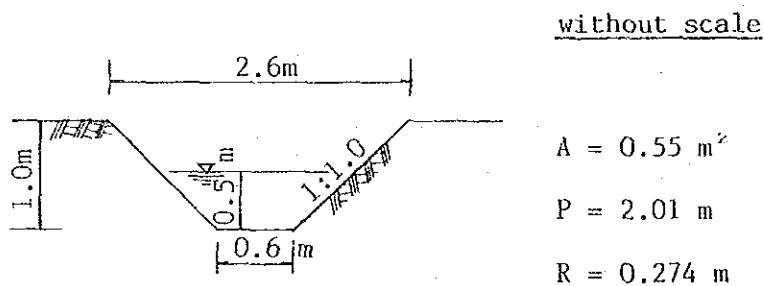
$$V = \frac{R^{2/3} I^{1/2}}{n} = \frac{(0.274)^{2/3} \times (\frac{1}{1000})^{1/2}}{0.03} = 0.45 \ (m/sec)$$

$$Q = AV = 0.55 \times 0.45 = 0.25 \ (m^3/sec) > Q_s$$

Annex H   Agricultural Economy and Marketing

Annex H   Agricultural Economy and Marketing

List of Tables

List of Figure

H.1 Agricultural Supporting Services

The Ministry of Agriculture and Livestock (Ministerio de Agricultura y Ganaderia: MAG), as shown in Fig.H.1.1, was divided into several directorates or divisions, known as the "direcciones", two of which were the Department of Agricultural Research and the Department of Agriclutural Extension in August 1987. The Agricultural Research Department is divided into five (5) divisions, and these divisions were divided into section and project office. The Agricultural Extension Division is divided into eight (8) regions, and these were further divided into eighty (80) districts (Canton) offices.

The Institute of Development Settlement (Instituto de Desarrollo Agrario: IDA) was established in 1962. IDA also has agricultural extension system in the settlement area.

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                          ┌──────────────┐
                          │   MINISTRO   │
                          └──────┬───────┘
                                 │              ┌──────────────┐
                                 │──────────────│    SEPSA     │
                                 │              │    (30)      │
                          ┌──────┴───────┐      └──────────────┘
                          │ VICEMINISTRO │
                          └──────┬───────┘
   ┌─────────────────────┐      │              ┌──────────────────────┐
   │ CONSEJO NIMISTERIAL  │──────┼──────────────│   DERECCION DE       │
   │        (4)           │      │              │  PLANIFICACION (7)   │
   └─────────────────────┘       │              └──────────────────────┘
       ┌──────────────────┐      │      ┌──────────────────┐
       │  DIREC. ASESOR.  │──────┼──────│ AUDITORIA INTERNA │
       │  JURIDICA (10)   │      │      │       (6)        │
       └──────────────────┘      │      └──────────────────┘
```

| DIREC. EJECUT. DE PROGRAMAS AGROPECUARIOS NACIONALES | ... | DIRECCION GENERAL ADMINISTRATIVE | ... | DIREC. EJECUT. DE PROGRAMAS AGROPECUARIOS REGIONALES |

NACIONALES:
- PESCA Y ACUACULTURA
- INVEST. Y EXTAGRICOLA
- SALUD Y PROD. PECUARIA
- SANID. VEGETAL
- MERCADEO AGROPECUARIO

REGIONALES:
- DIREC. REGIONAL PACIFICO SECO
- DIREC. REGIONAL V. C. ORIENTAL
- DIREC. REGIONAL PACIF. CNTRAL
- DIREC. REGIONAL V. C. OCCIDEN
- DIREC. REGIONAL PACIFICO SUR
- DIREC. REGIONAL NORTE
- DIREC. REGION. CENTRAL
- DIREC. REGION. ATLANTICA
- OFIC. CANTONAL

Fig. H.1.1   MAG Organization Chart

IDA Organization Chart

- AUDITORIA
- JUNTA DIRECTIVA
- PRESIDENCIA EJECUTIVA
- SECRETARIA GENERAL
- DEPARTAMENTO LEGAL
- GERENCA

DIRECCION PLANIFICACION
- COOPERACION EXTERNA
- DPTO. PROGRA. NACION Y PLANIFICACION ADMINISTRATIVA
- DPTO. PLANIFICACION REGIONAL Y PROYECTOS
- DPTO. EVALUACION Y ESTADISTICA

DERECCION OPERACIONES
- DEPARTAMENTO INFRAESTRUCTURA RURAL
  - SECCION TOPOGRAFIA
  - SECCION EDIFICACIONES RURALES
  - SECCION VIALIDAD RURAL
- DEPARTAMENTO ESTUDIOS BASCICOS
  - SEC. INVENTARIO DE TIEARAS
  - SECCION ABALUOS
  - SECCION ESTUDIOS AGROECONOMICOS
  - SECCION SELECCION DE DENEFICIARIOS
- DEPARTAMENTO ORGANIZ Y CAPAC. CANPESINA
  - SECCION ORGANIZACION Y CAPACITACION
  - SECCION MUJER Y FAMILIA
  - SEC. ADMINIST. Y ASESORIA EMPRESARIAL
- DEPARTAMENTO ORDENAMIENTO DE TIEARAS
  - SECCION TITULACION
  - SECCION ASUNTOS INDIENAS
  - SECCION ARRENDAMIENTOS
  - SEC. INFORMAC. POSESORIAS Y OCUPACION PRECARIA

DERECCION ADMINISTRATIVA
- DEPARTAMENTO SERVICIOS GENERALES
  - SECCION PROVEEDURIA
  - SECCION TRANSPORTES
  - SEC. MANTEMINIENTO Y COMUNICACIONES
  - SECCION PUBLICACIONES
- DEPARTAMENTO FINANZAS
  - SECCION TESORERIA
  - SECCION CONTABLIDAD
  - SECCION INGRESOS
  - SECCION RECAUDACION FISCAL
- DEPARTAMENTO RECUASOS HUMANOS
  - SECCION TECNICA
  - SECCION OPERATIVA
- CNETRO DE INFORMATICA
- OFICINA RELACIONES PUBLICAS
- DERECCION PROYECTO IDA/AID-034
- DIRECCION PROYECTO IDA/AID-041
- CAJA AGRARIA

DIRECCION REGIONAL GENERAL

DIRECCION REGIONAL CENTRAL
- OFICINA SUBREGIONAL TURRIALSA

DIRECCION REGIONAL CMOROTEGA
- OFICINA SUBREGIONAL CAÑAS
- OFICINA SUBREGIONAL LIBERIA
- OFICINA SUBREGIONAL UPALA
- OFICINA SUBREGIONAL SANTA CRUZ
- OFICINA SUBREGIONAL APALA

DIRECCION PACIFICO CENTRAL
- OFICINA SUBREGIONAL OROTINA

DIRECCION REGIONAL BRUNCA
- OFICINA SUBREGIONAL SAN ISIDAO
- OFICINA SUBREGIONAL COTO BRUS
- OFICINA SUBREGIONAL COTO SUR
- OFICINA SUBREGIONAL OSA
- OFICINA SUBREGIONAL PIEDAAS BLANCAS

DIRECCION REGIONAL MUETAR ATLANTICA
- OFICINA SUBREGIONAL RIO FRIO
- OFICINA SUBREGIONAL BATAAN
- OFICINA SUBREGIONAL CARIARI
- OFICINA SUBREGIONAL POCORA
- OFICINA SUBREGIONAL SIZAOLA
- OFICINA MARYLAND SIQUIRRES

DIRECCION REGIONAL MUETAR NORTE
- OFICINA SUBREGIONAL FORTUNA
- OFICINA SUBREGIONAL PITAL
- OFICINA SUBREGIONAL GUATUSO
- OFICINA SUBREGIONAL SAN CARLOS
- OFICINA SUBREGIONAL CNANBACU
- OFICINA SUBREG. LA VIRGEN SARAPIQUI

Fig. H.1.2   IDA Organization Chart

H.2. Research

The headquater of the Tropical Agricultural Research and Training
Center (CATIE) is located in the Turrialba about 40 km from the Study
Area, where it occupies 950 ha of land. It also has 100 ha of sub-
station in the Study Area for producing cacao seeds for planting and for
conducting research in cacao as a commercial crop.

CATIE was initiated by the Inter-American Institute of Agricultural
Sciences (IICA) of the Organization of American State in 1942. In 1973,
CATIE was created under the terms of a contract subscribed to by IICA and
the Government of Costa Rica. Its purpose is to conduct research in the
field of agricultural and animal sciences, renewable natural resources
and in related field, to benefit the American tropics, particularly in
Central America and the Caribbean, and to provide graduate training in
the above mentioned fields.

The main objectives are as follows:

-   To develop scientific research oriented toward the agricultural
    and forestry development of the member countries such as
    Guatemala, Honduras, Nicaragua, Costa Rica, Panama and few
    Caribbean countries.

-   To develop educational programs, at the graduate and
    specialization levels, as well as training activities to the
    agri-extension workers.

-   To provide technical cooperation to the member countries and
    other countries. The technical assistance will be oriented
    toward strengthening the national institutions of higher
    learning.

H.3 Farmer's Organization

The existing cooperatives and associations are shown in Table H.3.1
and Table H.3.2, respectively.

Table H.3.1   Types of Cooperatives

Canton \ Type	Coope Agricolas	Coope Consumo	Coope Ahorro y Credito	Coope Indurtriales	Coope Vivendo
Matina					
(1) Coope Bataan	O	O	–	O	–
(2) " Cinco	O	–	–	O	–
(3) " Veinteocho	O	O	–	–	–
(4) Acoo Agro	O	–	–	O	–
(5) Coope Oro	O	–	–	–	–
(6) " Sara	–	O	–	–	–
(7) " Buena Esperanza	–	–	O	–	–
Siquirres					
(1) Coope Carimp	–	–	O	–	–
(2) " Germania	O	–	–	–	–

Source: INFOCOOP (Limon, San Jose)
O : coops in activity

Table H.3.2   Number of the Associations

Canton \ Sort	Integrales	Especificas	Uniones	Total
Limon	17	3	–	20
° Matina	15	1	–	16
° Siquirres	15	2	–	17
Guapiles	26	5	–	31
Guacimo	10	2	–	12
Talamanka	12	–	–	12
province Total	95	13	–	108
Costa Rica Total	1,075	128	49	1,252

Source: DINADECO (Limon - 1987, San Jose - 1986)
° : Study area

```
ASAMBLES GENERAL DE ASOCIADOS
         (37 miembros)

    COMITE DE EDUCACION                    COMITE DE VIGILANCIA
           (3)                                    (3)

    COMITE DE ADMINISTRACION
              (9)

         GERENCIA
           (2)

SUPERMERCADO        ADMINISTRACION        BANANO        MAQUINARIA
    (6)                  (1)               (8)              (1)

CONTABILLIDAD      PLANILLAS           EMPLEADOS          TALLER
    (2)               (2)               (111)              (1)

   CAJA           SUMINISTROS
    (1)               (1)
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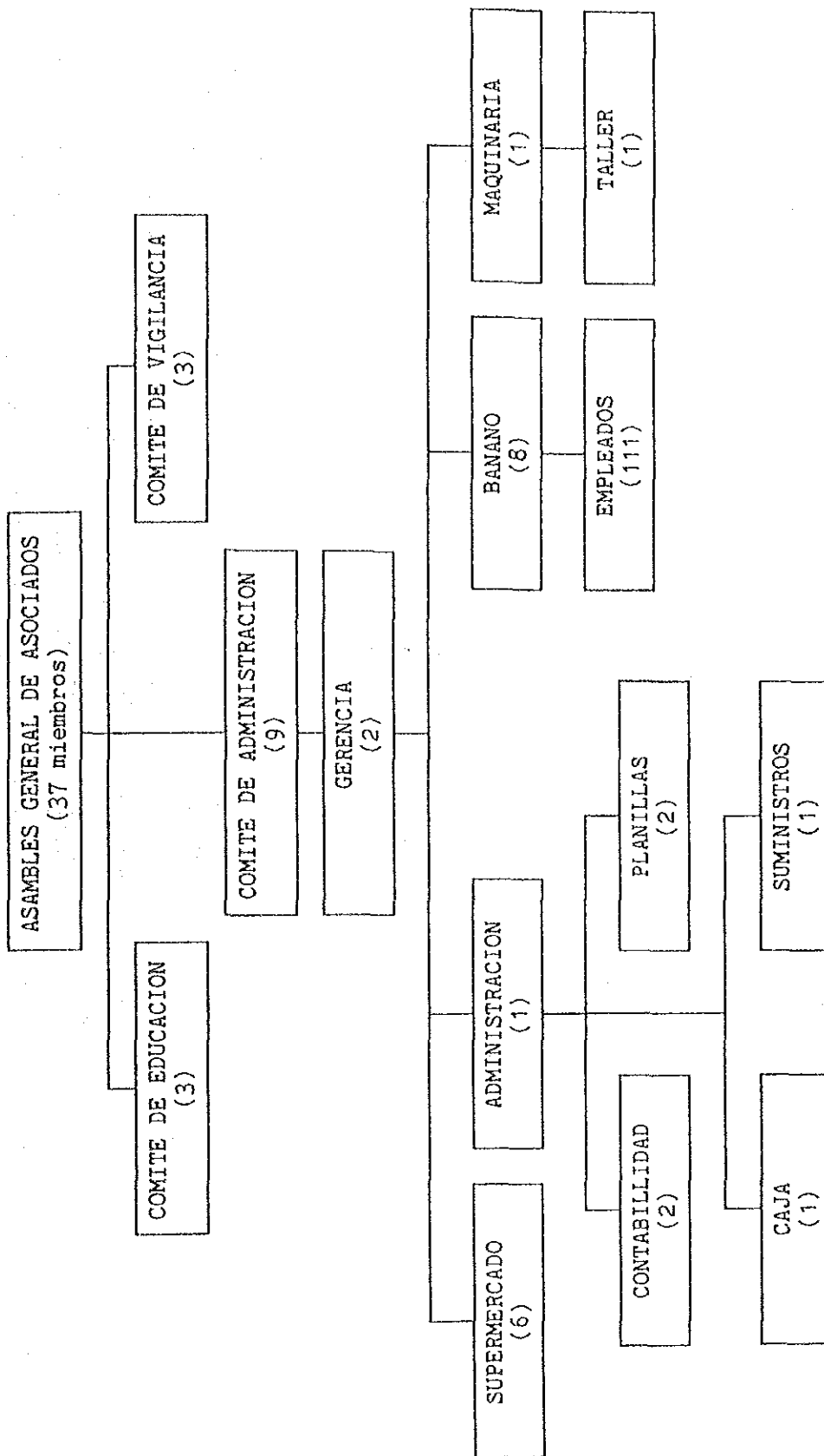
Fig. H.3.1   Agri-Cooperatives Organization Chart

H.4   Marketing for Agricultural Products

(1)   Marketability for Banana

Production situation of the leading countries in the central and south American countries are as follows:

Name of the Countries	Situation
Costa Rica (stability production by Government support)	Quality of the Costa Rica banana is much better than other countries, and stable production due to the export tax pull down to US$0.22 per pack/43 pound. It is now strong in the international market.
Guatemala (economic problem)	Quality of the banana is not at all inferior to Costa Rica, but production cost is increasing year by year. Inflated wage and materials are doubtful.
Colombia (political problem)	Export quality is difficult to keep, because of unstable production and packing due to the problem of communist guerrilla band.
Ecuador (quality problem)	Quality of the Ecuador banana is course through the export market, and weak to compete with other countries.

Acreage, export quantity, FOB prices in main port and export tax are shown in Table H 4.1.

Table H.4.1   Data of Banana in Costa Rica

	Acreage				Export (000) box/18kg	FOB Moin US$/box	Tax US$/box	(effectuation) Month
	Atlantica ha	(ratio) %	Pacifico ha	(ratio) %				
1982	20,957	78.5	6,440	21.5	50,662	3.40	0.95	—
83	21,325	84.1	5,168	15.9	52,199	3.40	0.95	—
84	20,934	90.3	3,126	9.8	51,682	3.40	0.70	—
85	20,139	98.1	395	1.9	44,300	3.55	0.55	Oct
86	21,291	98.3	395	1.7	48,637	3.85	0.25	Jan
87	22,491		395		50,000	3.90	0.22	Jan
							0.18(~88)	Jan
1990	27,891		395		60,000	-	0.15	Jan (Fixed)

Source: ASBANA

(2)　Demand for Cacao

As shown in Table H.4.2, cacao of 10,400 tons (in dry seed) was
produced in year 1978. However, after the outbreak of Monilia, the
production has decreased to a considerable extent. The cacao
production in 1983 amounted to 46 percent of that in peak years.

On the other hand, the domestic consumption of cacao in 1986 was
equivalent to only 71 percent of that in 1978. Since cacao
amounting to 500 to 1,000 tons is annually imported in addition to
the domestic production, the domestic consumption seems to be
constant. The domestic consumption of cacao in year 2000 is
forecasted to be about 6,500 tons, which is by 143 percent larger
than that in 1978.

Table H.4.2   Cacao Production, Domestic Consumption and
Export Quantity(tons)

Year	Export	Addition and Reduction Ratio	Domestic Consumption	Addition and Reduction Ratio	Total Production	Addition and Reduction Ratio
1976	4,180		1,675		5,855	
77	5,627		2,067		7,694	
78	5,842	100	4,539	100	10,381	100
79	4,235	72	6,130	135	10,365	100
80 /*	2,165	37	3,101	68	5,266	51
81	2,024	35	3,025	67	5,049	49
82	2,024	35	1,522	34	3,546	34
83	708	12	1,453	32	2,161	21
84	843	14	3,296	73	4,139	40
85	1,267	22	3,184	70	4,451	43
86	1,267	22	3,210	71	4,477	43
87	1,452	25	3,300	73	4,752	46 (target)
2000	8,500	145	6,500	143	15,000	144 (target)
					(10,000)	

(Cacao production in the Study area in 2000)

Source: Banco Central de Costa Rica

/* -- Morinia disease attacked in 1980.

Table H.4.3 Banana New York Market Price (1980-1985)

Unit: U. S. Dollar/Box (18.14kg)

Month	Year 1980	1981	1982	1983	1984	1985
1	9.38	9.22	10.28	9.48	9.93	10.55
2	9.37	10.25	10.75	10.24	11.14	11.38
3	10.41	10.96	11.25	11.11	11.47	12.50
4	10.45	11.10	11.25	12.92	11.36	13.11
5	10.84	11.67	10.88	14.50	10.81	12.30
6	9.32	10.54	10.75	14.06	11.35	11.43
7	9.10	9.09	9.00	13.17	11.44	10.37
8	9.04	9.00	n.d.	12.05	9.98	10.08
9	9.40	9.90	n.d.	12.17	10.7	10.03
10	8.92	10.00	n.d.	11.14	9.99	9.49
11	9.44	n.d.	n.d.	9.47	8.50	9.46
12	9.32	n.d.	9.37	9.20	8.96	9.12
Average	9.58	10.17	10.44	11.63	10.45	10.82

Source: New York Fruit and Vegetable Report, U. S. Department of Agriculture

Table H.4.4 Banana Export and Domestic Consumption (1976-1985)

Item / Year	Export				Consumption				Total			
	Volume (M. Ton)	Ratio (%)	Unit Price (Colones)	Value (Million Colones)	Volume (M. Ton)	Ratio (%)	Unit Price (Colones)	Value (Million Colones)	Volume (M. Ton)	Ratio (%)	Unit Price (Colones)	Value (Million Colones)
1976	1,068,513	90.0	1,201	1,283.7	118,634	10.0	237	28.1	1,187,147	100	1,093	1,297
1977	1,002,916	89.2	1,280	1,283.7	121,775	10.8	234	28.5	1,124,691	100	1,167	1,312
1978	1,058,022	89.4	1,371	1,450.7	124,940	10.6	274	34.2	1,182,962	100	1,255	1,484
1979	1,024,670	88.8	1,588	1,626.0	129,655	11.2	284	36.8	1,154,325	100	1,441	1,663
1980	973,190	87.9	1,938	1,886.5	134,328	12.1	293	39.4	1,107,518	100	1,739	1,925
1981	1,002,000	87.9	4,631	4,640.3	139,290	12.2	344	47.9	1,141,290	100	4,108	2,688
1982	1,013,000	87.8	8,274	8,381.9	140,305	12.2	694	97.4	1,153,305	100	7,352	8,479
1983	1,012,000	87.6	9,485	9,599.0	143,355	12.4	987	141.5	1,155,355	100	8,431	9,740
1984	1,020,000	87.3	10,847	11,064.2	148,623	12.7	1,063	158.0	1,168,623	100	9,603	11,222
1985	856,000	84.0	12,487	10,688.5	151,899	15.1	1,155	175.4	1,007,889	100	10,779	10,863

Source: Cifras de Produccion Agropecuaria de Costa Rica 1976-1985

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Table H.4.5   Cacao New York Market Price (1977/78-1984/85)

Unit : U.S. Dollar/45kg

Month \ Year	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85
10	176.82	171.86	132.62	98.03	98.50	67.43	90.19	110.49
11	181.92	179.37	127.73	90.61	93.60	61.58	95.58	111.00
12	148.72	174.63	136.74	89.14	95.70	67.25	-	105.30
1	139.68	161.90	137.81	95.00	95.40	76.15	-	105.40
2	135.39	153.91	142.28	92.60	94.70	82.62	-	106.52
3	154.51	147.15	136.64	95.90	88.30	78.06	124.32	109.85
4	156.64	140.63	127.85	95.50	79.20	79.50	121.89	113.33
5	141.81	147.27	112.21	87.70	77.80	88.61	128.58	110.34
6	137.92	148.18	106.57	75.30	71.20	97.65	117.35	109.17
7	144.74	136.77	105.35	91.90	70.60	96.96	106.43	111.68
8	153.84	132.00	95.99	101.80	71.00	98.13	110.72	114.56
9	169.00	140.94	101.58	106.30	76.40	92.28	116.71	116.84
Average	153.42	152.80	121.95	93.32	84.37	82.19	112.42	110.37
(per kg.)	(3.34)	(3.32)	(2.65)	(2.03)	(1.83)	(1.79)	(2.44)	(2.40)

Source: Organizacion del Estado Americana/The Wall Street Journal

Table H.4.6 Cacao Export and Domestic Consumption (1976-1985)

Item / Year	Export				Consumption				Total			
	Volume (M. Ton)	Ratio (%)	Unit Price (Colones)	Value (Million Colones)	Volume (M. Ton)	Ratio (%)	Unit Price (Colones)	Value (Million Colones)	Volume (M. Ton)	Ratio (%)	Unit Price (Colones)	Value (Million Colones)
1976	4,180	71.0	14,211	59.4	1,675	29.0	13,612	22.8	5,855	100	14,039	82.2
1977	5,627	73.0	26,000	146.3	2,067	27.0	27,334	56.5	7,694	100	26,358	202.8
1978	5,842	56.0	2,030	138.7	4,529	44.0	24,124	109.5	10,381	100	22,946	238.2
1979	4,235	41.0	19,599	83.0	6,130	59.0	21,958	134.6	10,365	100	20,994	217.6
1980	2,165	41.0	17,644	38.2	3,101	59.0	20,574	63.8	5,266	100	19,370	102.0
1981	2,024	40.0	35,25	71.7	3,025	60.0	3,504	107.4	5,049	100	35,453	179.0
1982	2,024	57.0	44,022	89.1	1,522	43.0	59,593	90.7	3,546	100	50,677	179.7
1983	708	33.0	55,367	39.2	1,453	67.0	82,657	120.1	2,161	100	73,716	159.3
1984	843	20.0	80,902	68.2	3,296	80.0	105,006	346.1	4,139	100	100,072	414.2
1985	1,267	28.5	85,083	107.8	3,184	71.5	98,210	312.7	4,451	100	94,473	420.5

Source: Cifras de Produccion Agropecuaria de Costa Rica 1976-1985

Table H.4.7 Received Tiquisque and Whole Sales Prices at San Jose Market (1981-1986)

Handling : Metric Tons/Month
Prices : 1,000 Colones/Ton

Year	Month	1	2	3	4	5	6	7	8	9	10	11	12	Total	Growth Rate
1981	Handling at Market	-	-	-	-	19.78	21.76	25.21	31.14	36.57	38.02	27.04	29.30	228.81	100
	Standard Price	-	-	-	-	2.6	2.6	2.5	2.4	2.6	2.6	2.7	2.85	2.6	100
1982	Handling at Market	34.91	26.86	17.62	12.83	18.81	19.87	12.47	20.47	13.71	10.49	28.38	22.79	239.22	104
	Standard Price	3.05	3.25	3.25	4.35	4.35	4.9	8.7	8.7	13.05	12.5	13.05	10.85	3.25	125
1983	Handling at Market	20.29	2.25	6.16	13.94	17.62	18.31	8.83	9.52	17.39	17.25	17.76	10.53	159.85	069
	Standard Price	11.95	9.8	10.0	9.8	9.8	9.8	15.0	15.0	18.0	19.55	20.0	18.0	9.80	376
1984	Handling at Market	22.47	16.64	21.97	31.37	19.96	27.60	17.49	33.40	31.50	36.91	40.48	33.60	333.39	146
	Standard Price	18.0	18.0	14.0	12.0	12.0	12.0	12.0	10.0	10.0	13.0	15.0	15.0	12.0	461
1985	Handling at Market	42.96	24.61	30.95	45.54	38.92	23.37	15.24	16.09	20.06	9.34	20.97	9.10	297.15	130
	Standard Price	15.0	15.0	15.0	15.0	15.0	15.0	15.0	20.0	20.0	20.0	20.0	25.0	15.0	576
1986	Handling at Market	13.01	11.39	10.49	19.36	15.00	17.07	20.29	17.15	23.78	24.11	21.88	23.34	216.85	094
	Standard Price	20.0	20.0	20.0	20.0	20.0	20.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	961

Source: Departmento Tecnico PIMA

Table H.4.8 Tubercrops Export in Different Countries (1983-1986)

Volume : Metric Tons
Value : U. S. Dollar

Countries	1983		1984		1985		1986		
Year	Volume	Value	Volume	Value	Volume	Volue	Volume	Ratio (%)	Value
Canada	270.9	130.0	189.0	72.0	221.8	95.6	242.9	(2.3)	135.6
U. S. A.	5,617.5	2,396.9	6,049.6	2,506.0	6,201.8	2,861.6	7,906.1	(75.3)	4,100.3
Puerto Rico	167.8	70.7	276.1	126.1	470.2	226.8	521.6	(5.0)	266.1
Colombia	455.8	59.5	456.0	60.0	329.9	46.7	258.8	(2.5)	55.5
W. Germany	205.8	86.9	111.6	42.6	33.6	17.7	230.5	(2.2	115.7
Holand	621.1	240.1	520.8	213.8	303.9	122.9	569.3	(5.4)	328.6
England	417.1	175.4	577.6	260.4	316.6	144.4	672.2	(6.4)	388.7
Others	88.8	34.7	301.4	160.2	128.3	52.9	94.7	(0.9)	61.6
Total	7,844.8	3,194.2	8,482.1	3,441.1	8,206.1	3,568.6	10,496.1	(100)	5,452.1
Average Price $/kg	-	0.40	-	0.40	-	0.43	-	-	0.52
[Growth Rate]	100	100	108	107	105	112	134		171

Source: Tabulados de Esportacion, Direccion General de Estadisticas y Censos   Anos 1983-1986

Table II.4.9 Yam New York Market Price (1982-1986)

Unit: US$/5 lb carton

Year	82		83	84		85		86	
Countries Imported / Month	Colombia	Brazil		Colombia	Brazil	Colombia	Brazil	Colombia	Brazil
1	27.00	—	NO DATA	—	24.50	—	23.0	22.33	24.17
2	27.00	—		—	24.50	—	23.0	20.25	24.0
3	2.40	—		22.0	24.50	—	23.0	19.80	24.0
4	25.50	—		22.0	26.80	—	23.0	19.75	23.88
5	24.75	—		24.0	27.50	23.0	25.0	29.50	23.13
6	24.20	—		24.0	28.50	23.0	27.50	19.50	23.50
7	24.25	—		23.50	29.50	23.0	27.15	19.88	22.38
8	24.50	29.50		25.50	27.75	23.0	29.0	20.0	22.0
9	—	30.00		25.50	24.87	23.70	23.60	20.0	21.0
10	30.00	29.00		25.50	23.00	24.0	24.0	21.75	22.88
11	30.20	29.00		—	23.00	24.0	24.0	21.75	22.88
12	28.20	—		—	23.00	24.00	24.0	24.1	24.10
Year Average	26.20	29.38		24.00	25.65	23.46	24.60	20.57	23.00
Price per M. tons	1,966	2,192	—	1,791	1,914	1,750	1,835	1,535	1,716

Source: Market News Service (USDA)

Table H.4.10 World Demand for Agricultural Production

Unit: Million Metric Tons

	Consumption 1969-71	Consumption 1980	Consumption 1985	Demand Forecast 1990	Total Increased (%) 1990/70	Growth Rate (%) 1990/70 annually
Cereals	1,207	1,538	1,725	1,910	58.3	2.3
Wheat	332	404	447	490	47.6	2.0
Paddy	310	400	447	493	59.1	2.3
Others	565	734	831	927	64.0	2.5
Tubercrops (Starch)	279	321	342	361	29.2	1.3
Sugar	82	107	124	145	76.8	2.6
Beans	52	69	79	91	73.5	2.8
Vegetables	223	290	330	374	67.7	2.6
Fruits	158	214	250	290	83.5	3.1
Meat	107	144	168	197	84.7	3.1
Cattle	39	51	60	70	80.1	3.0
Mutton and lamb	7	10	12	14	104.5	3.6
Pigs	36	46	53	61	71.4	2.7
Poultry	16	24	29	36	125.4	4.1
Eggs	19	25	29	34	75.1	2.8
Fish	41	57	68	81	96.3	3.4
Milk	389	476	532	587	53.3	2.2
(Skim Milk)	(40	50	58	66)	(65.5)	(2.6)
Cheese	9	12	14	16	74.4	2.8
Oil and fats	33	43	49	57	70.8	2.7
Butter	5	6	7	8	49.3	2.0
Vegetable oil	22	30	35	41	81.9	3.0

Table H.4.11   Commodity Consumption per Capita in Costa Rica in 1985

	Item	Consumption (kg/year/person)	Consumption for Group
1	Rice	60.11	
2	Wheat	43.96	124.93
3	Maize	20.86	
4	Cassava	20.90	24.14
5	Potato	13.24	
6	Beans	9.76	9.76
7	Tomato	9.88	
8	Onion	2.68	14.46
9	Other vegetables	1.90	
10	Banana	20.33	
11	Plantain	23.56	
12	Orange	40.39	97.78
13	Pineapple	3.65	
14	Papaya	2.52	
15	Other fruits	7.33	
16	Beef	23.18	
17	Pork	3.79	32.10
18	Chicken	5.13	
19	Egg	9.05	9.05
20	Milk	83.49	112.89
21	Dairy Products	29.40	
22	Fish	2.52	2.52
23	Cooking Oil	0.22	64.92
24	Sugar	64.70	
25	Coffee	6.95	7.70
26	Cocoa/Tea	0.75	
27	Spicery	0.14	0.14

Source: Food Balance Sheet.   SEPSA

Table H.4.12 Cacao Export in Different Countries

(Costa Rica 1983-1985)

Volume : Metric Tons
Value : U. S. Dollar

Year Countries	1983		1984		1985		1986		
	Volume	Value	Volume	Value	Volume	Value	Volume	Ratio (%)	Value
U. S. A.	17.4	19.7	69.7	133.5	460.2	718.5	27.8	(1.1)	50.2
W. Germany	65.6	86.4	4.4	5.2	332.9	610.1	251.5	(9.7)	402.6
Japan	653.5	915.7	768.9	1,407.4	596.0	1,013.7	1,018.7	(39.2)	1,597.4
France	-	-	-	-	40.5	72.3	1,298.1	(50.0)	2,051.1
Others	-	-	-	-	20.4	40.4	-	-	-
Total	736.5	1,021.8	843.0	1,546.1	1,450.0	2,455.0	2,596.1	(100)	4,102.3
Average Price $ / kg	-	1.38	-	1.83	-	1.69	-	-	1.58
[Growth Rate]	100	100	114	151	197	240	352		401

Source: Estadisticas de Exportacion, Direccion General de Estadisticas y Censos   Anos 1983-1986

Table H.4.13 Cacao Actual Production/Projected and Consumption in the World

Area \ Year	Actual 1970	1980	1983	Projected 1990	Growth Rate 1970-80	1980-90
	thousand metric tons				(%)	
World	1,388	1,616	1,518	2,060	1.5	2.5
Developing Countries	1,388	1,616	1,518	2,060	1.5	2.5
(Latin America)	(371	555	543	708)	(4.1	2.5)

| | Cacao Consumption | | | | | |
	Actual 1970	1980	1983	Projected 1990	Growth Rate 1970-80	1980-90
World	1,410	1,533	1,725	1,801	0.8	1.6
Developing Countries	140	192	225	275	3.2	3.7
(Latin America)	(111	134	152	192)	(1.9	3.7
Developed Countries	1,270	1,341	1,500	1,526	0.5	1.3
Canada	(37	33	44	39)	($\triangle$1.1	1.7)
U. S. A.	(364	342	412	386)	($\triangle$0.6	1.2)
Belgium	(24	33	37	34)	(3.2	0.3)
France	(80	101	111	114)	(2.4	1.2)
Germany	(160	164	172	170)	(0.2	0.4)
Italy	(31	40	47	46)	(2.6	1.4)
Netherland	(36	31	34	29)	($\triangle$1.5	$\triangle$0.7)
United Kingdom	(115	99	109	105)	($\triangle$1.5	0.6)
Spain	(35	29	38	34)	($\triangle$1.9	1.6)
Switzland	(21	27	28	29)	(2.5	0.7)
E. Europe USSR	(210	254	263	315)	(1.9	2.2)
Japan	(50	56	72	74)	(1.1	2.8)

Source: FAO

Table H.4.14   Tubercrops Actual Production/Projected and Consumption in
              the World

Year Area	Actual			Projected	Growth Rate	
	1970	1980	1983	1990	1970-80	1980-90
	thousand metric tons				(%)	
World	540,008	554,460	562,656	626,226	0.3	1.2
Developing Countries	293,419	342,538	357,298	422,002	1.6	2.1
(Latin America)	(49,337	45,111	40,866	54,520)	(△0.9	1.9)
Developed Countries	246,589	211,922	205,358	204,224	△1.5	△0.4

	Cacao Consumption					
	Actual			Projected	Growth Rate	
	1970	1980	1983	1990	1970-80	1980-90
	thousand metric tons				(%)	
World	542,444	561,936	-	626,090	0.4	1.1
Developing Countries	288,734	326,771	-	399,685	1.2	2.0
(Latin America)	(49,325	45,306	-	53,758)	(△0.8	1.7)
Developed Countries	253,710	235,165	-	226,405	△0.8	△0.4

Source: FAO

Figure H.4.1 Cacao Marketing System in Costa Rica
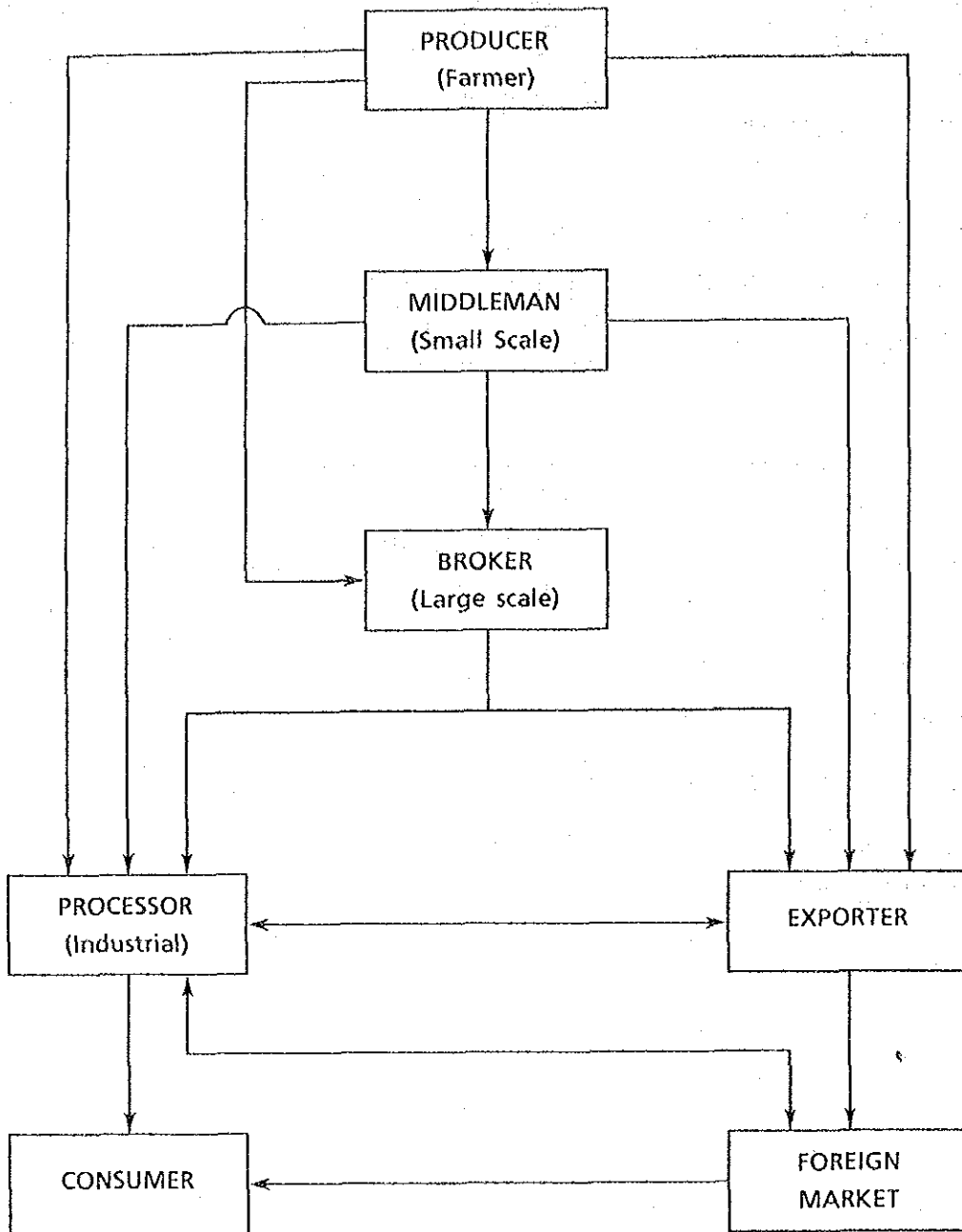
Source: SEPSA

H.5   Strengthening of Agricultural Extension Services

The scheme of this agri-extension services would be strengthening for the IDA and MAG. The scheme aims to increase the number of extension staff and provide adequate transport, as well as to provide the extension of audio-visual car.

Table H.5.1   Strengthening of Agricultural Extension

Services – MAG

	Atlantic Region		Siquirres District		Matina District	
	Existing Staff	Proposed Staff	Existing Staff	Proposed Staff	Existing Staff	Proposed Staff
Director	1	1	1	1	1	1
Extension Staff	4	10	3	10	1	10
Veterinarian	1	1	1	2	–	2
Livestock	5	5	3	4	–	4
Forestry	3	3	–	1	–	1
Assistants	17	20	10	10	2	10
Clerk	9	10	6	6	2	6
Total	40	50	24	34	6	34

	Existing	Proposed	Existing	Proposed	Existing	Proposed
Extension vehicles	12	20	1	10	1	10
Motorcycle	7	20	3	10	2	10
Audio-visual	–	1	–	–	–	–
Lecture room	–	$300m^2$	–	$200m^2$	–	$200m^2$

Table H.5.2   Strengthening of Agricultural Extension

Services — IDA

	Atlantic Region		Maryland Sub-Region		Bataan Sub-Region	
	Existing Staff	Proposed Staff	Existing Staff	Proposed Staff	Existing Staff	Proposed Staff
Director	1	1	-	-	-	-
Administrator	-	-	1	1	1	1
Professional for settlement	-	-	3	-	-	-
Agricultural technician	-	-	4	10	1	10
Accountant	-	-	1	1	-	1
Assistant administrator	-	-	1	-	-	-
Clerk	-	1	1	1	4	1
Office servant	-	-	1	2	2	2
Mechanic and Equipment Operator	-	2	-	5	-	5

	Existing	Proposed	Existing	Proposed	Existing	Proposed
Extension vehicle	-	1	7	10	1	10
Motorcycle	-	1	1	10	3	10
Audio visual-car	-	1	-	-	-	-

Supporting Services

Project	Items	1990 number	1990 unit price 10,000 yen	1990 Cost 10,000 yen	1992 number	1992 unit price 10,000 yen	1992 Cost 10,000 yen	1995 number	1995 unit price 10,000 yen	1995 Cost 10,000 yen	1998 number	1998 unit price 10,000 yen	1998 Cost 10,000 yen	2000 number	2000 unit price 10,000 yen	2000 Cost 10,000 yen	Total number	Total unit price 10,000 yen	Total Cost 10,000 yen
1 Strengthning of Agri-extension Servies	(1) Extension Vehicles				61	300	18,300										61	300	18,300
	(2) Motor-cycles				61	20	1,220										61	20	1,220
	(3) Audio visual-car				2	1,500	3,000										2	1,500	3,000
	(4) Lectur rooms (m2)				700	5	3,500										700	5.0	3,500
Sub Total							26,020												26,020
2 Cacao post-harvest Facilities	(1) Fermentation box (m2)	8,000	0.3	2,400				8,000	0.3	2,400	4,000	0.3	1,200				20,000	0.3	6,000
	(2) " house	480	3.0	1,440				480	3.0	1,440	240	3.0	720				1,200	3.0	3,600
	(3) Dryer (unit)	8	1,000	8,000				8	1,000	8,000	4	1,000	4,000				20	1,000	20,000
	(4) Covered dry yard	1,440	3.0	4,320				1,440	3.0	4,320	720	3.0	2,160				3,600	3.0	10,800
	(5) Packing facilities (unit)	8	500	4,000				8	500	4,000	4	500	2,000				20	500	10,000
Sub Total				20,160						(20,160)			(10,080)						50,400
3 Marketing facilities	(1) Washing/choice machine (unit)				2	800	1,600	4	800	3,200	2	800	1,600				8	800	6,400
	(2) Covered dry yard/covered				2	1,000	2,00	4	1,000	4,000	2	1,000	2,000				8	1,000	8,000
	(3) Weighing, Packing equipment				2	200	400	4	200	800	2	200	400				8	200	1,600
	(4) Transportation track (number)				2	300	600	4	300	1,200	2	300	600				8	300	2,400
Sub Total							4,600			9,200			4,600						18,400
4 Farm machinery	(1) Tractor (unit)	10	800	8,000				20	800	16,000				10	800	8,000	40	800	32,000
	(2) Bulldozer	2	1,100	2,200				4	1,100	4,400				2	1,100	2,200	8	1,100	8,800
	(3) Combine for paddy	4	600	2,400				-	600	-				4	600	2,400	8	600	4,800
	(4) Workshop	2	1,200	2,400				4	1,200	4,800				2	1,200	2,400	8	1,200	9,600
Sub Total				15,000						25,200						15,000			55,200
Total				35,160			30,620			54,560			14,680			15,000			150,020
(rotation of fund)				-			-			(△20,160)			(△10,080)			-			(△30,240)
Real expense				35,160			30,620			34,400			4,600			15,000			119,780

H.6 Existing Farm Management of Model Farmer

Existing farm management of model farmer in the study area are shown from Table H.6(1) to Table H.6(4).

Table H.6 (1)   Existing Farm Management of Model Farm

Model: ____A____

1. Block	B: MATINA
2. Farming Pattern	Cacao Single Crop
3. Land Holding Area (ha)	11.0 ha
4. Farming System	Cacao 4.0 ha Fallow land 7.0 ha
5. Family (No.)	7 Persons, Home Worker : 2 Persons
6. Cropping Pattern	(1) Cropping Area : 4.0 ha (2) Harvesting Area: 2.6 ha
7. Working Day (year)	250 days

8. Farm Management

(1) Agricultural Gross Income		(2) Production Cost		(3) Non Agricultural In	
Item	Value (¢)	Item	Value (¢)	Item	Value (¢)
Cacao	74,100	Wage	12,400	Banana Farm	72,600
		Seeds	-		
		Fertilizers	5,000		
		Pesticides	2,900		
		Rental Tractor	-		
		Others	1,000		
Total	74,100	Total	21,300	Total	72,600

9. Net Income and Living Cost

	Local Currency (¢)	U.S. $
(1) Net Agricaltural Income	52,800	861
(2) Total Net Income	125,400	2,046
(3) Living Cost	120,000 ~ 125,000	2,000 ~ 2,100

Table H.6 (2)　　Existing Farm Management of Model Farm

Model: ___B___

1. Block	B: Battan
2. Farming Pattern	Cacao and Rice
3. Land Holding Area (ha)	8.0 ha
4. Farming System	Rice 6.0 ha, Cacao 1.0 ha, Fallow 1.0 ha
5. Family (No.)	9 Persons, Home Worker : 2 Persons
6. Cropping Pattern	(1) Cropping Area : Cacao 1.0 ha, Rice 6.0 ha (2) Harvesting Area: - Dito - ha
7. Working Day (year)	300 days

8. Farm Management

(1) Agricultural Gross Income		(2) Production Cost		(3) Non Agricultural In	
Item	Value (¢)	Item	Value (¢)	Item	Value (¢)
Cacao	38,000	Wage	97,000	Banana Farm	30,000
Rice	460,000	Seeds	60,000		
		Fertilizers	60,000		
		Pesticides	122,500		
		Rental Tractor	7,500		
		Others	1,000		
Total	498,000	Total	415,500	Total	30,000

9. Net Income and Living Cost

	Local Currency (¢)	U.S. $
(1) Net Agricultural Income	82,500	1,347
(2) Total Net Income	112,580	489
(3) Living Cost	100,000 ~ 120,000	1,700 ~ 1,950

Table H.6 (3) Existing Farm Management of Model Farm

Model: ___C___

1. Block	8: Battan
2. Farming Pattern	Rice Single Crop
3. Land Holding Area (ha)	8.8 ha
4. Farming System	Rice 3.5 ha, Ohter 8.1 ha, Fallow 5.2 ha
5. Family (No.)	6 Persons, Home Worker : 2 Persons
6. Cropping Pattern	(1) Cropping Area : Rice 3.5 ha, Maize, Frijol .1 ha (2) Harvesting Area: - Dito - ha
7. Working Day (year)	380 days

8. Farm Management

(1) Agricultural Gross Income		(2) Production Cost		(3) Non Agricultural In	
Item	Value (¢)	Item	Value (¢)	Item	Value (¢)
Rice	268,380	Wage	45,000	Banana Farm	60,480
Maize	0	Seeds	35,000		
Frijol	0	Fertilizers	30,000		
		Pesticides	25,000		
		Rental Fee			
		Tractor			
		Others	1,000		
Total	268,380	Total	181,000	Total	60,480

9. Net Income and Living Cost

	Local Currency (¢)	U.S. $
(1) Net Agricaltural Income	87,380	1,425
(2) Total Net Income	147,860	2,412
(3) Living Cost	130,000 ~ 140,000	2,120 ~ 2,283

Table H.6 (4)   Existing Farm Management of Model Farm

Model: _____ D _____

1. Block	D: Marry Land				
2. Farming Pattern	Rice + Maizer + Frijol + Tuber Crops				
3. Land Holding Area (ha)	Rice 2.0, Maize 0.5, Frijol 0.5 Tuber 0.5, Fallow 6.5 ha				
4. Farming System	10 Prsons, Home Workers 2				
5. Family (No.)					
6. Cropping Pattern					
	(1) Cropping Area : 3.5 ha (2) Harvesting Area: 3.0 ha				
7. Working Day (year)	days				

8. Farm Management

(1) Agricultural Gross Income		(2) Production Cost		(3) Non Agricultural In	
Item	Value (¢)	Item	Value (¢)	Item	Value (¢)
Rice	156,200	Wage	59,800	Cattle Farm	43,000
Maize	6,900	Seeds	23,700		
Frijol	5,400	Fertilizers	23,300		
Tuber	42,000	Pesticides	32,800		
		Rental Tractor	28,600		
		Others	1,000		
Total	210,500	Total	169,200	Total	43,000

9. Net Income and Living Cost

	Local Currency (¢)	U.S. $
(1) Net Agricaltural Income	41,300	673
(2) Total Net Income	43,000	701
(3) Living Cost	80,000 ~ 85,000	1,300 ~ 1,880

Annex I   Settlement, Rural Development Plan and Roads

Annex I   Settlement, Rural Development Plan and Roads

List of Table

I.1 IDA's Role

(1) Purchase of land for settlement

(2) Project plan for land division and its execution

(3) Transference of land ownership and selection of farmers qualified for settlement

(4) Activity of propagation for settled farmers and dairy farmers

(5) Aid to commercial deal in products

(6) Allowance for traffic facilities to farmers

(7) Intermediation of loan for term house construction

(8) Lend-lease of agricultural machines and intermediation of farming fund

(9) Farmers' organization

The boards for development, welfare, education school administration will be set up to smooth the administrative affairs in the relative organizations.

I.2 IDA's Conditions for Settlement and Acquisition of Land Ownership

(1) IDA's Conditions for Settlement

1) To be a Costa Rican
2) The head of a family must be older than 18 in age
3) To be married and with sons and daughters
4) To be a farmer
5) Non land-owner
6) Low-income bracket less than 1,000 ₡ a month

7) Healthy

8) Literate

9) Holder of identification card

(2) <u>Acquisition of land ownership</u>

1) The period of test for six months is set to observe a farmer's ability.

2) Land is to be allowed to a farmer after his solvency has been confirmed. Land ownership is given after five years have passed.

3) Land ownership is given after five year have passed.

4) To continue farming for 15 years

5) After 15 years have passed, his land can be sold without IDA's approval.

6) Land Tax is exempt for 5 years after settlement.

7) Farm land for sale shall not be admitted for lease

8) The sale price of farm land is the sum of IDA's purchase price, construction cost and interest on loan (deferment for five years and rate of interest at 7%) which shall be paid for 20 years.

I.3 Actual Situation of Existing Roads

The actual situation of the existing roads in the area is indicated every zone in Table I.3.1 according to the following classification.

Classification of Actual Road

A: National road Route No. 32
B: Effective width more than 6 m
C: Effective width 4 m through 6 m
D: Effective width less than 4 m

I.4 Road Development Plan

As the planned road network in the area, main and trunk roads will be planned. As lateral roads are greatly influenced by the topography and location of the existing farms, they will be dealt within the farm maintenance and development plan.

These road networks will be used for the intake of agricultural materials and equipments and for the transportation of agricultural products.

Division, distance and classification of construction or repair in each zone are shown in the following Table I.4.1.

Table I.3.1 (1)   Actual Situation of Existing Roads

Zone A: CARRANDI

Section	Distance	Classification	Remark
1. R32 - Larga Distancia	2.9	C	N.R
2. Larga Distancia - Catorce Millas	1.6	D	N.R
3. Larga Distancia - Palacios	3.0	D	O.R
4. R32 - San Edmond	8.1	D	C.R
5. R32 ~ Punta de Riel	10.0	C	N.R
6. R32	10.8	A	N.R
Sub-Total	36.4		N.R = 25.3
			C.R = 8.1
			O.R = 3.0

Zone B: BATAAN

Section	Distance	Classification	Remark
1. R32 - Matina	4.2	B	N.R
2. Matina - Cuatro Millas	5.6	C	N.R
3. C.M - Bara Matina Norte	6.0	D	C.R
4. C.M - Helvetia	4.1	D	N.R
5. R32 - Bataan	5.0	B	N.R
6. Matina - Bataan	5.5	C	N.R
7. 25 Millas - Santa Marta	5.4	C	C.R
8. 25 Millas - Luzon - S.M	6.3	D	C.R
9. Santa Marta - Goschen	3.0	D	C.R
10. Santa Marta - Damasco	3.6	D	C.R
11. Davao - R32	3.0	D	C.R
12. Bataan - Berta	11.0	C	N.R
13. Bataan - Sara	2.0	C	N.R
14. Ferrocarril Desmantelado	4.8	D	N.R
15. F.D - Perla	5.0	C	C.R
16. R32 - 28 Millas	4.0	C	C.R
17. 28 Millas - Asbana	2.0	C	C.R
18. R32	15.5	A	N.R
Sub-Total	96.0		N.R = 57.7
			C.R = 38.3
			O.R = 0.0

Zone C: PACUARITO

Section	Distance	Classification	Remark
1. Madre de Dios - Perla	8.7	C	C.R
2. Madre de Dios - Plaza	9.8	D	C.R
3. R32 - Manila	8.3	D	N.R
4. Freehold - Bananera	1.8	C	C.R
5. R32	10.1	A	N.R
Sub-Total	38.7		N.R = 18.4
			C.R = 20.3
			O.R = 0.0

Table I.3.1 (2)   Actual Situation of Existing Roads

Zone D: SIQUIRES

Section	Distance	Classification	Remark
1. Siquirros - Indi Tres	9.2	C	C.R
2. R32 - Siq. - Carmen	14.5	B	N.R
3. R32 - San Alberto Nuevo	6.0	B	C.R
4. S.A.N - Santa Lucia	2.7	D	O.R
5. Carmen - Dorotea	5.6	C	N.R
6. Carmen - San Rafael	16.7	C	C.R
7. Punta del Riel - Rio Aguaz	17.7	D	C.R
8. Mery Land	24.6	D	O.R
9. R32	5.1	A	N.R
Sub-Total	102.1		N.R = 25.2
			C.R = 49.6
			O.R = 27.3

Total	273.2		
			N.R = 126.6 (46)
			C.R = 116.3 (43)
			O.R = 30.3 (11)
			273.2

Table I.4.1   Planned Road Network

Route	Section	Extension			Note
		New	Repair	Total	
A Zone					
A-1	R32 – Punta de Riel – R32	9.2	15.0	24.2	N.R. 803
A-2	R32 ~ Suborio	0.0	4.3	4.3	
A-3	Estrada – Catorce Millas	8.8	1.2	10.0	
Sub-Total		18.0	20.5	38.5	
B Zone					
MAIN ROAD	R32 ~ Bataan – Rio M.D.D.	3.0	11.0	14.0	N.R. 804
B-1	R32 – Matina	4.2	0.0	4.2	N.R. 808
B-2	Matina – Main Road	0.0	20.0	20.0	N.R. 805
B-3	Cuatro Millas – Canal Tortugero	0.0	7.0	7.0	
B-4	Margarita – B-2	5.1	3.1	8.2	
B-5	B-2 – Rio M.D.D.	0.0	1.4	1.4	
B-6	R32 – Rio M.D.D.	0.0	4.0	4.0	
Sub-Total		12.3	46.5	58.8	
C Zone					
Main Road	Rio M.D.D. – Rio Pacuare	6.5	0.0	6.5	
C-1	Rio M.D.D. – Perla – Rio M.D.D.	5.6	12.4	18.0	
C-2	Rio M.D.D. – Manila	0.0	8.0	8.0	N.R.804
C-3	R32 – Manila – Main Road	11.0	0.0	11.0	N.R.806
Sub-Total		23.1	20.4	43.5	
D Zone					
Main Road	Rio Pacuare – Golden Grove	10.0	0.5	10.5	
D-1	R32 – Indiana Tres	0.0	9.2	9.2	N.R.806
D-2	Siquirres – Carmen – Suerre	8.0	18.1	26.1	
D-3	D-2 – Barnstorf – D-4	3.0	8.0	11.0	
D-4	D-2 – Suiza – Main Road	5.1	2.1	7.2	
D-5	Main Road – Canal Tortuguero	0.0	14.0	14.0	
D-6	Main Road – Canal Tortuguero	2.0	12.0	14.0	
Sub-Total		28.1	63.9	92.0	
Total		81.5	151.3	232.8	

1) N.R. 803 : National Rute 803, It indicates also the overlaped
               division with MOPT's national road plan.

2) Rio M.D.D.: Rio Madre de Dios

Annex J   Project Evaluation

Annex J. Project Evaluation

J.1 Economic evaluation

The following parameters are employed in the economic evaluation of the Project.

(1) The term of evaluation is set up as 50 years after commencement of the Project. This term is coincident with land reclamation life which has longest durable period. The operation and maintenance cost in the project life is calculated assuming that equipment and machinery required for O & M are replaced in the course of its life.

(2) The Colones converted into US dollars are used for economic evaluation. The exchange rate of US$1.00 = ₡61.30 as formal rate of May, 1987 is used.

(3) The Costs of transfer items concerned to project cost and O & M cost (price contingency) are excluded.

(4) The economic labor cost concerned to project cost and O & M cost is applied at actual wage, consequently, the shadow price for labor cost is not used.

(5) Land acquisition costs are excluded assuming that the opportunity costs for these items is zero.

(6) The following price of agricultural products is used as economic price.

1) International market price:

Banana	¢ 18,810	(Financial price :	¢ 13,200)
Cacao	¢102,754	(Financial price :	¢ 95,000)
Coconut	¢ 10,697	(Financial price :	¢ 8,600)
Black pepper	¢223,609	(Financial price :	¢200,000)
Beef cows	¢ 46,218	(Financial price :	¢ 50,000)

Note: The economic prices were calculated considering freight and insurance charges from Limon port to international market(U.S.A) processing and handling charges in Costa Rica, except for banana. Economic price of banana is estimated based on the fixed price by ASBANA.

The international trade price is adopted from Agricultural Outlook, USAD, Aug. 1987and FAO Bulletin of Agricultural Statistics, June, 1987.

2) Farmgate price:

Plantain	¢ 8,500	(Equal to financial price)
Tuber crops	¢14,000	(")

Note: Actual farm gate price based on farm management survey is used as economic price.

3) Sustaining price:
(by CNP)

Rice	¢14,200	(Equal to financial price)
Maize	¢13,669	(")
Kidney bean	¢35,788	(")

Note: The sustaining price used as economic price is set up in 1987 by CNP.

(7) As the economic price for farm input which is included in the production cost, the price calculated on the basis of the fixed price for farm credit in the term of 1987 by BNCR and the MAG's statistics of import for agro-chemical and fertilizers are used as economic price.

The opportunity cost of labor has been computed at ¢47.19/hr. considering the average rate of unemployed in the Study Area (9.9%) and a wage of banana plantations (¢52.38/hr).

(8) Interest for farm credit and O & M charge are not included in the production cost for calculation of the internal rate of return.

(9) Annual production cost after completion of the Project is equal to the cost corresponding to the target yield.

J.1.1 Benefits

The project benefits are evaluated with incremental production value which represent the difference between the with Project and the without Project and reduced transportation cost of agricultural production and farm inputs with project.

- Total increased benefit in the target term

Unit : 1000 ¢
(1000 US$)

Zone :	A	B	C	D
	1,037,588	2,176,217	1,276,187	2,030,090
	(US$16,926)	(US$35,501)	(US$20,819)	(US$33,117)

Details are shown in Table J.1.1 and J.1.3

− Reduced transportation cost

<div align="right">Unit : US$</div>

Zone :	A	B	C	D
	24,697	152,261	27,422	265,857

Details are shown in Table J.1.7.(1) − (4)

J.1.2 Costs

(1) Project Costs

The project costs excluding price contingency will be paid corresponding to the process of works as described in Chapter 5 of Master Plan Study Report. Annual outlay of each zone used for the project evaluation is estimated as follows:

			Unit : 1,000US$	
Year	A	B	C	D
1	307	390	253	664 [1]
2	2,132	390	253	2,473
3	5,780	6,464	4,834	11,634
4	4,692	10,106	4,612	4,199
5	−	4,081	4,998	6,803
Total	12,911	21,431	14,950	25,773

Note: [1]/The construction cost for flood protection in the left bank of *Rio Reventazon is excluded due to an outside the* project area.

(2) O & M Cost

Annual O & M cost for the Project are shown in Chapter 5 of Master Plan Study Report.

(3) Production cost

Production cost of the Pproject is estimated as follows:

Unit : 1,000 ¢
(1,000US$)

	Zone A	Zone B	Zone C	Zone D
Without Project :	123,100	244,777	63,197	122,164
	(2,008)	(3,993)	(1,031)	(1,993)
With Project :	651,083	1,227,591	730,091	1,157,856
	(10,621)	(20,026)	(11,910)	(18,888)
Increased Cost :	527,983	982,814	666,894	1,035,692
	(8,613)	(16,033)	(10,879)	(16,895)

Detail is shown in table J.1.2, J.1.4, J.1.5 and J.1.6.

J.1.3 Economic internal rate of return and net present value

The economic internal rate of return (EIRR) on all project investment is computed based on the assumptions and parameters as mentioned above, and results are obtained below.

On the other hand, the benefit-cost ratio (B/C) at 8,12 and 18% discount rate and net present value (NPV) of each zone are also included in the following table.

EIRR, B/C and NPV of the Project

Zone	EIRR	B/C			NPV(1,000 US$)		
		* 8%	* 12%	* 18%	* 8%	* 12%	* 18%
A	21.7%	1.49	1.32	1.11	43,114.30	17,809.70	3,591.01
B	25.4%	1.67	1.48	1.24	101,349.00	43,822.50	12,225.00
C	22.8%	1.49	1.34	1.14	50,815.30	21,130.90	4,832.88
D	20.5%	1.48	1.30	1.08	78,431.60	30,616.40	4,664.25

* Discount rate

Details of EIRR are shown in table J.1.8.(1) - (4).

J.1.4 Sensitivity analysis

Sensitivity analysis have been made considering the parameters employed such as an increase of construction cost, reduction of benefit, and combination of these parameters.

		Zone A	Zone B	Zone C	Zone D
Case (1)	a 20% increase in construction cost	19.9%	22.7%	20.6%	16.8%
Case (2)	a 10% decrease of benefit (price or yield reduced)	18.0%	20.9%	18.5%	15.2%
Case (3)	a combination of (1) and (2)	16.5%	19.3%	17.0%	13.9%

Table J.1.1   Total Amount of Production Value - without Project

Crops \ Area	A	B	C	D
				Unit : 1,000 ¢
Banana	--	--	--	--
Cacao	16,235	50,041	23,736	30,929
Coconut	1,316	6,076	4,140	5,370
Plantain	--	--	--	--
Black pepper	--	--	--	--
Rice	121,154	221,606	15,336	33,470
Maize	2,679	5,727	6,069	13,450
Kidney bean	2,935	787	394	859
Tuber crop	5,628	19,992	27,636	61,488
Live stock	3,628	6,540	4,633	7,695
Total	153,587	310,769	81,944	153,531
(Us dollar)	(2,505)	(5,070)	(1,337)	(2,505)

Table J.1.2   Total Amount of Production Cost - without Project

Crops \ Area	A	B	C	D
				Unit : 1,000 ¢
Banana	--	--	--	--
Cacao	9,822	30,340	14,406	18,771
Coconut	880	4,056	2,767	3,584
Plantain	--	--	--	--
Black pepper	--	--	--	--
Rice	99,404	181,822	12,582	27,682
Maize	2,296	4,916	5,212	11,551
Kidney bean	2,698	710	347	792
Tuber crop	4,863	17,273	23,878	53,126
Live stock	3,145	5,660	4,005	6,658
Total	123,100	244,777	63,197	122,164
(Us dollar)	(2,008)	(3,993)	(1,031)	(1,993)

Table J.1.3   Total Amount of Production Value - with Project

Area / Crops	A	B	C	D
				Unit : 1,000 ¢
Banana	647,026	1,177,920	829,521	663,617
Cacao	208,077	266,338	154,439	295,932
Coconut	81,161	462,393	28,882	81,832
Plantain	19,278	63,878	36,720	97,538
Black pepper	--	79,605	177,098	531,295
Rice	165,572	295,474	45,298	95,523
Maize	5,850	16,471	14,175	41,745
Kidney bean	4,831	15,898	8,374	46,453
Tuber crop	27,468	97,370	52,220	306,166
Live stock	7,457	11,647	11,404	23,520
Total	1,166,720	2,486,986	1,358,131	2,183,621
(Us dollar)	(19,033)	(40,571)	(22,155)	(35,622)

Table J.1.4   Total Amount of Production Cost - with Project

Area / Crops	A	B	C	D
				Unit : 1,000 ¢
Banana	403,201	734,032	516,924	413,539
Cacao	82,367	105,430	61,135	117,144
Coconut	8,127	23,138	16,254	46,052
Plantain	12,384	41,280	24,768	70,176
Black pepper	—	21,787	48,416	145,248
Rice	114,366	209,188	13,938	73,108
Maize	3,849	10,849	9,723	29,891
Kidney bean	3,232	10,630	5,997	32,498
Tuber crop	17,099	61,177	27,071	209,844
Live stock	6,458	10,080	5,865	20,356
Total	651,083	1,227,591	730,091	1,157,856
(Us dollar)	(10,621)	(20,026)	(11,910)	(18,888)

Table J.1.5 Agricultural Return and Production Cost per Ha

Economic

Item	Production Cost								Target Yield (t/ha)	Unit Price (t)	Gross Income (A)	N.P.V (B)	B/A (%)
	Seed	Fert.	Agro Chem.	Labor	Mech.	Water Change	Others	Total					
1. Banana													
With Project	(76,000)	160,191	269,066	106,933			38,170	574,360	49	18,810	921,690	347,330	38
2. Cacao													
Without Project	(14,664)	5,037	2,933	12,822			1,035	21,827	0.35	102,754	35,964	14,137	39
With Project	(16,188)	10,489	4,566	24,585			1,035	40,675	1.00	102,754	102,754	62,879	60
3. Coconut													
Without Project	(5,600)	6,639	2,132	6,795			155	15,721	2.2	10,697	23,533	7,812	33
With Project	(11,360)	27,992	6,582	24,959			726	60,199	10.0	10,697	106,970	46,771	44
4. Plantain													
With Project	(12,600)	15,603	34,498	33,080			3,152	91,733	17.0	8,500	144,500	52,767	37
5. Black pepper													
With Project	(178,750)	41,223	6,690	83,998			2,578	134,489	2.2	223,609	491,940	357,451	73
6. Rice													
Without Project	5,036	4,834	7,296	7,296	6,429		566	31,457	3.0 (2.7)	14,200	38,340	6,883	18
With Project	5,283	6,232	12,521	8,442	7,007		728	40,213	4.5 (4.1)	14,200	58,220	18,007	31
7. Maize													
Without Project	705	4,272	973	7,839			298	14,087	1.2	13,669	16,402	2,315	14
With Project	1,815	5,150	1,676	8,140	5,540		987	22,508	2.5	13,669	34,172	11,664	34
8. kidney bean													
Without Project	1,857	2,388	2,658	9,292			305	18,500	0.5	35,788	17,894	1,394	8
With Project	3,280	3,337	7,131	12,770	7,021		2,373	35,912	1.5	35,788	53,682	17,770	33
9. Tuber crop													
Without Project	7,700	4,375	8,053	33,854	9,600		8,995	72,577	6.0	14,000	84,000	11,423	14
With Project	9,450	5,704	12,263	48,983	9,600		8,995	94,995	11.0	14,000	154,000	59,005	38

Table J.1.6 Return and Cost of Livestock per Head

Item	Production Cost	Target Yield (t/head)	Unit Price (t)	Gross Income (A)	N.P.V (B)
Without Project	2,500	0.25	46,218	11,555	9,055
With Project	3,500	0.35	46,218	16,176	12,676

Table J.1.7 (1) Benefit by Reduced Transportation - Zone A

Zone : A

1) Condition

	Capacity	Velocity	Transported distance
Without Project	2 t truck	15km	3km
With Project	8 t truck	30km	2km

2) Cost

Description	Without Project	With Project
Capacity(90%)	1.8 t	7.2 t
Traveling hour	0.2 hour	0.07hour
Traveling hour per ton	0.11hr/ton	0.01hr/ton
Depreciation	US$ 2.62	US$ 7.14
Fuel	1.31	3.48
Driver	1.02	1.02
Operating cost per hour	4.95	11.64
Transporting cost per ton	0.58	0.12

3) Benefit by reduced transportation

0.58 - 0.12 = 0.46 US$/ton

Year	Production	Farm input	Total	Benefit
1	12,180 t	4,335 t	16,515 t	6,936 US$
2	48,496	4,335	52,831	22,189
3	51,304	4,335	55,639	23,368
4	52,416	4,335	56,751	23,835
5	53,861	4,335	58,191	24,442
6	53,996	4,335	58,331	24,499
7	54,468	4,335	58,803	24,697

Table J.1.7 (2)   Benefit by Reduced Transportation - Zone B

Zone : B

1) Condition

	Capacity	Velocity	Transported distance
Without Project	2 t truck	15km	8km
With Project	8 t truck	30km	3km

2) Cost

Description	Without Project	With Project
Capacity(90%)	1.8 t	7.2 t
Traveling hour	0.53hour	0.1 hour
Traveling hour per ton	0.29hr/ton	0.01hr/ton
Depreciation	US$ 2.62	US$ 7.14
Fuel	1.31	3.48
Driver	1.02	1.02
Operating cost per hour	4.95	11.64
Transporting cost per ton	1.44	0.12

3) Benefit by reduced transportation

1.44 − 0.12 = 1.32 US$/ton

Year	Production	Farm input	Total	Benefit
1	25,028 t	7,974 t	33,002 t	43,563 US$
2	93,616	7,974	101,590	134,099
3	101,094	7,974	109,068	143,970
4	103,030	7,974	111,004	146,525
5	105,350	7,974	113,324	149,588
6	105,800	7,974	113,774	150,182
7	107,375	7,974	115,349	152,261

Table J.1.7 (3)   Benefit by Reduced Transportation - Zone C

Zone : C

1) Condition

	Capacity	Velocity	Transported distance
Without Project	2 t truck	15km	3km
With Project	8 t truck	30km	2km

2) Cost

Description	Without Project	With Project
Capacity(90%)	1.8 t	7.2 t
Traveling hour	0.2 hour	0.07hour
Traveling hour per ton	0.11hr/ton	0.01hr/ton
Depreciation	US$ 2.62	US$ 7.14
Fuel	1.31	3.48
Driver	1.02	1.02
Operating cost per hour	4.95	11.64
Transporting cost per ton	0.58	0.12

3) Benefit by reduced transportation

0.58 - 0.12 = 0.46 US$/ton

Year	Production	Farm input	Total	Benefit
1	7,008 t	3,484 t	10,492 t	4,407 US$
2	53,056	3,484	56,540	23,747
3	58,057	3,484	61,541	25,847
4	59,230	3,484	62,714	26,340
5	60,591	3,484	64,075	26,912
6	60,861	3,484	64,345	27,025
7	61,806	3,484	65,290	27,422

Zone : D

1) Condition

	Capacity	Velocity	Transported distance
Without Project	2 t truck	15km	15km
With Project	8 t truck	30km	4km

2) Cost

Description	Without Project	With Project
Capacity(90%)	1.8 t	7.2 t
Traveling hour	1.0 hour	0.13hour
Traveling hour per ton	0.56hr/ton	0.02hr/ton
Depreciation	US$ 2.62	US$ 7.14
Fuel	1.31	3.48
Driver	1.02	1.02
Operating cost per hour	4.95	11.64
Transporting cost per ton	2.77	0.23

3) Benefit by reduced transportation

2.77 - 0.23 = 2.54 US$/ton

Year	Production	Farm input	Total	Benefit
1	25,645 t	11,295 t	36,940 t	93,828 US$
2	64,221	11,295	75,516	191,811
3	83,062	11,295	94,357	239,667
4	86,902	11,295	98,197	249,428
5	89,931	11,295	101,226	257,114
6	90,696	11,295	101,991	259,057
7	93,373	11,295	104,668	265,857

Table J.1.8 (1)   Estimation of EIRR   – Zone A

YEAR		CONSTRUC-TION COSTS	O & M COSTS	SETTLE-MENT COSTS	PRODUCTION COST	TOTAL	INCREMENTAL BENEFIT	PROJECT RETURN	(21 %)	(22 %)
		PROJECT COSTS							PRESENT WORTH VALUE	
									DISCOUNT RATE	
1	1988	307.00	0.00	0.00	0.00	307.00	0.00	-307.00	-253.72	-251.64
2	1989	2132.00	0.00	0.00	0.00	2132.00	0.00	-2132.00	-1456.18	-1432.41
3	1990	5780.00	0.00	0.00	0.00	5780.00	0.00	-5780.00	-3262.66	-3183.09
4	1991	4692.00	32.00	263.00	0.00	4987.00	0.00	-4987.00	-2326.47	-2251.13
5	1992	0.00	283.00	0.00	9728.00	10011.00	615.00	-9396.00	-3622.57	-3476.51
6	1993	0.00	61.00	0.00	7940.00	8001.00	11414.00	3413.00	1087.49	1035.09
7	1994	0.00	67.00	0.00	8575.00	8642.00	12096.00	3454.00	909.55	858.63
8	1995	0.00	75.00	0.00	8594.00	8669.00	13523.00	4854.00	1056.37	989.06
9	1996	0.00	77.00	0.00	8613.00	8690.00	16355.00	7665.00	1378.62	1280.19
10	1997	0.00	67.00	0.00	8613.00	8680.00	16487.00	7807.00	1160.46	1068.77
11	1998	0.00	263.00	0.00	8613.00	8876.00	16951.00	8075.00	991.98	906.12
12	1999	0.00	75.00	0.00	8613.00	8688.00	16951.00	8263.00	838.91	760.01
13	2000	0.00	67.00	0.00	8613.00	8680.00	16951.00	8271.00	693.98	623.56
14	2001	0.00	77.00	0.00	8613.00	8690.00	16951.00	8261.00	572.85	510.50
15	2002	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	474.34	419.25
16	2003	0.00	81.00	0.00	8613.00	8694.00	16951.00	8257.00	391.07	342.82
17	2004	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	323.98	281.68
18	2005	0.00	263.00	0.00	8613.00	8876.00	16951.00	8075.00	261.22	225.25
19	2006	0.00	83.00	0.00	8613.00	8696.00	16951.00	8255.00	220.70	188.75
20	2007	0.00	75.00	0.00	8613.00	8688.00	16951.00	8263.00	182.57	154.86
21	2008	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	151.14	127.15
22	2009	0.00	67.00	0.00	8613.00	8680.00	16951.00	8271.00	124.82	104.15
23	2010	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	103.23	85.43
24	2011	0.00	81.00	0.00	8613.00	8694.00	16951.00	8257.00	85.11	69.85
25	2012	0.00	269.00	0.00	8613.00	8882.00	16951.00	8069.00	68.74	55.95
26	2013	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	58.27	47.05
27	2014	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	48.16	38.56
28	2015	0.00	81.00	0.00	8613.00	8694.00	16951.00	8257.00	39.70	31.53
29	2016	0.00	77.00	0.00	8613.00	8690.00	16951.00	8261.00	32.83	25.86
30	2017	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	27.18	21.24
31	2018	0.00	67.00	0.00	8613.00	8680.00	16951.00	8271.00	22.45	17.39
32	2019	0.00	277.00	0.00	8613.00	8890.00	16951.00	8061.00	18.08	13.90
33	2020	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	15.34	11.70
34	2021	0.00	83.00	0.00	8613.00	8696.00	16951.00	8255.00	12.65	9.56
35	2022	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	10.48	7.86
36	2023	0.00	75.00	0.00	8613.00	8688.00	16951.00	8263.00	8.65	6.43
37	2024	0.00	67.00	0.00	8613.00	8680.00	16951.00	8271.00	7.15	5.28
38	2025	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	5.92	4.33
39	2026	0.00	279.00	0.00	8613.00	8892.00	16951.00	8059.00	4.76	3.45
40	2027	0.00	81.00	0.00	8613.00	8694.00	16951.00	8257.00	4.03	2.90
41	2028	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	3.34	2.38
42	2029	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	2.76	1.95
43	2030	0.00	67.00	0.00	8613.00	8680.00	16951.00	8271.00	2.28	1.60
44	2031	0.00	91.00	0.00	8613.00	8704.00	16951.00	8247.00	1.88	1.31
45	2032	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	1.56	1.08
46	2033	0.00	269.00	0.00	8613.00	8882.00	16951.00	8069.00	1.26	0.86
47	2034	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	1.06	0.72
48	2035	0.00	75.00	0.00	8613.00	8688.00	16951.00	8263.00	0.88	0.59
49	2036	0.00	83.00	0.00	8613.00	8696.00	16951.00	8255.00	0.72	0.48
50	2037	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	0.60	0.40
51	2038	0.00	61.00	0.00	8613.00	8674.00	16951.00	8277.00	0.50	0.33
TOTAL		12911.00	4711.00	263.00	405196.00	423081.00	765481.00	342400.00	488.01	-248.99

INTERNAL RATE OF RETURN(IRR) = 21 + 488.01 / (488.01 + 248.99) = 21.7 %

Table J.1.8 (2)   Estimation of EIRR   - Zone B

	YEAR	---------- PROJECT COSTS ----------							- PRESENT WORTH VALUE - ---- DISCOUNT RATE ----	
		CONSTRUC-TION COSTS	O & M COSTS	SETTLE-MENT COSTS	PRODUCTION COST	TOTAL	INCREMENTAL BENEFIT	PROJECT RETURN	(25 %)	(26 %)
1	1988	390.00	0.00	0.00	0.00	390.00	0.00	-390.00	-312.00	-309.52
2	1989	390.00	0.00	0.00	0.00	390.00	0.00	-390.00	-249.60	-245.65
3	1990	6464.00	0.00	0.00	0.00	6464.00	0.00	-6464.00	-3309.57	-3231.39
4	1991	10106.00	0.00	0.00	0.00	10106.00	0.00	-10106.00	-4139.42	-4009.56
5	1992	4081.00	70.00	0.00	0.00	4151.00	0.00	-4151.00	-1360.20	-1307.07
6	1993	0.00	728.00	0.00	18349.00	19077.00	1586.00	-17491.00	-4585.16	-4371.11
7	1994	0.00	136.00	0.00	14945.00	15081.00	21985.00	6904.00	1447.87	1369.33
8	1995	0.00	142.00	0.00	15970.00	16112.00	24582.00	8470.00	1421.03	1333.27
9	1996	0.00	169.00	0.00	16033.00	16202.00	28365.00	12163.00	1632.49	1519.52
10	1997	0.00	166.00	0.00	16097.00	16263.00	32257.00	15994.00	1717.34	1585.81
11	1998	0.00	142.00	0.00	16097.00	16239.00	33011.00	16772.00	1440.70	1319.80
12	1999	0.00	607.00	0.00	16097.00	16704.00	35653.00	18949.00	1302.17	1183.42
13	2000	0.00	169.00	0.00	16097.00	16266.00	35653.00	19387.00	1065.81	960.94
14	2001	0.00	142.00	0.00	16097.00	16239.00	35653.00	19414.00	853.84	763.71
15	2002	0.00	166.00	0.00	16097.00	16263.00	35653.00	19390.00	682.23	605.37
16	2003	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	546.63	481.20
17	2004	0.00	175.00	0.00	16097.00	16272.00	35653.00	19381.00	436.42	381.13
18	2005	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	349.84	303.10
19	2006	0.00	607.00	0.00	16097.00	16704.00	35653.00	18949.00	273.08	234.72
20	2007	0.00	172.00	0.00	16097.00	16269.00	35653.00	19384.00	223.48	190.56
21	2008	0.00	169.00	0.00	16097.00	16266.00	35653.00	19387.00	178.81	151.26
22	2009	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	143.29	120.25
23	2010	0.00	142.00	0.00	16097.00	16239.00	35653.00	19414.00	114.60	95.41
24	2011	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	91.71	75.75
25	2012	0.00	199.00	0.00	16097.00	16296.00	35653.00	19357.00	73.13	59.92
26	2013	0.00	613.00	0.00	16097.00	16710.00	35653.00	18943.00	57.25	46.54
27	2014	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	46.95	37.87
28	2015	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	37.56	30.05
29	2016	0.00	175.00	0.00	16097.00	16272.00	35653.00	19381.00	29.99	23.80
30	2017	0.00	166.00	0.00	16097.00	16263.00	35653.00	19390.00	24.00	18.90
31	2018	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	19.23	15.02
32	2019	0.00	142.00	0.00	16097.00	16239.00	35653.00	19414.00	15.38	11.92
33	2020	0.00	640.00	0.00	16097.00	16737.00	35653.00	18916.00	11.99	9.22
34	2021	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	9.85	7.51
35	2022	0.00	172.00	0.00	16097.00	16269.00	35653.00	19384.00	7.86	5.95
36	2023	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	6.30	4.73
37	2024	0.00	169.00	0.00	16097.00	16266.00	35653.00	19387.00	5.03	3.75
38	2025	0.00	142.00	0.00	16097.00	16239.00	35653.00	19414.00	4.03	2.98
39	2026	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	3.23	2.36
40	2027	0.00	637.00	0.00	16097.00	16734.00	35653.00	18919.00	2.51	1.83
41	2028	0.00	175.00	0.00	16097.00	16272.00	35653.00	19381.00	2.06	1.49
42	2029	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	1.65	1.18
43	2030	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	1.32	0.94
44	2031	0.00	142.00	0.00	16097.00	16239.00	35653.00	19414.00	1.06	0.74
45	2032	0.00	199.00	0.00	16097.00	16296.00	35653.00	19357.00	0.84	0.59
46	2033	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	0.68	0.47
47	2034	0.00	613.00	0.00	16097.00	16710.00	35653.00	18943.00	0.53	0.36
48	2035	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	0.43	0.30
49	2036	0.00	169.00	0.00	16097.00	16266.00	35653.00	19387.00	0.35	0.23
50	2037	0.00	172.00	0.00	16097.00	16269.00	35653.00	19384.00	0.28	0.19
51	2038	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	0.22	0.15
52	2039	0.00	136.00	0.00	16097.00	16233.00	35653.00	19420.00	0.18	0.12
	TOTAL	21431.00	10603.00	0.00	757468.00	789502.00	1603560.00	814057.00	329.32	-510.67

INTERNAL RATE OF RETURN(IRR) = 25 + 329.32 / (329.32 + 510.67) = 25.4 %

Table J.1.8 (3)　　Estimation of EIRR　　- Zone C

| | | ---------- PROJECT COSTS --------- | | | | | | - PRESENT WORTH VALUE - |
| | | | | | | | | ---- DISCOUNT RATE ---- |
YEAR	CONSTRUC- TION COSTS	O & M COSTS	SETTLE- MENT COSTS	PRODUCTION COST	TOTAL	INCREMENTAL BENEFIT	PROJECT RETURN	(22 %)	(23 %)
1 1988	253.00	0.00	0.00	0.00	253.00	0.00	-253.00	-207.38	-205.69
2 1989	253.00	0.00	0.00	0.00	253.00	0.00	-253.00	-169.98	-167.23
3 1990	4834.00	0.00	0.00	0.00	4834.00	0.00	-4834.00	-2662.12	-2597.71
4 1991	4612.00	0.00	0.00	0.00	4612.00	0.00	-4612.00	-2081.85	-2014.97
5 1992	4998.00	32.00	145.00	0.00	5175.00	0.00	-5175.00	-1914.75	-1838.17
6 1993	0.00	283.00	0.00	13466.00	13749.00	718.00	-13031.00	-3952.02	-3763.11
7 1994	0.00	61.00	0.00	9966.00	10027.00	15017.00	4990.00	1240.46	1171.56
8 1995	0.00	67.00	0.00	10803.00	10870.00	18257.00	7387.00	1505.18	1410.03
9 1996	0.00	75.00	0.00	10841.00	10916.00	19039.00	8123.00	1356.68	1260.58
10 1997	0.00	77.00	0.00	10879.00	10956.00	20631.00	9675.00	1324.50	1220.67
11 1998	0.00	67.00	0.00	10879.00	10946.00	20678.00	9732.00	1092.05	998.27
12 1999	0.00	263.00	0.00	10879.00	11142.00	20844.00	9702.00	892.37	809.10
13 2000	0.00	75.00	0.00	10879.00	10954.00	20844.00	9890.00	745.62	670.55
14 2001	0.00	67.00	0.00	10879.00	10946.00	20844.00	9898.00	611.66	545.60
15 2002	0.00	77.00	0.00	10879.00	10956.00	20844.00	9888.00	500.85	443.13
16 2003	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	411.20	360.85
17 2004	0.00	81.00	0.00	10879.00	10960.00	20844.00	9884.00	336.37	292.78
18 2005	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	276.27	238.52
19 2006	0.00	263.00	0.00	10879.00	11142.00	20844.00	9702.00	221.83	189.96
20 2007	0.00	83.00	0.00	10879.00	10962.00	20844.00	9882.00	185.20	157.31
21 2008	0.00	75.00	0.00	10879.00	10954.00	20844.00	9890.00	151.93	127.99
22 2009	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	124.71	104.21
23 2010	0.00	67.00	0.00	10879.00	10946.00	20844.00	9898.00	102.16	84.67
24 2011	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	83.79	68.88
25 2012	0.00	81.00	0.00	10879.00	10960.00	20844.00	9884.00	68.54	55.89
26 2013	0.00	269.00	0.00	10879.00	11148.00	20844.00	9696.00	55.11	44.57
27 2014	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	46.14	37.01
28 2015	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	37.82	30.09
29 2016	0.00	81.00	0.00	10879.00	10960.00	20844.00	9884.00	30.94	24.42
30 2017	0.00	77.00	0.00	10879.00	10956.00	20844.00	9888.00	25.37	19.86
31 2018	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	20.83	16.17
32 2019	0.00	67.00	0.00	10879.00	10946.00	20844.00	9898.00	17.06	13.14
33 2020	0.00	277.00	0.00	10879.00	11156.00	20844.00	9688.00	13.69	10.46
34 2021	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	11.47	8.69
35 2022	0.00	83.00	0.00	10879.00	10962.00	20844.00	9882.00	9.38	7.05
36 2023	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	7.71	5.74
37 2024	0.00	75.00	0.00	10879.00	10954.00	20844.00	9890.00	6.31	4.66
38 2025	0.00	67.00	0.00	10879.00	10946.00	20844.00	9898.00	5.17	3.79
39 2026	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	4.24	3.09
40 2027	0.00	279.00	0.00	10879.00	11158.00	20844.00	9686.00	3.40	2.45
41 2028	0.00	81.00	0.00	10879.00	10960.00	20844.00	9884.00	2.85	2.04
42 2029	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	2.34	1.66
43 2030	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	1.92	1.35
44 2031	0.00	67.00	0.00	10879.00	10946.00	20844.00	9898.00	1.57	1.10
45 2032	0.00	91.00	0.00	10879.00	10970.00	20844.00	9874.00	1.28	0.89
46 2033	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	1.06	0.72
47 2034	0.00	269.00	0.00	10879.00	11148.00	20844.00	9696.00	0.85	0.58
48 2035	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	0.71	0.48
49 2036	0.00	75.00	0.00	10879.00	10954.00	20844.00	9890.00	0.58	0.39
50 2037	0.00	83.00	0.00	10879.00	10962.00	20844.00	9882.00	0.48	0.32
51 2038	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	0.39	0.26
52 2039	0.00	61.00	0.00	10879.00	10940.00	20844.00	9904.00	0.32	0.21
TOTAL	14950.00	4711.00	145.00	512873.00	532679.00	948944.00	416265.00	552.26	-135.16

INTERNAL RATE OF RETURN(IRR) = 22 + 552.26 / (552.26 + 135.16) = 22.8 %

Table J.1.8 (4)   Estimation of EIRR   – Zone D

(UNIT : THOUSAND US$)

	YEAR	CONSTRUC- TION COSTS	O & M COSTS	SETTLE- MENT COSTS	PRODUCTION COST	TOTAL	INCREMENTAL BENEFIT	PROJECT RETURN	(20 %)	(21 %)
									– PRESENT WORTH VALUE – ---- DISCOUNT RATE ----	
1	1988	664.00	0.00	0.00	0.00	664.00	0.00	-664.00	-553.33	-548.76
2	1989	2473.00	0.00	0.00	0.00	2473.00	0.00	-2473.00	-1717.36	-1689.09
3	1990	11634.00	0.00	0.00	0.00	11634.00	0.00	-11634.00	-6732.64	-6567.09
4	1991	4199.00	0.00	0.00	0.00	4199.00	0.00	-4199.00	-2024.98	-1958.86
5	1992	6803.00	42.00	659.00	0.00	7504.00	0.00	-7504.00	-3015.69	-2893.12
6	1993	0.00	705.00	0.00	23028.00	23733.00	4262.00	-19471.00	-6520.80	-6204.06
7	1994	0.00	151.00	0.00	14676.00	14827.00	17728.00	2901.00	809.62	763.92
8	1995	0.00	160.00	0.00	16692.00	16852.00	27590.00	10738.00	2497.32	2336.90
9	1996	0.00	184.00	0.00	16799.00	16983.00	29642.00	12659.00	2453.40	2276.83
10	1997	0.00	171.00	0.00	16908.00	17079.00	32774.00	15695.00	2534.83	2332.96
11	1998	0.00	160.00	0.00	16908.00	17068.00	32909.00	15841.00	2132.01	1946.00
12	1999	0.00	622.00	0.00	16908.00	17530.00	33383.00	15853.00	1778.02	1609.49
13	2000	0.00	184.00	0.00	16908.00	17092.00	33383.00	16291.00	1522.62	1366.90
14	2001	0.00	160.00	0.00	16908.00	17068.00	33383.00	16315.00	1270.72	1131.34
15	2002	0.00	171.00	0.00	16908.00	17079.00	33383.00	16304.00	1058.22	934.36
16	2003	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	882.93	773.15
17	2004	0.00	193.00	0.00	16908.00	17101.00	33383.00	16282.00	733.88	637.32
18	2005	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	613.15	528.07
19	2006	0.00	622.00	0.00	16908.00	17530.00	33383.00	15853.00	496.21	423.83
20	2007	0.00	180.00	0.00	16908.00	17088.00	33383.00	16295.00	425.04	360.04
21	2008	0.00	184.00	0.00	16908.00	17092.00	33383.00	16291.00	354.11	297.48
22	2009	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	295.69	246.35
23	2010	0.00	160.00	0.00	16908.00	17068.00	33383.00	16315.00	246.27	203.48
24	2011	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	205.34	168.26
25	2012	0.00	213.00	0.00	16908.00	17121.00	33383.00	16262.00	170.47	138.53
26	2013	0.00	631.00	0.00	16908.00	17539.00	33383.00	15844.00	138.41	111.54
27	2014	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	118.83	94.98
28	2015	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	99.03	78.49
29	2016	0.00	193.00	0.00	16908.00	17101.00	33383.00	16282.00	82.31	64.70
30	2017	0.00	180.00	0.00	16908.00	17088.00	33383.00	16295.00	68.65	53.52
31	2018	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	57.31	44.31
32	2019	0.00	160.00	0.00	16908.00	17068.00	33383.00	16315.00	47.73	36.60
33	2020	0.00	655.00	0.00	16908.00	17563.00	33383.00	15820.00	38.57	29.33
34	2021	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	33.16	25.01
35	2022	0.00	180.00	0.00	16908.00	17088.00	33383.00	16295.00	27.59	20.63
36	2023	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	23.03	17.08
37	2024	0.00	184.00	0.00	16908.00	17092.00	33383.00	16291.00	19.15	14.09
38	2025	0.00	160.00	0.00	16908.00	17068.00	33383.00	16315.00	15.98	11.66
39	2026	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	13.33	9.64
40	2027	0.00	642.00	0.00	16908.00	17550.00	33383.00	15833.00	10.77	7.73
41	2028	0.00	193.00	0.00	16908.00	17101.00	33383.00	16282.00	9.23	6.57
42	2029	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	7.71	5.44
43	2030	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	6.43	4.50
44	2031	0.00	160.00	0.00	16908.00	17068.00	33383.00	16315.00	5.35	3.72
45	2032	0.00	204.00	0.00	16908.00	17112.00	33383.00	16271.00	4.45	3.06
46	2033	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	3.72	2.54
47	2034	0.00	631.00	0.00	16908.00	17539.00	33383.00	15844.00	3.01	2.04
48	2035	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	2.58	1.73
49	2036	0.00	184.00	0.00	16908.00	17092.00	33383.00	16291.00	2.15	1.43
50	2037	0.00	180.00	0.00	16908.00	17088.00	33383.00	16295.00	1.79	1.18
51	2038	0.00	151.00	0.00	16908.00	17059.00	33383.00	16324.00	1.49	0.98
	TOTAL	25773.00	11064.00	659.00	781331.00	818827.00	1480230.00	661398.00	756.81	-733.27

INTERNAL RATE OF RETURN(IRR) = 20 + 756.81 / (756.81 + 733.27) = 20.5 %

J.2. Financial Analysis

J.2.1 Financing

The project cost estimated at US$78,548,000 and its disbursement schedule is shown in table 6.2.1, the Master Plan Study Report.

Assuming that a considerable sum of the project cost will be financed from an international financial agency and the remain is assumed to take charge of national treasury (a part of this cost will be withdrawed as withdrawal charge from farmers in future).

Repayment schedule has been proposed as shown in table 6.2.2.

J.2.2 Financial analysis of model farmer

In case of the farming pattern I of model farmer, a forecast of the profit and loss after completion of the Project was estimated. As a result. Though this model farmer shows a deficit of profit on the farming during 4 years of initial period, since then it will be able to keep a balanced farm management.

The main reason is that perennial crops cannot harvest during 3 years after planting and the interest of farm credit is a great burden to farmer. Concerning the O&M charge (¢800), it is desirable that the burden will be released during 7 years of initial period due to the financial situation of model farmer.

Profit and loss and cash flow in model farmer (Farming pattern I) are estimated as shown in Table 6.2.2 and 6.2.3 of Interim Report.

Table J.2.1 Disbursement Schedule (Estimation)

Unit : 1,000 US $

Year	Zone A			Zone B			Zone C			Zone D		
	Project cost	L/C	F/C	Project cost	L/C	F/C	Project cost	L/C	F/C	Project cost	L/C	F/C
1988	--	--	--	443	--	443	--	--	--	--	--	--
89	--	--	--	443	--	443	--	--	--	--	--	--
90	824	325	499	7,350	2,271	5,079	2,767	830	1,937	--	--	--
91	824	325	499	11,491	3,514	7,977	1,220	520	700	857	--	857
92	--	--	--	4,640	1,355	3,285	2,843	1,206	1,637	3,966	1,308	2,658
93	--	--	--	--	--	--	288	--	288	15,815	5,407	10,408
94	--	--	--	--	--	--	288	--	288	4,833	1,303	3,530
95	--	--	--	--	--	--	2,729	802	1,927	7,793	2,424	5,369
96	--	--	--	--	--	--	4,023	1,144	2,879	--	--	--
97	349	--	349	--	--	--	2,840	841	1,999	--	--	--
98	2,424	621	1,803	--	--	--	--	--	--	--	--	--
99	5,748	1,747	4,001	--	--	--	--	--	--	--	--	--
2000	4,511	1,378	3,133	--	--	--	--	--	--	--	--	--
Total	14,680	4,396	10,284	24,367	7,140	17,227	16,998	5,343	11,655	33,264	10,442	22,822

Note : Interest rates and the terms of repayment

Interest Rate : 6 %

Grace Period : 7 years

Amortization : 2 times repayment annually with constant
amount unifromity of the principel

Annex K   Management Association for Facilities

Annex K. Management Association for Facilities

Annex K. Management Association for Facilities

K.1 Basic Concept

It is planned that SENARA and MOPT will be charged with the main-tenance and management of basic drainage systems to be newly constructed or improved, such as rivers, principal canal system and secondary canal system. However, the maintenance and management of the tertiary canal system and farm roads will be undertaken by a management association to be organized by farmers concerned.

Since this association will be responsible mainly for the main-tenance and management of drainage canals, it will be organized for each drainage system and made up of branches and groups.

K.2 Organization

The association will be organized according to the standard division of drainage system (ref. Fig. 4.6.1, Main Report). Each of its branches will cover the 900-ha block (1,500 m x 3,000 m) delineated by a main road a principal drainage canal, and each group will cover the 150-ha block having one secondary drainage canal in the said 900-ha block.

Each group will be made up of 10 - 15 farm households and each branch will comprise 60 - 90 farm households. Each association will be set up by organizing these branches for each drainage system. The organ-ization chart of the association is shown below.

SENARA Management Office

Management Association — Management Association

Branch (60 - 90 households)   Branch   Branch   Branch   Branch

Group (10 -15 households)   Group   Group   Group   Group   Group   Group   Group   Group
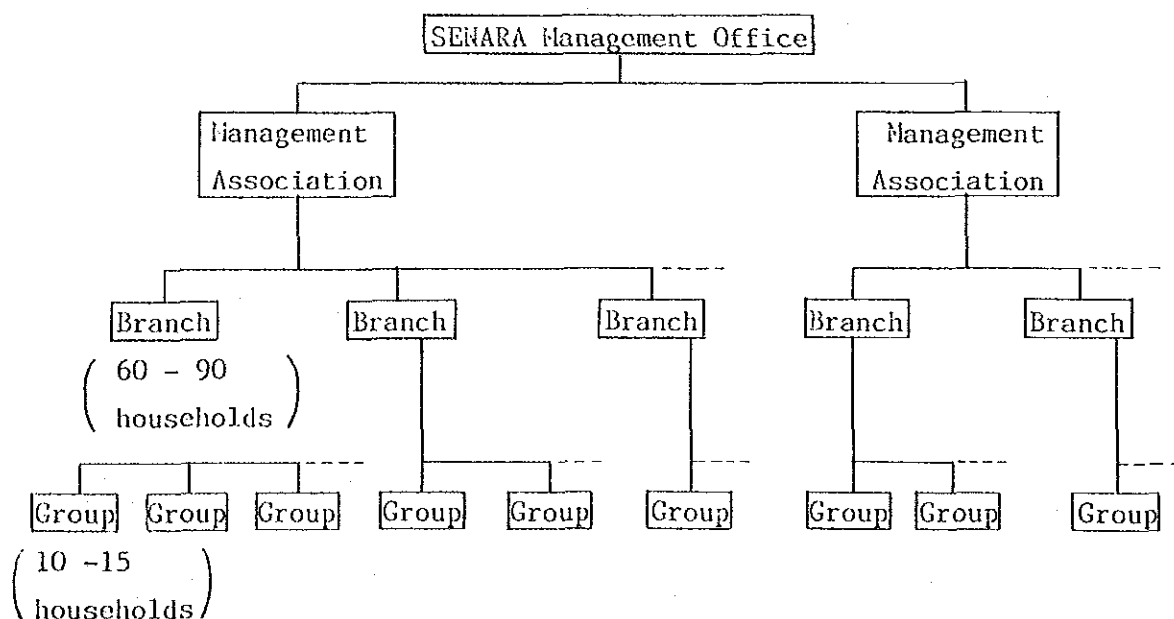
The number of branches in an association will vary according to the size of the drainage system, so that the membership will also vary from one association to another. The suitable number of associations, to be adjusted for each block by the size of drainage system, is two for blocks A and C and three for blocks B and C.

K.3 Operation

Each association will have its office at the SENARA Management Office to be established in each of blocks A, B, C, D, and will be operated by the members selected from each group under the guidance of SENARA. In the actual maintenance and management service, the organization will use the equipment available at the SENARA Management Office, but the manpower required for such service will be provided by the member households.

The expense for terminal canal maintenance service, which is to be borne by beneficiary farmers, will be collected together with the expense for maintenance and management of main drainage systems.

Annex L   Others

Annex L. Others

List of Figure

L.1 Topographical Survey

In order to collect the topographical information, the following topographical survey was carried out.

(1) Survey of point elevation of the study area

(2) Survey of cross-section and longitudinal profile of Rio Madre de Dios

The obtained results are illustrated in Fig. L.1 - L .3.

Fig. L.1 Point Elevation of Study Area

Fig. L.2 Profile of Rio Madre de Dios

L – 3

Vertical scale: 100.00 / 90.00 / 80.00 / 70.00 / 60.00 / 50.00 / 40.00 / 30.00 / 20.00 / 10.00 / 0.00 DL=–10.00

1/776000   1/600

DESCRIPTION			
STATION No.	DISTANCE	LENGTH	RIVER BED
C-0	0.0	0.0	94.58 / 93.88
C-1	100.0	100.0	93.88
C-2	900.0	1000.0	76.01
C-3	1000.0	2000.0	53.02
C-4	1000.0	3000.0	35.65
C-5	1000.0	4000.0	20.74
C-6	1000.0	5000.0	10.73
C-7	1000.0	6000.0	9.98
C-8	1000.0	7000.0	9.17
C-9	1000.0	8000.0	9.02
C-10	1000.0	9000.0	8.27
C-11	1000.0	10000.0	6.26
C-12	1000.0	11000.0	5.29
C-13	1000.0	12000.0	4.21
C-14	1000.0	13000.0	3.84
C-15	1000.0	14000.0	2.77
C-16	1000.0	15000.0	0.03
C-17	1000.0	16000.0	0.25
C-18	1000.0	17000.0	0.37
C-19	1000.0	18000.0	-1.85
C-20	1000.0	19000.0	-3.00
C-21	1000.0	20000.0	-4.20
C-22	1000.0	21000.0	-5.25
C-23	1000.0	22000.0	-6.41
C-24	1000.0	23000.0	-7.51

Fig. L.3 (1) Cross-Section of Rio Madre de Dios
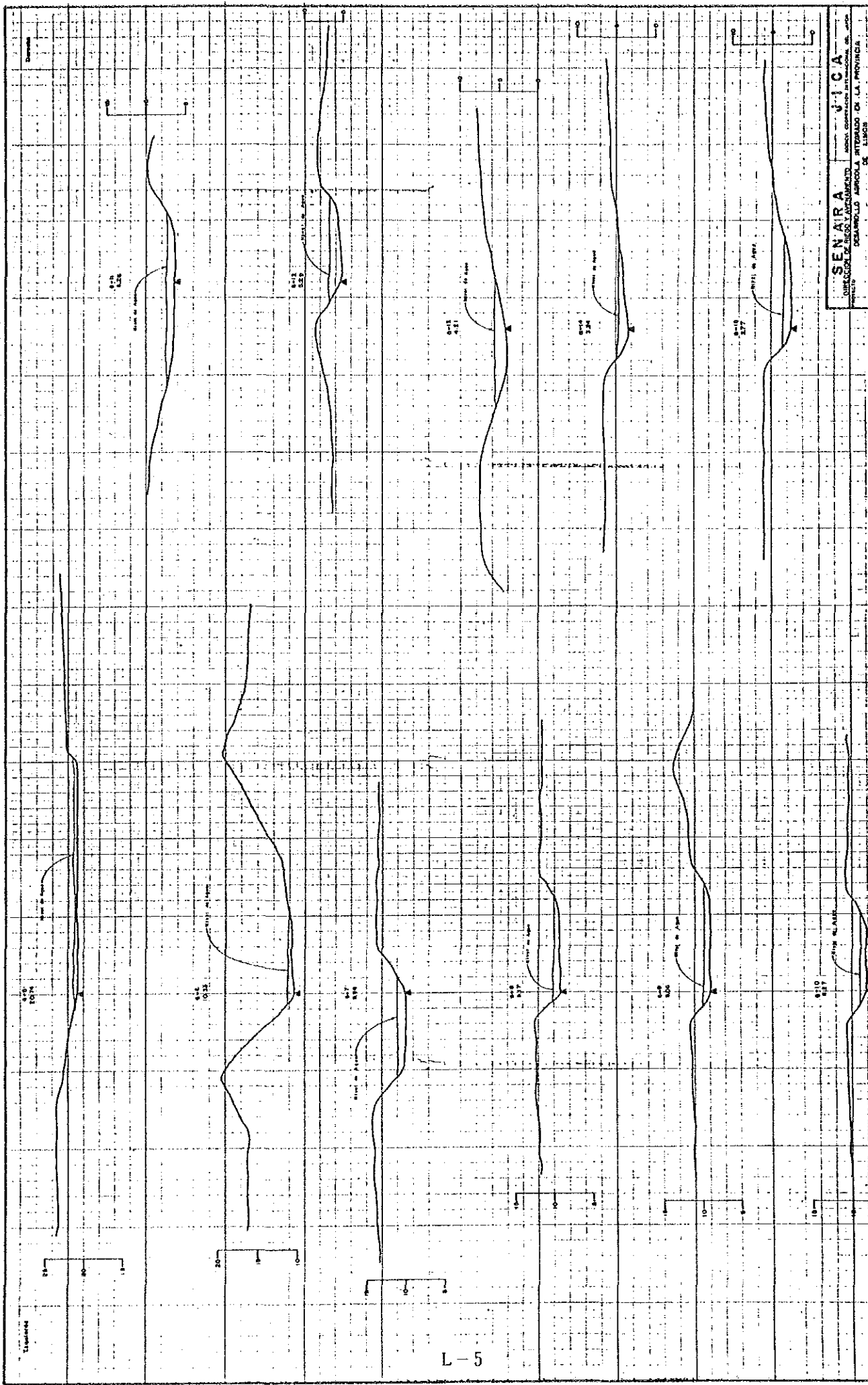
Fig. L.3 (2)   Cross-Section of Rio Madre de Dios

L−5
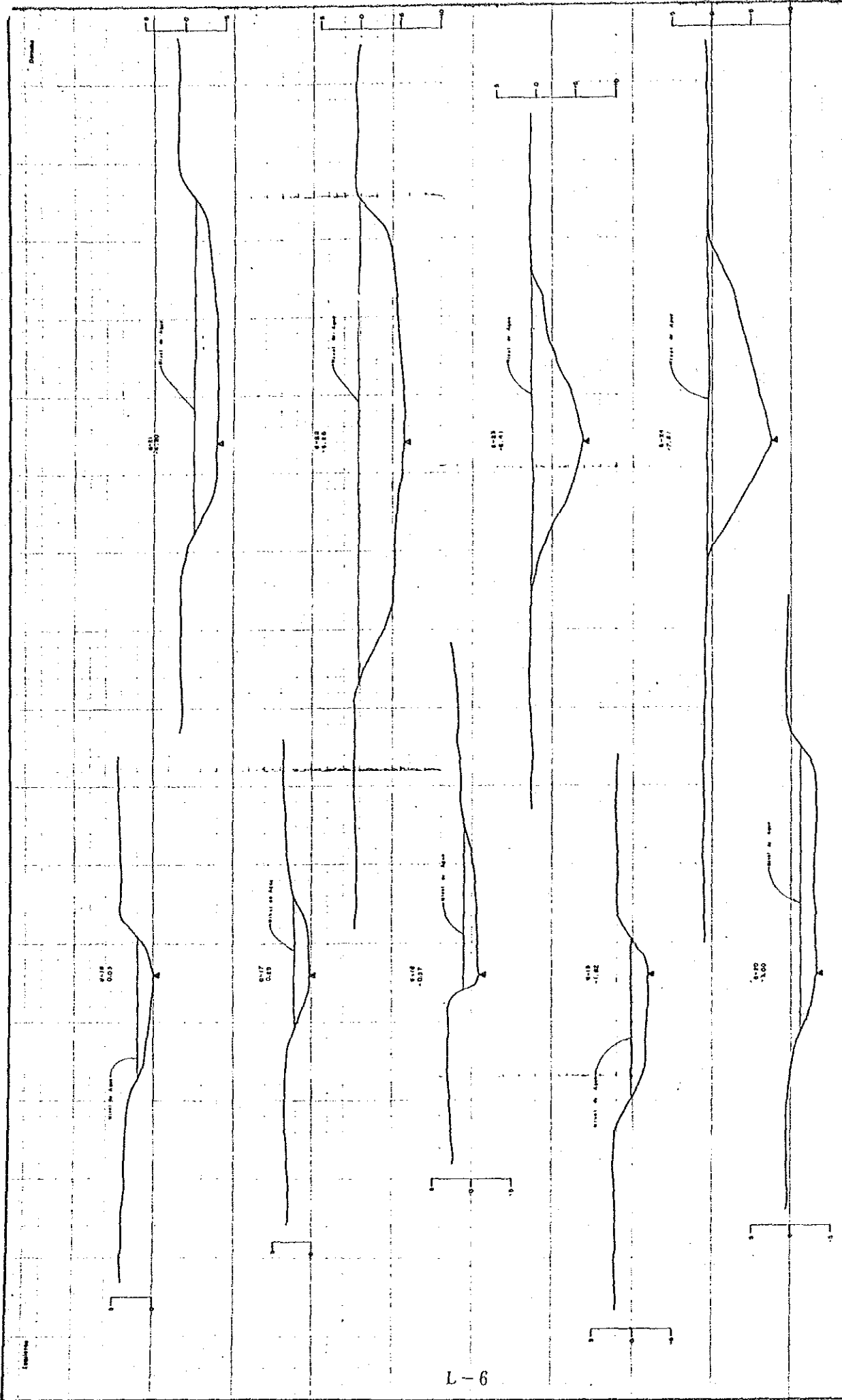
Fig. L.3 (3)   Cross-Section of Rio Madre de Dios

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