3.1.3 Soil and Land Classification

(1) Soil

The topographical feature may divide the study area into five sub-areas: river bed, hollow between terraces, lower terrace, middle terrace and high terrace. The soils distributed in these sub-areas are classified into 12 associations (Table 3-1-10).

(2) Soil characteristics

Soil distribution is shown in Fig. 3-1-3 and soil characteristics of each type are as follows:

1) Soils on river bed (LC)

These soils are distributed on narrow area along the Guape River and Ariari River. Topographic feature is so flat that flooding takes place sometimes in the sub-area. Drainage condition is good due to its texture being medium-moderately coarse. The pH of the soil is neutral to moderately acidic. The effective soil depth is shallow and the soil fertility is medium-low. Therefore, this sub-area is mainly used as pasture land.

2) Soils on fan (LR, TL, UP, MC)

These soils are distributed in the greater part of the Upper Zone with a gradient below 1/100. Soil texture is medium-moderately coarse, moreover some soil families such as Lejanias contain much gravel that facilitates good drainage. The pH of the soil is acidic to heavily acidic. The effective soil depth is variable.

3) Soils on hollow between terraces (EC, DQ)

These soils are distributed in the Middle and Lower Zones. The distribution is limited mainly at the sub-area along caños, and therefore flooding occurs during the rainy season. Drainage

condition is poor due to medium-moderately fine soil texture. The pH is moderately acidic. The effective soil depth is large. Soil fertility is medium-low. Many paddy fields are distributed in this sub-area.

4) Soils on lower and middle terraces (GF, GU, FO)

These soils are distributed on flat plain of the Middle and Lower Zones. Drainage condition is good because of medium-moderately coarse texture. The pH is neutral to moderately acidic. The effective soil depth is variable. Soil fertility is the highest in the Area.

5) Soils on high terrace (LA, EB)

Most of these soils are distributed in the Lower Zone. Drainage is poor because of medium-moderately fine texture. The pH is heavily acidic and the concentration of iron and aluminum is high. For these reasons, soil fertility is low.

(2) Land classification

1) Land classification

Land classification for paddy field and upland is shown in Table 3-1-11.

Land classification for upland was carried out taking account of topography, soil and drainage and on the basis of the USDA's guideline. For paddy field new criteria was set up by using the same factors mentioned above.

Table 3-1-11 Area by Land Classification

Paddy field

Class		Area (ha) Upper zone	Middle zone	Lower zone	Total	%
Suitable land	PII	500	6,330	10,910	17,740	43.2(47.9)
	PIII	0	6,130	2,100	8,230	20.0(22.2)
	PIV	5,380	2,140	3,550	11,070	26.9(29.9)
Sub total (%)		5,880 (65)	14,600 (95)	16,560 (100)	37,040	90.1(100)
Marginal land	PV	3,220	800	40	4,060	9.9
Total		9,100	15,400	16,600	41,100	100

Upland field

Class		Area (ha) Upper zone	Middle zone	Lower zone	Total	%
Suitable land	II	0	2,630	6,330	8,960	21.7(23.1)
	III	5,030	9,690	2,120	16,840	41.0(43.4)
	IV	2,340	2,950	7,680	12,970	31.6(33.5)
Sub total (%)		7,370 (65)	15,270 (95)	16,130 (100)	38,770	94.3(100)
Marginal land	V	1,690	80	430	2,200	5.4
	VI	40	50	40	130	0.3
Total		9,100	15,400	16,600	41,100	100

Land classification for paddy field ranges from PII to PV and for upland from II to VI. From the viewpoint of irrigation suitability, class II - IV are suitable, while class V - VI are marginal. As a result, the lands suitable for paddy field and upland are of 37,040 and 38,770 ha, respectively. These lands account for more than 90% of the Area. About 48% of suitable land for irrigated paddy field belongs to class PII, while about 22% of suitable land for upland belongs to class II. These facts show the high irrigation suitability for paddy field. On the other hand, classification of each zone, unsuitable for

irrigation is distributed at some parts in the Upper Zone. However most of the area is almost suitable for irrigation in the Middle and Lower Zones.

Detailed description on this matter is shown in ANNEX D.

2) Land suitability

Taking into account soil characteristics, land classification and present land use, the land suitability was assessed.

The land suitability of the Area is shown in Table 3-1-12 and Fig. 3-1-4. Detailed description for each class is mentioned in ANNEX D.

The land suitability of the Area is resumed as follows:

- Agricultural potential area, which corresponds to classes 1 to 8, occupied the majority of the Area, thus the potentiality of the Area for agricultural use seems to be high.

- Lands without major constraints on crop cultivation or with some problems to be improved belong to classes 1 to 5 and 6-1 if used as irrigated paddy field and classes 1 and 3 to 5 as ordinary upland field.

- The suitable area is 33,350 ha for irrigated paddy field and 25,800 ha for ordinary upland field which account for 81% and 63% of the Area, respectively. This means that the Area is highly suitable to be used for agricultural purpose.

The land suitability of each zone is shown as follows:

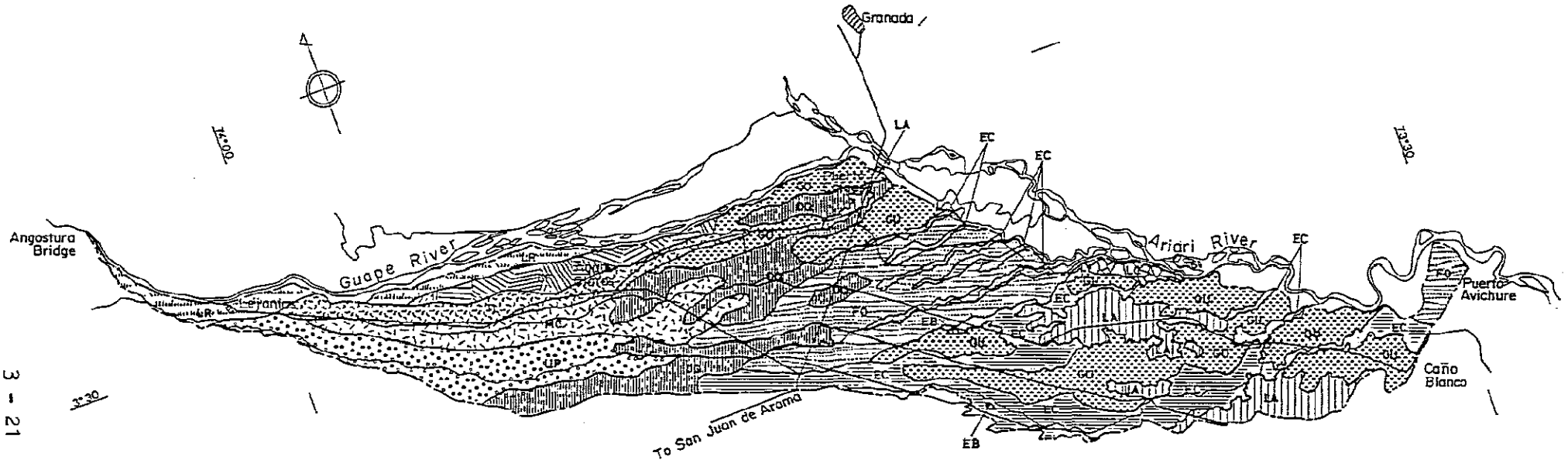
(ha)

	Upper Zone	Middle Zone	Lower Zone
Paddy field	5,880(64.6%)	14,460(93.9%)	13,010(78.4%)
Ordinary upland field	5,030(55.3%)	12,320(80.0%)	8,450(50.9%)

Some parts of the Upper Zone present restricting factors for their land use. On the other hand, generally speaking, lands in the Middle and Lower zones are highly suitable, although some constraints are presented if used as ordinary upland field.

- Comparing the suitability in relation to the present land use, some lands with higher classes are used extensively as pasture.

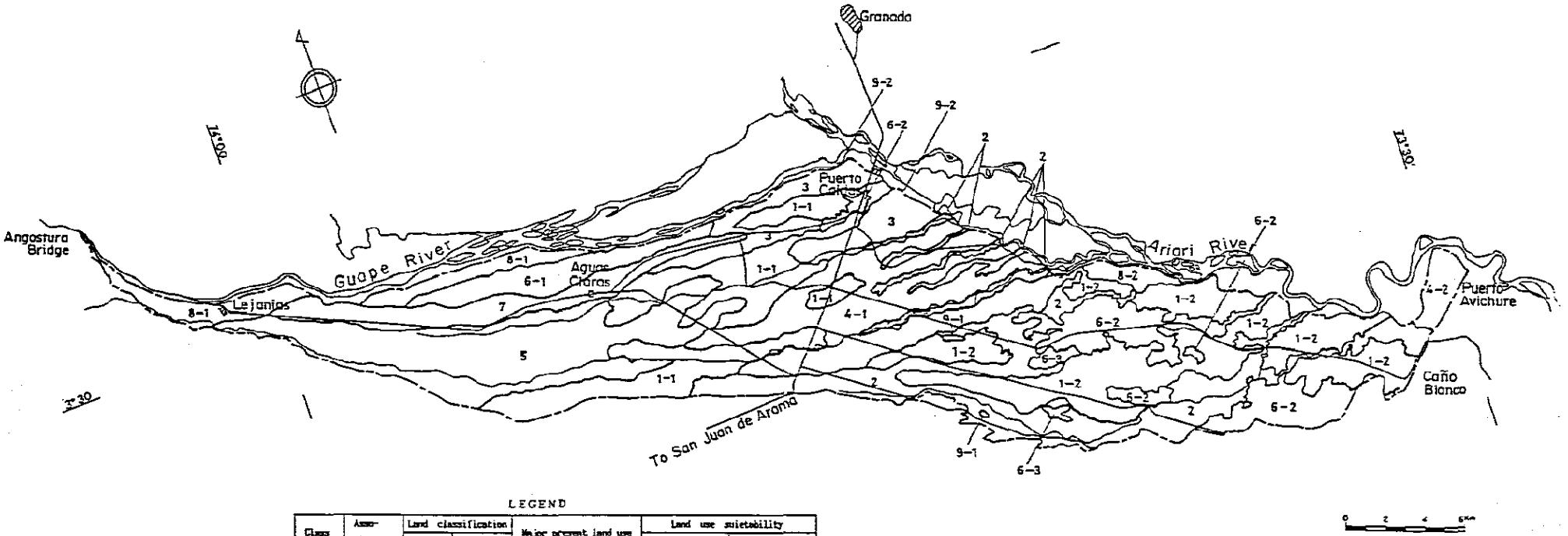
- Paddy fields generally show low suitability belonging to classes 3, 4, 5 and 6-1 (15,600 ha) because of better drainage. It is expected that the productivity of these fields will be improved subject to providing them with sufficient irrigation water.



LEGEND

Topography	Association		Soil family	Soil classification USDA	Area ha (%)	Topography	Association		Soil family	Soil classification USDA	Area ha (%)
River reservation		LC	Limon Playon	Tropofluvents Troporthents	520 (1.3)			LA	Los Alpes El Bosque	Dystropepts Haplorthox	3,050 (7.4)
Hollow in low terrace		EC	El Porvenir Dos Quebradas	Eutropepts Tropaquepts	6,260 (15.2)	High terrace		EB	El Bosque Los Alpes	Dystropepts Haplorthox	40 (0.1)
		DQ	Dos Quebradas Venado	Tropaquepts Hapludolls	5,050 (12.4)			MC	Macuya Topacio Lejanías	Hapludolls Dystropepts Udorthents	2,865 (7.0)
Low-Middle terrace		GF	Guape Urichare Lejanías	Eutropepts Udorthents	1,500 (3.6)	Fan land		UP	Urichare Topacio	Eutropepts Dystropepts	3,015 (7.3)
		GU	Guanayas El Porvenir	Haplumbrepts Eutropepts	8,960 (21.8)			TL	Topacio Lejanías Guanayas	Dystropept Udorthents Haplumbrepts	2,160 (5.3)
		FO	Fuente de Oro El Porvenir Guanayas	Dystropepts Eutropepts Haplumbrepts	5,870 (14.2)			LR	Lejanías Topacio	Udorthents Dystropepts	1,770 (4.3)

Fig. 3-1-3 SOIL MAP



LEGEND

Class		Association	Land classification		Major present land use	Land use suitability	
			Paddy	Upland		Paddy	upland
1	1-1	DQ	P II	III	upland	suitable	suitable
	1-2	GU	P II	II	paddy, upland		
2		EC	P II	IV	paddy, upland		poorly suitable
3		GU	P III	II	upland, pasture, orchard	moderately suitable	suitable
4	4-1	FO	P III	III	upland		moderately suitable
	4-2	FO	P III	III	upland		
5		MC-UP	P IV	III	upland, orchard	poorly suitable	
6	6-1	GF	P IV	IV	pasture, orchard		poorly suitable
	6-2	LA	P IV	IV	pasture		
	6-3	EC	P IV	IV	pasture		
7		TL	P V	IV	pasture, orchard	non suitable	
8	8-1	LR	P V	V	pasture, orchard		defined use
	8-2	LC	P IV	V	upland		
9	9-1	EB	P V	VI	pasture		non-suitable
	9-2	LC	P V	VI	forest		

Fig. 3-1-4 LAND USE SUITABILITY MAP

Table 3-1-10 SOIL CLASSIFICATION AND CHARACTERISTICS

Zone	Distribution topography	Association	Soil family	Soil classification by USDA	Texture	Soil fertility	Area ha (%)
Whole zone	River reservation 520ha(1.3%)	LC	Limon	Tropofluvents	SiL	Low—Medium	520
			Playon	Troporthents	SL	Low—Medium	(1.3)
Upper zone	Fan land 9,810ha (23.9%)	LR	Lejanias	Udorthents	SL	Medium	1,770
			Topacio	Dystropepts	L,SiL	Medium	(4.3)
		TL	Topacio	Dystropepts	L,SiL	Medium—Alt	2,160
			Lejanias	Udorthents	SL	Medium—Alt	(5.3)
			Guanayas	Haplumbrepts	SL,L,SiL	Medium—Alt	
		UP	Urichare	Eutropepts	L,CL	Medium	3,015
			Topacio	Dystropepts	L,SiL	Medium	(7.3)
		MC	Macuya	Hapludolls	L	Medium—Alt	2,865
			Topacio	Dystropepts	L,SiL	Medium	(7.0)
			Lejanias	Udorthents	SL	Medium	
Middle -Low zone	Hollow in low terrace 1,1350ha (27.6%)	EC	El Condor	Eutropepts	L/SCL	Low—Medium	6,260
			Dos Quebradas	Tropaquepts	L	Low—Medium	(15.2)
		DQ	Dos Quebradas	Tropaquepts	L	Low—Medium	5,090
			Venado	Hapludolls	L	Medium—Alt	(12.4)
	Low-Middle terrace 16,330ha (39.7%)	GF	Guape	Eutropepts	L,SiL	Medium	1,500
			Urichare	Eutropepts	L,CL	Medium	(3.6)
			Lejanias	Udorthents	SL	Medium	
		GU	Guanayas	Haplumbrepts	SL,L,SiL	Medium—Alt	8,960
			El Porvenir	Eutropepts	L,SiL/CL	Medium—Alt	(21.8)
		FO	Fuente de Oro	Dystropepts	SiL	Medium	5,870
			El Porvenir	Eutropepts	L,SiL/CL	Medium—Alt	(14.3)
	High terrace 3,090ha (7.5%)	LA	Guanayas	Haplumbrepts	SL,L,SiL	Medium—Alt	3,050
			Los Alpes	Dystropepts	L	Low	(7.4)
			El Bosque	Haplorthox	L/CL	Low	
		EB	El Bosque	Haplorthox	L/CL	Low	40
			Los Alpes	Dystropepts	L	Low	(0.1)

Table 3-1-12 LAND USE SUITABILITY

Class		Association	Land classification		Present land use	Land use suitability		Area ha (%)					Subject
			Paddy rice	Upland crops		Paddy field with irrigation	Ordinary upland field	Upper zone	Middle zone	Low zone	Sub-total	Total (%)	
1	1-1	DQ	PII	III	paddy field [1] ordinary upland [2] orchard. pasture.	suitable	suitable	500	4,590	0	5,090	11,690 (28.4)	irrigation
	1-2	GU	PII	II	paddy field. ordinary upland pasture.			0	270	6,330	6,600		
2		EC	PII	IV	paddy field. ordinary upland pasture.	suitable	poorly suitable	0	1,490	4,560	6,050	6,050 (14.7)	irrigation. surface drainage in the Rainy Season
3		GU	PIII	II	ordinay upland. pasture.	moderately suitable	suitable	0	2,360	0	2,360	2,360 (5.7)	irrigation.
4	4-1	FO	PIII	III	paddy field. ordinary upland pasture. orchard.	moderately suitable	moderately suitable	0	3,750	1,610	5,360	5,870 (14.3)	
	4-2	FO	PIII	III	ordinary upland.			0	0	510	510		
5		MC. UP	PIV	III	paddy field. ordinary upland orchard. pasture.	poorly suitable	moderately suitable	4,530	1,350	0	5,880	5,880 (14.3)	
6	6-1	GF	PIV	IV	ordinary upland. pasture. orchard.	poorly suitable	poorly suitable	850	650	0	1,500	4,760 (11.6)	plowing. irrigation.
	6-2	LA	PIV	IV	pasture.			0	140	2,910	3,050		glassland improvement
	6-3	EC	PIV	IV	pasture. ordinary upland.			0	0	210	210		surface drainage in the Rainy Season
7		TL	PV	IV	pasture. orchard. ordinary upland.	non-suitable	poorly suitable	1,490	670	0	2,160	2,160 (5.3)	plowing. land use for pasture or orchard
8	8-1	LR	PV	V	pasture. orchard.	non-suitable	defined use	1,690	80	0	1,770	2,200 (5.4)	land use for pasture or orchard
	8-2	LC	PIV	V	ordinary upland.			0	0	430	430		surface drainage in the Rainy Season
9	9-1	EB	PV	VI	pasture. orchard.	non-suitable	non-suitable	0	0	40	40	130 (0.3)	glassland improvement
	9-2	LC	PV	VI	forest.			40	50	0	90		revetment
Total								9,100	15,400	16,600	41,100	41,100 (100)	

Note [1] paddy field : paddy field with irrigation. [2] ordinay upland : annual crops, perennial crops, upland rice.

3.1.4 Groundwater

Basically, groundwater stored in the Area is recharged by rainfall during the wet season. Rainfall which filtrates in and out of the Area turns to be groundwater and flows down into aquifers consisting non-consolidated sediments. Distribution of groundwater is limited by the location of rivers, ground slope and geological characteristics of the aquifers. The types of groundwater in the Area are: spring, deep and shallow groundwater. The distribution and utilization of these types of groundwater are described as follows;

(1) Spring

This type of groundwater is found at the ending margins of alluvial fans, foot of plateaus and river terraces. Spring flows into caños or forms stagnant pond in concaved parts. High groundwater table sector in the Middle and Lower Zones is affected by the behavior of this type of groundwater outside of stagnancy of rain water. Some farmers obtain spring water for domestic use through conducting pipes.

(2) Deep groundwater

Deep groundwater is distributed in the Middle and Lower Zones which show large thickness of non-consolidated sediments. Groundwater table is lower than GL-50m without fluctuation throughout the year. Development of deep groundwater has not been extensively practiced except for Canaguaro, Puerto Caldas and Caño Blanco where this groundwater is utilized for water supply through pumping. It may be possible to use this resource for water supply and irrigation after grasping of possible development volume in the near future.

(3) Shallow groundwater

This type of groundwater is distributed throughout the Area. The groundwater table fluctuates between 0 and 4m from the ground surface. Of this range, the sector of groundwater table shallower than 0.5m is observed in gentle slope lands, feet of plateaus and terraces, concaved parts, flooding areas, heavy clay areas that correspond to poor drainage area. These sectors show problems to grow some crops and to carry out mechanical farming. The sector of the table deeper than 2m is recognized in hills, coarse grain sediments area, surroundings of the Guape and Ariari rivers. This type of groundwater is utilized for domestic water through manual pumping at private shallow wells. The characteristics of shallow wells are as follows:

Excavation	:	hand dug made
Diameter of well	:	0.5 - 1.4m
Depth of well	:	2 - 8m (3.5m on the average)
Water table from ground surface	:	0.3 - 4m (2m on the average)
Depth of water layer	:	1 - 2.5m

Many wells show draw down between 0.5 and 2.0m during the dry season, including dry up. Groundwater is taken less than 800 1/day per one well.

No sanitary problem has been encountered to date in the utilization of shallow groundwter.

3.1.5 Environmental Aspect

The objective of this study is to assess the environmental impact after the implementation of the Project and to check the proposed negative factors of environment which prevent sound implementation of the Project.

The study in this aspect can be divided into natural and social environments. Some of the items of the social environment will be discussed in section 3.3.3.

(1) Natural environment

1) Flora

The Area shows a great variety of flora being included in the tropical humid climate. However, after colonization in the 1960's, exploitation of forests was carried out to expand agricultural land and pasture. As a result, little virgin flora remains except for forest along caños, sporadic little wood land and shadow tree for some crops.

Principal trees in the Area are Amarillo, Cedro (Cedrela Odorata sp), Yarumo (Cecropia burriada sp), Balso (Ochroma sp), Jobo (Spondies mombin sp), Macano (Terminalia amazónica sp), etc.

Some commercial trees such as Amarillo, Cedro, Balso, etc. come to a crisis of extinction.

Principal grasses in the Area are Pingamosa (Urtica baccifera), Helecho (Belechum occidentale), Bijao (helilonia lingulata), Verbena (Stachytarpheta cayennenis), Lulo de perro, Masiquia, etc.

Illegal destruction and burning of forest are carried out continually during the dry season, although they are prohibited as illegal activities.

2) Fauna

Just like the flora, the variety and number of fauna are diminishing through small habitat by means of colonization and unreasonable hunting. Birds, reptiles and mammalia in the Area are as follows:

Birds : Aguilita (Butes magnirostris), Chulo (Caragyps attratus), Garrapatero (Crotophaga mayor), Garza del Ganado (Bulbucus ibis), Hormiguero (Thannophillus doliatus), Torcaza (Columba gayernrses), etc.

Reptiles : Lobato (Tupinanbis tequixin), Charapa (Podocnemia expansa), Teracay (Podocnemia unifillis), Iguana (Iguana iguana), etc.

Mammalia : Micos, Muciélago (Desmodus rotundus), Ratas (Eteromydae), etc.

The greater portion these species have disappeared or just being disappeared. Little aquatic fauna is seen in the Area. Some of them are Bocachico (Prochilodus sp), Coperito (Curimata sp), Caribe (Serasalmus sp), Capaz (Pimelodus sp), etc.

The number of this fauna is remarkably decreasing because of excessive spraying of insecticide over paddy fields by light airplane (There is no regulation to control this spraying).

3) Water quality

Surface water in the Area is identified as C_1S_1 (low salinity and low alkalinity) which indicates that the water is suitable for irrigation and may be used without treatment. However, result of coliform bacillus analysis shows that it is polluted. This surface water is utilized for domestic use without treatment in many villages. This may be one of the causes of disease of digestive organs in the Area. Moreover, the spraying of chemicals may cause the pollution of water in the Lower Zone.

4) Land conservation

Small land slides have been recognized on steep slope of deep valley, colluvial deposits on piedmonts, boundary zone between terraces and the Guape river, foot of plateau located in the surroundings of the Area. But as all land slides occur in the improductive land, direct damage has not been detected.

(2) Social Environment

Social environmental survey has been carried out by means of questionnaire at principal villages, such as Lejanías, Cacayal, Aguas Claras, Canaguaro, Dos Quebradas, Puerto Caldas, La Cooperativa and Caño Blanco.

1) Solid wastes treatment

Each family throws wastes at banks of river and caños except Lejanías where collection services is carried out. Therefore, many sanitary problems are detected in some sectors, for example, contamination of surface water and groundwater, appearance of germs, etc.

2) Market and slaughter house

Market is held twice a week in Lejanías and Canaguaro, but the rest of villages do not have the market facility. Most of the villages have slaughter house near caños, but its facility is poor from the sanitary viewpoint.

3) Health and medical service

Medical clinic is available in all the villages, but medical instruments and medicine are deficient in all the clinics. Moreover, doctors and nurses don't stay permanently, but only medical counsellor attends. Therefore, it's impossible for local inhabitants to get effective medical services. In case of

emergency, patients are taken to regional hospital located in Granada which has no sufficient facility to offer better service, neither. Therefore, difficulty to attend immediately may cause high mortality in case of emergency. Common diseases in the Area are intestinal diseases, respiratory diseases, anaemia, malaria, viral diseases, etc.

4) Transportation and communication

Public bus service between Granada and San Juan de Arama or Lejanías is available a few times a day. Apart from bus service, public taxi transportation is also available between principal villages and Granada.

(3) Consideration of environmental aspects

Principal problems of environmental aspects in the Area are as follows:

- Diminution in variety and number of flora and fauna, soil loss, flood, river bank erosion, and air pollution due to destruction and burning of forest.

- Diminution in variety and number of flora and fauna, water and air pollution due to excessive spraying of insecticides.

- Occurrence of diseases, soil and water pollution, deterioration of environmental beauty due to deficiency of social infrastructure.

3.2 SOCIO-ECONOMIC AND AGRICULTURAL CONDITIONS

3.2.1 Socio-economy

The study area is located within the jurisdiction of Lejanías, Granada and Fuénte de Oro. The territory of these three municipalities covers 778km^2, 365km^2 and 542km^2 respectively, thus the three municipalities together occupy approximately 2% of the departmental extension. Furthermore, the study area corresponds to one-fourth of the whole of the three municipalities.

The majority of inhabitants in the study area are immigrants coming from other parts of the country. The flow of immigration took place in the period of 1948 - 53, so-called "civil war period", and it was accelerated by the commencement of the Ariari-Gujar colonization project undertaken by INCORA (Caja Agraria at that time) in 1967. In addition, the completion of the Guillermo Leon Valencia Bridge over the Ariari River in 1965 contributed greatly to facilitate the flow. According to the survey result conducted by the study team, more than 90% of interviewees came from departments other than Meta, of which Tolima, Valle del Cauca and Cundinamarca predominate.

Population of Lejanías, Granada and Fuente de Oro for the last three censuses is shown below:

Table 3-2-1 Population of the Three Municipalities

	1964			1973			1985		
	Urban	Rural	Total	Urban (%/year)	Rural (%/year)	Total (%/year)	Urban (%/year)	Rural (%/year)	Total (%/year)
Fuente de Ore	1,109	1,090	2,199	1,214 (1.0)	6,177(21.3)	7,391(14.4)	1,320 (0.7)	6,811 (0.9)	8,131 (0.8)
Granada	5,683	4,556	10,239	9,867 (6.3)	10,576 (9.8)	20,443 (8.0)	21,318 (6.6)	9,268 (1.1)	30,586 (3.4)
Lejanias	n.a.	n.a.	n.a.	- (-)	1,906 (-)	1,906 (-)	3,122 (-)	6,725 (-)	9,847 (-)

Because of the implementation of colonization project, the population of Lejanías had grown at a very high rate for the term of 1973 - 85. Nonetheless, it is presumed that the trend should be decelerated and the population should be grown at a moderate level, as there remains very little land for new settlement.

Granada is the second largest city in Meta next to the capital city of Villavicencio and it is located as a core commercial city in the Ariari region. Under the situation, the urban population grew at a remarkably rapid pace with 6.6% per year during 1973 - 85. The rural area, on the other hand, had increased its population notably (10%/year) during 1964 - 73 due to an immigration of people seeking for new arable lands, but negative growth was recorded for the subsequent inter-census period because of lack of virgin lands and exodus of farm owners to urban areas.

Similar to the rural area of Granada, the population of Fuente de Oro had ascended highly between 1964 and 1973, but its growth had became such low level as below 1%/year in 1973 - 1985.

The study area comprises urban area of Lejanías, and towns (Inspeccion de policia) and villages (Vereda) totalling 36. Breakdown by municipality and number of households are as follows:

Table 3-2-2 Number of Household by Municipality

MUNICIPALITIES	TOWN	VILLAGE	TOTAL	NO. OF HOUSEHOLDS
Lejanías	1	12	13	629
Granada	4	7	11	1116
Fuente de Oro	2	10	12	711
Total	7	29	36	2456

Taking account of this number of households, number of family members per household, growth rate of population and urban population in Lejanías, the population of the study area as of 1988 is estimated as shown below:

Lejanías	8,160
Granada	5,870
Fuente de Oro	3,770
Total	17,800

Thus, the population of the study area covers one-third of the total population of the three municipalities.

With an exception of urban area of Lejanías and town area such as Puerto Caldas, Aguaselaras and Cacayal, crop production is a hub activity in the study area and greater portion of inhabitants are comprised of farm owners and farm workers. In the upper part of the study area farms with relatively small size are operated by farm owners and their family members, while in the lower part, large farms employing permanent and temporary workers predominate.

Under-development of social infrastructure constitutes one of the constraints preventing local populations from being ameliorated their living conditions. Electricity and water supply are generally served in urban area of Lejanías and town areas, but are deficient in rural area to cover the whole study area. The sewage system is out of service in the majority of both urban and rural areas. Under these circumstances, not a few farm owners prefer to live in urban areas (Villavicencio, Granada, Bogota, etc.) entrusting crop cultivation to employed farm administrators.

3.2.2 Land Use and Land Tenure

(1) Land use

85.5% of the Area, or equivalent to 35,140 ha, is utilized as arable land. The arable land is divided into cultivated land and fallow land. Furthermore, the cultivated land consists of paddy field and upland. The latter, in turn, is classified into ordinary field for rice, annual and perennial crops, orchard and pasture land.

Of the total arable lands, irrigated paddy field accounts for 3.5 - 4.6% for the 1st and 2nd semesters. And rain-fed rice field, upland for annual crops, orchard and pasture land account for 4.5 - 32.6%, 6.9 - 25.9%, 6.7% and 31.6%, respectively. Moreover, fallow land accounts for 12.9% in the dry season (1st semester). Improductive land occupies 5,960 ha, which includes forest land and others. Forest land is mainly distributed along caños in 4,880 ha of area. Exploitation of forest lands is limited in accordance with INDERENA's guideline which contemplates environmental conservation and water resources preservation.

Lands located around Lejanías (the Upper Zone) are characterized by sandy soil with higher content of gravel. Therefore, these lands are not suitable for cultivation of crops, thus most of the lands are actually used for orchard and pasture. In the eastern part of the upper zone, various land uses are shown due to a variety of soil property. The extension of paddy fields accounts for only 23% of arable land even in the rainy season. The Middle Zone shows various land uses because of different natural conditions; paddy fields occupy 6,740 ha which accounts for 50% of arable land in the rainy season. In the Lower Zone, the land use is represented by paddy fields which account for 6,640 ha (49%), meanwhile orchard accounts for only 2%. Pasture land is concentrated in high terraces in the center of this zone.

The land use between rainy and dry seasons differs remarkably in the Middle and Lower zones; in the rainy season paddy fields dominate, while during the dry season they decrease due to lack of irrigation facilities and annual crop fields and fallow land offset the decreased area.

Present land use is shown in Table 3-2-3 and Fig. 3-2-1.

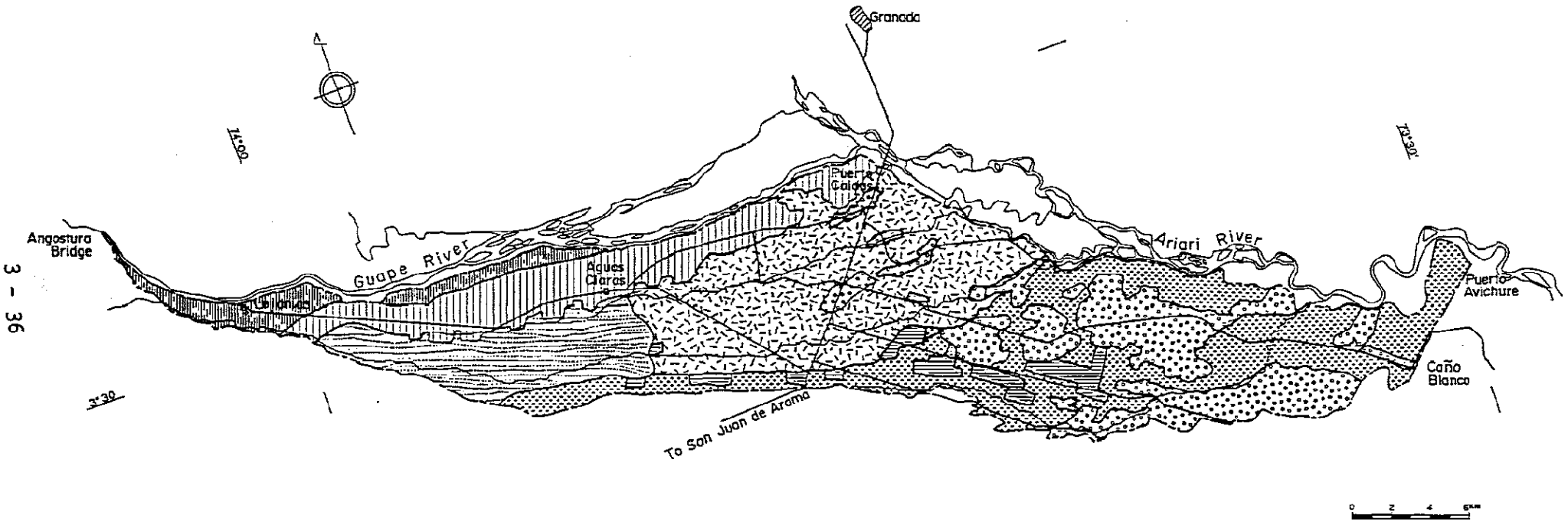
(2) Land tenure

The total number of farms in the Area is 1,301, of which 705 farms (54%) are owned by small-scale farmers with holding below 20 ha accounting for only 16% of the total farmland. 547 farms (42%) are owned by middle-scale farmers with holding of 20 - 100 ha and account for 65% of the total farmland. Large-scale farmers with holding over 100 ha accounts for 19% of the total farmland, although the number of farms owned by them is only 49 (3.8%).

The average farm size is 28.2 ha in the Upper Zone, 20.4 ha in the Middle Zone and 36.7 ha in the Lower Zone. Small-scale farmers account for half of the number of farmers in the Lower Zone. More large-scale farmers are encountered in the Lower Zone, however their average size (125 ha) is smaller than that (288 ha) of the Upper Zone (Table 3.2.4).

As for land tenure, farm owners account for 90% of the total number of farmers, while tenant farmers, who are predominately settled in the Upper Zone, accounts for 10% the Upper Zone. Cooperative farmers scarcely exist (Table 3-2-5).

Land tenure and status of land holding are shown in Table 3-2-4 and 3-2-5, respectively.



LEGEND

	Major Land Use (Minor Land Use)
	Pasture. Orchard
	Pasture. Orchard. (Upland)
	Upland. Orchard. (Pasture)
	Upland. (Orchard. Pasture)
	Upland. (Pasture)
	Pasture
	Paddy field with irrigation

Note : exception of forest and others

Fig. 3-2-1 PRESENT LAND USE MAP

Table 3-2-3 Present Land Use

(ha)

		Arable land								Non-arable land		Total
		Arable land										
		Irrigated [1] paddy field	Upland					Fallow land	Sub total	Forest	Others; road, river, bulding land, etc.	
			Ordinary upland			[4] Orchard	Pasture					
			Rain-fed rice field	[2] Annual crops	[3] Perennial crops							
Upper zone	1st [5]	50	1,840	785	1,020	1,110	3,195	0	8,000	720	380	9,100
	2nd [6]	45	300	1,865				465				
Middle zone	1st	605	6,135	1,165	590	710	4,295	0	13,500	1,500	400	15,400
	2nd	425	840	4,935				1,705				
Lower zone	1st	1,215	5,425	490	760	240	5,510	0	13,640	2,660	300	16,600
	2nd	970	710	2,310				3,140				
Total	1st	1,870	13,400	2,440	2,370	2,060	13,000	0	35,140	4,880	1,080	41,100
	2nd	1,440	1,850	9,110				5,310				
Rate (%)	1st	4.6	32.6	5.9	5.8	5.0	31.6	0	85.5	11.9	2.6	100
	2nd	3.5	4.5	22.2				12.9				

1) Paddy rice cultivation with inundated irrigation and preparing simple levee along with contour line for every cropping.
2) Maize, soybean, sorghum, cotton, cassava, kidney bean, sugar-cane.
3) Plantain
4) Cacao, papaya, oil palm, maracuya, guava, coffee, lemon.
5) Rainy season
6) Dry season

Table 3-2-4 Farm Distribution by Size

Farm Size (ha)	Upper Zone		Middle Zone		Lower Zone		Total (%)		Avarage Area (ha/House)
	Number	Area	Number	Area	Number	Area	Number	Area	
< 20 (Small Scale)	118	1,018	386	3,094	221	1,930	705 (54)	6,042 (16)	8.6
20~50 (Middle Scale)	72	2,501	161	5,442	183	5,870	416 (32)	13,813 (38)	33.2
50~ 100 (〃)	18	1,311	34	2,214	79	6,480	131 (10)	10,005 (27)	76.4
> 100 (Large Scale)	4	1,151	6	812	39	4,890	49 (4)	6,853 (19)	139.9
Total	212	5,981	567	11,562	522	19,170	1,301	36,713	
Average (ha/house)	28.2		20.4		36.7		28.2		

Table 3-2-5 Status of Land Holding

	Upper Zone Number (%)	Middle Zone Number (%)	Lower Zone Number (%)	Total Number (%)
Owner farmer	212 (72)	567 (100)	514 (98.4)	1293(93.5)
Tenant farmer	82 (28)	0 (0)	5 (1)	87 (6.2)
Cooperative	0 (0)	0 (0)	3 (0.6)	3 (0.5)
Total	294 (100)	567 (100)	522(100)	1383(100)

3.2.3 Agriculture and Livestock

(1) Agriculture

In the Upper Zone, traditional husbandry is conducted to produce mainly maize in uplands, while paddy fields are scarcely found. In the Middle and Lower Zones, rain-fed rice culture is the most predominant farming done in the rainy season. During the dry season arable lands with sufficient irrigation facility are cropped with rice, whereas in other locations dry land crops like soybean, sorghum, etc. are grown. Mechanized culture is common for cultivation of these crops. Other major crops planted in the Area are: plantain as perennial crop, papaya, cacao, oil palm and cotton as industrial crops (Table 3-2-6).

Table 3-2-6 Agricultural Difference in Three Zones

Zone	Annual precipi-tation	Average Farm Size	Farming System	Cultivated Crops
Upper	3,500mm	28.2 ha	S. intensive fruits & indus. crops and S. to M. traditional upland farming	plantain, papaya, cacao, fruits & vegetables, maize, beans, sorghum
Middle	3,000mm	20.4 ha	S. to M. indus. crops and M. to L. mechanized upland farming	plantain, cacao, oil palm, rice, soybean, sorghum
Lower	2,500mm	36.7 ha	L. mechanized upland farming	rice, soybean, sorghum sugarcane (fixed area)

Note: S.: small scale, M.: middle, L: large

Cultivation practices for each crop is shown as follows:

1) Rice

In the Area, rice is cultivated on about 15,300 ha, where 13,400 ha is for upland rice and 1,900 ha is for paddy rice. Double cropping of rice is conducted on 1,440 ha included in the said paddy rice field. The typical double cropping of rice is as follows:

	Field preparation	Seeding	Harvesting
1st. semester	Mid. Jan.	Mid. Feb.	Late June
2nd. semester	Mid. to late July	Mid. Aug.	Mid. Dec.

On the other hand, in the case of single cropping, seeding in March/April and harvesting in July/August is the most common cultivation pattern. Representative cropping pattern is shown in Fig. 3-2-2.

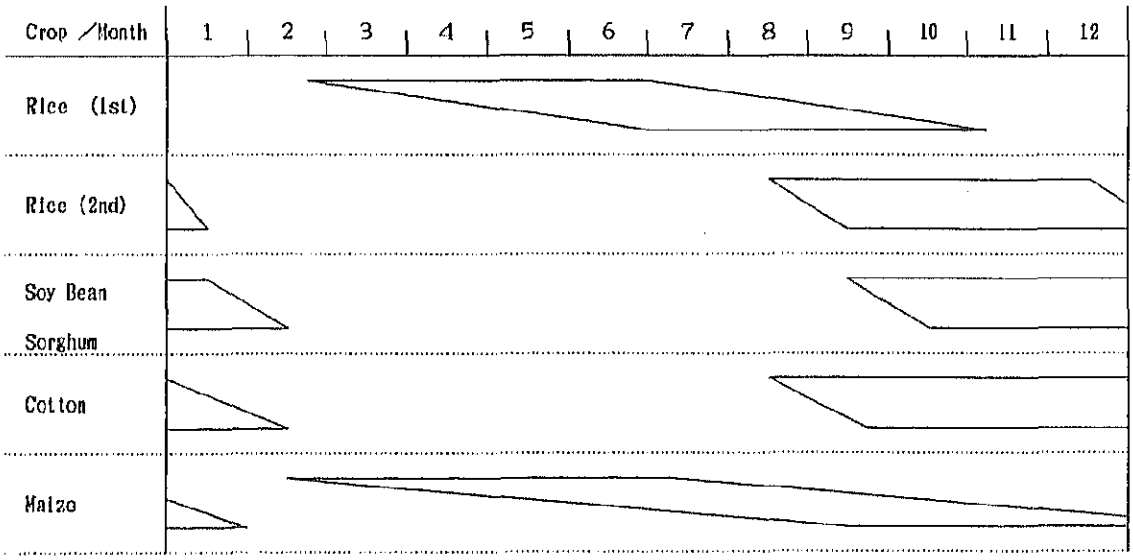


Fig. 3-2-2 Actual Cropping Pattern

Direct seeding with an amount of 200 - 220kg/ha, which exceeds the recommended seed rate of 150 - 180kg/ha, is carried out. The greater portion of the culture depends on machinery. Average

yield of upland rice is 4.1t/ha, while paddy is 5t/ha for the 1st harvest and 4.4t/ha for the 2nd one. According to the Fedearroz's survey, rice produced in the Area contains 26% of grain moisture and 7% of chaff on the average. Applying these figures to a conversion table of IDEMA, average yield in real terms is estimated as 4.1t/ha for the 1st harvest and 3.6t/ha for the 2nd one, respectively.

Water shortage, pests and diseases control and lack of machinery (especially for harvest) are major constraints of rice culture. However, farmers are willing to grow the grain due to the fact that climatological conditions of the Area are suited to its production and the price rose remarkably from 1987 to 1988.

2) Soybean

In Granada, soybean was sown for the first time in 1983 as an off-season crop of rice. Higher profitability compared with sorghum causes an expansion of its cropping area. For example, the planting area in the Area was only 200 ha at first but it reached 2,000 ha in 1987 and might reach 6,200 ha in '88 season, as estimated by ICA's Granada Office. In some cases credit service and technical assistance are provided by processing firms of the crop.

Seeding is done either by broadcasting or drilling and the amount of seed required for the former is 120 - 140kg/ha and for the latter, 80kg/ha. More farmers adopt broadcasting technique due to the easiness of work. Problems related to cultivation are downpour at young stage of plants, inundation of water, attack of pests and diseases. Post-harvest loss takes place since the same combine as the case for rice is used. Average yield is 1.6t/ha. Cropping pattern with rice is as shown below.

Seed	Harvest	Seed	Harvest
March ---- (rice) ----	July	Sep. ---- (soya) ----	Jan.

3) Sorghum

Sorghum is cultivated on about 1,400 ha as a secondary crop of rice with an average yield of 2.6t/ha. All the products are processed for animal feeds. Low profitability compared with other crops is the main reason for the decrease of cropping area.

The optimum sowing period is between September 15 and October 10. After the period fall beyond rainy season which will affect the growth of plants. Major problems are the occurrence of anthracnose and stem borer.

4) Cotton

A few farmers have resumed to cultivate the crop on about 260 ha in 1987/88 season after several years of its absence caused by low market price.

The planting area may be limited because the culture requires a lot of man-power for pest (ball worm) control and harvest which needs 30 persons/ha. Last season the production of one farm was 1.6t/ha.

5) Maize

Main cultivation area is encountered in the Upper and Middle zones where it is cultivated in small lands with relatively steep slope, gravelly soil and unsuitable for mechanization of cropping. Seeding is possible from February to September. It is grown at different seasons with different cropping. Patterns include double cropping and single cropping with sorghum. In rare cases it is grown as off-season crop of rice. With all high precipitation, better drainage due to deep slope and sandy soils make it possible to produce the crop in the Area. Priority of renting machinery is mainly given to large farmers, so hardly available for small-medium farmers are faced with difficulty in procurement of machinery in time of necessity. Moreover the

cultivation is conducted in a traditional manner. Therefore, some problems such as land preparation occurs in the maize cultivation.

Home raised seeds are often used though improved varieties are available. Herbicide is widely applied as the case for other crops in the area. Cultural practices are as shown below:

Space furrows plants	Sowing volume	Standing	Yield
90 - 100 x 60cm	3 - 4/point	2/point	1.6t/ha (2.5t/ha mechanization)

6) Papaya

The cultivated area is 840 ha most of which are lands with gravel soil in the Upper zone. The soil is well drained and is suitable for the crop growing under the high rainfall condition. It is said that stones do not prevent plants from growing healthy.

Cropping form is as shown below

Sow	Transplant 4 each	Thin 1 each	Harvest	Replant
0	2	3½	12	30 - 36 month

Since home raised seeds are sown, the variety is unknown. The planting space and density are 2.5 x 2.5m and 1,600 plants/ha including five male plants. Yield is 20t/ha/year.

7) Plantain

The total cropping area is about 2,400 ha and the crop is planted in the neighborhood of the Guape and Ariari Rivers. Small-scale plantain lands are common in the Upper and Middle Zones, while large-scale plantation is grown in the Lower Zone.

The two methods of planting are as follows:

	Planting space (m)	Density (plants/ha)	Yield (t/ha/year)	Plants life (years)
Ordinary	3 x 4, 2 x 5	800 - 1,000	6.5 - 8	20 - 30
Intensive	2 - 2.5 x 1.5	2,600 - 3,300	20 - 26	1 - 2

Ordinary cultivation is commonly carried out in the Area. On the other hand, intensive cultivation is conducted by a few farmers over the last 2 - 3 years. An example of the same is shown below.

Transplant	Fertilization 1	2	3	Harvest (25t/ha)		(20t/ha)
0	2	3½	5	11	15	22 24 month

Application amount of fertilizers for each 1, 2 and 3 are the same, is 75 grams of urea and potassium chloride per plant (225kg/ha).

Due to intensive cultural practice in short term, an irrigation is highly required to attain higher yield. Actually, the harvest after dry season is rare. Since this intensive cropping is able to rotate with cereals, it is expected that the planting area will be expanded in the future.

8) Cacao

Cropping area is about 870 ha and the product is grown principally in the Middle Zone. Cultivation is usually done nearby homestead in a relatively small area. Cropping area per household is 8 ha on the average.

The majority of seeds sown come from either seed distributers or ICA, and the remainder (about 10%) is covered by home-raised ones (ICA, Granada). Despite the crop requires uniformity in harvent, it seems to be under-developped to establish an organized quality

and cultivation control management like qualified seeds distribution and products shipment.

The cropping stage is shown below:

Sowing -(on nursery)-	Transplant	Start produce --(productive age)--		Replant
-¼	0	1½	4	30 year

The average yield in the Ariari region is 450kg/ha/year. The attack of Escoba de bruja (witches broom) and Moniliasis are the most serious problems on the culture and 80% of production loss might be caused by these problems (ICA Granada).

9) Oil Palm

Oil palm is grown in 320 ha of lands located in the Middle Zone. In the Area there are a combination of aged trees of more than 20 years and immature young plantations. The former has passed the optimum period of production. It yields as low as 4.8t/ha/year now, which is far inferior to an average yield of 11.5t/ha/year in the Department of Meta. There are four plantations in the later case and all of farm owners entrust their farm management to others.

The cropping calender is as shown below:

P.G.T.	Sow	T/plant	Start produce	(high production)	Replant (decline yield)
-2m	0	½	5	10	20 year

P.G.T., Pre-Germination Treatment

An organized cultivation and quality control management system is not established as the case of cacao.

10) Passion Fruit (Maracuya)

The planted area is such small as around 10 ha. Although there are some matters to be settled like an establishment of cultivation method, market channel and the like, it is expected that the planted area may be expanded. The actual yield level is 4t/ha/2 years, however it is viable to raise the productivity up to a level of 15 - 20t/ha/year employing an adequate farming system.

Cropping system is as follows:

Sow	Transplant	Harvest -	Decline - -	Y. Harvest - -	Decline yield - - (Replant)
-2	0	8	13	18	24 month

(2) Livestock

Livestock farming is done all over the Area. There is no other livestock activity on a commercial base but cattle breeding and fattening. Dairy farming is not conducted except a few breeding farms which use milk for the home-consumption.

1) Cattle

Cattle farming is done for any of the following three purposes; Breeding, fattening or both breeding and fattening (dual purpose farming). Small to middle scale farms tend to realize breeding or fattening, whereas dual purpose farming is done by rather large scale farms.

According to information obtained through the field's survey, an average land size per livestock farm is 80 ha, of which 37 ha is covered by grassland. About 40% of the farms in the Area have grassland, but the farms that run grass more than half of their land are only 30% of the total number of livestock farmers.

The great majority of cattle kept in the Area are Cebu and its crossbreed with criollo. There are no other breed but Romo Sinuano which is rarely found. Grazing is the only source to feed cattle. It is provided either salt or mineralized salt by all the farms however, their quantity is less in some cases. Carrying capacity including calf is 1.6 for breeding and dual purpose farming, 2.4 for fattening (1.7 head/ha on average). As for liveweight gain, it is 124 kg/ha/year for breeding 190 kg/ha/year for total grazing and 338 kg/ha/year for fattening, thus the average is 202 kg/ha/year.

In terms of sanitation for livestock, more attention is paid to prevent foot and mouth diseases and anthrax. The vaccination against both of these diseases is given regularly in all the farms. Endo and ectoparasite control and prevention are given to nearly 100%, though occasionally it is insufficient in frequency.

2) Grassland

Grassland occupies about 13,000 ha in the Area which represent 32% of the total area. Grassland is divided into two categories by its development level and management: natural and improved.

Although a grassland where more proportion of weeds are growing is classified as an improved, if only such grass as stated later are planted. This is the reason why the improved grasslands occupy higher percentage (75%).

Braquiaria (Brachiaria decumbens) is the most predominant grass. Other grass like puntero (Hyparrhenia rufa), aleman (Echinochloa polystachya), india (Panicum maximum) and so on are seen somewhere, but no legume pasturage is seen.

Grazing is usually done in rotational way, although in some cases it is continuous. The latter is mainly the case for small lands or lands immediately after the exploitation. Brush cut with mower, roller (rolo) or by hand after a period of grazing is the

main care given to renovate the grass as well as weed. Moreover, 60% of the farms use herbicide at an average of twice a year for weed control. Fertilizing to grass is not done even for well managed lands.

3.2.4 Agro-economy and Marketing

(1) Agricultural production

Planted area for the first semester of 1988 was represented by rice, which accounted for 43% of the total area, pasture (37%), maize (7%), and plantain (7%). On the other hand, planted area of rice for the second semester was reduced to 9% of the total area and this reduced area was offset by such upland crops as soybean, sorghum and cotton, although one-third of lands used as rice field for the first semester was left in fallow. Table 3-2-8 illustrates an evolution of planted area registered with ICA. In recent years, reflecting the behavoir of market, farmers tend to substitute rice for maize, and soybean for sorghum. As for perennial and tree crops which require longer period from sowing to putting into production, no major change takes place in terms of their cultivated area.

(2) Balance of crop production

In view of estimating balance of production regarding such major crops as rice, soybean, sorghum, maize, cacao, papaya and plantain, a survey was conducted on planted/harvested area, output, unit yield, farm-gate price, production cost, etc. The result of the survey is given in Table 3-2-7.

1) Rice

An average planted area was 74 has with the largest area of 1,500 ha. Farmers cultivating lands more than 100 ha accounted for 14% of the total number of rice growers. Close to 20% of farmers realized double cropping of rice, but area and yield of the second harvest shrank to 30% and 80% of the first harvest, respectively. The unit yield of paddy was 5.0 t/ha on the average. Nevertheless, it is worth while to point out that paddies in the Area contain higher proportion of moisture and foreign materials. Thus, unit yield in real terms is estimated

to be 4.1 t/ha for paddy and 3.3 t/ha for upland rice. The support price of IDEMA for the semester A (June 1-November 30) of 1988 was originally established as Col$72,000/t, but it was hiked to Col$80,000/t in the course of the semester. This price level is higher than that of semester B in 1987 by 50%. Consequently, the cultivated area of rice increased considerably.

2) Other annual crops

- Sorghum

Sorghum was produced in large amount in 1987 as a secondary crop of rice, but in 1988, not a few farmers shifted their cropping practice from sorghum to soybean. Consequently, sorghum's planted area in 1988 was 60% as few as that in 1987. Farmers attained a yield of 2.6 t/ha in an average land of 18.1 ha. The support price of the crop was Col$63,000/t for the semester A of 1988, which was revised from the initial price of Col$58,000/t.

- Soybean

Within the study area, the unit area per farmer was the second largest (34 ha in 1987) next to rice. In 1988, as a consequence of farmers' trend to cultivate the crop on behalf of sorghum, the study area produced about half of the output in the Department of Meta. The unit yield was 1.6 t/ha on average and the support price attained Col$125,000 for the semester A in 1988, 33% up from the last semester.

- Maize

By and large, maize is harvested twice a year in the study area. The crop is cultivated in smaller lands than other grains such as rice, soybean and sorghum; an average planted area is 6.5 ha and lands smaller than 5 ha represent three-quarters of the total number of lands used for maize. The

largest extension of farm with maize was 16 ha in the study area. The return ratio of the crop was inferior to that of other grains.

- Cotton

Cotton is mainly cultivated in the middle zone of the study area as a secondary crop of rice. An average planted area was 6 ha. On account of unstable marketing condition, farmers are inclined to cultivate the crop referring to the behavoir of price. Thus, very few farmers practice production of cotton consistently. The return ratio of the crop is the lowest among annual crops.

3) Perennial and tree crops

- Plantain

In the upper zone of the study area, plantain is predominantly produced together with papaya and maize in relatively smaller fields, while in the lower zone, large scaled plantations are found somewhere. The product is yielded yearly 6 t/ha during major production period.

- Cacao

The greater portion of cacao fields are located in the upper part from the national road which penetrates through the study area. An average planted area ranges around 9 ha and an annual yield is 0.45/ha.

- Papaya

The majority of papaya's field corresponds to lands with rocks and stones along the Guape river. Close to 80% of the departmental output come from the study area. Most fields are in the range of 3-5 ha. Papaya is one of the most remunerable

crops in the study area and it is estimated that an annual net return of Col$640,000/ha is made from cultivating the fruit.

- Oil palm

The production of oil palm is entrusted to the oil extracting factory located on the left margin of the Ariari river, because adequate supporting services to growers are completely scare.

- Sugar-cane

There is only one plantation producing sugar-cane on a commercial basis. The cultivated area is 70 ha and the product is processed in a factory owned by the same farmer.

- Maracuya

Although maracuya is regarded as a promising crop to be cultivated in the study area, at present only a couple of farmers realize the cultivation in lands as small as 1 ha.

4) Cattle raising

Pasture lands in the study area reach an extension of 13,000 ha, which account for a third of the total arable land. The productivity of cattle raising remains in low level in the absence of intensive farming practice. Gross and net returns of cattle raising are each one tenth and one fifth of rice production.

(3) Marketing of agro-products

1) Rice

Owing to the favorable behavoir of the support price, the production of rice has increased in Meta starting 1987 and reached 415 thousand tons for the year of 1988. The capacity of

existing rice storage and milling facilities is as summarized below.

Table 3-2-9 Rice Milling Facilities

Facilities	Nos.	Drying Capacity(t/hr)	Storage Capacity(t)	Milling Capacity(t/hr)
Rice mill	45	346	222,600	121
IDEMA*	4	50	18,000	-

* Granada, San Martin, San Juan de Arama & Villavicencio

As for the study area and its neighboring area, there are two privately owned rice mills in Granada and three in San Martin. Due to the fact that as high as 90% of annual paddy production is concentrated on the rainy season, the rate of operation for these rice mills is very low in the dry season; without consistent nor sufficient supply of paddy, the plant in this season is operated for drying rice seed, harvested soybean and maize, etc. This situation is a major constrain on developing rice industry in Granada.

Paddies produced in the study area are traded through rice mill, intermediary, IDEMA and Comarroz-a subsidiary of Fedearroz; about 70% of the production are purchased by the former two agencies, 25% by IDEMA and the rest by Commaroz. Amount and price traded by IDEMA's purchase center in Granada are as given below:

Table 3-2-10 Volume and Price Traded by IDEMA

Year	Volume (t)	Price (Col$/t)[1)]
1985	9,907	30,900
1986	4,596	38,000
1987	6,206	49,100
1988[2)]	3,677	80,000

Note: 1) Semester A
2) Corresponds to August and September only

IDEMA's support price is established subject to 3% of foreign materials and 13% of moisture content; it also varies according to quality and variety of paddy. Referring to the information collected from Commarroz, an average proportion of foreign materials and moisture content of paddy produced in the study area was 7% and 26%, respectively. Accordingly, farmers are paid 81.55% of the established support price (Refer to Table G-2-7).

2) Other annual crops

- Sorghum

The harvest period of the grain falls between December and February. Purchase is made by intermediaries or IDEMA, and the grain is, in turn, sent to feed producing factories in Bogota. Intervention by IDEMA in the trade of sorghum has been inconsistent.

- Soybean

Starting August 1988, one factory inaugurated its operation to process soybean in Villavicencio. The factory, although the processing capacity is 60 t/day, is presently operated close to 70% of its capacity. The factory collects soybean from farmers to whom production is entrusted providing inputs. Approximately 65% of farmers growing soybean in the study area are affiliated with the factory. Extracted crude oil is refined at final processing factories located in Bogota or Cali. IDEMA has not participated in the trade of soybean except for the year of 1985.

- Maize

About 10% of the production is reserved for the self-consumption of farmers. Trade of maize in the local market is conducted mainly through intermediates and IDEMA (IDEMA's intervention has been irregular). Products are transported to

Bogota, Villavicencio and other major markets; only 1% of the production is consumed locally.

3) Perennial and tree crops

- Papaya and plantain

The study area is the leading zone for the production of papaya and plantain sharing 85% and 40% each of the departmental production. Fruits harvested in the upper zone are collected by a cooperative or intermediaries, who transport them to Corabasto- the biggest wholesale market in Bogota. Plantain produced in the lower zone is purchased at farms and forwarded to Bogota by intermediaries.

Plantain, one of the basic foods for Colombian meal, has a stable and consistent market, while papaya's market is not consolidated with larger fluctuation of prices.

- Cacao

Granada is one of the major trading center of cacao in Colombia, thus products are collected from Ariari region including the study area. Procame has established its head office in Granada and Compañia Nacional de Chocolate and Luker--the leading chocolate producing firms of the country--have their own purchase center there. The latter collects cacao exclusively for domestic market, whilst the former exports half of its trade volume. Cacao is exported mainly to U.S.A., Italia, West Germany and Japan. Procame's balance in the foreign trade is in deficit due to descended international price.

Cacao's trade in Granada had been calm during 1988 with less price fluctuation in the range of Col$380-415/kg, but in only two months starting from January 1989, price has sharply risen from Col$435/kg to Col$520/kg.

- Oil palm

Fruits of oil palm produced in the study area are extracted their oil in the factory located on the left margin of the Ariari river at the rate of 250 tons per month. Extracted crude oil is refined in Bogota or in Villavicencio.

- Maracuya

Maracuya is a minor product without having consistent market. At present, the fruit is traded by a cooperative in Lejanias for sale in Bogota or by farmers themselves who transport the product to local market. In the latter's case, prices are drastically variable from Col$40,000/t to Col$120,000/t.

4) Cattle

Except for those slaughted and consumed locally, the transaction of cattle had been made at farm between farmers and intermediaries placing the former at an disadvantageous position on determining prices. Nonetheless, since an establishment of the Catama Livestock Center in Villavicencio, which has an objective to improve marketing channel of livestock in Villavicencio, the majority of livestock trade in Meta has been concentrated in the center and farms' situation for sale of their cattle has been improved.

Without having sufficient processing facilities at regional level, greater portion of cattle produced in the study area are finally processed in Bogota. It is estimated that close to 60% of beaf consumed in Bogota come from Meta.

Table 3-2-7 BALANCE OF CROP PRODUCTION

(A) ANNUAL CROPS

CROPS	Unit Yield (ton/ha)	Farm-gate Price (Col$/ton)	Gross Return (Col$/ha)	Production Cost (Col$/ha)	Net Return (col$/ha)	Return Ratio (%)
Upland Rice	4.1	80,000	328,000	204,770	123,230	37.6
Paddy	3.3	80,000	264,000	151,740	112,260	42.5
Sorghum	2.6	63,000	163,800	104,660	59,140	36.1
Soybean	1.6	125,000	200,000	140,390	59,610	29.8
Maize	1.6	65,000	104,000	81,580	22,420	21.6
Cotton	1.0	210,000	210,000	165,530	44,470	21.2

(B) PERRENIAL CROPS

CROPS		Unit Yield (ton/ha)	Farm-gate Price (Col$/ton)	Gross Return (Col$/ha/year)	Production Cost (Col$/ha/year)	Net Return (Col$/ha/year)
Plantain	(Establishment)	1.6	50,000	80,000	121,810	-41,810
	(Maintenance)	6.0	50,000	300,000	106,670	193,330
Cacao	(Maintenance)	0.45	436,000	196,200	98,550	97,650
Papaya	(Establishment)	2.0	40,000	80,000	156,290	-76,290
	(Maintanance)	20.0	40,000	800,000	136,790	636,210
Oil Palm	(Maintenance)	1.8	229,000	412,200	120,460	291,740
Passion Fruit		2.0	40,000	80,000	77,680	2,320

Table 3-2-8 EVOLUTION OF PLANTED AREA REGISTERED WITH ICA

CROPS	1982		1983		1984	1985	1986		1987		1988	
	Semester A	Semester B	Semester A	Semester B			Semester A	Semester B	Semester A	Semester B	Semester A	Semester B
Upland Rice	8,400	50	6,424	1,313			9,712	90	10,903	330	13,707	426
Paddy	2,764	407	1,916	153			1,513	642	758	649	1,775	1,281
Maize	1,136	247	702	311	n.a.	n.a.	624	137	548	137	624	78
Sorghum	-	3,568	-	4,065			-	1,891	-	3,449	-	2,028
Soybean	-	-	-	-			-	1,435	-	1,680	-	4,466
Cotton	-	608	-	1,040			-	42	-	326	-	682

Source: Area inscrita para cultious en el ICA

3.2.5 Institutional Services and Farmers' Organization

(1) Institutional Services

Institutional services to support farmers' activities and farmers' organization in the Area are summarized in Table 3-2-11.

Table 3-2-11 Agricultural Supporting Services

Acronyms of Public Institutions and Organizations	Function	Major Activities
HIMAT	- Hydrological and meteorological data collection - Land reclamation	- Forecast and information
INCORA	- Redistribution of farm lands - Extension services and agricultural credits for small farmers	- Land acquisition and irrigation land preparation of national lands for farmers - Agricultural credits and related services
ICA	- Research, education and extension services for agriculture and livestock	- Plant breeding, improvement of pasture - Improvement of agricultural machinery and technical extension services - Agricultural dignosis, control of insects and certification of seed
INDERENA	- Conservation of environment - Control and protection of natural resources - Control of marketing of agricultural and livestock products	- Environmental conservation for fauna and flora - Establishment of efficient forest control - Data collection, analysis and publication - Planning of agricultural production
SENA	- Technical education for agriculture and livestock	- Education of agricultural management, cultivation technique and mechanization to students

Acronyms of Public Institutions and Organizations	Function	Major Activities
CAJA AGRARIA	- Credits for agriculture and livestock	- Credit banking for agricultural and livestock development - Credit banking for regional development - Orientation of agricultural technics
Fondo-DRI	- Credits for integrated rural development	- Improvement of rural infrastructures - Supporting for agricultural production - Promotion for consolidation of rural organizations
Banco Cafetero	- Credits for agricultural production, transports and export of coffee and other products	- Credit banking
Banco Ganadero	- Credits for agriculture and livestock	- Credit for weak livestock funds - Credit for small-scale agro-industry
FEDEARROZ	- Promotion of rice production - Improvement of marketing system of rice	- Extension of rice cultivation technique - Supply of production inputs - Buying of rice
FEDECACAO	- Promotion of cacao production - Improvement of marketing system of cacao	- Technical extension of cultivation technique of cacao - Improvement of marketing system - Supply of seeds and seedlings - Buying and processing of cacao
PROCAME	- Improvement of marketing and processing of cacao	- Buying and processing of cacao
COAGRO LEJANIAS	- Exploitation of marketing	- Collection, distribution and buying of agricultural products
COAGROARIARI	- Improvement of marketing	- Selling of productive inputs - Buying of agricultural products

1) Credit services

Public credit services for crop production and livestock are rendered through three major lines: FFA, own fund of CAJA AGRARIA and Fondo-DRI Program. These three lines cover about 90% of the total credit amount provided to farmers. The remaining portion is rendered by quasi-public banks represented by Banco Cafetero and Banco Ganadero, and private banks, and other agencies such as FEDEARROZ, FEDECACAO and so on. There are some farmers who get financial assistance from cooperatives, friends or relatives. So far as the Area is concerned rice shares the largest amount of credit services; for the first semester of 1988, 68% of the total amount provided by Caja Agraria (Granada) was directed to rice production which was followed by, although by far inferior to rice, maize (8.6%) and cattle raising (5.4%). According to the survey on farmers, more than 80% of rice producting farmers had access to credit services and greater portion of the farmers received credit services for the production of soyabean and cotton. On the other hand, only half of the farmers got financial services to produce maize and perennial crops. More than 70% of the livestock farmers conducted animal husbandry without any credit service.

The loan conditions varied with agencies; public agencies offer more favorable conditions to users than private ones. For example, as far as rice cultivation is concerned, farmers get loan from public agencies with an annual interest rate of 21%, while an interest increases to more than 25% in case of loan from quasi-governmental agencies (Banco Cafetero, Banco Ganadero) and Fedearroz. In the first semester of 1988, the cultivated area of rice with loan of FFA covered 7,200 ha in Granada, Fuente de Oro and Lejanías and this area corresponds less than half of the total cultivated area (15,270 ha) of rice in the said three municipalities. This fact intimates that more than half of the area with rice were cultivated with particular resources or loan from private sector without having access to the FFA.

The FFA's credit services are for small and medium farmers only; in case of rice cultivation, an average area among beneficiaries is 12 ha and the amount of credit was Col$93,000 per ha. Refering to the production cost of rice as of the first semester of 1988 (Col$181,000/ha), it is supposed that the FFA's credit covered 50% of the production cost.

The reason why the FFA's credit covers less area is that strict appraisal system on providing farmers with loan is established so as to prevent failure of repayment as far as possbile. On the other hand, the major cause for farmer to fail repayment of their loan is that they can not attain expected production at the time of request for loan. In this connection, Caja Agraria is oblidged to render technical assistance to beneficiaries of their credit services, but it is not conducted appropriately. Under the situation, it is of importance that more appropriate and more frequent technical assistance should be rendered by Caja Agraria so that this assistance may contribute to increasing agricultural production followed by better repayment proportion by farmers.

The credit condition depends on purpose or activity, period, financial ability of users, etc. It is said that there are more than 120 credit lines to help farmers to develop agricultural activity and to improve their living conditions. In the case of credit to crops (annual or perennial) production, conditions are set forth as given below:

Beneficiaries:	small and medium farmers
Amount:	to be determined by borrowing capacity of users
Covering range:	direct production cost
Period:	until harvest time plus one month allowance for marketing
Interest:	in accordance with fortune of users

Features of other credit lines are given in ANNEX H.

2) Extension and Technical Assistance

ICA is a leading institution which undertakes extension and technical assistance services to farmers. ICA's services cover investigation, education, technical assistance, diagnosis of agricultural and livestock activities, disease control of plants and animals, supervision of agricultural inputs, certification of seeds, development of appropriate technology and rural development, etc. ICA's regional office No. 8 is located in Villavicencio and its branch office (CRECED) exists in Granada. Principal activities of the CRECED are to identify problems confronted by farmers pertinent to their crop and animal husbandries and render them appropriate technical advice to solve the problems. For this purpose, 5 agronomists, 1 veterinarian, 1 zoological technician and 16 agricultural experts are working to provide required services; of 16 agricultural experts, 4 are stationed in Granada, 2 in Lejanías and 1 in Fuente de Oro.

Apart from ICA, extension and technical assistance services are also rendered by: INCORA, SENA, CAJA AGRARIA, FEDEARROZ, FEDECACAO and independent experts. INCORA's services is directed to small farmers or beneficiaries of agrarian reform, SENA undertakes technical training and organization of communities, CAJA AGRARIA is obliged to give technical assistance to users of credits, FEDEARROZ and FEDECACAO are advising technical aspect on cultivation of rice and cacao, and independent experts are incharge of technical assistance on mainly to such crops as rice, sorghum, soybean, maize and plantain.

According to the survey result conducted by the study team, technical assistance services are focused on control of weeds and disease. On the other hand, advices on appropriate cropping technology such as optimum amount of inputs, land preparation, water control, operation of machinery, harvest and post-harvest management, etc. are deficiently provided. The lack of both number of experts and education and training opportunity constrains from developing the said technologies among farmers.

3) Rural development

In collaboration with other public organizations, rural development programs aiming at providing more adequate infrastructure and upgrading the quality of rural environment have been conducted in Colombia within the context of strategies of the National Development Plan and under responsibilities of PNR and Fondo-DRI. PNR has objectives to eradicate absolute poverty in the least developed region of the country and to prevent the acceleration of disequilibrium among regions. Three municipalities--Fuente de Ore, Granada and Lejanías--are among 11 municipalities in Meta to which PNR's programs are to be implemented and, in 1987, 46% of the departmental budget for the program was directed to these three municipalities.

Within the Area, the following projects among others are envisaged under the PNR's program.

- Roads construction: Trocha 11, Lejanías-Mesa de Fernandez and Narajal-Gualmal

- Provision of water supply (La Cooperativa and Reg. San Ignacio) and sewerage system (La Playa, Canaguaro and Puerto Caldas)

- Rehabilitation of health center at Cacayal and construction of new sanitary center at Canaguaro and Aguas Claras

Fondo-DRI concentrates its activity on three fundamental areas: production, infrastructure and development of rural communities. In the region, the institution promote production and marketing of four crops comprising plantain, cacao, maize and cacao. As for the infrastructure development, construction and improvement of water supply system and road network are major range actually undertaken by Fondo-DRI; in the past, such fields as electrification, education and health were also covered by the institution, but are entrusted to other organizations in charge of each field now. With regard to rural communities development,

Communal Action Committee, National Association of Rural Users (ANUC), Cooperatives, etc. are promoted under the initiative of Fond-DRI.

4) Education and Training to Farmers

The Agricultural Center "Los Naranjos", affiliated with SENA, is located within the study area. The Center is teaching and training students who will be engaged in agriculture and livestock sector in the future. Themes to be treated in this Center are as follows:

- Operation and maintenance of tractors
- Land preparation
- Seeding, maintenance and harvest of crops
- Mechanization of livestock sector

Students are trained one year in the Center and another one year in the fields or enterprises so as to have practical experience.

(2) Farmers' organization

1) Crop growers' organization (Cooperative)

In the Area the following cooperatives are identified.

a) COAGROLEJANIAS

This cooperative was organized with technical and financial assistance rendered by INCORA. About 40 farmers are participated in this cooperative. The principal motive to form the cooperative was to attain better marketing of products, mainly plantain and papaya. The cooperative has established its own sales place at Bogotá's market to which products are transported twice a week by their own trucks.

b) COAGROARIARI

The cooperative, formed by 118 members, was established in 1986 without any assistance by public agencies. The main activities of the cooperative are to sell inputs and to market grains. The cooperative has a plan to establish a rice mill but it has not come true yet.

c) PROCAME

In search of better marketing of cacao, growers of cacao in Meta have incorporated the cooperative in 1984. The cooperative has its head office in Granada and five purchase centers in Granada and the other four municipalities in the Ariari region. At present, a total of 280 growers are affiliated with the cooperative. The main activity of Procame is to purchase cacao from growers and to trade it to both international and domestic markets.

3.3 AGRICULTURAL INFRASTRUCTURE

3.3.1 Irrigation and Drainage

There is a distinctive seasonal difference of rainfall and the amount of rainfall for the rainy season and the dry season is in the proportion of 85:15. The rainy season has enough precipitation to grow crops, but the dry season with only 30mm per month in January crops are prevented from growing healthy some lands are left in fallow. Moreover, it sometimes happens that even in the rainy season sufficient precipitation may not be obtained.

For this reason, the implementation of irrigation facilities is the main work of this project in order to realize crop cultivation throughout the year.

In the Area, some irrigated paddy fields by taking water from caños is encountered principally in the Middle and Lower Zones. In addition, some experimental irrigated fields for cacao, tomato, etc. are also operated.

Irrigation system for paddy fields is shown below:

- Water resources : Sardinata, Mucuya, Venado Urichare, Guanayas and Upin Caños.
- Diversion facilities : Simple temporary weirs made of board, stones and earth bags in majority of the cases; Concrete weir and pumping intake in some rare cases.
- Water requirement : 2ℓ/sec/ha.
- Canal structure : Earth canal except for crossing parts of roads and caños.

- Operation and maintenance of irrigation facilities : Weeding on canal slope, section repair and rectification of weir by individual farmers or by several farmers.

- Irrigation method : Ponding irrigation.

- Irrigation period : From March to August (120 days) in the 1st semester.
  From September to December (120 days) in the 2nd semester.

- Number of irrigated farms : 37

- Irrigated area : 1,870 ha in the rainy season.
  1,440 ha in the dry season.

- Irrigated area per farm : From 10 to 150 ha
  (from 20 to 40 ha in the majority)

Existing problems of irrigation culture are as follows:

- Only some caños are available to take water all the year, therefore irrigated area is limited.

- Decrease of water discharge causes a shrinkage of irrigable area in the dry season.

- Water right is not established in the Area, therefore it is difficult to obtain irrigation water in the lower reach if several intakes in the upper reach of the same caño exist.

- Appropriate water management is not available without being standardized irrigation method; for example, there are cases of intake in unnecessary time.

- Effective water use is not carried out causing water loss because of fragile levee and disordered distribution of water.

(2) Drainage

The drained water in the Area is discharged to caño by gravity. No drainage problem is encountered in the Upper Zone, as lands have enough slope to drain water. On the other hand, there are some poor drainage areas in the lower part from the national road as follows:

- Lands being located along caños where overflow occurs frequently due to reduced flowing capacity and preventing obstacles caused by weeds or bushes.

- Lands where rain water is collected and remain in the concaved parts due to low density of caños, high groundwater level and clay soils.

The former is encountered in the long belt along caños and the lower reach where there is only slight gradient. Representative caños are: Mogotes, Upin and Guanayas. Ponding period, in general is less than 2 days. Actually these lands are covered by swamp, bush and natural forest.

The latter is distributed sporadically in small scale. Ponding period fluctuates from 3 days to one year. Actually these lands have been left as small lagoons and ponds.

Basically poor drainage is caused by rain water in the Area.

Small-scaled drainage canals are encountered in some sugarcane, plantain and cacao fields to discharge to caños, but systematic drainage facilities are not available in the Area. Actually, poor drainage does not create serious problems for land use, but with introduction of irrigation system, drainage improvement is one of the important measures to attain an efficiency of irrigation system.

3.3.2 Land Conservation and Disaster Prevention

Farm lands in the Area are mainly damaged by flooding during the rainy season as well as bank erosion of the Guape and the Ariari Rivers. No soil erosion damages such as gulley and rill have been encountered in the Area.

(1) Flooding

Three flood sections are shown below (Fig. 3.3.1).

- The section between the Cubillera tributary deviated from the Guape River and it's confluence with the Ariari River.
- The section between the confluence of the Ariari River and the Cubillera tributary and Puerto Caldas.
- The section extended to 5km upstream from the confluence of Mogotes Caño and the Ariari River.

At these river sections terraces are not so developed as to protect the Area from flooding.

At the former two sections, river water flows into the Area in time of high water with a rising of river water level of main river. As the Guape River is steep in a longitudinal gradient, and is wide in river width, the variation of the high water level accompanied by flood discharge is small. Therefore, it is notable that flooded areas are small in width of the inflow and long in both upstream and downstream directions. On the other hand, at the confluence of the Mogotes Caño and Ariari River in the latter section, the separated Ariari River is concentrating in. Then there is much variation of the high water level and the flooding depth in the Area is relatively large. Moreover, the Mogotes Caño is flooded by the influence of a backwater of the Ariari River at its high water.

(2) Bank Erosion

Bank erosion occurs at almost all the sections of the Guape River, the Gubillera River and Ariari River. At the section where a main stream flows close by a river bank and a lower part of a talus at the river terrace is formed of sandy-gravel deposit, bank erosion is occurred even at the normal water levels and land loss during high water levels. These phenomena can be seen remarkably along the river about 30km downstream from Puerto Caldas.

3.3.3 Rural Infrastructure

(1) Road

A national road which links Villavicencio with San Juan de Arama by way of Granada is crossing almost through the center of the Area (Fig. 3-3-1). The road has a two-lane and been paved up to Punta Brava located in the Area. Improvement and asphalt pavement works will be made as for the rest of road by MOPT. This national road constitutes one section of the Llanos trunk road project, so called "Carretera Marginal de Selva", which will stimulate the regional development of the Llanos. On the other hand, only one bridge crossing over the Ariari River, - the Guillermo León Valencia Bridge, is limiting traffic volume due to its being a suspension bridge with one-lane.

12 provincial roads called "Trocha" link the said national road with towns and villages in the Area, of which principal roads are: Trochas No. 4 and 12 run to Lejanías in the Upper Zone, Trochas No. 5, 7, 9 and 12 run to Caño Blanco in the Lower Zone. These roads play an important role in the transportation of agricultural inputs and products. But, the majority of them shows regular condition due to gravel pavement.

Furthermore, there exist farm roads and private roads connecting farms with the departmental roads. These roads are so narrow that fluid transportation is limited. Actually, construction of bridges is being implemented over some caños by Fondo-DRI. The total length of existing roads is 454km with an average density of 11km/ha.

Table 3-3-1 Extension of Road Network

Zone	Length (km)	Density (m/ha)
Upper	121	13
Middle	169	11
Lower	164	10
Total	454	11

The departmental road Trocha No. 4 which connects the national road with Lejanías is very important from standpoint of traffic volume. Almost 50% of all road sections are implemented with simple asphalt pavement, but the pavement condition is not good causing the restriction for fluvial traffic.

(2) Electric Power and Communication

Electric power is supplied by EMSA to the urban area in Granada, but not to the Area. However, some towns and villages (Lejanías, Cacayal, Aguas Claras, Puerto Caldas, Dos Quebradas, Canaguaro, La Cooperativa, Caño Blanco) in the Area have their own power generating plant to supply an electric energy. However, the service time is limited. Not all houses do not receive this service because of high cost for operation and maintenance. Some farms are equipped with a small scale generator or a storage battery harnessing solar heat.

Under the PNR, EMSA has a plan to implement an electric transmission program from Granada to San Juan de Arama and Lejanías that can be expected to provide stable electric power for the Area.

TELECOM and post offices are available in the major towns such as Lejanías, Aguas Claras, Puerto Caldas and Canaguaro to offer telephone, telegram and correspondence services. However, these towns have been often held incommunicable in accord with meteorological conditions, etc. Some large farms have transmitters.

(3) Water Supply

Some towns have public waterworks, making use of wells or caños as their sources, are utilized without treatment. These towns receive water supply only for some hours in a day. Water volume is not sufficient to supply the total demand due to poor distribution facilities. The remaining households take domestic water from shallow wells.

(4) Sewerage

Some parts of Lejanías, Canaguaro and Puerto Caldas have sewerage facilities and sewage is drained into the nearby rivers and caños without treatment. Other villages and farms do not have those facilities, thus each house treats sewage with primitive method.

(5) Education and Medical Care

As for educational facilities in three municipalities including the Area there exist seven kindergardens, 76 primary schools and 11 secondary schools. Generally speaking, educational facilities are not sufficient for attaining adequate education. The Area falls under the jurisdiction of Granada Regional Hospital. Medical care is offered by this Hospital, public central health centers at Lejanías and Fuente de Oro and public health centers at Canaguaro, Aguas Claras, Dos Quebradas and La Cooperativa.

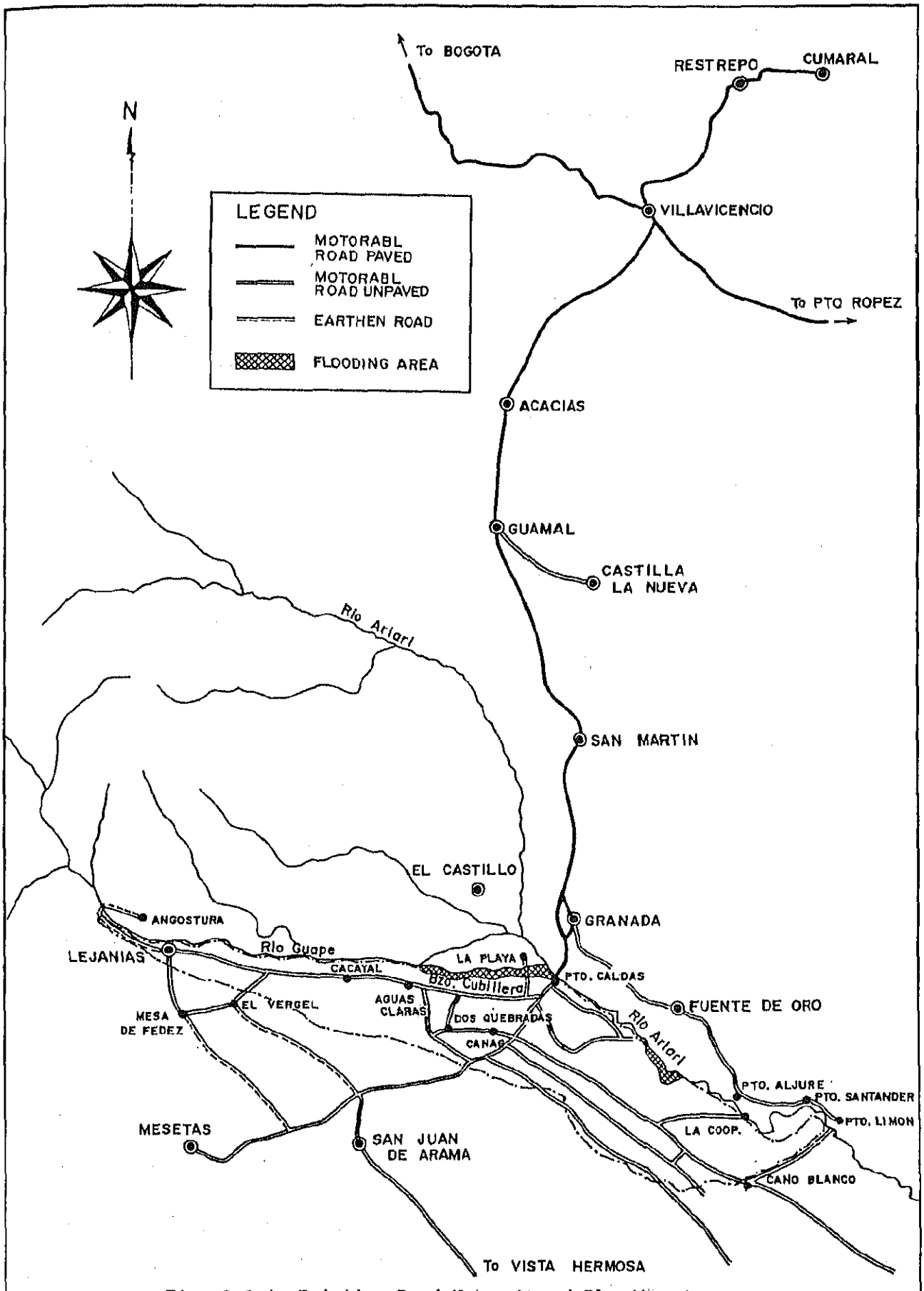


Fig. 3-3-1 Existing Road Network and Flooding Area

3.4 IMPLEMENTATION SYSTEM OF IRRIGATION AND DRAINAGE PROJECTS

(1) Implementation Organization

In Colombia, the implementation of large scaled irrigation and drainage projects falls under the responsibility of HIMAT. Planning of a project, procurement of financial resources, selection of consultants, detailed designing, award to contractors and supervision of construction works are undertaken by the Engineering Div.; the design work is done by design section and supervisory work by construction section. HIMAT's responsibility covers intake facilities, main and secondary works, while tertiary works are to be developed by farmers themselves.

Other infrastructure relevant to rural development are developed under the responsibility of: National Fund for Local Roads (roads), National Hygien Institute (water supply and sewerage), EMSA (electric supply, etc.). An integrated rural development project in less developed region is carried out under the program of PNR and Fondo-DRI.

(2) Land Titling and Redistribution

Starting from 1967 when colonization project for Ariari-Guejar was promoted, INCORA has been attending to titling of virgin lands within the study area. At present, almost no virgin land is left in the study area, so INCORA's services are directed to rendering technical and financial assistance to small farmers.

By Law 30 of 1988, any public organization which envisages to implement a project including land titling and redistribution is obliged to inform INCORA of the outline of the project to be formulated so that INCORA may examine and analyze the social situation of the proposed project area, especially as for the land tenure. The result of INCORA's study will be advised to the project executing organization accompanied by their evaluation report on the situation of land tenure. If INCORA concludes that

the actual lands in the proposed project area are inappropriately distributed, they will negotiate with land owners for expropriation of their lands based on the prices registered with IGAC's property book and charges the whole cost to new settlers of redistributed lands (INCORA provides financially handicapped settlers with credit services subject to longer amortization period).

(3) Land Acquisition

Land acquisition in proposed sites for construction of irrigation and drainage works is made in the following manner.

1. HIMAT conducts topographic survey in the proposed sites.
2. Ask IGAC to make evaluation of lands.
3. Negotiate with land owners, on the basis of IGAC's evaluation and, if an agreement is made between the parties, sign a contract.

Required time for the procedure ranges from two to six months. In case that the parties do not enter into an agreement, an expropriation procedure will be taken, and, in such case, one to four years are estimated for the procedure.

(4) Operation and Maintenance of Facilities

Water users' association which will be formed by beneficiaries will be in charge of the operation and maintenance for completed works, but substantial assistance is rendered by engineers of HIMAT's regional office subject to expenses to be borne by an association.

Water users' association has to be organized in all the land improvement projects. This association generally consists of the following sections:

- Board of directors (to make final decision of the association)

- Administration section (general affairs and accounting including collection of water charge)
- Operation section (operation of facilities and distribution of water)
- Maintenance section (maintenance of facilities, vehicles and machinery)
- Technical assistance section (technical assistance on farming, especially irrigation farming)

(5) Burden of Project Cost

Although the investment on the irrigation facilities is to be borne for their total amount by users, in reality the Government puts relief measure such as reduction of burden portion and grace period in accordance with farm size, financial capacity of farmers, productivity of irrigable land, etc. Repayment of project cost will be collected as water charge by means of users' association. The water charge is calculated on the basis of fixed tariff (Col$/ha/year) and proportional one (Col$/$m^3$).

Actually, among water users' associations existing in irrigation districts managed by HIMAT, only a couple of ones have attained financial independence operating their associations depending only on water charges to be collected by their associates. The rest of associations are rendered financial assistance (subside) by HIMAT. Major reasons why many associations can not be independent without financial assistance from HIMAT are as follows:

- The irrigation district can not attain as high production as expected at the time of planning and designing the project, thus farmers can not pay water charge due to low production.
- Farmers are not willing to pay water charges-less conscious of performing duty.

3.5 CHARACTERISTICS OF ZONE

Each zone of the Area differs in terms of topography, meteorology, soils, irrigation and drainage conditions, land tenure and land use, etc. In view of facilitating subsequent analysis as well as formulating specific development plan suited to each zone, the said parameters have been compiled and summarized as shown in Table 3-5-1.

Table 3-5-1 Characteristics of Zone

	UPPER ZONE (LEJANIAS)	MIDDLE ZONE (GRANADA)	LOWER ZONE (FUENTE DE OR
1. Area (ha)	9,100	15,400	16,600
2. Topography	Composite fan	Composite fan & Alluvial plains	Alluvial plain
- Land Elevation (m.A.S.L.) Above Sea Level	788 - 470	470 - 290	290 - 240
- Average Gradient	1/60 (Consistent gradient)	1/120 (Consistent gradient)	1/500 (Less undulation in central part)
3. Annual Rainfall (mm)	3,500	3,000	2,500
4. Soils	Fan Deposit	Fan & Alluvial Deposit	Alluvial Deposit
- Texture	Coarse (Gravel) - Fine	Coarse (Gravel - Fine	Medium - Fine
- Fertility	Medium - Low	High - Low	High - Low
5. Major Populated Area	Lejanías Cacayal	Aguas Claras, Dos Quebradas, Canaguaro, Puerto Caldas	La Cooperativa Caño Blanco
6. Population	8,160	5,870	3,760
7. No. of Farmers	210	570	520
8. Land Tenure			
- Proportional Distribution by Farm Size 1)	6:4:1	7:3:0.1	4:5:1
- Proportional Distribution by Coverage Area 1)	2:6:2	3:6:1	1:6:3
- Status of Land Tenure	Settlers of agrarian reform, Independent farmers	Independent farmers	Independent farmers
9. Major Crop	Pasture, papaya, plantain, maize	Upland rice, paddy rice, soyabean, plantain, cacao, pasture	Upland rice, paddy rice pasture, plantain, soyabean
10. Irrigation System	---	Water is taken from caños by gravity and supplied to paddy fields	Water is taken from caños by gravity and supplied to paddy field
11. Drainage	Good	Some inundated area are founded along caños in the rainy season	Consistent poor drainag areas are found
12. Drainage due to flooding of Guape and Ariari Rivers	No substantial drainage area is found	No substantial drainage area is found	Some farmlands are damaged at outflows of caños
13. Bank erosion	Urgent measures are not required	Some roads and farmlands are eroded	Some roads and farmland are eroded

Note: 1) Small farm (less than 20 ha) : Medium farm (20 - 100 ha) : Large farm (more than 100 ha).

3.6 PREVAILING CONSTRAINTS AND DEVELOPMENT PROPOSAL

Prevailing constraints grasped by means of collected data and information are compiled so that development proposal can be clearly identified (Table 3-6-1).

Table 3-6-1 Prevailing Constraints and Development Proposal

Prevailing Constraints	Development Proposal	Development Plan
Water and Land Use		
- Deficient use of water and land use due to lack of water in the dry season and unknown factors of irrigation farming	- Better utilization of water and land by provision of irrigation system	- Land use plan and irrigation plan
- Under development of crop production and farm mechanization due to topographic and soil characteristics	- Agricultural management and crop production to accord characteristics of sector	- Agricultural management and crop production plans
Agriculture		
- Difficulty of systematic agriculture due to different level of farm development	- Improvement of extension services, education and orientation	- Institutional services and farmers' organization plans
- Unstable farmers' economy because of lack of an appropriate agricultural management	- Promotion to organize farmers' association	- ditto
- Inconvenient agricultural management because of lack of financial resources	- Improvement of agricultural credit services system	- Agro-products marketing and agro-industry plans
Rural Infrastructure		
- Discomfort of rural life and inconvenience for effective transportation of products due to underdeveloped rural infrastructure	- Improvement of rural infrastructure	- Rural infrastructure plan

Prevailing Constraints	Development Proposal	Development Plan
Disaster Prevention and Land Conservation		
- Damages of farmland and road due to flooding and fluvial erosion on banks	- Provision of disaster prevention measures	- Land conservation and disaster prevention plan
Implementation of Project		
- All the investment of project is levied on beneficiaries that puts pressure on financial management of small farmers	- Some measures against small farmers relative to imposition of the project cost	- Recommendations on imposition system of the project cost
- Less experience in irrigation farming that requires institutional support for substantial period until farmers can obtain new technology and extend O/M for facilities	- Implementation of appropriate development level	

CHAPTER 4

THE DEVELOPMENT PLAN

CHAPTER 4: THE DEVELOPMENT PLAN

4.1 OBJECTIVES AND BASIC POLICIES OF DEVELOPMENT

4.1.1 Objectives of Development Plan

The Government of Colombia has laid emphasis on the integrated development program of the Llanos Orientales (Eastern Plains), and within the context of the Program, the construction of the Llanos Trunk Road system is in progress. Under the circumstances, the Government seeks to implement an agricultural development with core component of land improvement so that the Llanos Orientales may become substantial zone for supplying Colombian people with foods.

The Ariari River Integrated Agricultural Development Project (the Project) is the first agricultural development project in the said region, and is also identified as a pilot project to show an example for future development of the region. Physical resources of the project area such as topography, climate and land are highly capable for agricultural production. Nonetheless, the project area has been under-developed due to inadequate utilization of these resources. In particular, lack of available water in the dry season constitutes the major constraint on better utilization of arable lands.

The Project aims, first of all, to relax the prevailing constraints, and then to intensify agricultural production per unit of land, to activate regional economic performance, and to ameliorate and stabilize livelihood of local population. For attainment of these objectives, the following policies shall be employed.

- Consistent agricultural production throughout the year.
- Better utilization of land and water resources.
- Improvement of productivity per farmer.

4.1.2 Component of the Project

In accordance with the said policies, the following agricultural and infrastructure development plans shall be formulated.

- Agricultural development plans
  - Land use plan
  - Farming system plan
  - Agro-products marketing plan
  - Institutional supporting plan

- Infrastructure development plans
  - Irrigation and drainage plan
  - Land conservation and disaster prevention plan
  - Rural infrastructure plan

4.1.3 Basic Plan for Development

(1) Development goal

The majority of farmers in the area have less experience in irrigation farming without being endowed with adequate knowledge in technology for the husbandry. In addition, there are distinctive imbalance among farmers in terms of size of land holding and financial capability. Under the circumstances, if the development goal of the Project should be established in such level as is far from the actual situation, expected benefits of the Project may not be generated on account of various problems associated with availability of credit, cropping technology, operation and maintenance system of facilities, etc.

Bearing the said point in mind, the development goal for the Project is to be established in such a level as can be practically attained by farmers from economic and technical viewpoints. To be more concrete, the farming system of the Project shall follow the prevailing cropping practice and irrigation farming is to be developed in phases.

(2) Premises

1) Proposed crops

Proposed crops for the Project has been selected in due consideration of the parameters given below:

- Physical and social conditions
- Cropping technology of farmers
- Sensitivity to irrigation system
- Marketability
- Productivity per farmer

Rice is identified as a suitable crop for the area, because: a). it is cultivated in an area of about 43% of arable lands in the rainy season, b). farmers are familiar with its cultivation, and c). marketing channel of inputs and products is already established. Accordingly, rice will remain as staple crop for the Project.

Apart from rice, major crops of the Project are as follows.

Annual crops	:	maize, soybean, sorghum
Perennial crops	:	plantain
Tree crops	:	papaya, cacao
Non-traditional crops	:	sunflower, kidney bean

2) Sources of irrigation water

The land suitability study has disclosed that approximately 30,000 ha of lands are capable for cultivation of irrigated rice. Given double cropping of paddy is realized in these lands, the maximum water requirement is estimated to be around $60m^3$/sec in January which falls on dry season. The available water discharge of the Guape river at around the urban area of Lejanias will reach around $40m^3$/sec, which is equivalent to be irrigable to more or less 20,000 ha of land. In sum, if more than 20,000 ha of paddy field should be irrigated in the dry season, other measures than surface flow of the Guape river should be taken;

construction of a reservoir on the upper reach of the Guape river and installation of a pumping station along the Ariari river are examples of the measures.

A comparison was made with regard to each alternative of water intake in the following manner.

Table 4-1-1 Comparison of Water Source

Source of Irrigation Water	Irrigable Area (ha)	Total Investment (In mil. of Col$)	Investment per Ha (US$)
Surface water of the Guape river plus reservoir on its upper reach	30,000	40,000	3,800
Surface water of the Guape river plus pumping station of the Ariari river	30,000	36,000	3,400
Surface water of the Guape river only	20,000	12,000	1,700

In this Project, from viewpoints of farmers' capability to repay the investment as well as operation and maintenance of facilities, it is concluded that the alternative to depend exclusively on surface water of the Guape river is the most viable one.

3) Location of water intake

Three sites on the right margin of the Guape river were selected for assessment of their suitability as the optimum location of water intake.

No. 1 site: just down stream from the Angostura bridge

No. 2 site: approx. 5.3km upstream from the urban area of Lejanias

No. 3 site: approx. 4.6km down stream from the urban area of Lejanias

As a result of technical and economic review on each site, it is judged that the No. 3 site is the most appropriate site for construction of water intake works. Advantageous aspects for construction of intake works at No. 3 site are that:

- Less constraints are presented in terms of civil engineering aspects;
- Construction works and operation and maintenance of completed facilities are less complicated; and
- Investment cost is the most economical.

Table 4-1-2 Comparison of Proposed Sites of Head Works

Sites	Workability of Construction	Scale of Facilities	Suitability of Water Intake	Construction Cost (million Col$)	Annual O/M Cost (million Col$)	Remarks
No. 1	Difficult	Small	Good	4,445	646	
No. 2	No problem	Middle	No problem	3,889	565	
No. 3	No problem	Large	No problem	2,130	319	Including Pumping System

4) Irrigable area

Within the study area, approximately 3,500 ha of land with higher elevation are technically infeasible to be irrigated by gravity. The greater portion of this extension is used as grazing land. In order to irrigate these lands, pumping or sprinkler system is indispensable, which is considered to be economically infeasible if anticipated benefits are not sufficient enough to compensate the investment. Accordingly, irrigable area shall be limited to such lower lands as are suitable to be irrigated by gravity. Grazing land shall also be alienated from irrigable area from economic standpoint.

5) Development of crop fields

Effective water utilization is attained only when farm lands are divided into lots and prepared in leveled condition. The problem associated with the development of these works is the burden of additional expense for the farmers. In addition, extensive farming using machinery and aircraft is common in Colombia. Considering these aspects as well as actual cropping practice, development of crop fields including leveling will not be taken into account in the Project. With regard to irrigation method in paddy fields, traditional method comprising of reclamation of border in parallel with counter lines and inundating fields will be employed.

6) Land use

Land use plan has been incorporated following the criteria given below:

- The whole lands allocated to rice fields shall be irrigated.
- Forest shall not be exploited in terms of environmental conservation.
- Of actual pasture land of 13,000 ha, 2,800 ha will be shifted into crop cultivation land.
- Extension of lands with perennial and tree crops shall not have substantial change.

7) Development area and irrigable area

The development area shall be 35,140 ha, which is equivalent to the whole study area (41,100 ha) minus forest, rivers, canals, urban areas and other improductive lands (5,960 ha in total).

On the other hand, irrigable area by gravity reaches 23,815 ha. Lands included in development area but alienated from irrigable area are as shown below.

- Right-of-way for canaland other facilities:	250 ha
- Lands not irrigable by gravity:	3,455 ha
(Lands located in upper part of proposed diversion and main canals)	(1,300 ha)
(Hill lands located in middle and lower zones)	(2,155 ha)
- Pasture lands not included in above lands:	7,620 ha
Total	11,325 ha

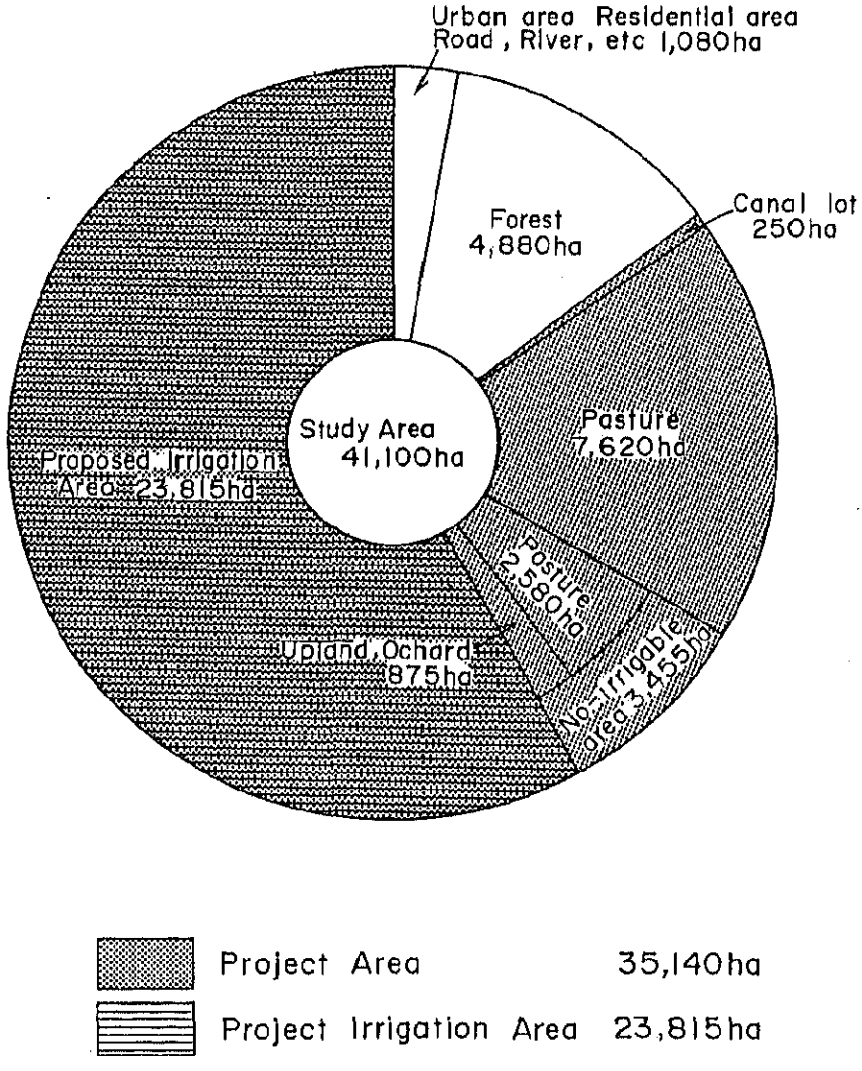


Fig. 4-1-1 Project Area

4.2 LAND USE ALTERNATIVES

4.2.1 Introduction

In accordance with basic development policies cited before, land use alternatives have been proposed in view of generating maximum benefits with available water and land resources.

The alternatives consist of two categories: I and II, which differ with each other in extension of rice field; furthermore, the ration between paddy and upland crops for the 2nd semester is different from the 1st semester.

Each alternative plan presents following features.

Alternative I: to expand rice field as much as possible from viewpoints of land suitability and water availability.

- I-1: to expand paddy field up to 18,990 ha for both semesters.
- I-2: the same extension will be allotted to paddy for the first semester, while the actual extension of rice (upland and paddy) will be maintained for the second semester; the rest of land for the second semester will be used as upland of annual crops.

Alternative II: to maintain actual extension of rice field

- II-1: to plant rice in 15,070 ha of land for both semesters.
- II-2: to plant rice in the same extension for the first semester, while for the second semester rice field will be reduced to 10,000 ha and the remaining 5,070 ha will be covered by annual crops other than rice.

The land use plan for respective alternative is given in Table 4-2-1 and Fig. 4-2-1.

4.2.2 Selection of the Optimum Land Use Plan

Each alternative has been evaluated with regard to the following factors:

Table 4-2-1 Comparison of Land Use Alternatives

Alternatives	I-1	I-2	II-1	II-2
Maximum water requirement (m^3/sec)	43	37	37	28
Approx. cost (In million Col$)	18,170	15,617	15,617	13,855
Annual incremental benefits (In million of Col$)	10,688	9,975	8,760	7,555
Financial internal rate of return (%)	24.5	25.8	23.7	23.1

The above calculation is based on the following parameters:

- The project life shall be 50 years.
- The cost is estimated pertaining to head works, irrigation and drainage canals, access roads and tertiary field works, but not on land acquisition, pavement of Trocha 4, bank protection, consultants' fee and physical contingency.
- Construction period shall be 5 years per capita basis.
- Operation and maintenance cost, which is equivalent to 2% of the construction cost, will be included in the project cost annually starting 6th year of the Project.
- Incremental benefits and production cost shall be contemplated from 6th year of the Project, each same amount yearly.

The above evaluation has lead to the conclusion that the Alternative I-2 which has the highest rate of return and is secured with consistent supply of irrigation water to be taken from the Guape river is the optimum alternative plan of land use (Refer to Annexes I & N).

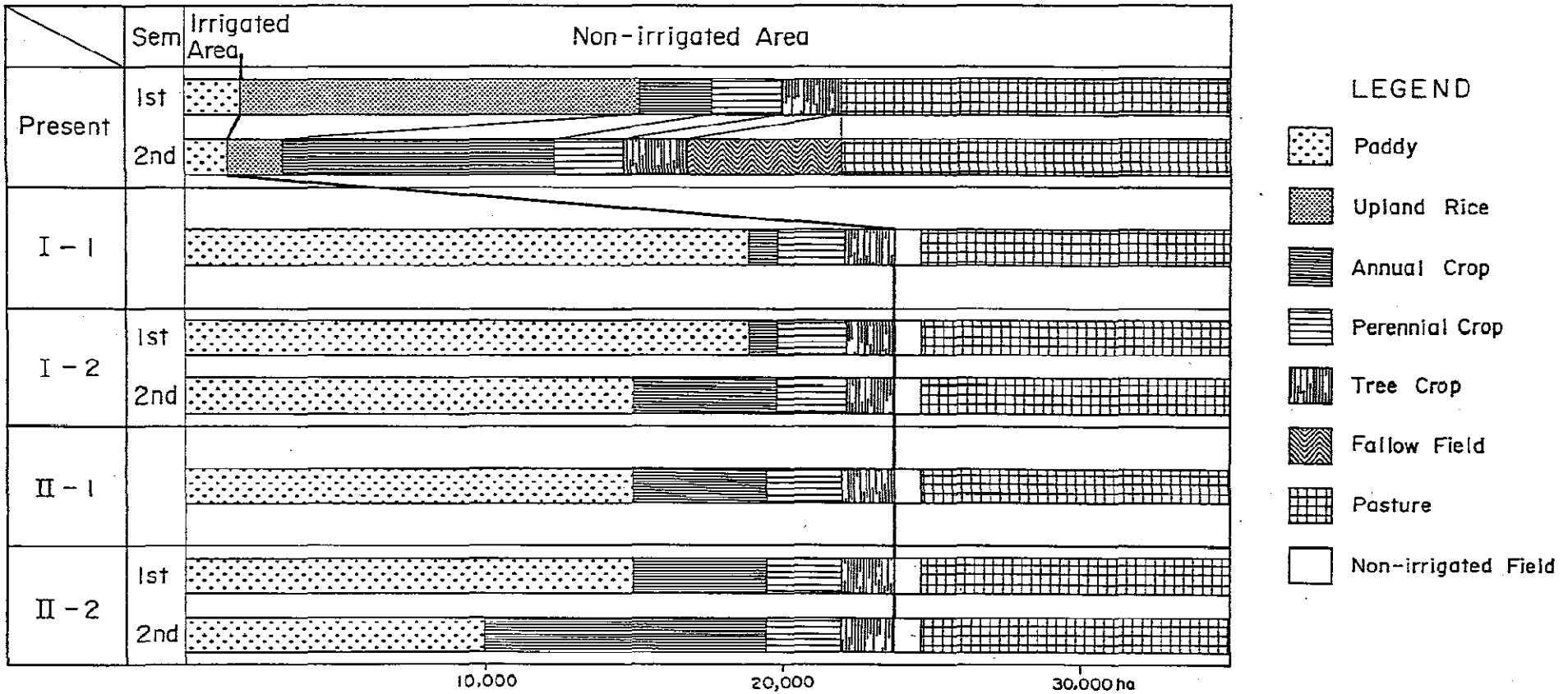


Fig. 4-2-1 Land Use Plan

Table 4-2-2 LAND USE ALTERNATIVES

	Actual Land Use		Alternative I-1	Alternative I-2		Alternative II-1	Alternative II-2	
	1st Semester	2nd Semester	1st Semester	2nd Semester	1st Semester	2nd Semester	1st Semester	2nd Semester
Rice	15,270	3,290	18,990	18,990	15,070	15,070	15,070	10,000
Paddy	(1,870)	(1,440)	(18,990)	(18,990)	(15,070)	(15,070)	(15,070)	(10,000)
Upland	(13,400)	(1,850)	(0)	(0)	(0)	(0)	(0)	(0)
Annual Crops	2,440	9,110	1,270	1,270	5,190	4,790	4,790	9,860
Irrigated	(0)	(0)	(895)	(895)	(4,815)	(4,415)	(4,415)	(9,485)
Dry Land	(2,440)	(9,110)	(375)	(375)	(375)	(375)	(375)	(375)
Perennial Crops	2,370		2,370	2,370		2,570	2,570	
Irrigated	(0)		(2,310)	(2,310)		(2,510)	(2,510)	
Dry Land	(2,370)		(60)	(60)		(60)	(60)	
Tree Crops	2,060		2,060	2,060		2,260	2,260	
Irrigated	(0)		(1,625)	(1,625)		(1,820)	(1,820)	
Dry Land	(2,060)		(440)	(440)		(440)	(440)	
Pasture	13,000		10,200	10,200		10,200	10,200	
Irrigated	(0)		(0)	(0)		(0)	(0)	
Dry Land	(13,000)		(10,200)	(10,200)		(10,200)	(10,200)	
Fallow	0	5,310	0	0		0	0	
Arable Land	35,140		34,890	34,890		34,890	34,890	
Irrigated	(1,870)	(1,440)	(23,815)	(23,815)		(23,815)	(23,815)	
Dry Land	(33,270)	(33,700)	(11,075)	(11,075)		(11,075)	(11,075)	
Improductive Land	5,960		6,210	6,210		6,210	6,210	
Forest	(4,800)		(4,800)	(4,880)		(4,880)	(4,880)	
Road, Caño, etc.	(1,080)		(1,330)	(1,330)		(1,330)	(1,330)	
Total	41,100		41,100	41,100		41,100	41,100	

4.3 Agricultural Plan

4.3.1 Land Use Plan

Following Case I-2 selected from the four alternative cases discussed earlier, the land use plan for each zone is shown in Table 4-3-1, and the land use plan is Figure 4-3-1.

(1) Upper Zone

The area lying in the upper part of the upper-reaches regions will be left as dry land, while the area in the lower part will be irrigated. Namely, the dry upper area will be used for pastures or orchards. The northern part of the irrigated area will be used mainly for pastures and orchards, and partly for paddy and upland fields for semi-annual cropping as appropriate. The southern part will be used mainly for paddy fields into which 995 ha of the existing grassland will be converted, and the remainder will be a mixture of orchards and upland fields.

(2) Middle Zone

The majority of the region is irrigated, and will be used for paddy fields. In the dry season, Classes 1, 2 and 3 will be used mainly as paddy fields, and Class 4 will be used partly for upland fields, to meet respective soil conditions.

The greater part of the 3,430 ha dry area will be used as grassland.

(3) Lower Zone

This region is divided into irrigated lowlands and dry highlands. The former will be used mainly for double-crop paddy fields. Class 1-2 will provided 1,305 ha for conversion from grass to paddies. Of 4,425 ha in the dry highlands, 91% will remain as grassland.

Table 4-3-1 Land Use Plan

(ha)

		Farm Land						Non-Farm Land		Total
		Paddy with Irriga-tion	畑 Uplan Crop		Orchard	Pasture	Sub-Total	Forest	Urban, Road, River, etc.	
			Annual	Perennial						
Upper Zone	1st	2,715	505 (130)	1,020 (60)	1,110 (430)	2,600 (2,600)	7,950 (3,220)	720	430	9,100
	2nd	1,860	1,360 (130)							
Middle Zone	1st	8,300	405 (25)	590	710 (10)	3,395 (3,395)	13,400 (3,430)	1,500	500	15,400
	2nd	6,660	2,045 (25)							
Lower Zone	1st	7,975	360 (220)	760	240	4,205 (4,205)	13,540 (4,425)	2,660	400	16,600
	2nd	6,550	1,785 (220)							
Total	1st	18,990	1,270 (375)	2,370 (60)	2,060 (440)	10,200 (10,200)	34,890 (11,075)	4,880	1,330	41,100
	2nd	15,070	5,190 (375)							

Note: the number in () indicates the area of non-irrigable land.

LEGEND

	Major Land Use Plan
	Pasture. Orchard
	Paddy / Paddy-Upland [1]
	Paddy / Paddy
	Upland
	Pasture
	Unirrigable Area

Note: exception of forest and others

[1] 1st cropping /2nd cropping

Fig. 4-3-1 Future Land Use plan

4.3.2 Farming Plan

(1) Proposed crops

The key crop of the Project shall be rice. Apart from rice, crops contemplated in the Project are: maize, soybean, sorghum, cotton, plantain, cacao, papaya, oil palm, maracuya, sugar cane (traditional crops) and sunflower and kidney bean (non-traditional crops).

Taking land suitability and water availability into account, rice will be planted twice a year and its planted area shall be expanded as much as possible. On the other hand, as for such annual crops as soybean, sorghum and cotton which are actually cultivated as a secondary crop of rice shall be reduced their area to such proportion as 60% to the actual area and the reduced area will be substituted by paddy. Thus, the cultivated area of rice will be drastically expanded in the dry season owing to the provision of irrigation water.

Cultivated area of maize is to be decreased, because some portion of land actually used for the crop will be covered by paddy. Furthermore, a part of lands to be planted maize for the 1st semester will be cropped sunflower, and kidney bean for the 2nd semester, so that deivesification of cropping activity among small farmers may come true.

Perennial and tree crops shall be preserved their actual planted area. Except for such lands as are not irrigated by gravity due to their topographic condition, fields of perennial and tree crops shall be, in principle, irrigated. This provision of irrigation water accompanied by application of more adequate cropping technique will contribute to elevating unit yield of these crops.

Kidney bean, although the crop is not cultivated in the study area on a commercial basis, is one of staple foods for Colombian people and is presently cultivated among farmers in the area as

self-consumable crop. Thus, farmers will be confronted less constraint on cultivation of the crop. The introduction of sunflower seeks for reducing importation of edible oil. Pasture lands shall be shrunk to 80% of their actual area, but current output shall be maintained by improving productivity of cattle raising.

(2) Cultivated area

Because of right-of-way for irrigation and drainage facilities, arable land will decrease from 35,140 ha to 34,890 ha. On the other hand, the total cultivated are throughout the year will increase from 47,540 ha to 55,150 ha owing to expansion of the area in the dry season. Consequently, the cropping intensity will rise from 135% to 158%.

Cultivated area by crop shall be as given below:

Table 4-3-2 Cropping Area

Unit: ha

Crops	Actual Situation 1st Semester	Actual Situation 2nd Semester	With Project 1st Semester	With Project 2nd Semester	Balance 1st Semester	Balance 2nd Semester
Paddy	1,870	1,440	18,990	15,070	17,120	13,630
Upland Rice	13,400	1,850	0	0	△13,400	△1,850
Sub-total	15,270	3,290	18,990	15,070	3,720	11,780
Maize	2,370	1,150	1,200	500	△1,170	△650
Soybean	0	6,220	0	2,750	0	△3,470
Sorghum	0	1,410	0	1,300	0	△110
Other Annual Crops	70	230	70	640	0	310
Sub-total	2,440	9,110	1,270	5,190	△1,170	△3,920
Plantain	2,370		2,370		0	
Cacao	870		870		0	
Papaya	840		840		0	
Oil Palm	320		320		0	
Other Perennial Crops	30		30		0	
Sub-total	4,430		4,430		0	
Pasture	13,000		10,200		△2,800	
Total Cultivated Area	35,140	29,830	34,890	34,890	△250	5,060
Fallow Land	0	5,310	0	0	0	△5,310
Total Arable Land	35,140	35,140	34,890	34,890	△250	△250
Cropping Intensity	135%		158%		23%	

(3) Proposed irrigated crops

All crops but pasture will be irrigated as far as circumstances allow. The whole paddy fields will be provided irrigation water and fields of other crops are also irrigated except for disqualified land for irrigation by gravity.

(4) Farming system plan

Farming system of proposed crops for the Project will be in the following manner.

1) Paddy

a) Field leveling, sowing and inundation

Leveling fields uniformly is essential for direct seeding, thus it is necessary to level undulating soils so as to attain more efficient irrigation system in the future. This fields preparation practice will be followed for cultivation of other crops as well.

Varieties to be sowed are either Oryzica Llanos 4 or 5 and they are to be sprayed directly in drained field with machinery. No germination measures will not be taken, accordingly. The amount of seeds to be sowed will be around 150kg/ha. Borders are to be prepared in parallel with counter lines, so that seeds may be submerged immediately after being sowed. The bordering will be made by tractor, but it is prerequisite to finish by manpower aiming at preparing regular water level.

b) Application of fertilizer

The amount of fertilizers to be applied per ha are: 70kg of nitrogen, 25kg of phosphorus and 55kg of potassium. An application model with representative fertilizers is as shown below:

Table 4-3-3 Fertilization

Fertilizer	Basal dress	Top dress (days after germination) 1st (25-30)	2nd (50-55)	3rd (70-75)	Total
Urea		50	50	50	150
Calfos	150				150
Kcl	45	45			90

c) Weeding and pest control

Herbicide will be applied twice: 15 days and 50 - 60 days after germination. The amount of herbicide may be decreased owing to an adequate water management practice which can prevent fields from growing weed more densely. As for pest control, an application of pesticide is contemplated twice in the growing period of plants. Furthermore, resistant varieties to attack of insect, an adequate water management, sowing of the optimum amount of seed, partial application of nitrogen, frequent weeding and so on are other proposals for pest control.

In view of an extension of unit field, an application of chemicals shall be made by aircraft. In case of small fields, joint application comprising some fields will be taken into account.

d) Harvesting

Harvesting will be carried out by combines. In accordance with the degree of ripening, fields will be drained 10 - 14 days in advance to harvesting period, so that harvesting may be facilitated. It is expected that the drainage of fields should contribute to lowering the proportion of water content in paddy up to 24% on average.

e) Water management

An adequate water management has positive effect on fertilization, weeding, pest control and so forth. Therefore, it is prerequisite that this adequate water management practice including distribution of irrigation water by water users' association should be diffused among farmers.

2) Farming proposal for crops other than rice is as summarized in the Table 4-3-4.

3) Perennial and tree crops are to be cultivated shown in Table 4-3-5.

Table 4-3-4 Proposed Farming Plan (Annual Crop)

	MAIZE	SORGHUM	SOYBEAN	COTTON	KIDNEYBEAN	SUNFLOWER
LAND PREPARATION			Ploughing and Harrowing (twice)			
VARIETY OF SEED	ICA-V-214 ICA-V-157	NK-266 D-61	SOICA P-33 ICA-L-189	DP-61	Caraota Diacol	
AMOUNT OF SEED	25kg/ha	20kg/ha	80kg/ha	25kg/ha	60kg/ha	6kg/ha
SEEDING DISTANCE	Drill Seeding	Broadcast Seeding	30cm inter row	100cm x 30cm	60cm x 15cm	75cm x 30cm
APPLICATION OF FERTILIZER	10-20-20: 100kg/ha Urea: 50kg/ha		Refer to ANNEX F			
WEEDING	Within 45 days after Germination Intertillage (once) and application of herbicide (once)	Within 30 days after germination and at a moment of sowing Application of herbicide (twice)	Same as the case of maize			
PEST CONTROL	Application Heptacloro at a rate of 70kg/ha.	Application of pesticide shall be subject to the degree of appearance of insect.		Same as the case of sorghum but bollworm has to be controlled after appearing buds	Same as the case of sorghum	(70kg/
HARVESTING	Combine/ Manpower	Combine		Manpower		Combine/ Manpower

Table 4-3-5 Proposed Farming Plan (Perennial Crop)

	CACAO	PAPAYA	PLANTAIN	MARACUYA	OIL PALM
VARIETY	Recommended varieties by ICA	Traditional varieties taken from fields	Halton to be procured within the region	To be taken from fields	Tenera to be purchased
NURSERY METHOD AND PERIOD	Nursery bag 3-4 months	Nursery bag 1 month		Nursery bag 2 months	Nursery bag 6-9 months
PLANTING DISTANCE AND INTENSITY	3.5 x 3.5m 942 plants/ha	2.5 x 2.5m 1,600 plants/ha	3 x 3m 1,100 plants/ha	3 x 4m 850 plants/ha	9 x 9m 150 plants/ha
APPLICATION OF FERTILIZER	Refer to ANNEX F				
WEEDING	Around planted area-by manpower Other area- application of herbicide				
PEST CONTROL	To control at the source of appearance of insect				
HARVESTING	Manpower				
OTHER OBSERVATION	Guamo will be planted as a shade tree	Thinning 3 months after planting: 1 plant/point			

(5) Livestock plan

1) Cattle raising

The prevailing practice of cattle raising will remain unchanged, though some improvement is expected in such aspects as production of pasture, sanitation and feeding. As a consequence of these improvements, an increase of liveweight will be raised from 202 kg/ha/year to 260 kg/ha/year. By conducting better disease control method, the mortality rate of calves will be attained less than 3% for those younger than 1 year and less than 1% for the rest of calves. At the same time, provision of appropriate amount of mineralized salt together with an improvement for the quality of pasture is expected to result in raising the birth rate of cow up to 70%. Improvement proposal of cattle raising is as summarized below:

Table 4-3-6 Proposed Cattle Raising Plan

Sanitation and Feeding	Actual Situation	With Project	Recommendation by ICA, etc.
Vaccination			
Foot & Mouth Disease (Freq./year)	2	2	2
Anthrax (Freq./year)	1	1	1
Parasite Control			
Endoparasite (Freq./year)	2.7	Calf:6, Steer:4 Cattle:2	Calf:6, Steer:4, Cattle:2
Ectoparasite (Freq./year)	6.6	12	More than 6
Mineralized salt (g/day)	28 *	Lactated cow:67, cow:33, Calf:17	Lactated cow:67, Cow:33, Calf:17

* Plain salt is included.

Cattle production plan is shown in Table 4-3-7 (refer to Annex F for further information).

Table 4-3-7 Beef Cattle Production Plan

	Actual Situation			With Project		
	Reproduction	Reproduction & Fattening	Fattening	Reproduction	Reproduction & Fattening	Fattening
Carrying capacity (head/ha)	1.6	1.6	2.4	2.0	2.0	2.5
Birth rate (%)	65	55	-	70	70	-
Mortality rate 0-1 year(%)	5	5		3	3	
1 year and older(%)	2	2	2	1	1	1
Initial weight (Kg)	-	240	250	-	220	220
Fattening period (month)	-	15	19½	-	15	16
Final weight (Kg)	-	450	485	-	450	450
Annual weight gain Kg/head	-	170	144	-	182	168
Kg/ha	124	61 + 129	338	160	84 + 169	415
Mean annual weight gain Kg/ha		202			260	

2) Pasture Improvement Plan

Defective and natural gazing area should be covered with pure stand of braquiaria. This variety has shown satisfactory results for improvement in many pasture and its seed is easily available. Seeding is followed by ploughing and harrowing with basal dressing of the Calfos 250kg/ha and the potassium chloride 50kg. Putting cattle to gazing will be made alternately at intervals of six to eight weeks. Maintenance of the grass consists of brushcut after grazing, yearly intertillage and herbicide application (twice a year). No top dressing is considered, though the grass will be replanted every five years applying the said quantity of fertilizer.

In accordance with this improvement plan, the cattle production will be raised by 29% in comparison with the actual situation. Thus 22% of the total pasture, which is equivalent to 2,800 ha out of 13,000 ha, is able to convert into the crop field.

3) Cropping plan

Annual crops to be cultivated for the first semester (rainy season) shall be paddy-key crop--and maize, which is relatively resistant to be cultivated under the humid condition. As secondary crops of paddy, soybean, sorghum, maize, sunflower, kidney bean (exclusively for upper zone), and cotton (upper and middle zones only) are projected. In view of maintaining laid productivity, some portion of lands for upland crops are interchanged with grazing land at intervals of every 5 years. Proposed cropping pattern is as given below.

Table 4-3-8 Cropping Plan

First Crop	Secondary Crop	Upper Zone	Middle Zone	Lower Zone	Total
Paddy	Paddy	1,490ha	6,285ha	6,470ha	14,245ha
Paddy	Soybean	670	1,175	630	2,475
Paddy	Sorghum	300	500	500	1,300
Paddy	Maize	130	150	220	500
Paddy	Cotton	30	150	-	180
Paddy	Kidney bean	80	-	-	80
Paddy	Sunflower	15	40	155	210
Maize	Paddy	370	375	80	825
Maize	Soybean	30	25	220	275
Maize	Kidney bean	100	-	-	100
Others	Others	5	5	60	70
Total		3,220	8,705	8,335	20,260

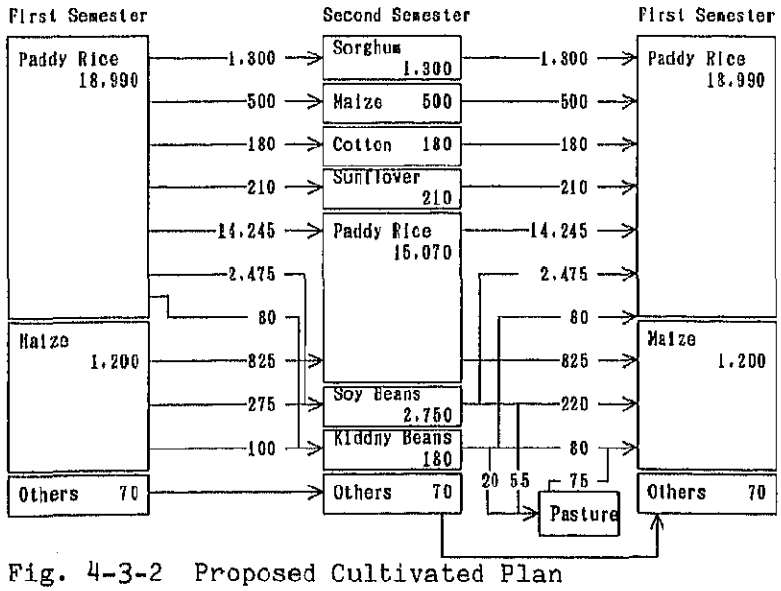


Fig. 4-3-2 Proposed Cultivated Plan

The cropping calender for annual crops is proposed in Fig. 4-3-3.

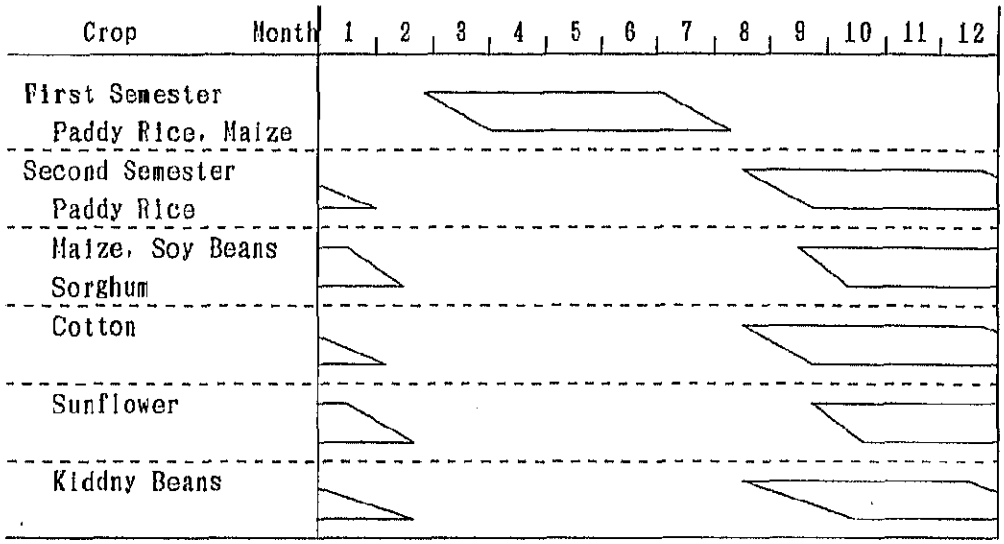


Fig. 4-3-3 Cropping Pattern

The cultivation of perennial crops except for cacao and oil palm is to be interchanged with that of annual crops or pasture in accordance with growth period of each crop. Nonetheless, the cultivation of maraouya shall be made in 5 years in which two harvests are expected.

The figure below illustrates economic period of respective perennial crop.

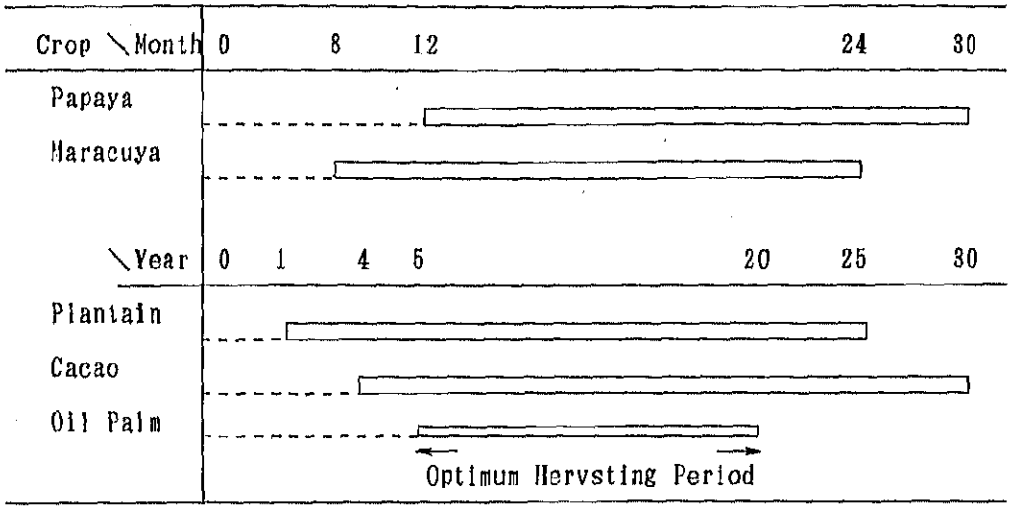


Fig. 4-3-4 Economical Growth Period of Perennial Crops

(7) Unit Yield

With a provision of irrigation system, unit yield of rice is projected from actual level of 4.1 ton/ha (paddy) and 3.3 ton/ha (upland rice) to 5.5 ton/ha. The rest of crops are also envisaged an increase of their unit yield subject to consistent supply of irrigation water and application of more appropriate cropping technology. The projected until yield will be achieved in phases, taking account of allowance for farmers to be accustomed with new cropping technology.

The projection of unit yield is summarized in table below.

Table 4-3-9 Projection of Unit Yield

	Actual Situation	With Project				
		1st year	2nd year	3rd year	4th year	5th year
Crops (ton/ha)						
Paddy	4.1	4.5	5.0	5.5		
Upland rice	3.3					
Maize	1.6	1.7	1.8	2.0		
Soybean	1.6	1.65	1.7	1.8		
Sorghum	2.6	2.7	2.8	3.0		
Others *1	1.0	1.1	1.2	1.3	1.4	1.5
Plantain	6.0	7.0	8.0	10.0		
Cacao	0.45	0.5	0.55	0.63		
Papaya	20.0	20.5	21.0	22.0		
Oil palm	1.8	2.66	3.14	3.52	3.8	
Others *2	2.0	5.0	8.0	11.0	14.0	17.0
Cattle (kg/ha)	202	230	260			

*1: Represented by cotton
*2: Represented by Maracuya

(8) Balance of production

The balance of production per hectare for crops and cattle is given in Table 4-3-10. With regard to farm-gate prices, IDEMA's supporting prices for the Semester A (June 1 - November 30) of 1988 have been employed. In addition, production costs have been estimated on the basis of Caya Agraria's projection.

(9) Production volume and value

Summary of agricultural production and value to be attained with Project is presented as follows:

Table 4-3-11 Projection Agricultural Product

Ag Production	1st year	2nd year	3rd year	4th year	5th year
Volume (ton)	202,531	223,502	247,339	247,590	247,751
Value (Col$ x 1,000)	15,944,083	17,633,473	19,416,038	19,415,069	19,483,576

The breakdown of above information by crop is given in Table 4-3-4: The annual production volume and value of crops and cattle for 5th year--the maturing year of the Project-onward is projected each 2.37 and 2.08 times as much as the actual situation.

(10) Balance of agricultural machinery and labor

1) Machinery

Referring to information collected from SENA located in the study area, working efficiency of agricultural machinery is assumed in the following manner.

Table 4-3-13 Capacity of Tractor and Combine

	Working Capacity (ha/hr)	Working Capacity (ha/day: 8 hrs)	Working Efficiency	Actual Working Hectarage per Day
Tractor attached				
Ploughing 4 discs	0.6ha	4.8ha	75%	3.6
Harrowing 20 "	1.8	14.4	80	13.0
32 "	2.3	18.4	80	(mean)
Seeding broadcast	3.0	24.0	80	19.0
drill 4 rows	1.5	12.0	80	10.0
Combine				
harvesting rice		8.0	70	5.6
sorghum		20.0	70	14.0
soybean		6.0	70	4.2

The farm mechanization is envisaged for such activities as land preparation and seeding for every crops and harvesting for paddy, soybean, sorghum, maize and sunflower.

In accordance with cropping plan and calender, the maximum quantity of tractors required for land preparation and sowing will fall on 35 days prior to the commencement of the secondary cultivation of rice; in these days about 200 units of tractors are needed, because 430 ha of land need to be prepared and sowed a day. On the other hand, the maximum quantity of combine

(90 units) will come to in 40 days in advance to harvest time of the first crop. The work load of tractor and combine will increase by 64% and 65% respectively in comparison with the actual load.

2) Labor balance

The demand of labor force in a year with Project will be 1,244,181 man-day, with an increase of 659,055 man-day from the actual demand of 585,126 man-day. This multiplied demand of labor force will contribute to generating employment opportunity for 2,197 person/year. The number of unemployment in the study area is assumed to be 700, which is calculated on the basis of URPA's information (Diagnostico Agropecuario). Thus, it is intimated that one third of the multiplied demand should be offset by people in search of job opportunity. The remaining labor force will be satisfied with people living in Granada and occasional immigrants from other part of the country.

Table 4-3-10 Balance of Production per Unit of Land

CROPS	Unit Yield (ton/ha)	Farm-Gate Price (Col$/ton)	Gross Return (Col$/ha)	Production Cost (Col$/ha)	Net Return (Col$/ha)
Paddy	5.5	80,000	440,000	181,740	258,260
Sorghum	3.0	63,000	189,000	113,880	75,120
Soybean	1.8	125,000	225,000	138,100	86,900
Maize	2.0	65,000	130,000	89,310	40,690
Cotton	1.5	210,000	315,000	178,430	136,570
Sunflower	1.5	150,000	225,000	105,990	119,010
Kidneybean	0.7	270,000	189,000	124,840	64,160
Plantain (Establishment)	3.0	50,000	150,000	165,190	-5,190
(Maintenance)	10.0	50,000	500,000	147,680	352,320
Cacao (Maintenance)	0.63	436,000	274,680	148,830	125,850
Papaya (Establishment)	4.0	40,000	160,000	255,930	-95,930
(Maintenance)	22.0	40,000	880,000	207,970	672,030
Oil Palm	3.8	229,000	870,200	252,760	617,440
Maracuya	17.0	40,000	680,000	559,030	120,970
Cattle Raising					
Pasture	-	-	-	56,550	-56,560
Cattle	0.26	270,000	70,200	10,140	60,060

Table 4-8-12 ANNUAL PRODUCTION VOLUME AND VALUE WITH PROJECT

CROPS	Planted Area (ha)	Unit Yield (ton/ha) Year 1	2	3	4	5~	Production Volume (ton) Year 1	2	3	4	5~	Price (Col$/ton)	Production Value (Col$ ×1,000) Year 1	2	3	4	5~
Paddy	34.060	4.5	5.0	5.5			153.270	170.300	187.330			80.000	12.261.600	13.624.000	14.986.400		
Sorghum	1.300	2.7	2.8	3.0			3.510	3.640	3.900			63.000	221.130	229.320	245.700		
Soybean	2.750	1.65	1.7	1.8			4.537.5	4.675	4.950			125.000	567.188	584.375	618.750		
Maize	1.700	1.7	1.8	2.0			2.890	3.060	3.400			65.000	187.850	198.900	221.000		
Other Annual Crops 1/	710	1.1	1.2	1.3	1.4	1.5	781	852	923	994	1.065	210.000	164.010	178.920	193.830	208.740	233.650
Plantain	2.370	7.0	8.0	10.0			16.590	18.960	23.700			50.000	829.500	948.000	1.185.000		
Cacao	870	0.5	0.55	0.63			435	478.5	548.1			436.000	189.660	208.626	238.972		
Papaya	840	20.5	21.0	22.0			17.220	17.640	18.480			40.000	688.800	705.600	739.200		
Oil Palm	320	2.66	3.14	3.52	3.8		851.2	1.004.8	1.126.4	1.216		229.000	194.925	230.092	257.946	278.464	
Other Perennial Crops 2/	30	5.0	8.0	11.0	14.0	17.0	150	240	330	420	510	40.000	6.000	9.600	13.200	16.800	20.400
Cattle Raising	10.200	0.23	0.26				2.346	2.652				270.000	633.420	716.040			
Total	55.150						202.580.7	223.502.3	247.339.5	247.590.1	247.751.1		15.944.083	17.633.473	19.416.038	19.455.069	19.483.576

Note : 1/ includes cotton, sunflower and kidneybean, but yield and price are represented by cotton

2/ includes passion fruit and citrus, but yield and price are represented by passion fruit

4.3.3 Agro-products Marketing Plan

(1) Evolution of output

With an implementation of the Project, an output of agricultural products will have a transition as summarized in the table below:

Table 4-3-14 Evolution of Output

Products	Actual Situation	With Project	Balance
Rice	63,896	187,330	123,434
Maize	5,632	3,400	-2,232
Soybean	9,952	4,950	-5,002
Sorghum	3,666	3,900	234
Cotton	260	260	10
Kidney bean	-	56	56
Sunflower	-	315	315
Plantain	14,220	23,700	9,480
Cacao	392	548	156
Papaya	16,800	18,480	1,680
Oil Palm	576	1,216	640
Maracuya	8	340	332
Cattle	2,626	2,652	26

The output of rice will be multiplied by three times. In case of maize and soybean, the shrinkage of output is attributable to remarkable decrease of cultivated area, whereas the output of sorghum, the cultivated area of which will also decrease, will have a slight expansion owing to an improvement of unit yield. Furthermore, output of perennial and tree crops will rise in parallel with enhancement of productivity, although their cultivated area will remain unchanged. As for cattle production, the actual production level will be kept, the reduced area of pasture will be offset by improvement of productivity.

(2) Forecast of markets for agro-products

Forecast of market for agro-products with major growth and that for non-traditional ones is stated hereinunder.

1) Rice

The output of rice in Colombian had reached its highest level in

1982 and from that year on it has been hovered in the range of 80 - 90% of the 1982's level. In this period, the consumption of rice per capita has been kept almost in the same standard as 1982 and the stock of rice in the national level has run out accordingly. In the light of this, Colombia is forced to become an importer of rice once again. Under the circumstances, Colombian government has decided to implement "rice production promotion plan" (September 15, 1988). With the Project, an output of rice in the area is expected to increase by approximately 123,000 tons per year, which is equivalent to about 7% of the national production in 1988. This increase together with 1988's output does not catch up with 1982's level.

Judging from the said analysis, it is considered that an increase of rice with the Project would not bring dislocation of market condition accrued to an excess of production, but would contribute to satisfy domestic demand of Colombia.

2) Sunflower

Even in the national level, sunflower has a minor cultivated area: as few as 3,400 ha in 1982 and 1,450 ha in 1988. The Department of Valle is the leading production area accounting for almost half of the national production. In Meta, only 70 - 80 ha is planted. The recession of cultivated area in 1988 was due to slumped harvest brought by use of disqualified seeds in the previous year. Currently, a distributor of seeds has shown interest in cultivating sunflower and, therefore, has entrusted the Agriculture Center of SENA to test its potential for cultivation in Meta. According to the Center, the result is favorable and the production of sunflower in the Department will have bright prospects.

Sunflower is one of alternate crops for substituting importation edible oil. Thus, the Government of Colombia has included the crop among such agro-products as are established supporting price of IDEMA since 1987. At present, the product is traded mainly

through processing factories in Valle. It is thought that sunflower has a promising market, so the success of the production depend largely on producing qualified seed.

3) Kidney bean

Kidney bean is one of basic grains for diet of Colombian people, but it is produced beyond demand. In consequence, the grain has been imported to satisfy consumption of the Colombian people. This circumstance has also lead the Government of Colombia to implement production promotion plan of the crop. In particular, the Department of Meta has produced very few amount of kidney bean contributing no more than 1% of the national production; furthermore, in the Ariari region including the study area the crop is cultivated only in 150 ha of land. Referring to the estimate of URPA, in Meta the departmental production of kidney bean was 840 tons in 1984, which is fewer than half of the departmental consumption (1,800 tons = 500,000 x 3.6 kg/person). The balance of departmental consumption is compensated with supply from other parts of the country. Production of kidney bean with the Project thus seeks to participate in the local market.

4) Plantain

The Project area constitutes a major productive zone of plantain and about half of the departmental output is produced there. Close to 90% of output recorded in the study area is sold directly to wholesale markets in Bogota. An increase of output for plantain with Project is envisaged to reach 9,480 tons per year. This increased volume is equal to 7% of the annual transaction at Corabastos in Bogota, so it may be traded without disordering prevailing marketing circumstances. In addition, a processing plant to produce powder of plantain is projected presently and, if the project is realized, additional demand for the product is expected.

(3) Marketing plan

In the study area, many crops which are needed to be processed before the final product are cultivated. These crops include rice, soybean, sorghum, oil palm, cotton and cacao. For these crops the construction of processing facilities is expected in the light of generating more value added and activating local economy. Generally speaking, agro-industries have rooms for development where rural population is high and labor force is easily available for the industry; as far as the Project area is concerned, more labor force will be required in parallel with an expansion of cultivated area, but surplus manpower will not be expected. In the light of this, it is recommended that agro-industries should be developed in Granada. Granada is the second largest city in Meta next to Villavicencio and is placed as a core center for commercial activity and transportation network in the Ariari Region. Comprising agro-industries, Granada may foster further development in terms of quality in the future.

Judging from above consideration, marketing and processing facilities will not be contemplated in the Project. At present, a project named CESCO (Centro Regional de Servicios a la Comercialización) is promoted under coordination of Fondo-DRI. This project has an objective to integrate development plans or projects of agro-industry craved for by 7 cooperatives in the Ariari region. It is desired that this project should be realized as sooner as possible and be made a contribution to enhancement of marketing system for products to be produced with the Project. Information on the CESCO project is given in ANNEX G.

4.3.4 Institutional Supporting Services and Farmers' Organization Plan

(1) Industrial supporting services

The present Project is a large scale agricultural development project without any similar example in the past in the Department of Meta. At the same time, the Project envisages to comprise non-traditional crops. For these reasons, it will be difficult to attain expected benefits of the Project unless adequate supporting services to farmers are provided by concerned institutions.

In concrete, the following institutional supporting services are expected.

1) Cropping technology of paddy

The Project proposes to change rice culture from actual rain-fed or extensive irrigation systems to duly organized and modern irrigation system. The cultivated area of paddy will have a drastic rise from 1,870 ha to 18,990 ha. For the greater portion of farmers in the Project area, it will be the first case to cultivate rice in paddy field with orderly prepared borders. In these circumstances, two pilot farms shall be established in view of demonstrating an appropriate cropping technology of paddy and making diffusion of it among farmers.

The technical assistance for paddy cultivation in irrigated fields is expected to be provided by Fedearroz. Fedearroz is a nation-wide organization composed of rice growers and their major activities are: 1) to promote production, quality control and technical research of rice, 2) to guarantee rice growers with marketing channel, 3) to enhance living standard of farmers, and 4) to provide credit services to affiliated members. The organization is developing rice cultivation technology (variety, weed control, adequate sowing density, etc.) suited to respective areas and this task is entrusted to CIAT (International Center

for Tropical Agriculture). There is an experimental farm of CIAT in Villavicencio in which research on cropping technology, suited to agro-climatological conditions of the Llanos Orientales is undertaken.

The result of these technological developments shall be transferred to farmes by Fedearroz, on the basis of contract with the water users' association.

The major fields of technical assistance from Fedearroz are:

- Irrigation farming at model farms (two farms with an extension of 3 ha)
- Extension services to small farmers
- Technology transfer and training to extension workers who will be stationed at the water users' association.

2) Cropping technology of non-traditional crops.

ICA will be responsible for providing technical services to cultivate sunflower and to realize irrigation farming for crops other than paddy. These services will be provided for six years starting from the year in which facilities are put into operation.

3) Operation and maintenance of facilities

The operation and maintenance (O/M) of irrigation and drainage facilities will be undertaken by water users' association to be formed by beneficiaries of these facilities. Because farmers in the Project area have less experience in O/M of facilities, supporting service shall be rendered by the regional office No. 6 of HIMAT. For this purpose, some engineers of HIMAT will be stationed at the association, so that technology on O/M of facilities may be transferred to farmers through "On-the-job training" method. The service period of HIMAT should cover a period sufficiently long to ensure that the technical skills can be imparted to persons of the association who will ultimately assume the responsibility.

4) Operation of machinery and organization of farmers

With an eye to attaining more intensive use of lands, farmers to use agricultural machinery in their farming will be increasing. The Agricultural Center "Los Naranjos" of SENA shall take charge of instructing farmers how to operate and maintain machinery adequately.

SENA shall also provide technical assistance on organization and management of water users' association.

5) Credit services

The greater portion of annual crops are actually cultivated with credit services rendered by Caja Agraria and other financing institutions. The cultivated area of annual crops will increase from 30,110 ha to 40,520 ha yearly. The increased area of annual crops is totally covered by paddy. Referring to actual covering share (47%) and unit loan amount (Col$94,500/ha) of the FFA, it is estimated that increased demand of credit to paddy cultivation is Col$462 million for two semesters. This value corresponds to 32% of the total credit amount provided by Caja Aqraria's Granada branch but to as few as 2% of the total amount in the national level. It is therefore judged that, by means of coordination with credit demand for other regions, the increased demand for credit of rice cultivation with the Project will be covered by actual line of the FFA.

(2) Farmers' organization

As explained before, the Project aims to expand largely cultivated area of paddy by means of providing new irrigation system. In order to accomplish projected agricultural production, formation of water users' association and integration of existing organization shall be indispensable factor.

1) Water users' association

In order to carry out operation and maintenance of irrigation facilities and distribution of irrigation water from intake point to fields, a water users' association with participation of beneficiaries of said facilities shall be formed. Information on organization and administration of the association is as per given in 5.2.1.

2) Integration of existing cooperatives

Cooperatives existing in the study area has no other function but marketing of products and procurement and sale of inputs. These cooperatives have various independent plans to participate more aggressively in the commercialization of products, without having come true due to lack of financial resources. Under the circumstances, Fondo-DRI has formulated a project named "CESCO" which aims to coordinate and arrange interests of each cooperative and to integrate them in a form of a center and to hold a dominant position in the trade of agro-products making advantage of scale.

As stated before, demand of machinery will increase in par with an expansion of cultivated area. Actually, harvest of rice is conducted by contractors using combine, but from standpoint of work efficiency, farmers with larger farm are given priority in ordering contract. As a consequence, small and medium farmers are sometimes suffering from lack of machinery for harvest losing some portion of their products. Judging from this situation and lest disadvantageous situation for small and medium farmers should be accelerated in the future, joint operation of machinery among some farmers will be critical. It is thus recommended that a function for joint operation of machinery should be included in the "CESCO".

4.4 AGRICULTURAL INFRASTRUCTURE IMPROVEMENT PLAN

4.4.1 Irrigation and Drainage Plan

(1) Irrigation Plan

Irrigation plan was made with the consideration of gravitational irrigation for paddy field mainly, taking water from the Guape River by means of head works.

1) Water Source

The river discharge at the proposed site of head works on the Guape River was estimated from the discharge at Angostura bridge using the portion of catchment area (815/775km^2) (See Fig. 4-4-2).

Monthly Mean River Discharge of The Guape River
- Proposed Head Works Site - (m^3/s)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Discharge	60.7	77.8	50.0	63.4	85.0	141.0	125.5	93.7	81.4	76.1	59.2	44.7

According to the guideline of INDERENA, 15% of the minimum river discharge data of observation period will be considered as the minimum flow for lower stream (it is estimated as 1.7m^3/s at proposed site).

2) Field Irrigation Method

Considering topography, soil, agro-technology of farmers and development level, the ponding irrigation with borders prepared in parallel with contour line for paddy field, and the contour furrow irrigation for up land are considered.

3) Water Requirement

As there is a difference in the meteorological conditions among the upper, middle and lower zones, the water requirement was calculated for each zone.

a) Crop Water Requirement

- Evapotranspiration (ETo)

Evapotranspiration was estimated by the Penman Method for the upper, middle and lower zones and the values for January are 132, 111 and 109mm/month respectively. These results are shown in Table 4-4-1 and Fig. 4-4-1.

- Crop Water Requirement (ETcrop)

Based on the result of field investigation and the guideline of FAO, the crop water requirement (Kc value) was determined for each crop and each zone. The results are shown in Tables 4-4-2 and 4-4-3.

b) Irrigation Water Requirement

- Irrigation Efficiency (Ep)

Based on the guideline of FAO, soil conditions of the study area, actual data of the neighboring projects and examples of other similar plans, it is predicted that the irrigation efficiency for ponding irrigation is 42% and the same for furrow irrigation is 35%.

- Effective Rainfall (Pe)

In the study area, more than 2,000mm of annual rainfall can be expected. Therefore, effective rainfall was considered in the irrigation water use plan.

- Calculation of Irrigation Water Requirement

Irrigation water requirement was calculated according to the irrigation area and cropping pattern determined in the land use plan (4.3.1) and cropping plan (4.3.2).

$Wr = A \times (ETcrop - Pe) \times 100/Ep \times 10/86400$

where Wr : Irrigation Water Requirement (m^3/s)
A : Irrigable Area (ha)
ETcrop : Crop Water Requirement (mm/day) = ETo x Kc
Pe : Effective Rainfall (mm/day)
Ep : Irrigation Effeciency (%)

For paddy field, infiltration amount of 6mm/day is added and the rest of this calculation is shown in Table 4-4-3.

- Determination of Design Year

The optimum design year for the system was determined based on the benefit and cost for 2.5 and 10 year return period. From the result of the study, it was understood that the system for 5 year return period is the most effective with high Internal Rate of Return (IRR). The maximum capacity of the system for year return period was as $36,725m^3/s$.

- Base Flow of Caños

The total flow of the main caños (Urichare, Guanays, Mucuya, Sardinata) in January of 5 year return period is estimated as approximately $0.92m^3/s$ (ANNEX C), which is negligible amount comparing with the water requirement ($36.7m^3/s$). Therefore the discharge of caños is not considered as one of water sources for irrigation water requirement.

4) Irrigation System

From the viewpoint of cost saving, it is proposed to use the existing caños as irrigation canals. For this purpose, it is necessary to improve the capacity of caños (adjusting of

longitudinal slope, enlargement of section) because of existing land slope being so steep as to use them as irrigation canal. Furthermore, considering the complexity to control the water discharge from the Guape River and the operation of intake facilities in the high water time, it is infeasible to use the caños as irrigation system.

Although the basic concept of planning a canal system is to minimize the incidental structures such as siphon, bridge, drops, etc. as far as possible, it is estimated that a great number of large scale drop works are required for the Project in view of the land slope which is as significant as more than 1%. Furthermore, because of many caños which run in parallel with each other throughout the area, crossing structures are also required to distribute the irrigation water all over the area.

Bearing the afore-mentioned aspects in mind the following two alternatives were studied to delineate a proposed course for the main canal (Refer to Annex I, Page I-25).

I. Plan A : Several main canals were designed in parallel with the caños so that the number of crossing points of secondary canals with caños may be minimized. In this case the main canal was designed longer, but the number of crossing points becomes fewer. There was no substantial change in the drainage system (Refer to Fig. I-2-8 of Annex I).

II. Plan B : The number of main canals was designed as few as possible, while more secondary canals were disposed along the contour line. The total length of main canal was less, but the number of secondary canals crossing with the caños is more. Improvement works of drainage in field are required (Refer to Fig. I-2-9 of Annex I).

Irrigation canals will be distributed with the consideration of rotation block for the tertiary field irrigation system. Therefore, the total length of irrigation canal is independent from the plan of irrigation area.

(2) Drainage Plan

Elimination of flood water from farm land is the main subject and improvement of the drainage condition for poor drainage land will not be considered at this stage of the Project. Lands with poor drainage will be used as paddy or pasture at this stage and the drainage improvement plan will be considered when more effective land use is expected in the future. On the other hand, the land inundated frequently by overflow of caños and existing forest land are excluded from the development area.

1) Design Condition

a) Design year

In Colombia, the flood control plan is generally prepared for the flood of 4 - 5 year return period. In this study, the drainage plan for the field was made for the flood of 5 year return period.

b) Design Discharge

Considering the conditions of upper, middle and lower zone, the peak runoff discharge for 5 year return period is calculated by the Rational Formula. The design discharge was estimated depending on the catchment area of each zone.

c) Allowable Inundation Period

In this project the allowable inundation period is considered as 24 hours for paddy fields and 4 hours for upland fields. Hence following the land use plan, the allowable inundation period should not exceed 4 hours.

2) Flowing Capacity of Caño and Check Point

a) Drainage System

Existing caños are regarded as the main drainage canals and runoff discharge at the main check point is estimated. The drainage system is shown in Fig. 4-4-4.

b) Check of Existing Flowing Capacity

Considering the design runoff discharge, the flow capacity in the existing section of caños and the check point are checked and period and depth of inundation are estimated. The results are shown in Table 4-4-4. It is estimated that the inundation period with a design discharge of 5 year return period will be more than 4 hours at Caño Venado and at the lower part of Aviohule. Hence, the drainage improvement works are required for these areas.

3) Drainage Improvement Plan

Because of the reason mentioned above, drainage plan is proposed, for the following two caños.

a) Caño Venado

Existing culvert will be changed to bridge and the existing flow capacity will be improved from $9m^3/s$ to $32m^3/s$.

b) Lower Part of Aviohule

Considering the actual flow capacity of Caño Chule, the capacity of existing drainage canal will be improved from 2 m^3/s to 6 m^3/s by means of improvement works of drainage canal and culvert for 5 km length.

Table 4-4-1 Evapotranspiration of The Ariari Project Area

(mm/month)

AREA	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
Lower Zone	132.3	118.0	111.8	91.7	92.0	79.0	85.6	91.3	100.3	105.8	106.7	119.3	1233.7
Middle Zone	110.8	103.6	107.6	98.1	88.5	78.0	82.7	92.4	97.0	102.3	100.7	104.6	1166.3
Upper Zone	108.9	97.7	105.4	87.0	83.9	74.5	82.6	88.7	90.0	92.0	87.3	111.4	1109.5

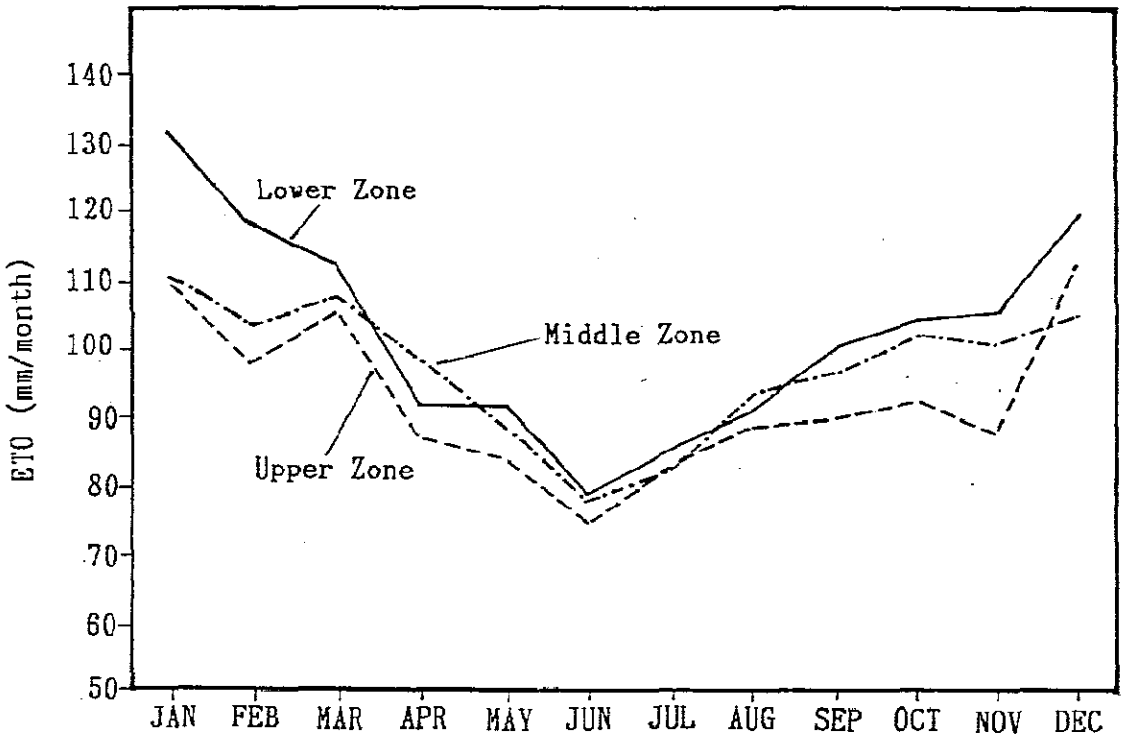
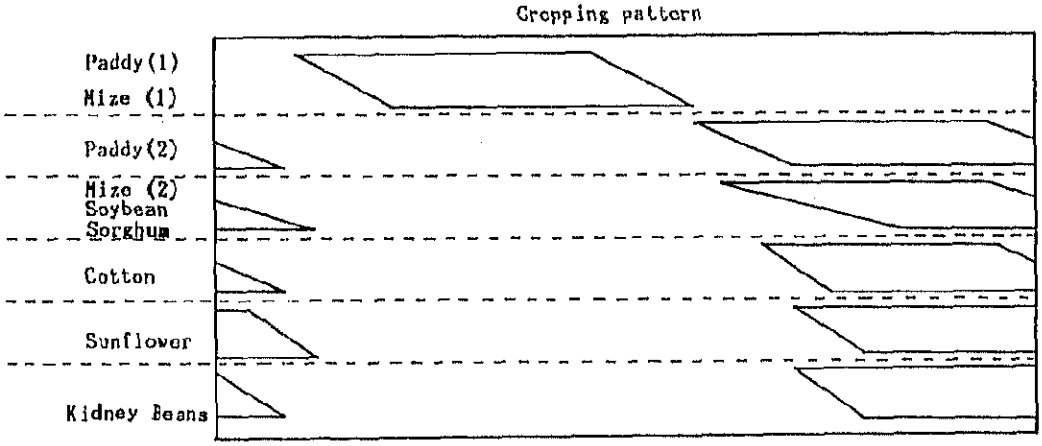
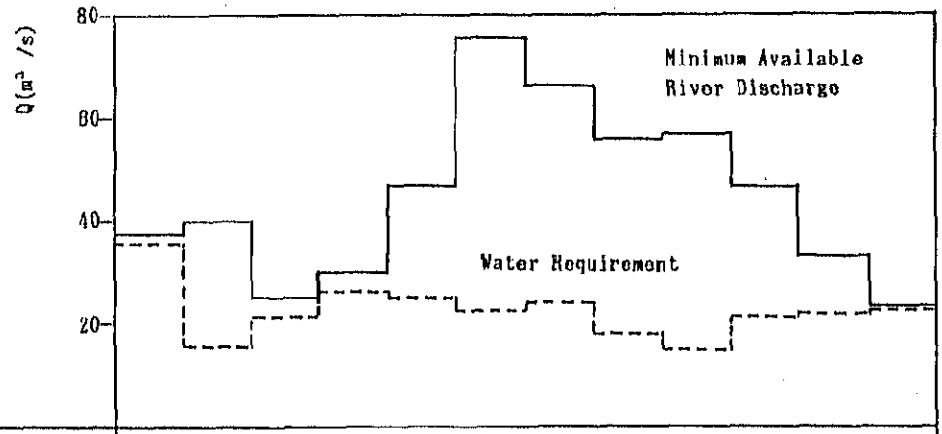


Fig. 4-4-1 Evapotranspiration of The Ariari Project Area





	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Mean River Discharge	80.7	77.8	50.0	63.4	85.0	141.4	125.5	93.7	81.4	70.1	59.2	44.7
*	Minimum Available R. Discharge	38.8	40.0	25.0	29.5	47.0	76.2	67.2	55.8	57.2	46.9	33.1	22.6
	Water Requirement	38.7	18.0	22.0	28.0	24.9	23.0	23.8	18.0	15.0	21.5	21.7	22.4

* Exclude the reserved water for lower basin ,1.6m³ /s.

Fig.4-4-2 River Discharge and Water Requirement

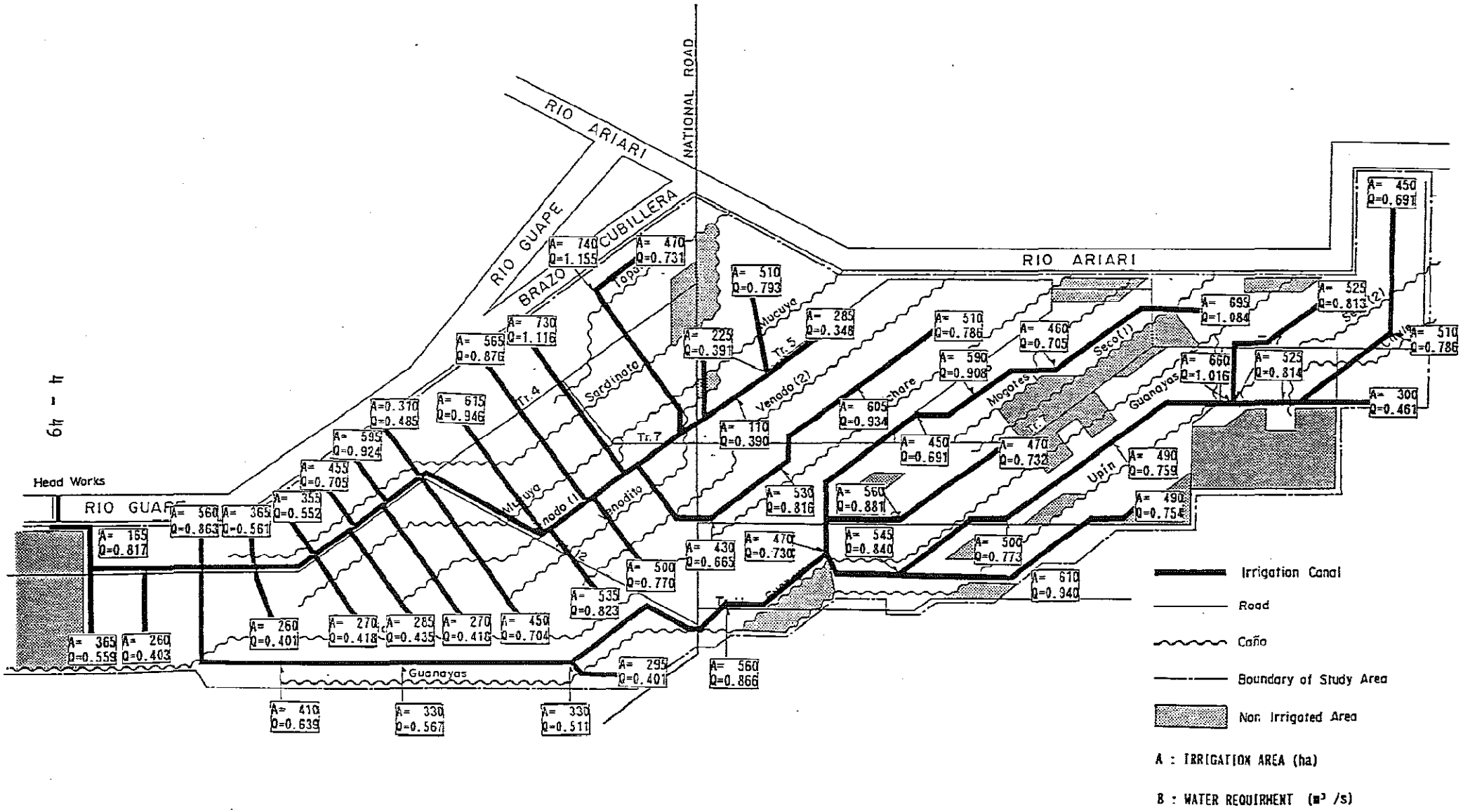


Fig. 4-4-3 IRRIGATION CANAL SYSTEM

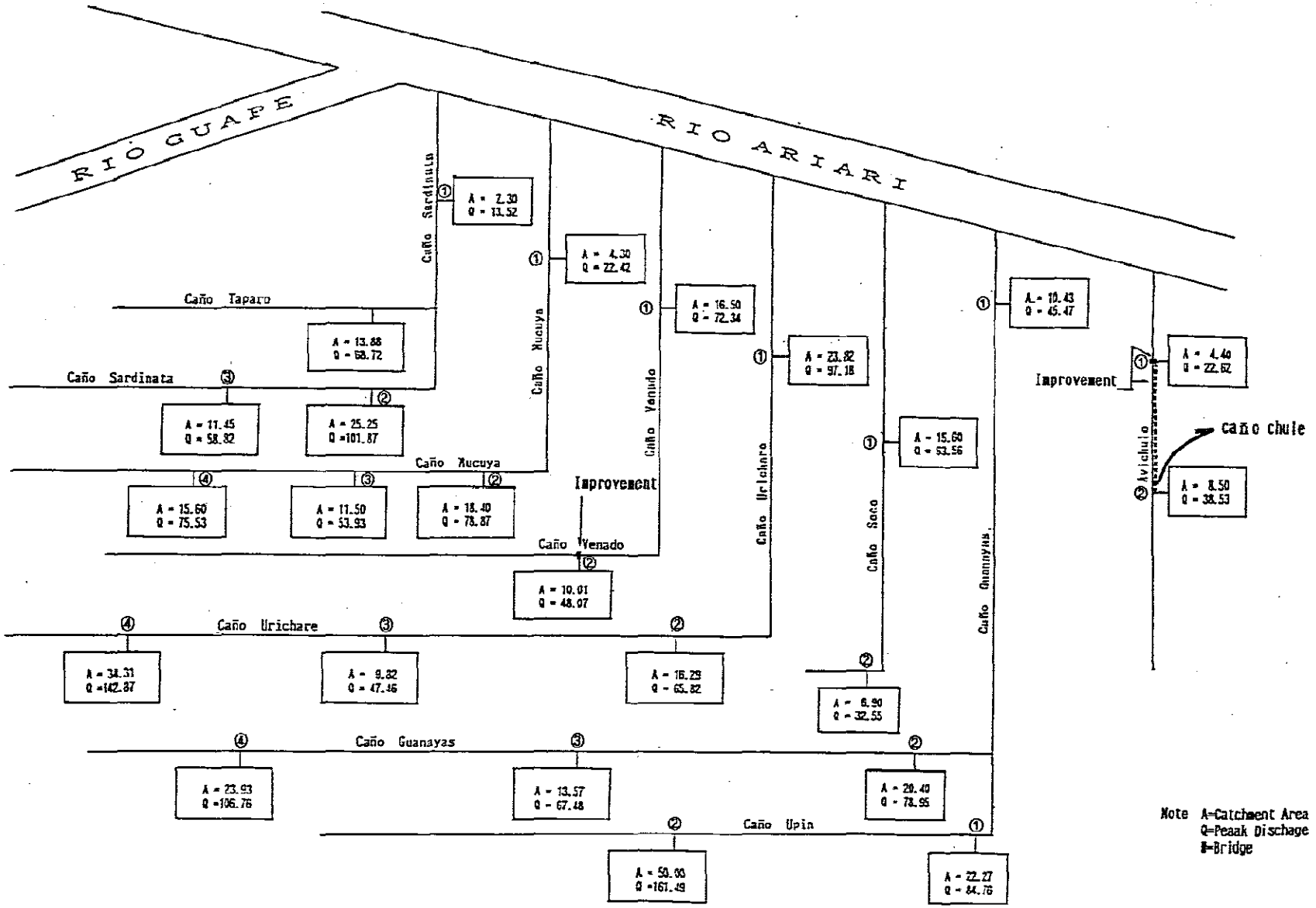


Fig. 4-4-4 Drainage System and Runoff Peak Discharge

Table 4-4-2 Kc Value of Proposed Crop

Annual Crop	Stage			
	Initial	Crop Development	Mid-Season	Late
	days , kc	days , kc	days , kc	days , kc
Rice	30 , 1.10	30 , 1.05	60 , 1.05	30 , 0.95
Maize (1)	30 , 0.31	40 , 1.05	50 , 1.05	30 , 0.55
Maize (2)	30 , 0.40	40 , 1.05	50 , 1.05	30 , 0.55
Sorghum	20 , 0.35	30 , 1.00	40 , 1.00	30 , 0.55
Soy Beans (2)	20 , 0.40	30 , 1.00	60 , 1.00	25 , 0.45
Sunflower	25 , 0.40	40 , 1.05	45 , 1.05	40 , 0.40
Sugarcane	60 , 0.50	60 , 1.05	280 , 1.05	30 , 0.60
Kidney Beans	15 , 0.40	25 , 1.05	50 , 1.05	20 , 0.30
Cotton	30 , 0.40	50 , 1.05	55 , 1.05	45 , 0.65

Purennial Crop	Kc
Plantain	0.80－1.10
Papaya	1.00
Tree Crop	0.90
Oil Palm	0.85
Cacao	0.85

Table 4-4-3 Crop Water Requirement

(mm/month)

Zone	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
UPPER	Paddy Rice (1)	–	221.1	299.3	271.9	274.1	256.4	227.3	–	–	–	–	–
	Paddy Rice (2)	240.4	–	–	–	–	–	–	234.2	276.7	283.2	271.7	300.2
	Maize (1)	–	15.1	47.3	69.9	86.8	68.9	33.0	–	–	–	–	–
	Maize (2)	43.6	–	–	–	–	–	–	17.7	47.0	76.7	90.5	103.0
	Sorghum	42.2	–	–	–	–	–	–	–	17.3	57.0	80.9	98.9
	Kidney Beans(2)	24.6	–	–	–	–	–	–	–	22.4	69.2	89.8	83.7
	Soy beans (2)	29.8	–	–	–	–	–	–	18.26	59.7	98.4	81.4	109.4
	Papaya	108.9	97.7	105.4	87.0	83.9	74.5	82.6	88.7	90.0	92.0	87.3	111.4
	Tree Crop	98.0	87.9	94.9	78.3	75.5	67.0	74.3	79.8	81.0	82.8	78.6	100.3
	Plantain	95.3	100.1	115.9	89.2	73.4	59.6	72.3	90.9	99.0	94.3	76.4	89.1
	Cacao	92.6	83.0	89.6	74.0	71.3	63.3	70.0	75.4	76.5	78.2	74.2	94.7
MIDDLE	Paddy Rice (1)	–	224.3	301.7	283.6	278.9	260.0	227.3	–	–	–	–	–
	Paddy Rice (2)	241.4	–	–	–	–	–	–	236.2	284.3	294.1	285.7	293.2
	Up Land Rice	–	56.3	115.7	103.6	92.9	79.9	41.4	–	–	–	–	–
	Up Land Rice	55.4	–	–	–	–	–	–	50.2	104.3	108.1	105.7	107.2
	Soy beans (2)	–	–	–	–	–	–	–	20.3	63.1	95.1	93.9	102.7
	Sugaroane	116.3	108.8	113.0	103.0	92.9	81.9	76.5	64.7	53.3	69.1	86.9	103.3
	Cotton	40.6	–	–	–	–	–	–	18.5	48.2	79.7	101.3	108.1
	Sunflower	9.0	–	–	–	–	–	–	19.8	60.4	91.7	104.7	62.4
	Maize (1)	–	16.1	48.3	78.9	91.6	72.2	33.1	–	–	–	–	–
	Maize (2)	44.3	–	–	–	–	–	–	18.5	50.7	85.3	104.4	96.8
	Tree Crop	99.7	93.2	96.8	88.3	76.7	70.2	74.4	83.2	87.3	92.1	90.6	94.1
	Plantain	121.9	106.2	94.2	78.5	77.4	80.0	91.0	94.7	84.9	81.8	88.1	107.2
	Cacao	94.2	88.1	91.5	83.4	75.2	66.3	70.3	78.5	82.5	87.0	85.6	88.9
	Oil palm	94.2	88.1	91.5	83.4	75.2	66.3	70.3	78.5	82.5	87.0	85.6	88.9
LOWER	Paddy Rice (1)	–	232.2	306.2	276.9	282.6	261.0	228.8	–	–	–	–	–
	Paddy Rice (2)	252.1	–	–	–	–	–	–	235.6	287.8	297.8	292.0	308.3
	Up Land Rice	–	64.2	120.2	96.9	96.6	81.0	42.8	–	–	–	–	–
	Up Land Rice	66.2	–	–	–	–	–	–	49.6	107.8	111.8	112.0	122.3
	Soy beans (2)	18.2	–	–	–	–	–	–	21.7	68.7	99.5	117.1	84.1
	Sorghum	51.3	–	–	–	–	–	–	–	19.3	65.6	98.9	105.9
	Sunflower	10.3	–	–	–	–	–	–	20.5	62.4	97.2	119.4	74.5
	Sugarcane	72.8	79.7	96.4	90.6	96.6	83.0	89.9	95.9	105.3	111.1	98.7	83.5
	Maize (1)	–	18.3	50.2	73.7	95.2	73.1	34.2	–	–	–	–	–
	Maize (2)	47.2	–	–	–	–	–	–	20.1	55.2	89.0	123.7	122.4
	Plantain	145.5	121.0	97.8	73.4	30.5	81.0	94.2	93.6	87.8	84.6	93.4	122.8
	Cacao	112.5	100.3	95.0	77.9	78.2	67.2	72.8	77.6	85.3	89.9	90.7	101.4

Table 4-4-4 Proposed Irrigated Area (ha)

Zone	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
UPPER	Paddy Rice (1)	—	1,358	2,715	2,715	2,715	2,715	1,558	—	—	—	—	—
	Paddy Rice (2)	930	—	—	—	—	—	—	930	1,860	1,860	1,860	1,860
	Maize (1)	—	185	370	370	370	370	185	—	—	—	—	—
	Maize (2)	65	—	—	—	—	—	—	65	130	130	130	130
	Sorghum	150	—	—	—	—	—	—	—	150	300	300	300
	Kidney Beans(2)	3	—	—	—	—	—	—	—	3	5	5	5
	Soy beans (2)	150	—	—	—	—	—	—	—	150	300	300	300
	Papaya	410	410	410	410	410	410	410	410	410	410	410	410
	Tree Crop	270	270	270	270	270	270	270	270	270	270	270	270
	Plantain	960	960	960	960	960	960	960	960	960	960	960	960
	Cacao	260	260	260	260	260	260	260	260	260	260	260	260
MIDDLE	Paddy Rice (1)	—	4,150	8,300	8,300	8,300	8,300	4,150	—	—	—	—	—
	Paddy Rice (2)	3,330	—	—	—	—	—	—	3,330	6,660	6,660	6,660	6,660
	Soy beans (2)	600	—	—	—	—	—	—	600	1,200	1,200	1,200	1,200
	Cotton	48	—	—	—	—	—	—	48	95	95	95	95
	Sunflower	50	—	—	—	—	—	—	50	100	100	100	100
	Maize (1)	—	188	375	375	375	375	188	—	—	—	—	—
	Maize (2)	63	—	—	—	—	—	—	63	125	125	125	125
	Plantain	590	590	590	590	590	590	590	590	590	590	590	590
	Cacao	380	380	380	380	380	380	380	380	380	380	380	380
	Oil palm	320	320	320	320	320	320	320	320	320	320	320	320
LOWER	Paddy Rice (1)	—	3,988	7,975	7,975	7,975	7,975	3,988	—	—	—	—	—
	Paddy Rice (2)	3,275	—	—	—	—	—	—	3,275	6,550	3,275	6,550	6,550
	Soy beans (2)	425	—	—	—	—	—	—	425	850	850	850	850
	Sorghum	250	—	—	—	—	—	—	250	500	500	500	500
	Sunflower	105	—	—	—	—	—	—	105	210	210	210	210
	Sugarcane	5	10	10	10	10	10	10	10	10	10	10	5
	Maize (1)	—	90	180	180	180	180	90	—	—	—	—	—
	Maize (2)	—	—	—	—	—	—	—	—	—	—	—	—
	Plantain	760	760	760	760	760	760	760	760	760	760	760	760
	Cacao	230	230	230	230	230	230	230	230	230	230	230	230

Table 4-4-5 Irrigation Water Requirement

(m3/s)

ZONE	(ha)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
UPPER ZONE	(4,730)	7.081	5.611	6.822	7.310	7.228	7.126	7.353	6.404	5.046	6.126	6.446	6.725
	1/2	4.541	2.031	2.864	3.509	3.418	3.185	3.337	2.510	1.756	2.486	2.414	2.660
	1/5	4.956	2.328	2.939	3.509	3.418	3.185	3.378	2.551	1.785	2.486	2.457	3.107
	1/10	5.122	2.551	3.063	3.551	3.418	3.185	3.378	2.551	1.785	2.486	2.457	3.375
	1/20	5.294	2.776	3.165	3.551	3.459	3.227	3.378	2.572	1.800	2.514	2.501	3.598
MIDDLE ZONE	(9,970)	18.051	14.216	16.765	19.838	18.865	18.342	18.389	15.895	13.740	17.424	18.166	15.279
	1/2	15.996	6.342	9.000	11.500	10.880	9.974	10.208	7.789	6.487	9.459	9.535	9.285
	1/5	16.339	6.404	9.509	11.500	10.880	9.974	10.208	7.789	6.643	9.459	9.639	10.056
	1/10	16.510	6.530	9.727	11.630	11.005	9.974	10.208	7.789	6.643	9.459	9.847	10.484
	1/20	16.596	6.530	9.956	11.630	11.068	10.103	10.208	7.915	6.643	9.560	10.003	10.741
LOWER ZONE	(9,115)	18.735	14.261	16.035	18.231	18.028	17.356	17.564	14.971	13.313	16.844	17.666	15.491
	1/2	15.046	6.964	9.102	10.933	10.556	9.648	9.987	7.572	6.471	9.539	9.599	8.651
	1/5	15.431	7.233	9.525	10.995	10.556	9.835	9.987	7.692	6.574	9.588	9.599	9.189
	1/10	15.661	7.441	9.738	11.120	10.616	9.835	9.987	7.752	6.574	9.588	9.651	9.496
	1/20	15.815	7.648	9.951	11.244	10.676	9.835	9.987	7.752	6.574	9.638	9.702	9.726
Ground Total	(23,815)	43.868	34.088	39.622	45.379	44.121	42.825	43.305	37.270	32.100	40.395	42.278	37.495
	1/2	35.583	15.337	20.966	25.942	24.854	22.807	23.532	17.871	14.714	21.484	21.548	20.595
	1/5	36.725	16.965	21.973	26.004	24.854	22.993	23.573	18.032	15.002	21.534	21.696	22.351
	1/10	37.293	16.521	22.528	26.301	25.039	22.993	23.573	18.093	15.002	21.534	21.955	23.354
	1/20	37.705	16.954	23.072	26.425	25.203	23.165	23.573	18.239	15.016	21.712	22.206	24.065

Table 4-4-6 Summary of Inundation Time
(1/5 Return period)

Name of Caño	Inundation Time (hr)	Peak Flow for Lower Basin (m^3 /s)	Maximum Water Level (m)
Avichure 2	3.0	23.11	0.44
Avichure 1	* 6.0	16.58	0.26
Avichure 2	3.0	23.11	0.44
Avichure 1 ★	3.8	20.13	0.09
Caño Seco 2	3.5	13.79	0.28
Caño Seco 1	3.6	52.94	0.92
Caño Upin 2	2.5	64.00	0.66
Caño Upin 1	3.3	142.10	0.28
Caño Guanayas 4	2.4	91.67	0.99
Caño Guanayas 3	3.6	84.19	0.39
Caño Guanayas 2	3.9	80.78	0.48
Caño Guanayas 1	3.6	206.89	0.46
Caño Urichare 4	2.4	134.26	0.87
Caño Urichare 3	3.8	114.65	0.83
Caño Urichare 2	3.6	111.85	0.73
Caño Urichare 1	1.7	108.80	0.16
Caño Venado 2	* 10.5	8.99	1.23
Caño Venado 1	1.7	66.29	0.09
Caño Venado 2 ★	2.7	32.05	0.45
Caño Venado 1	3.4	70.10	0.19
Caño Mucuya 4	3.6	45.67	0.79
Caño Mucuya 3	2.2	50.50	0.10
Caño Mucuya 2	3.4	64.47	0.12
Caño Mucuya 1	3.2	63.40	0.08
Caño Sardinata 3	3.2	37.53	0.94
Caño Sardinata 2	3.9	71.23	0.14
Caño Sardinata 1	2.7	117.69	0.73
Caño Taparo	2.8	51.63	0.82

Note * : Improvement works are required
★ : Expected Effect

4.4.2 Rural Infrastructure Plan

(1) General

The infrastructures such as principal roads, telecommunication system, electricity, water supply system, etc. are carried out by the concerned authorities in accordance with the "PNR" program as below. Therefore, in this project the road improvement plan which has intimately associated with agricultural production has been proposed for being given high priority.

Road improvement plan ..... MOPT, FNCV
Telecommunication and Electricity plan ..... TELECOM, EMSA, ICEL
Educational facilities improvement plan ..... MUNIC.-SEC. DE META
Public medical facilities improvement plan .. S.S.S. META
Water supply and sewerage improvement plan .. FONAM

(2) Road Improvement Plan

1) Basic concept

To fulfill function of the road network in the project area, the improvement of "Trocha 4" and the construction of service roads along the irrigation canals and farm roads based on the land consolidation plan have been planned.

It is considered that a road network including service roads will be satisfied in density.

The department road "Trocha 4", one of the existing roads, is a principal route which connects the national road with urban area of Lejanias. At present, a part of its road has been paved with asphalt but it has not been maintained adequately, presenting disorder of surface.

In Lejanias and its surrounding area fruits represented by papaya are cultivated. Therefore, reduction of damages during

transportation will be expected by improvement of "Trocha 4". For the other departmental roads, their improvement will be entrusted to FNCV.

The service roads will be constructed along principal and secondary canals which will not run along the existing roads.

2) Lengths of proposed roads

The total length of roads including service and farm roads proposed on the basis of the irrigation and drainage plan will be 1,002 km as shown in Table 4-4-7.

Table 4-4-7 PROPOSED ROAD DENSITY

Zone	Existing Road (km)	Service Road (km)	Farm Road (km)	Total (km)	Agricultural Land (ha)	Road Density (m/ha)
Upper	121	36	71	228	9,100	25
Middle	169	77	150	396	15,400	26
Lower	164	77	137	378	16,600	23
Total	454	190	358	1,002	41,100	25

4.4.3 Land Conservation Plan

Damages to farmland in the study area are caused by flooding in rainy season, which is attributable to mainly bank erosion of the Guape and Ariari Rivers.

Most of flooded areas in the upper zone are covered by bush and other improductive trees which are grown in less capable land for farming. At the area of "PUERTO NUEVO" and its surrounding area in the lower zone, flooding occurs once very two to three years with inundating depth of 50 to 60 cm. The vegetation is groves and plantain. Therefore, flood protection plan at both sites are excluded from the project (See ANNEX J).

(1) Bank Erosion Control

1) General

Bank erosion occurs at almost the whole reach of the Guape and Ariari Rivers especially at the meandering section downstream from Puerto Caldas. Construction of prevention works for whole sections brings an increase of the project costs and a burden of the beneficiaries. On the other hand, "Ariari River Protection Work" for the left bank is being carried out by HIMAT under the "PNR".

Considering above-mentioned situation, the scope of the works for prevention of bank erosion has been limited to the sections where have been in urgent need of countermeasures. The dimensions and construction method of the works in the initial stage are scheduled considering the situations of farmland, urban area and road. As for other areas it is recommended that measures for erosion control shall be carried out under "PNR".

2) Proposed Sections for Bank Erosion Control

The following three sections are identified to be in need of urgent care.

(a) 1.0 km section near Puerto Caldas community
(b) 1.0 km meandering section where "Trocha 5" runs along the Ariari River (Caño Venado)
(c) 2.0 km meandering section of the Ariari River near La Cooperativa

3) Measures

As for the situation of erosion, a foot of the bank and a river bed with sandy-gravel are eroded, then a revetment work is mainly planned. This plan shall be adjusted to "Flood Protection Plan and Bank Erosion Control Plan" of HIMAT. Taking account of the situation of bank erosion in the area and the cost of these facilities, the revetment work and the foot protection work are planned for maintaining the stability of the river bed.

As countermeasures, using gabion for the work at Puerto Caldas and concrete block at Caño Venado and La Cooperativa are proposed considering the preparation of the materials.