

## CHAPTER 1. INTRODUCTION



## CHAPTER I. INTRODUCTION

### 1.1 Background

The territory of the Republic of Colombia covers approximately 114,000 km<sup>2</sup>, and one-third of its territory is occupied by the Andes mountain range (consist of Oriental, Central and Occidental mountain ranges and called La Region Andina) which run through from north to south along the Pacific coast.

The country is situated in a tropical zone at 4°13'-12°30'N latitude, but the climate is warm and cool due to its high location ranging from 1,500 m to 3,000 m in the Andes region.

According to the census 1973 by DANE, the Republic of Colombia had a population of approximately 25 million. In this region, 70% of the total population are living and producing 64% of the staple food. It's characteristics in the region that there are so many mini scale and small scale farmers (minifundio y pequeña propiedad), specially in slope area. Therefore, the agricultural production in this area has a great deal of influence to the national socio-economic conditions.

In view of the foregoing, the Government of the Republic of Colombia gives the first priority to the agricultural development in this region through the National Development Plan (1983-1986). According to the national policy, all of the concerned governmental organizations are undertaking various actions necessary to realize the policy. Among others, HIMAT has established a program to expedite construction of the irrigation facilities in sloped area in order to increase the food production and to secure the working opportunity for the small scale farmers through effective utilization of the arable land spreads in the sloped area.

In order to accelerate the program, the Government of the Republic of Colombia looks forward to a technical assistance from Japan, because Japan has similar topography and innovative technology to develop the sloped area. In November 1984, the Government of Colombia requested a

technical cooperation of the project (details are explained later) to the Mission of Japan International Cooperation Agency (hereinafter referred to as "JICA") as representative of the Japanese Government which visited the Republic of Colombia. In response to the request, the JICA, the official agency responsible for the implementation of technical cooperation program of the Japanese Government dispatched a preliminary cum scope of work mission to discuss the implementation manner of the Study, and the mission finalized the scope of work for the study. Accordingly, it was decided to conduct the study of the project along with the above-mentioned scope of work.

## 1.2 Agricultural Development Plan in Slope Area and this Project

Agriculture has played significant role in economy of the Republic of Colombia. The Government of Colombia proposes the targets of the national policies on acceleration of agricultural development after scrutinizing constrains existing in countermeasure.

- Increment of production in agriculture and livestock and level-up of self-sufficient rate by increasing productivity
- Enhancement of employment opportunity and farmers' income
- Improvement of distribution system of agricultural products
- Expansion of exportation of agricultural products by diversification of crops
- Equitable distribution of profit and agricultural products

Specially, agriculture in the Andes region has performed important role in socio-economic fields of the country as mentioned above, besides, this region has some factors of a restriction for the agriculture such as topography (slope area), rainfall, sunshine hour and so on.

Taking into consideration the above-mentioned concept, the Government of Colombia has implemented various activities in cooperation with the international financing institutes in line with the Agricultural Development Program in Slope Area which was established by the Government.

Particularly, implementation of the small scale irrigation project in slope area is desired by so many farmers because such irrigation scheme can be easily constructed and quickly completed by the hand of beneficiary. More than one hundred of applications for implementation of the irrigation scheme were submitted to the Government as of end 1985. This shows that the irrigation scheme is one of the most attractive programs to the farmers cultivating in slope area.

The four sub-project areas located in both Department of Boyaca and Cundinamarca will be executed under the technical cooperation of the Japanese Government and in line the above-mentioned program.

### 1.3 Objectives of the Study

The objectives of the study are to formulate a small scale agricultural development project, of which major component will be irrigation, and to examine its technical feasibility and economical viability in Santa Sofia and San Pedro de Iguaque in Departamento de Boyaca, and Caqueza and Fusa-Tibacuy in Departamento de Cundinamarca.

In addition, technology will be transferred to the concerned engineers of the Republic of Colombia in the course of the study of the agricultural development project.

Furthermore, as a guide-line book on the said program, HIMAT has prepared "PROGRAMA DE PEQUENA IRRIGACION - RIEGO EN LADERA Y PEQUENOS LAGOS" (Oct. de 1985) and "RIEGO EN LADERA - UNA FORMA DE ADECUACION PARA INCORPORACION MINIFUNDIO Y LA PEQUENA PROPIEDAD AL DESARROLLO COLOMBIANO" (Oct. de 1985), then has expedited implementation of the program.

The four sub-project areas selected in this time have different conditions in terms of topography, soil, elevation, climate, availability of water resources, land utilization, cropping pattern and so on. Therefore, it is considered that the "Know-How" which is obtained during planning and implementation of the irrigation scheme, will be useful to supplement the said guide-line.

In establishing the project, a countermeasure corresponding to the specific features of these sub-project areas and the method of analysis by a kind of data obtainable are having the consideration in order to be instructive for the planning of similar project in the future.

#### 1.4 Scope of the Study

The project area will be approximately 9,955 ha of the selected four sub-project areas, namely Santa Sofia and San Pedro de Iguaque in Departamento de Boyaca, and Caqueza and Fusa-Tibacuy in Departamento de Cundinamarca. The study is conducted according to the detailed study items shown in the Scope of Work which agreed between the both executing agencies.

#### 1.5 Implementation of the Study

The performance of the study was carried out dividing into two phases, that are Phase I and Phase II.

During the Phase I study (from January to June 1986), major studied items were to clarify the present conditions of the proposed project areas and problems on farm management, and to establish basic concept to solve the said problems.

In the course of the Phase II study (from July to November 1986), based on the basic concept, the study was conducted to justify technical feasibility and economical viability of the proposed four sub-project areas. Furthermore, a preliminary design of the irrigation facilities in the pilot area which are located in the sub-project areas of San Pedro de Iguaque, Santa Sofia and Tibacuy.

## 1.6 Report

The results of the field study and the home work have been incorporated in the feasibility report, of which contents are as follows:

1. MAIN REPORT : Japanese, English
2. RESUME : Spanish
3. ANNEX : English (Supplementary datas of main report)
4. PRELIMINARY DESIGN OF PILOT AREA: Spanish
5. DRAWINGS : Spanish





## **CHAPTER 2. PRESENT CONDITION IN THE PROJECT AREA**



## CHAPTER 2. PRESENT CONDITION OF THE PROJECT AREA

### 2.1 General Futures of the Project Area

The project area is composed of the four sub-project areas, which are located in the highland region among the Oriental Mountain Range, one of the ranges formulating the Andes mountain range. Name and location of these four sub-project areas are shown in Table 2.1.1 (Location of the Sub-Project Areas).

Table 2.1.1 Location of the Sub-Project Areas

Sub-project area	Location
San Pedro de Iguaque	: Chiquiza, Departamento de Boyaca
Santa Sofia	: Santa Sofia, Departamento de Boyaca
Caqueza	: Caqueza, Departamento de Cundinamarca
Tibacuy	: Tibacuy, Departamento de Cundinamarca

San Pedro de Iguaque and Santa Sofia sub-project areas are located 37 km east (via Cucaita) and 15 km northwest, respectively from Villa de Leyva, Departamento de Boyaca which is situated about 150 km northeast from Bogota, the capital city of Colombia. Caqueza and Tibacuy sub-project areas are located in Departamento de Cundinamarca and about 44 km southeast and 60 km southwest from Bogota, respectively.

These sub-project areas were selected by HIMAT among the possible areas requested by the farmers in accordance with agricultural development program in slope areas which has been established by the Government of Colombia.

Location and boundary of the four sub-project areas are shown in General Plan and Table 2.1.4 (Limits of Project Area), and areas of these sub-projects are as follows;

San Pedro de Iguaque : 3,690 ha (including cultivated land of  
1,184 ha)

Santa Sofia : 3,880 ha (including cultivated land of  
360 ha)

Caqueza : 1,150 ha (including cultivated land of  
589 ha)

Tibacuy : 1,235 ha (including cultivated land of  
347 ha)

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Total : 9,955 ha (including cultivated land of  
2,480 ha)

Each of these sub-project areas is located in slope area with gradient of 11<sup>o</sup>-20<sup>o</sup> and their elevations are ranging from 1,200 to 3,100 meter. (refer to the attached General Plan and Table 2.1.5 Location and Elevation of Project Area) In these sub-project areas, there is no river but many small streams (called as "Quebrada").

The average annual precipitation is fluctuated from 750-1,120 mm, which means less precipitation area in the country. Average annual temperature varies between 13 and 20<sup>o</sup>C. Thus, they are divided into two zones in terms of climate, namely warm and cool.

Administrative constitution of the country of Colombia is classified into Departamento (Department), Municipio (equivalent to city) and Vereda (equivalent to parish) and population of Municipio related to the sub-project areas are as shown in the Tables 2.1.6 (Administrative Constitution of Project Area) and 2.1.2 (Population of Municipio related to the Sub-Project Areas).

Table 2.1.2 Population of Municipio related to the Sub-Project Areas

Municipio	Population (capita)			Population density (capital per km <sup>2</sup> )
	1973	1983	1985	
Chiquiza (San pedro de Iguaque)	-	4,589	-	36 ('83)
Santa Sofia	3,868	5,192	3,401	47 ('85)
Caqueza	14,178	14,178	16,505	150 ('85)
Tibacuy	4,613	5,952	4,303	34 ('85)

Source '83 : Caja Agraria (Agrarian Bank)

'85 : Census '85

In the project area, soil of which mother material is weathered sedimented rock is dominated and soil of which mother material is volcanic ash exists partly. Both of soils are of good permeability and weak acidity.

Relatively low elevation area under condition of favorable geography and good water availability is occupied by farmers who hold a large scale of farms. On the contrary, small scale farmers are cultivating the areas where its elevation is normally high and geographical condition and water availability are not so good. Major crops in the area are home-consumption crops such as maize and so on and cash crops such as potato, vegetables and others.

Input of farming materials and equipment and output of agricultural production are transported through unpaved lateral roads connecting the sub-project areas and paved main roads which is leading to Bogota, the capital city of Colombia. Therefore, there seems to be no trouble in the condition of transportation. (refer to Table 2.1.4) However, lateral roads under less transportation are eroded due to steep slope of the project areas.

Regarding educational facilities, primary school has been established in each of every vereda, secondary school in each of every municipio and a national institute of agriculture has been set up in Santa Sofia.

As for the medical services, there is a medical clinic in Santa Sofia. In other areas, a system of the circuit medical doctors who give services once every ten days for a area is available.

Electric power is supplied to almost every farmer's house in spite of scattered form of the village in the project area.

Water supply and sewage system are not provided in the areas except a part of the urban areas.

Branch offices of government organization and agricultural institution established in the project areas and its vicinity are as shown in the Table 2.1.3 (Location of Branch Offices of Agricultural Institutions).

Table 2.1.3 Location of Branch Offices of Agricultural Institutions

Agricultural Institutions	San Pedro de Iguaque	Santa Sofia	Caqueza	Tibacuy
ICA	Tunja	-	Caqueza	-
Caja Agraria	Tunja, Villa de Leyva	Tunja Villa de Leyva	Caqueza	Fusagasuga
FEDECAFE	-	-	-	Fusagasuga

Table 2.1.4 Limits of Project Area

Sub-Project area	Limits
San Pedro de Iguaque	Carrizal, Corregidor, Llano Grande, Patiecitos, Monte Centro (Only the Zo. Moyet basin. The limits of southern part is as far as linkage line between Q. Chiquiza and a confluence of the Q. Yerbabuena and Q. Carrizal)
Santa Sofia	Sorcola (Only the Q. Piedras basin.) Guatoque Arriba, Guatoque Abajo, Agudelo Arriba, Agudelo Abajo, Hornillas, Durazno y Colorados (The limits of western highland is to 2,700 m in elevation)
Caqueza	Giron de Blancos (Southwestern area of the Cuchilla del Alto del Uvo) Moyas, Giron de Resguardo, El Carmen (As far as the Chorro del Carmen basin)
Tibacuy	San Jose, La Portada, Centro (Only the left side bank of Q. Boza), Chisque (Only the left side bank of Q. Boza), Municipio Sylvania (Only the Q. Sylvania basin and the higher basin of Sylvania-Tibacuy route. The limits of western highland is to 2,000 m in elevation.)

Note: Area's name (vereda) refers to Table 2.1.7.

Table 2.1.5 Location and Elevation of Project Area

Sub-project area	Departamento	Longitude-Latitude	Elevation (m)
San Pedro de Iguaque	Boyaca	5°36'N, 73°30'W	2,800 - 3,100
Santa Sofia	Boyaca	5°44'N, 73°35'W	2,200 - 2,400
Caqueza	Cundinamarca	4°25'N, 73°56'W	1,600 - 2,100
Tibacuy	Cundinamarca	4°20'N, 73°25'W	1,200 - 1,800

Table 2.1.6 Administrative Constitution of Project Area

Sub-project area	Departamento	Municipio	Vereda
San Pedro de Iguaque	Boyaca	Chiquiza	Carrizal, Corregidor, Iguaque Monte, Centro, Llano Grande, Patiecitos
Santa Sofia	Boyaca	Santa Sofia	Sorrocota, Guatoque Arriba, Guatoque Abajo, Agudelo Arriba, Agudelo Abajo, Hornillas, Durazno y Colorados
Caqueza	Cundinamarca	Caqueza	Giron de Blancos, Giron de Resguardo, El Carmen, Mayas
Tibacuy	Cundinamarca	Tibacuy	San Jose, La Portada, Centro, Chisque



Table 2.1.7 Access Road to the project Area

Sub-project area	Main road	Junction	Distance from junction to sub-project area	Pavement	Distance to nearest city
San Pedro de Iguaque	Tunja - Villa de Leyva	Cucaita	Approx. 19 Km	No	Approx. 34 Km to Tunja
Santa Sofia	"	Villa de Leyva	Approx. 15 Km	No	Approx. 48 Km to Tunja
Caqueza	Bogota - Caqueza	Caqueza bridge	Approx. 4 Km	No	Approx. 8 Km to Caqueza
Tibacuy	Bogota - Fusagasuga	Silvania	Approx. 10 Km	to Silvania Sanatorium	Approx. 11 Km to Fusagasuga

## 2.2 Meteorology and Hydrology

### 2.2.1 Meteorological Conditions

The project area is located in the Oriental mountain range of Andes region and is classified into the categories by climatic condition as shown in the Table 2.2.1 (Altitude and Climatic Conditions of the Sub-Project Areas).

Table 2.2.1 Altitude and Climatic Condition  
of the Sub-project Areas

Sub-project area	Altitude	Category
San Pedro de Iguaque	2,800 - 3,100	Cool or cold
Santa Sofia	2,200 - 2,400	Cool
Caqueza	1,600 - 2,100	Cool or mild
Tibacuy	1,200 - 1,800	Mild

#### (1) Meteorological stations

12 gauging stations are located in and around both sub-project areas of San Pedro de Iguaque and Santa Sofia in Dept. de Boyaca. On the other hand, four gauging stations are located around Caqueza. Tibacuy has only one gauging station which is managed by FEDECAFE.

Locations of each station are shown in Fig. 2.2.4-2.2.6 (Location of Meteorological Observation Stations) and their records obtained through the study are mentioned in Annex A, Table A.1.1 (Recorded Items of Each Observation Station).

After having examined these data, the data of the stations shown in the Table 2.2.2 (Meteorological Station) are used for the project formulation of each sub-project area.

Table 2.2.2 Meteorological Station

Item	San Pedro de de Iguaque	Santa Sofia	Caqueza	Tibacuy
Temperature	UPTC	Villa Carmen	HIMAT (data)	Tibacuy
Humidity	Villa de Leyva	Villa de Leyva	Villa de Leyva	Villa de Leyva
Evaporation	San Pedro de Iguaque	Santa Sofia	Villa de Leyva	Villa de Leyva
Wind	Villa Carmen	Santa Sofia	Villa de Carmen	Villa de Carmen
Sunshine duration	Villa de Leyva	Villa de Leyva	Chingaza Laguna	Tibacuy
Rainfall	Santa Sofia	Santa Sofia	Caqueza	Tibacuy

(2) Temperature

The mean annual temperature is affected by the elevation of the area and ranges from 12°C to 14°C in San Pedro de Iguaque and Santa Sofia, and from 19°C to 20°C in Caqueza and Tibacuy.

The average monthly temperature tends to become low from June up to August, and high from February up to April and October up to December. (refer to Fig. 2.2.1 Meteorology of Sub-Project Areas and Annex A, Table A.1.2 Temperature of Sub-Project Areas)

(3) Relative humidity

The average monthly relative humidity of the sub-project areas ranges from 69% to 88%, the average monthly relative humidity of three sub-projects except Caqueza tends to become low for the period from July to September, and high during this period in Caqueza. (refer to Fig. 2.2.1 Meteorology of Sub-Project Areas)

(4) Evaporation and sunshine duration

According to the record obtained from a gauging station at Villa de Leyva which is established in the vicinity of San Pedro de Iguaque and Santa Sofia, daily evaporation is assumed at the range from 3.0 mm/day to 4.3 mm/day. (refer to Fig. 2.2.1 Meteorology of Sub-Project Areas)

Average monthly sunshine duration of all sub-project areas is 2 hr/day to 6 hr/day. As shown in Fig. 2.2.3 (Monthly Mean Sunshine Hours), average monthly sun shine duration is recorded at lowest in June for Caqueza and in April and October for the rest of the areas.

(5) Rainfall

The average annual rainfall is indicated among 750 mm-1,120 mm. Regarding fluctuations of monthly rainfall in yearly basis, in San Pedro de Iguaque, Santa Sofia and Tibacuy, which are located on the western slope of the Oriental mountain range, the average monthly rainfall reaches at its peak in April to May and October to November (twice a year) as shown in Fig. 2.2.1 (Meteorology of Sub-Project Areas). In Caqueza which is located on the eastern slope of the Oriental mountain range, monthly rainfall reaches its peak in June (once a year).

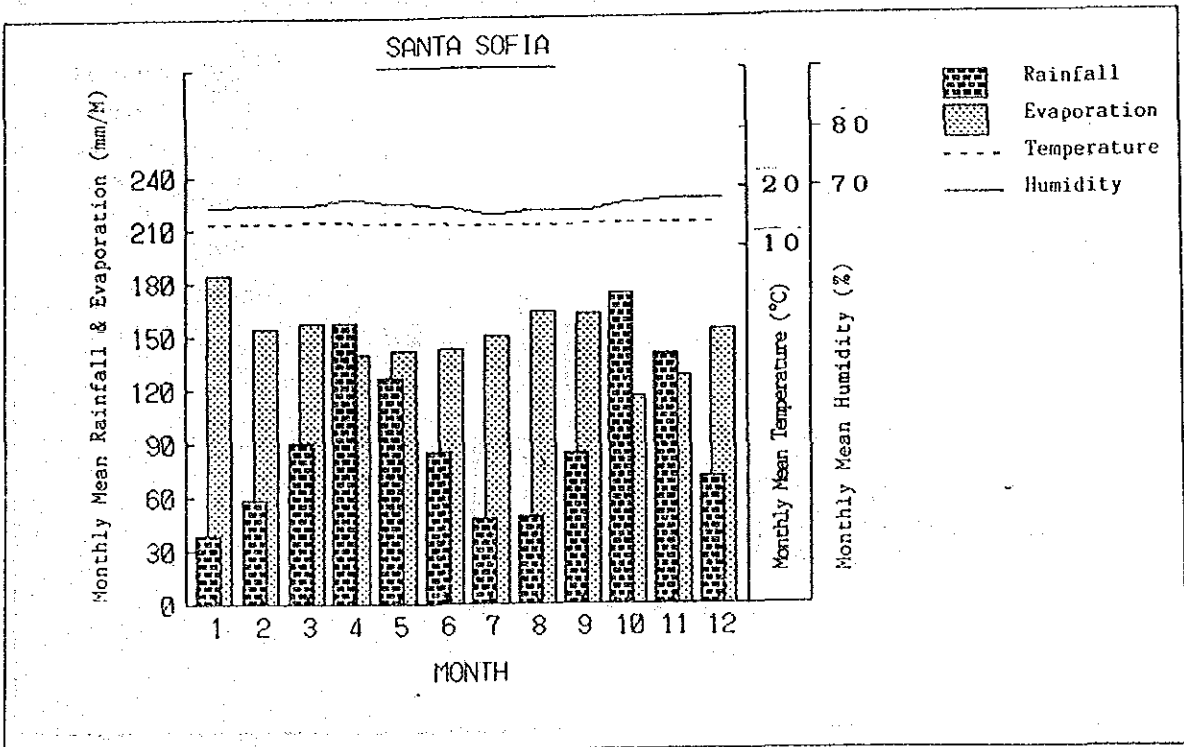
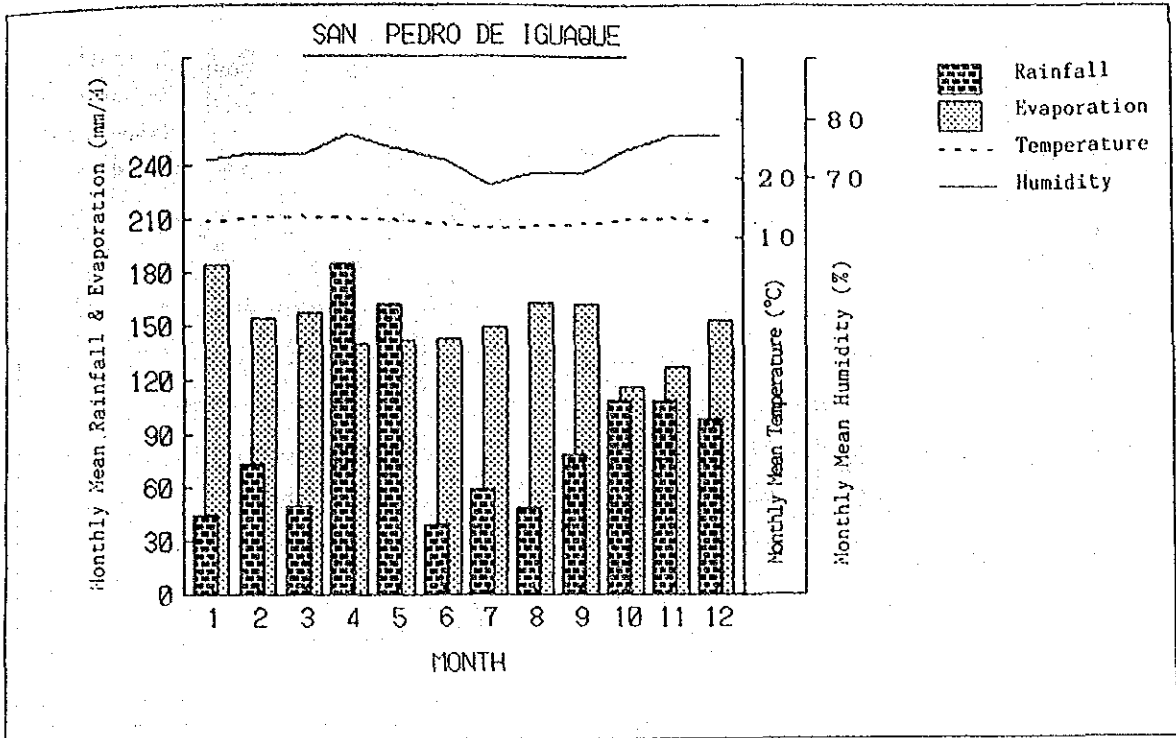


Fig. 2.2.1(1) Meteorology of Sub-Project Areas

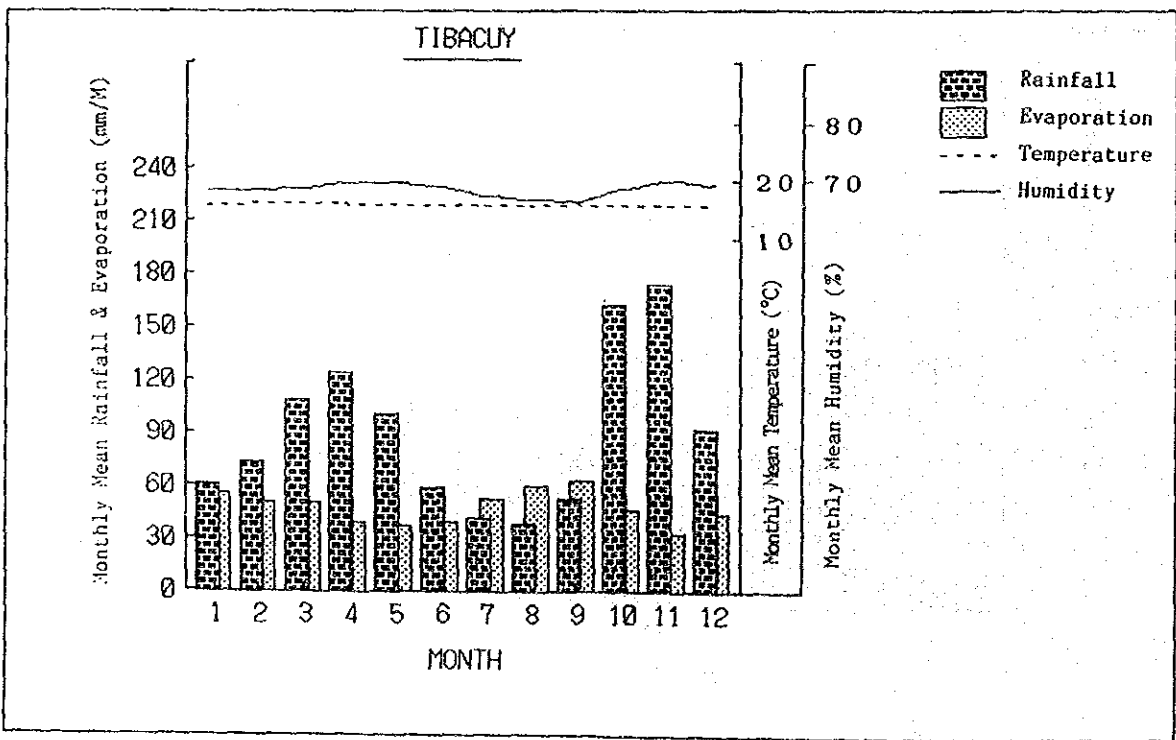
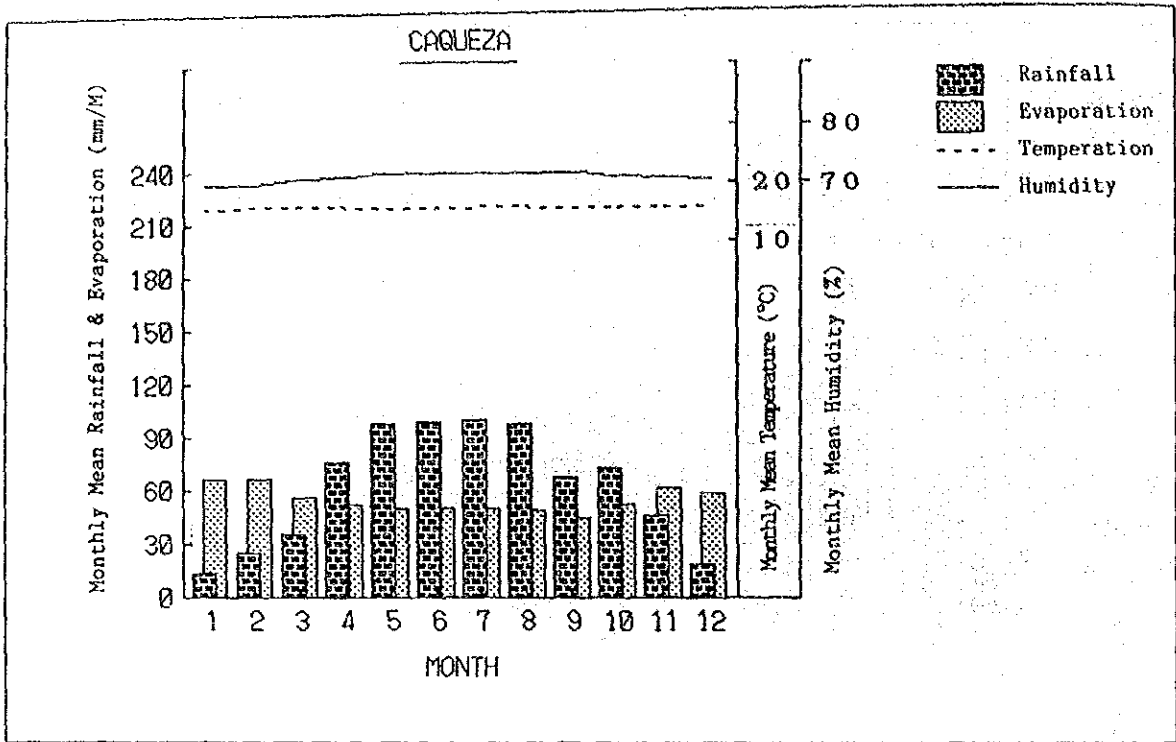


Fig. 2.2.1(2) Meteorology of Sub-Project Area

(6) Particular climate

1) Rainfall in droughty year

The probable rainfall (with non exceedance) in sub-project area as shown in the Table 2.2.3 (Probable Rainfall).

Annual precipitation of San Pedro de Iguaque, Santa Sofia and Tibacuy is 1,000-1,100 mm in normal year (Probability : 1/2) and approximately 900 mm in droughty year (Probability : 1/5), and on the other hand in Caqueza is assumed 76 mm and 680 mm, respectively. (refer to Fig. 2.2.2 Probability Density Curve of Annual Rainfall)

Table 2.2.3 Probable Rainfall

Unit: mm/year

Observation Point	Probable rainfall with non exceedance (mm)	
	1/2	1/5
San Pedro de Iguaque	1,020	890
Santa Sofia	1,120	980
Caqueza	720	680
Tibacuy	1,070	960

Note: Probable rainfall of San Pedro de Iguaque is calculated by using simulation data from the rainfall records of Santa Sofia during 1966-1980.

2) Rainfall in dry season

During dry season in droughty year, monthly rainfall recorded at the observation points are as shown in the Table 2.2.4 (Minimum Rainfall).

In all the sub-project areas, no rainfall month occurs in dry season.

Table 2.2.4 Minimum Rainfall

Observation Point		Minimum	Minimum	Minimum	Period of observation
		1st	2nd	3rd	
		mm/occurrence	mm/occurrence	mm/occurrence	
		year	year	year	
San Pedro de Iguaque					
	First half	0.0 (Jan.'83)	5.6 (Feb.'83)	20.0 (Jan.'81)	'81-'84
	Later half	3.2 (Sep.'83)	9.0 (Aug.'83)	10.2 (Jun.'84)	'81-'84
Santa Sofia					
	First half	0.0 (Feb.'73)	3.0 (Jan.'83)	5.0 (Jan.'75)	'66-'83
	Later half	2.0 (Jul.'69)	3.0 (Jul.'76)	3.0 (Aug.'82)	'66-'83
Caqueza	Throughout the year	0.0 (Jan.'57)	0.0 (Jan.'77)	0.0 (Jan.'81)	'57,'70-'84
Tibacuy					
	First half	5.8 (Jan.'75)	10.4 (Feb.'77)	12.7 (Jan.'66)	'56-'79
	Later half	4.0 (Jul.'76)	7.3 (Jun.'65)	7.3 (Jul.'69)	'56-'79

(Refer to Annex A, Table A.1.7 Monthly Precipitation)

3) Continuous no rainfall days

The continuous no rainfall days recorded at the observation points are shown in the Table 2.2.5 (Continuous No Rainfall Days).



There are cases that the continuous no-rainfall days extends to approximately 30 days in Santa Sofia and Tibacuy, and approximately 50 days in Caqueza. And there is no long term observation record in San Pedro de Iguaque, but it is assumed that the case of San Pedro de Iguaque is similar to the record in Santa Sofia due to near by Santa Sofia.

Table 2.2.5 Continuous No Rainfall Days

Observation point (Observation duration)	Longest 1st Days Occurrence date	Longest 2nd Days Occurrence date	Longest 3rd Days Occurrence date
Santa Sofia ( '66 - '83)	32 days Jan.2-Feb.2,'83	31 days Mar.12-Apr.11,'81 Jul.12-Aug.12,'79	31 days Mar.12-Apr.11,'81
Caqueza ( '70 - '84)	52 days Dec.2-Feb.16,'80	51 days Dec.19,'76- Feb.6,'77	48 days Dec.9,'78- Jan.25,'79
Tibacuy ( '62 - '81)	48 days Jul.12-Aug.18,'76	29 days Dec.4,'74- Jan.1,'75	27 days Dec.23,'76- Jan.18,'77

Note: Rainfall less than 1 mm is considered as no rainfall.

Although the above-mentioned record is observed in dry season, the rainfall distribution of coffee just before the flowering stage (April, May and October, November) is substantially affected to the coffee production for cultivation of coffee in the Tibacuy sub-project area. The continuous no rainfall days extends over to 10 days before the flowering stage of coffee, therefore, the irrigation effects for coffee production can be expected.

The longest : 19 days (1975 Apr.4 - Apr.22)  
 Second longest: 15 days (1977 Apr.7 - Apr.21)  
 Third longest : 13 days (1980 Nov.19 - Oct.31)

## 2.2.2 Hydrology

### (1) Discharge of the related major river

In the related area to the sub-project areas, gauging stations are set up along the following rivers. No other gauging stations exist the streams running through the sub-project areas. (refer to Fig. 2.2.4-2.2.6 Location of Meteorological Observation Stations)

Moniquira River	: Watershed	1,116 km <sup>2</sup>
Une River	: Watershed	165 km <sup>2</sup>
Subia River	: Watershed	156 km <sup>2</sup>

Observation of river discharge have been conducted for the above-mentioned major rivers such as the Moniquira, Une and Subia river where the gauging stations are located. Observation results of the river discharge are as follows;

Average monthly discharge	Moniquira R.	Une R.	Subia R.
Maximum (m <sup>3</sup> /sec)	55.1	17.7	11.5
Minimum (m <sup>3</sup> /sec)	1.3	0.2	0.1
Average (m <sup>3</sup> /sec)	11.7	4.7	3.1

Note: Observation duration are as follows:

Moniquira River: 1975 - 1984

Une River : 1966 - 1984

Subia River : 1972 - 1984

(refer to Annex A, Table A.2.1-A.2.3 Monthly Discharge)

Furthermore, the annual discharge fluctuation is shown in Fig. 2.2.7 (Comparison between Estimated Discharge and Measured Discharge). As same as rainfall distribution, the rainy and dry seasons has been occurred twice a year at the Moniquira River and Subia River in the western slope of the Oriental mountain range. In the Une River which is located on the eastern slope of the mountain range, the rainy and dry seasons has been occurred once a year.

(2) The relevant river and their basin area

In each of the sub-project areas several streams flow, of which features are shown in the Table 2.2.6 (Feature of the Streams in the Project Area). The streams related to Santa Sofia and San Pedro de Iguaque converge together and turn into the Moniquira River. The streams relevant to the Caqueza and Tibacuy areas join the Caqueza River and the Chocho River respectively. (refer to Fig. 2.2.4-2.2.6 Location of Meteorological Observation Stations)

Table 2.2.6 Feature of the Streams in the Project Area

Name of Area	Quebrada (Streams)	Length (km)	Aver. Slope (%)	Basin Area (km <sup>2</sup> )
San Pedro de Iguaque	Yerbabuena	4.5	6.0	9.4
	Carrizal	6.5	5.2	10.9
	Soavita	4.4	13.9	7.7
Santa Sofia	Palonegro	4.3	16.9	3.9
	Bengala	4.7	17.4	3.3
	La Cruz	4.7	14.5	2.7
	Camelo	5.5	17.4	5.8
	Guatoque	3.0	13.8	16.6
Caqueza	Negra	4.1	18.3	3.3
Tibacuy	San Jose	4.8	18.9	8.3
	Boza	3.3	23.1	4.6

(3) Discharge observation of the streams

Discharge observation on streams flowing in the project areas was carried out from June to August 1986. The results are shown in the Figs. A.2.3 and A.2.4 (Observed Rainfall and Stream Discharge of Q. Yerbabuena and Santa Sofia) of Annex A. The low flow of the streams are estimated as shown in the Table 2.2.7 (Discharge of the Streams).

Table 2.2.7 Discharge of the Streams

Sub-project area	Quebrada (streams)	Discharge (1/s)	Drainage area (km <sup>2</sup> )	Unit discharge (1/s/km <sup>3</sup> )
San Pedro de Iguaque	Q. Yerbabuena	6.0	2.94	2.04
Santa Sofia	Q. La Cruz	2.0	0.83	2.4
	Q. Camelo	3.0	1.05	2.9
	Q. Palonegro	1.0	1.00	1.0
	Q. Guatoque	4.0	0.65	6.2

(4) Estimation of available stream discharge

No discharge observation records with long period on the streams flowing in the studied area are available. Therefore, stream discharges in the project areas are estimated using the discharge records of the river flow in the neighboring area observed for long period, and precipitation and stream discharge observed by HIMAT.

Estimation method is explained in Annex A.2.2 (Run-off Analysis). Discharge of the streams in San Pedro de Iguaque and Santa Sofia areas are estimated from the precipitation records applying the Multiple Regression Run-off model which is developed with the actual precipitation records and the discharge observed during the previous field study. Regarding the streams flowing in Caqueza and Tibacuy areas, the stream discharges are estimated by the discharge records (specific discharge) of the nearest river, Une (165 km<sup>2</sup> of drainage area) and Subia (156 km<sup>2</sup> of drainage area). The estimated low flow and mean flow during 10 years in each sub-project area are shown in the Table 2.2.8 (Estimated Discharge in Sub-Project Areas).

Table 2.2.8 Estimated Discharge in Sub-project Areas

(Unit: 1/sec/km<sup>2</sup>)

Area	Flow	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
San Pedro de Iguaque	Low	2.0	2.3	2.3	2.9	2.6	2.3	2.0	2.0	2.3	3.6	3.3	2.3
	Mean	2.2	3.0	3.1	4.0	3.8	3.2	2.7	2.5	3.1	4.4	3.8	2.9
Santa Sofia	Low	2.4	3.4	4.4	7.4	7.4	4.4	3.4	3.4	5.4	13.4	11.4	5.4
	Mean	4.6	9.3	9.7	16.4	14.9	10.3	7.6	5.7	9.7	18.9	15.3	8.8
Caqueza	Low	0.6	0.6	0.9	3.1	3.5	9.9	8.5	7.7	3.1	1.8	4.3	2.4
	Mean	4.0	3.9	5.1	11.1	17.2	24.2	22.6	20.3	15.0	13.5	12.1	7.4
Tibacuy	Low	2.7	2.0	2.9	9.7	6.1	5.8	2.6	1.7	1.3	6.4	12.1	11.8
	Mean	16.1	18.0	18.9	29.3	29.2	15.6	8.3	6.0	12.3	23.5	32.9	25.2

(refer to Annex A, Table A.2.6, A.2.7, A.2.9 and A.2.10 Unit Monthly Discharge)

Note: Lowest during 10 years for San Pedro de Iguaque and Santa Sofia areas.

Lowest during 19 years for Caqueza area.

Lowest during 13 years for Tibacuy area.

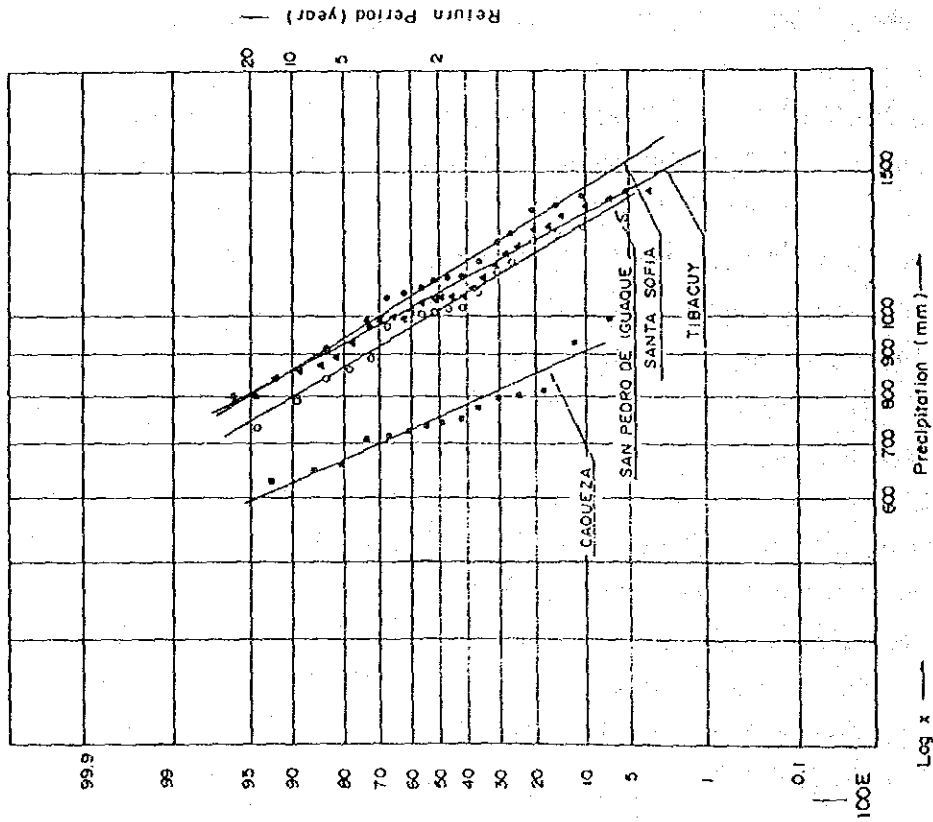


Fig. 2.2.2 Probability Density Curve of Annual Rainfall

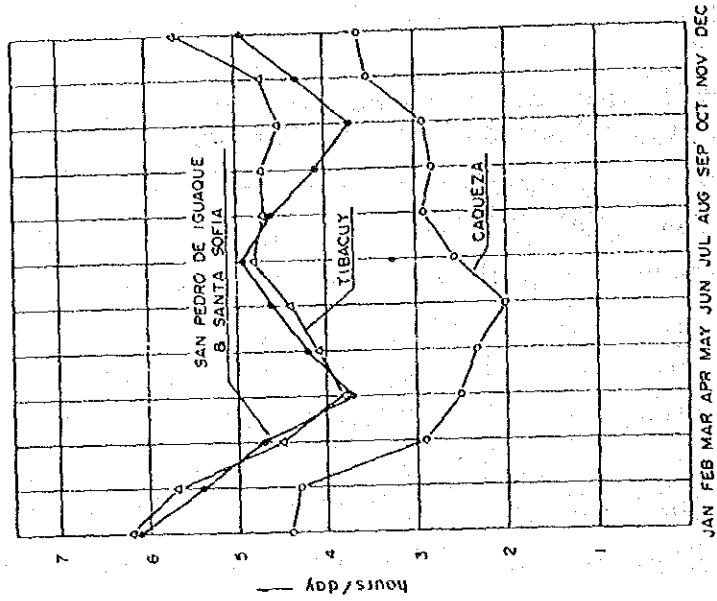


Fig. 2.2.3 Monthly Mean Sunshine Hours

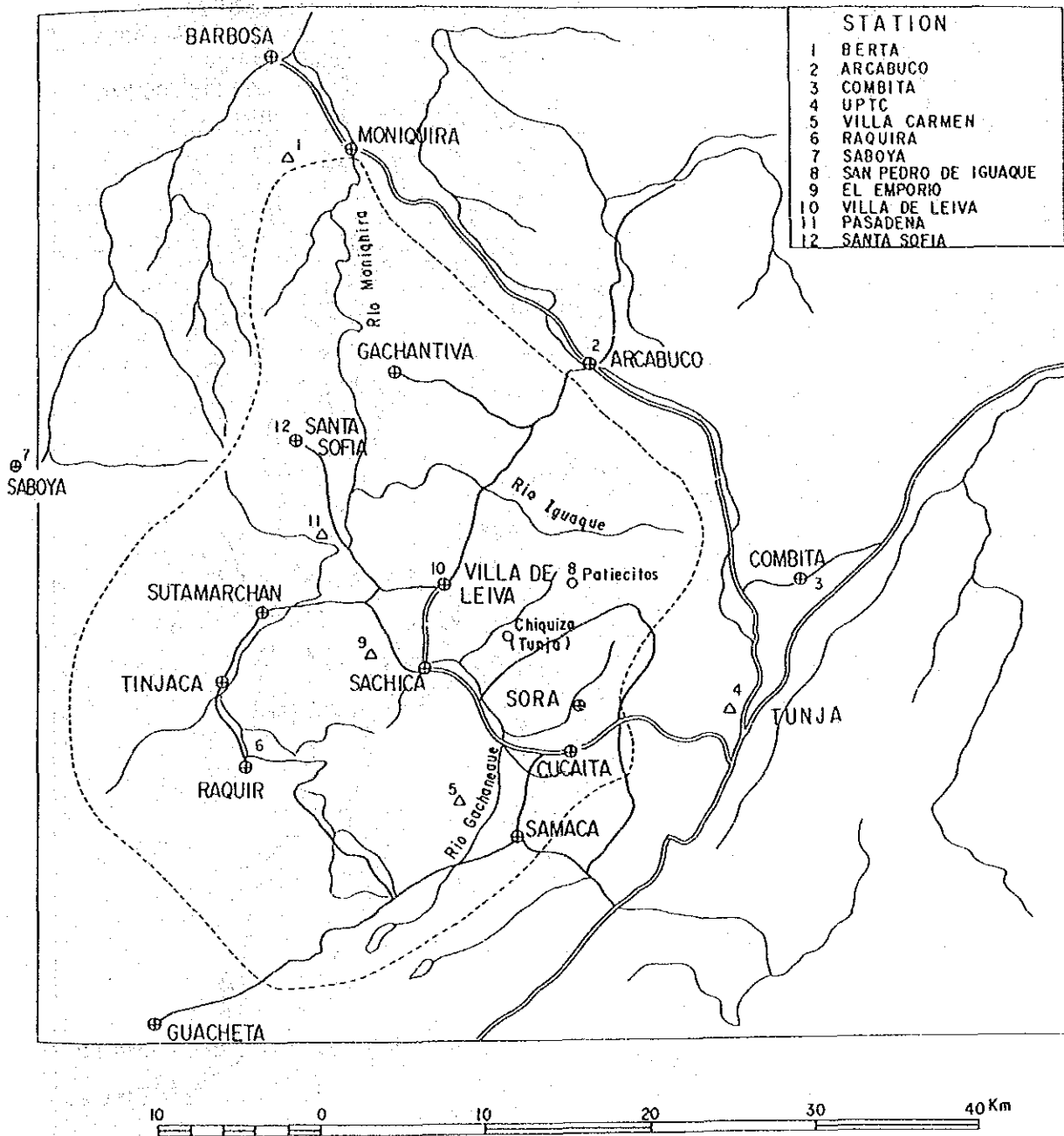


Fig.2.2.4 Locatio of Meteorological Observation Stations  
in San Pedro de Iguaque and Santa Sofia and their  
Neighboring Area

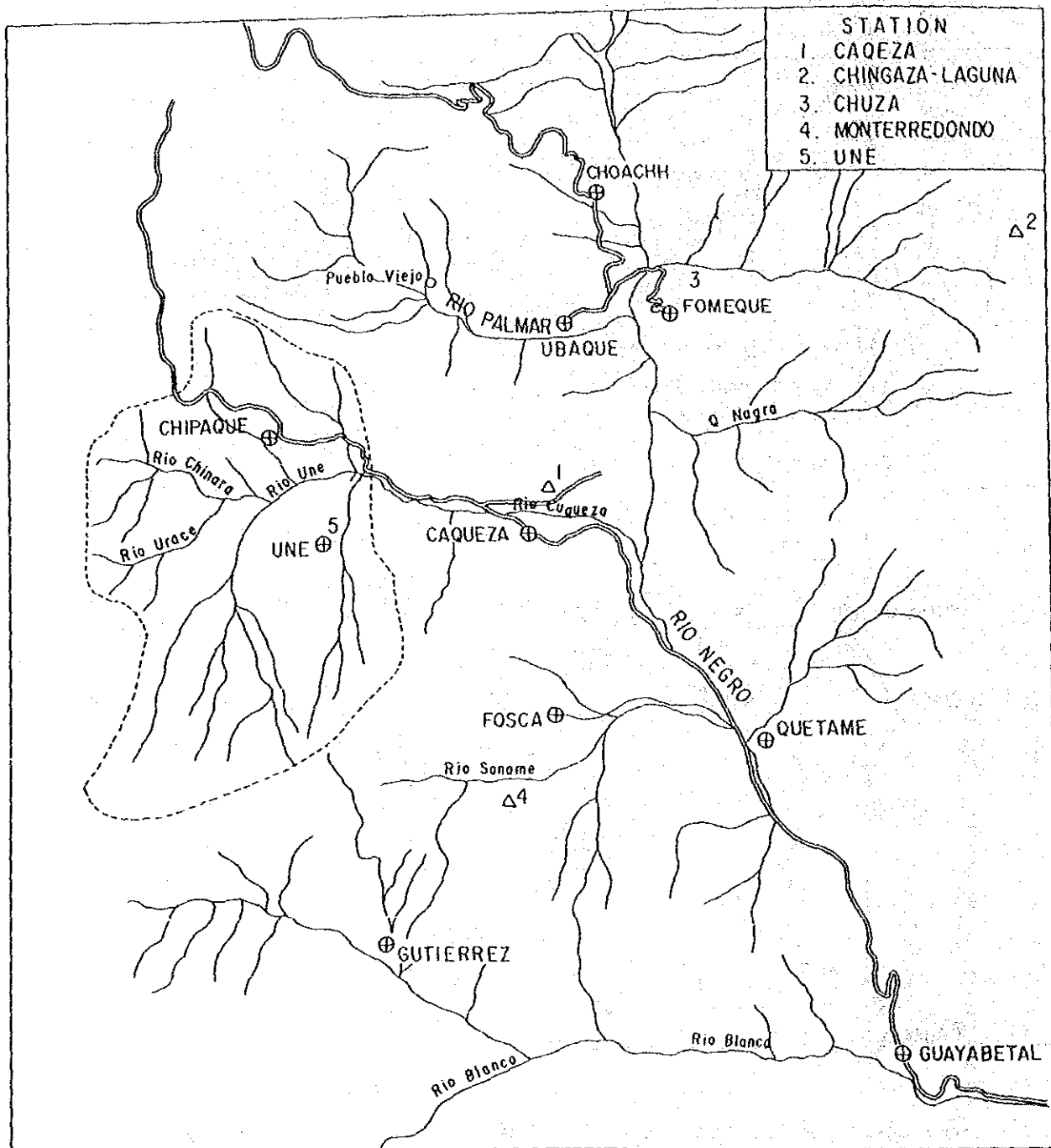


Fig.2.2.5 Location of Meteorological Observation Stations  
in Caqueza and its Neighboring Area



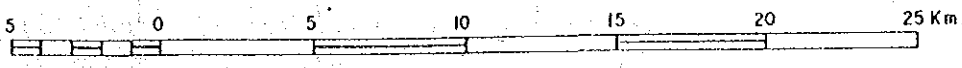
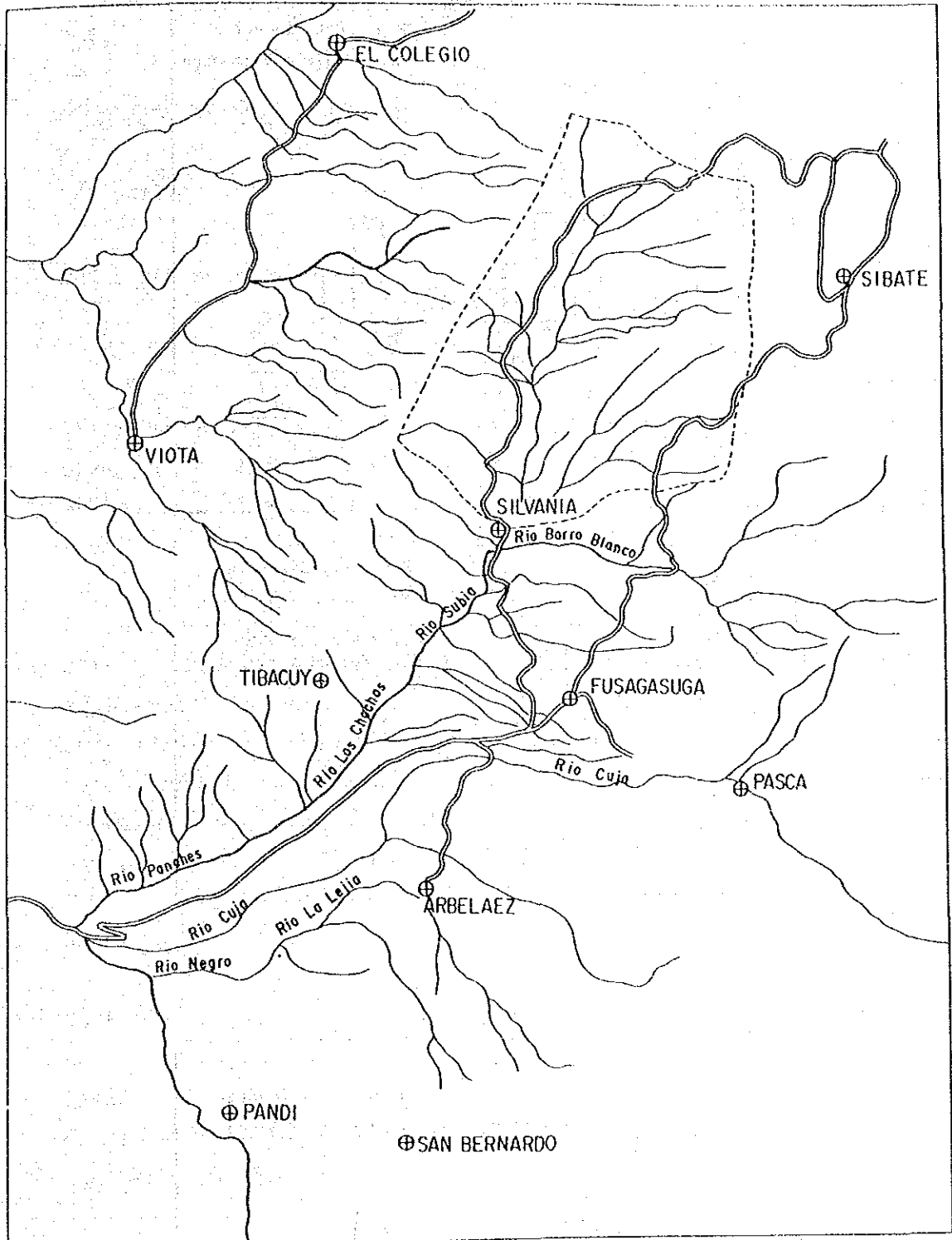


Fig. 2.2.6 Location of Meteorological Observation Stations in Tibacuy and Neighboring Area

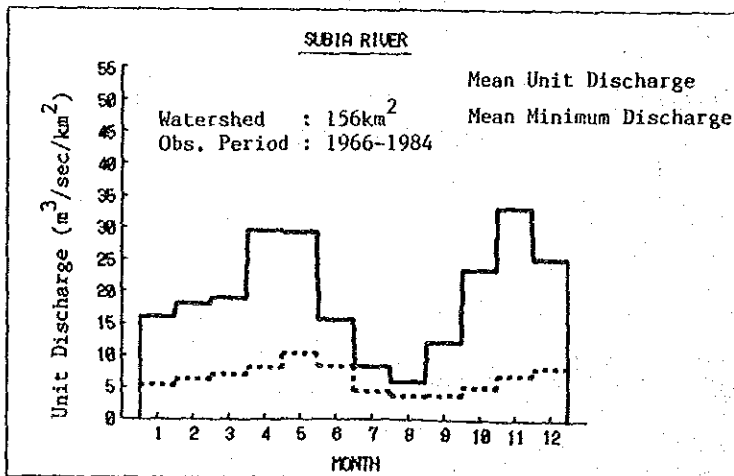
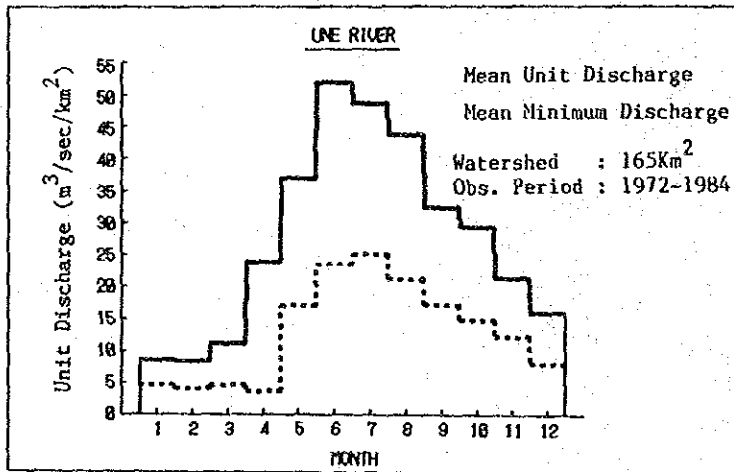
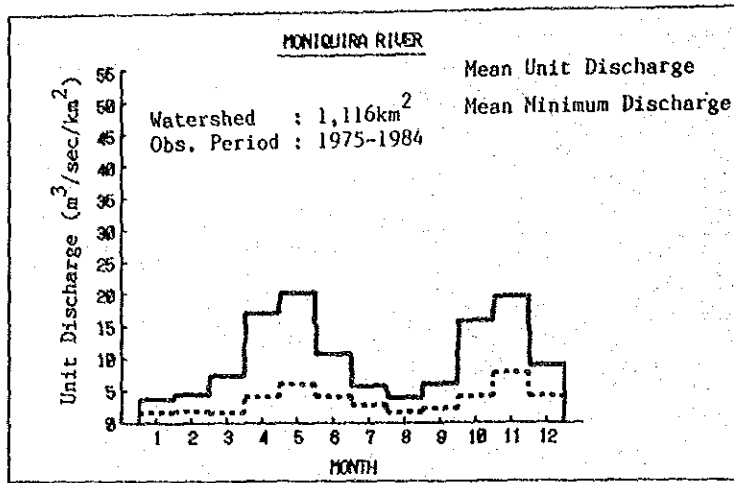


Fig. 2.2.7 Annual Discharge Fluctuation

## 2.3 Soil

### 2.3.1 Outline of Soil Condition

The soil conditions of the sub-project areas are described below.

#### (1) San Pedro de Iguaque

Soil of this sub-project area consists mainly of weathered shale and/or its re-sedimentation accompanied with clay and sand strata (Association CABRERA: CB). The soil texture is medium or fine grain size, the permeability is preferable, and depth of soil is as large as 100 cm at flat lands while it shallows out to 30-50 cm at slope area.

As for the chemical characteristics of top-soil, it varies from strong acid to weak acid with pH of 3.9 to 5.1. Its cation exchangeable capacity is very high and as a result its fertilizer retentivity is large, but on the other hand it contains few soil nourishment because of leaching effect. Humus, total nitrogen and available phosphorus are abundant. The soil fertility is medium to poor.

#### (2) Santa Sofia

Soil of this sub-project area consists mainly of weathered sedimentary rocks (mainly slate and shale) and their re-sedimentation (Association SAN ISIDRO: SI). The soil texture is medium to fine grain, and the permeability is preferable. The depth of solid is generally of 50 to 100 cm.

As for the chemical characteristics of top-soil, it is acid with pH of 4.6 to 6.5. Its cation exchangeable capacity is very high and its fertilizer retentivity is large, but on the other hand it contains few soil nourishment due to leaching effect. The contents of humus, and total nitrogen are high and available phosphorus is poor. The soil fertility is medium to poor.

(3) Caqueza

Soil of this sub-project area consists mainly of slope sediments comprising clay and silt (Association GIRON DE RESGUARDO; GR) and weathered sedimentary rock (mainly slate) (Association LLANO LARGO: LO). The former has fine grain soil texture and satisfactory permeability, and the soil depth is 50 to 100 cm. As for the chemical characteristics of top-soil, it is weakly acid to neutral with pH 5.8 to 6.7. Its cation exchangeable capacity and bases are high. It is classified in 5 soil phases by gradient. On the other hand, the latter type of soil has medium grain texture, and it has shallow soil depth in the order of 30 to 50 cm, because it is distributed on steep slope areas. As for the chemical characteristics of the top-soil, it is weakly acid with pH 5.3, and moreover it is a soil with low fertility, with small fertilizer retentivity and low soil nourishment.

(4) Tibacuy

Soil of this sub-project area is classified into three categories, namely soils consisting of volcanic ashes (Consociation EL CAPRICHIO), of weathered slates and sandstone (Association EL PLAN) and of clayey slope sediments (Consociation LA PORTADA, LA GRANJA, INCORA, BALSILLAS).

EL CAPRICHIO (CP): Its soil texture consists of coarse grains, its permeability is satisfactory, and its soil depth is in the order of 80 cm. As for the chemical characteristics of top-soil, it is weakly acid with pH 5.7, it contains much humus and has high fertilizer retentivity, but on the other hand, it is very poor in cations and available phosphorus, and consequently, the soil fertility as a whole is poor.

EL PLAN (PL): Its soil texture consists of fine grains, but its permeability is satisfactory. Its soil depth is approximately 50 cm. As for the chemical characteristics of top-soil, it is strongly acid with pH 4.7. This soil contains abundant humus and its

fertilizer retentivity is large. On the other hand, the base saturation is relatively high, and the soil fertility as a whole is medium.

LA PORTADA (LP): Its soil texture consists of fine grains, but its permeability is satisfactory. Its soil depth is in the order of 40 to 80 cm. As for the chemical characteristics, it is weakly acid with pH 5.3. This soil contains abundant humus, its cations are medium, and the base saturation is relatively high. The soil fertility is medium.

LA GRANJA (GN): Its soil texture consists of medium grains and fine grains, and its permeability is relatively good. Its soil depth is approximately 60 cm. As for the chemical characteristics of top-soil, it is weakly acid with pH 5.9. This soil contains abundant humus, its fertilizer retentivity is large and moreover its cations and base saturation are high. The soil fertility is high.

INCORA (IN): Its soil texture consists of fine grains, but permeability is relatively good. Its soil depth surpasses 100 cm. As for the chemical characteristics of top-soil, it is weakly acid with pH 6.0. This soil contains abundant humus, but its fertilizer retentivity, cations and base saturation are high. The soil fertility is high.

BALSILLAS (BL): Its soil texture consists of fine grains, but its permeability is satisfactory. Its soil depth is in the order of 50 to 100 cm. As for the chemical characteristics of top soil, it is weakly acid with pH 5.8. This soil contains few humus and its fertilizer retentivity is medium, but its base saturation is satisfactory. The soil fertility is medium.

### 2.3.2 Soil Distribution

The results of detailed classification according to the criteria of gradient, erosion extent and existences of rock outcrops which are adopted by the government of Colombia are shown in Table 2.3.1 (Soil

Distribution) and Figures 2.3.1 to 2.3.4 (Soil Distribution Map). The soil distribution in the sub-project areas is summarized as below;

- San Pedro de Iguaque

Soil in San Pedro de Iguaque has good conditions of gradient ( $1^{\circ}$ - $12^{\circ}$ ) covers 1,900 ha (51%). The extent of erosion is medium and over, of which area is 530 ha (15%). The rock outcrops are not found in this area.

- Santa Sofia

Soil in Santa Sofia has good conditions of gradient ( $7^{\circ}$ - $12^{\circ}$ ) covers 1,865 ha (48%). The extent of erosion is medium and over, of which area is 480 ha (12%). The existence of rock outcrop covers 340 ha (9%).

- Caqueza

The majority of this area is occupied by soil (GR) consisting of sediments in slope. Soil in Caqueza has good conditions of gradient ( $7^{\circ}$ - $12^{\circ}$ ) covers 515 ha (45%). The extent of erosion is medium and over, of which area is 115 ha (10%). The rock outcrops are not found in this area.

- Tibacuy

Soil of this area is classified in soils consisting of volcanic ashes (CP), of weathered slates and sandstone (PL), of which mother material is clayed slope sediments (LP, GN, IN, BL). The area is classified in 160 ha (13%) of CP, 275 ha (22%) of PL and 800 ha (65%) of LP, GN, IN, BL, etc. The extent of erosion is medium and over, of which area is 495 ha (40%) and rock outcrops are found in most of the area.

Table 2.3.1 Soil Distribution

San Pedro: de	soil	area(ha)	Santa Sofia:	soil	area(ha)
Iguaque	Cbab	305		SIc	240
	Cbbc	910		SIbc	640
	Cbc	85		SIcd	445
	Cbcd	600		SIcd1	200
	Cbde	480		SIcd1P	340
	Cbe	120		SIde	855
	Cbef	610		SIde2	90
	Cbef1	50		SIef	680
	Cbef2	220		SIef2	230
	Cbef3	310		SIef4	160
Total		3,690			3,880

Caqueza:	soil	area(ha)	Santa Sofia:	soil	area(ha)
	GRc	190		CPcdp	160
	GRcd	325		PLcd1p	190
	GRde	420		PLefip	85
	GRe	65		LPcd1p	215
	GRef2	115		GNbc1p	40
	LOef1	35		INc1p	10
				BLd1p	40
				Blef2P	495
Total		1,150			1,235

Note:

Suffix a - f : slope (%)    suffix 1 - 4 : erosion    suffix p : rock outcrop

a - 1	e - 25	1 - light
b - 3	f - 50	2 - moderate
c - 7		3 - strong
d - 12		4 - very strong

### 2.3.3 Land Classification

Land is classified according to the criteria adopted by the Soil Conservation Service of the U.S. Department of Agriculture, and the classification factors are soil texture, soil stratum depth, pH and topography (gradient and erosion). The classification criteria and the land classes are shown in Table 2.3.2 (Basis of Land Classification).

Figures 2.3.3 (Land Classification) and 2.3.5 to 2.3.8 (Land Classification Map) are land classification map and its classified area is shown in Table 2.3.3.

The proportion of land areas suited for farming amounts to 64% in San Pedro de Iguaque, 62% in the Santa Sofia, 81% in Caqueza and 53% in Tibacuy, the remaining areas are not favored land to cultivate the crops due to Class 3 to 4.



Table 2.3.2 Basis of Land Classification

Item	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
<b>1. SOIL</b>								
Soil Texture	L-LiC	L-LiC	CL-HC	CL-HC	CL-HC	CL-HC	CL-H	CL-HC
Depth of Soil (cm)	>150	>120	>90	>60	>60	>60	>30	>30
pH	5.5-7.0	5.0-7.0	4.5-7.5	4.5-7.5	4.0-8.0	4.0-8.0	4.0-8.0	4.0-8.0
<b>2. TOPOGRAPHY</b>								
Slope (%)	1-3	3-7	3-7-12	7-12-25	7-12-25	12-25-50	25-50-	25-50-
	Non	Non	Non or Light	Non or Light	Non or Light	Light or Moderate	Moderate or Strong	Strong

Note: Class 1: Highly suitable for cropping  
 Class 2: Moderately suitable for cropping  
 Class 3: Marginally suitable for cropping  
 Class 4: Limited arable and special use  
 Class 5: Not damaged by erosion, but susceptible of restrictions difficult to overcome when used for cropping (no land falling under this classification in the project area)  
 Class 6-8: Unsuitable for cropping

Table 2.3.3 Land Classification

unit: ha (%)

Land Class	San Pedro de Iguaque	Santa Sofia	Caqueza	Tibacuy	Total
Arable Land					
Class 1					
Class 2					
Class 3	1,300 (35)	880 (23)	190 (16)	50 (4)	2,420 (24)
Class 4	1,080 (29)	1,500 (39)	745 (65)	605 (49)	3,930 (39)
Sub Total	2,380 (64)	2,380 (62)	935 (81)	655 (53)	6,350 (63)
Non-Arable Land					
Class 6	780 (21)	1,020 (26)	100 (9)	85 (7)	1,985 (20)
Class 7	220 (6)	320 (8)	115 (10)	495 (40)	1,150 (12)
Class 8	310 (9)	160 (4)	-	-	470 (5)
Sub Total	1,310 (36)	1,500 (38)	215 (19)	580 (47)	3,605 (37)
Total	3,690(100)	3,880(100)	1,150(100)	1,235(100)	9,955(100)

Table 2.3.4 Arable Land Classification by Basin

AREA	Basin	Arable land (ha)			Total
		Class 3	Class 4	Class 6	
San Pedro de Iguaque	Carrizal	108	92	-	200
	Yerbabuena	114	46	-	160
Iguaque	Soavita	87	33	-	120
	Highland	371	333	-	704
	Sub Total	680	504	-	1,184
Santa Sofia	Palonegro	33	20	-	53
Sofia	Camelo	77	41	-	118
	La Laja	56	36	-	92
	Piedras	4	44	-	48
	Salitrillos	9	40	-	49
	Sub Total	179	181	-	360
Caqueza	Negra	34	290	-	324
	Blanca	35	75	-	110
	Carmen	5	150	-	155
	Sub Total	74	515	-	589
Tibacuy	San Jose	5	38	-	43
	(Coffee Plantation)	(25)	(147)	(65)	(237)
	Boza (Coffee Plantation)	-	(67)	-	(67)
	Sub Total	5 (25)	38 (214)	- (65)	43 (304)
TOTAL		938 (25)	1,238 (214)	- (65)	2,176 (304)

Note: 1) The basins of Q. Mamarita and Q. Los Robles are included in the basins of Q. Carrizal and Q. Yerbabuena respectively and the basins of Q. La Pila and Q. Moyeta are included in the basin of Q. Soavita. Elevation of the highland is 3,100 m or more.

2) The basins of Q. Bengala and Q. Bolivar are included in the basins of Q. Palonegro and the basins of Q. La Cruz and Q. Tambor are included in the basin of Q. Camelo.

3) The basins of Chorro de la Capellania and Chorro Seai are included in the basin of Chorro del Carmen.

## 2.4 Land Utilization and Road Network

### 2.4.1 Present Land Utilization

#### (1) Outline of land utilization

The project area is located in a farming zone comprising a large number of small scale farmers. They cultivate mainly home consumption crops (such as maize) as well as cash crops (such as potato and vegetables), but these crops are generally cultivated on higher and steeper places where both land and water supply conditions are relatively bad. On the other hand, lower places, where land is relatively flat and the conditions are better, are occupied by farmers called "Latifundio" (large-scale farmers).

Present land utilization, which was studied by aerial photographs and field investigation, is summarized in Table 2.4.1 (Present Land Utilization). The land utilization map is shown in Figures 2.4.1 to 2.4.4 (Land Utilization Map).

Grassland accounts for large proportion in each sub-project area (20%-47%). The sub-project areas of which accounts for large proportion of farmland are Caqueza (51%) and San Pedro de Iguaque (32%). Further, it accounts for 25% of coffee plantation in Tibacuy.

Table 2.4.1 Present Land Utilization Unit: ha (%)

Land Category	San Pedro				Total
	de Iguaque	Santa Sofia	Caqueza	Tibacuy	
Cultivated land	1,184 (32)	360 (9)	589 (51)	43 (3)	2,176
Grassland	741 (20)	1,833 (47)	294 (26)	333 (27)	3,201
Forest land	1,071 (29)	1,318 (34)	220 (19)	195 (16)	2,804
Waste land	580 (16)	250 (7)	- (-)	325 (26)*	1,155
Coffee plantation	- (-)	- (-)	- (-)	304 (25)	304
Others**	114 (3)	119 (3)	47 (4)	35 (3)	315
<b>Total</b>	<b>3,690(100)</b>	<b>3,880(100)</b>	<b>1,150(100)</b>	<b>1,235(100)</b>	<b>9,955</b>

Note: \* Including very small-scale cultivated land

\*\* Including roads, streams and housing lots

(2) Land Utilization in Sub-project areas

1) San Pedro de Iguaque

Most of the cultivated land and grassland of this sub-project area are scattered throughout the slopes and undulated areas as Loma Alta and Cuchilla Las Cruces, with altitudes surpassing 3,000 m. Eroded land spreads throughout the southern part of this sub-project area. Moreover, forests are preserved in the steep slopes along the streams.

The area with relatively flat topography, located in the lower course of Q. Yerbabuena which crosses approximately the center of this sub-project area, has relatively good water supply conditions, but actually most of the farmlands located therein are possessed by large-scale farmers.

2) Santa Sofia

The lower part of this sub-project area, located below approximately 2,500 m altitude, consists of grassland and farmland, except the eroded area adjacent to streams flowing down the area.

On the other hand, in the higher part with altitudes above approximately 2,500 m, the gradient becomes relatively steep, the land utilization pattern consists mainly of grassland used for stock raising, besides cultivated land is scattered here and there. In the western part of this sub-project area, there is cultivation of curuba.

3) Caqueza

This sub-project area consists of the Alto La Virgen highlands with altitudes surpassing 2,100 m, and the adjacent slope with conspicuous undulations. Residents of Alto La Virgen highland are engaged mainly in stock-raising and farming, and on the

other hand such crops as maize, vegetables, etc., are being cultivated by mini scale farmers in plateau-shaped small terraces scattered throughout the slope areas adjacent to the highland.

#### 4) Tibacuy

In this sub-project area, the land utilization pattern has distinct characteristics according to the altitude. At altitudes surpassing 1,800 m land utilization consists mainly of grasslands at altitudes ranging from 1,500 m to 1,800 m land utilization consists mainly of coffee plantations, and at altitudes under 1,500 m there are waste-lands, very small-scale farmland and grassland.

### 2.4.2 Road Networks in the Sub-project Area

#### (1) San Pedro de Iguaque

San Pedro de Iguaque sub-project area can be accessible from the neighboring cities and towns through unpaved road from Chiquiza or directly from Cucaita which located in midway of paved main road connecting Tunja and Villa de Leyva (refer to Table 2.1.7 Access Road to the Project Area).

As for the road networks in the sub-project area, there are a loop road running periphery of the area and short-cut roads across the area. These roads are unpaved and passable by light vehicles.

#### (2) Santa Sofia

Lateral road connecting Villa de Leyva and Moniquira is passing through the middle part of the sub-project area from south to north and is considered as main road for the area. These roads are unpaved.

In southern part of the sub-project area, from urban area of Santa

Sofia as a center, many roads are radiating in all direction. In northern part, many branch roads are connecting with the above-mentioned lateral road. These branch roads are unpaved and passable by vehicles.

(3) Caqueza

An access road to the sub-project area is branched off from vicinity of a bridge crossing Caqueza River and carrying a main road connecting Bogota and Caqueza. The access road is running through the middle part of the project area from south to north, crossing Alto La Virgen, the highest point of the project area and leading to Ubaque which is located in northern side of the project area. The road is a main road of the project area and connecting with some roads which are running along contour line of the area. These roads are all unpaved and passable by vehicles.

(4) Tibacuy

The middle part of the sub-project area is penetrated by the road connecting Silvania and Tibacuy (unpaved) which joins main road connecting Bogota and Fusagasuga (paved) at Silvania. A certain number of roads are branched off from the road connecting Silvania and Tibacuy and extended to higher part and lower part of the project area. The roads connecting Silvania and Tibacuy and Tibacuy (Puesto Saldo) and San Jose running through the project area are both trafficable by any type of vehicles. However, most of roads in the sub-project area are not passable by vehicles.

In all sub-project areas, route of the roads inside the project area are selected along the contour line as far as possible. However, some roads are laid out right angle to the contour line and are eroded to loss its function as road because such roads turn to the stream when rain falls. They are a farm road going east from urban area of Santa Sofia, a road going to northwest at its outlet from the urban area, a road connecting FEDECAFE office and San Jose in the Tibacuy sub-project area and so on.

# SAN PEDRO DE IGUAQUE

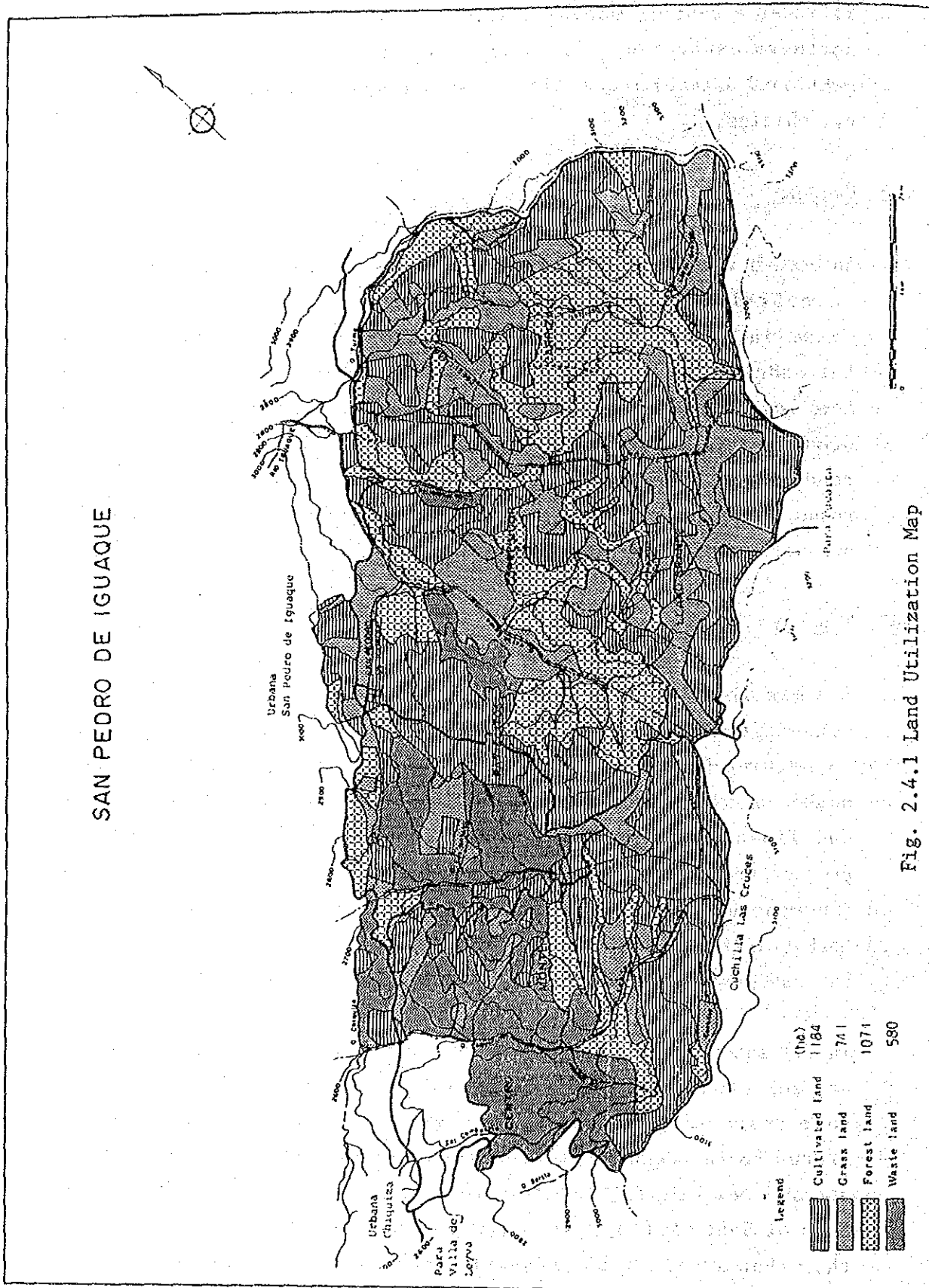


Fig. 2.4.1 Land Utilization Map





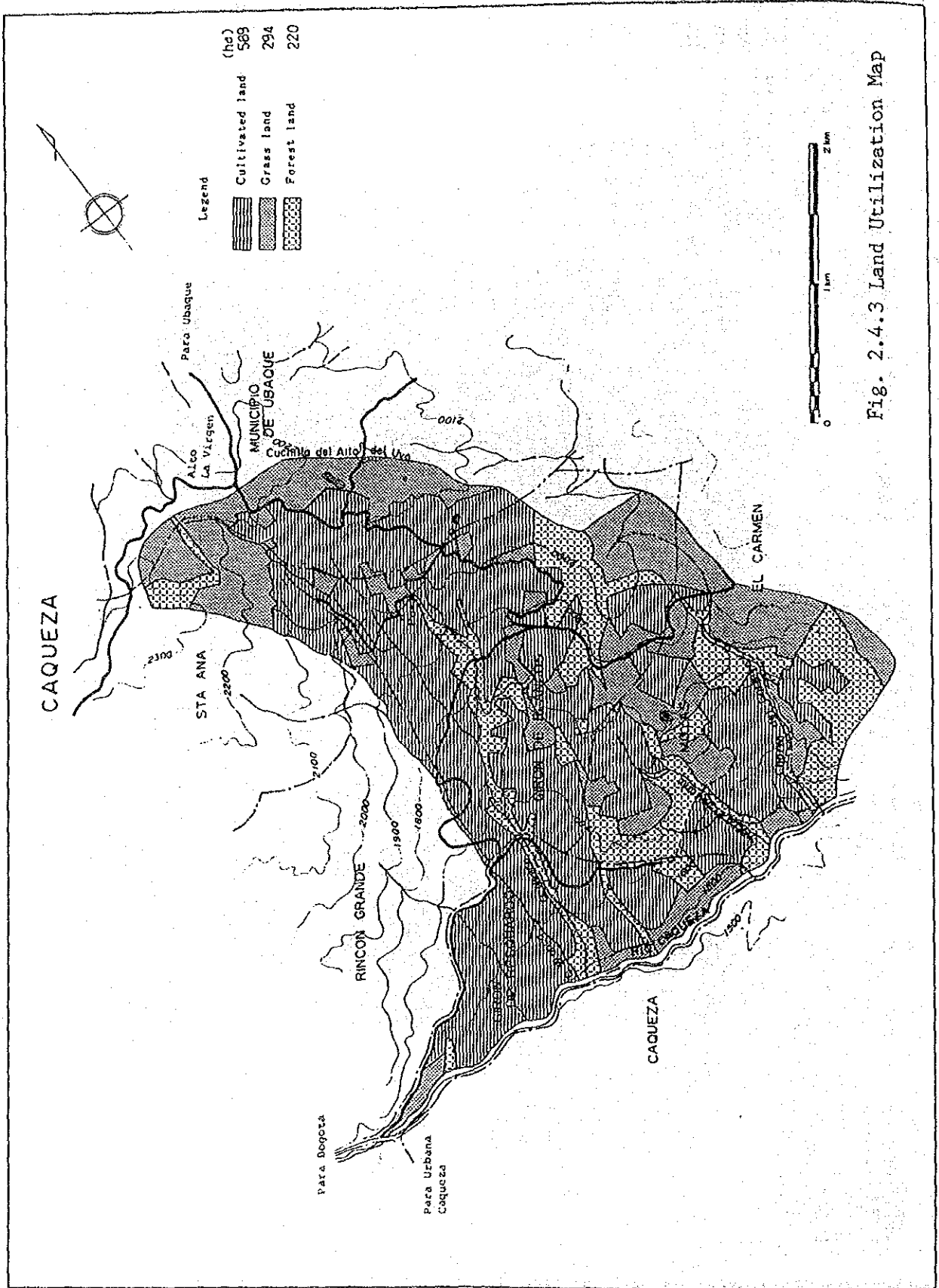


Fig. 2.4.3 Land Utilization Map

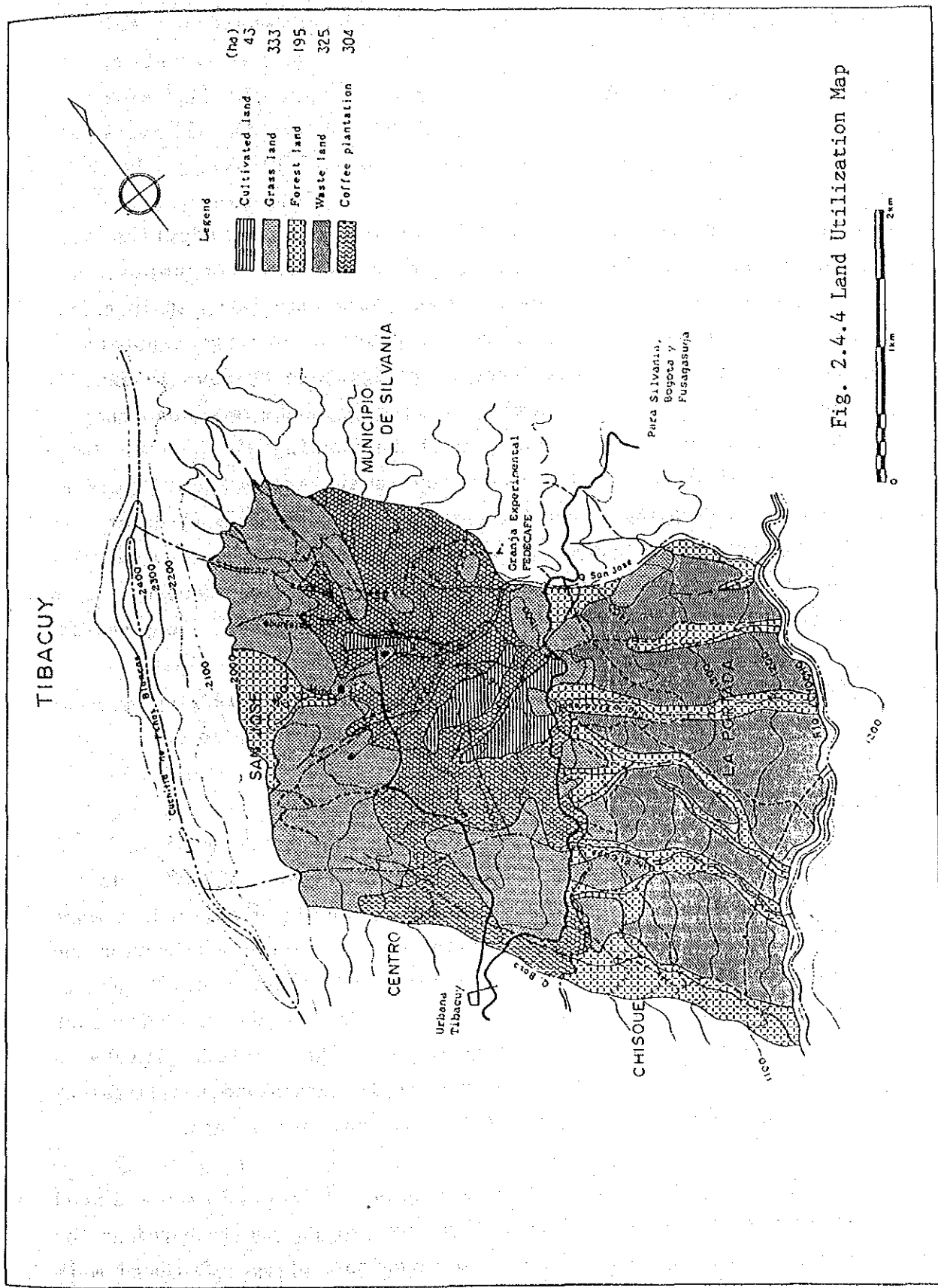


Fig. 2.4.4 Land Utilization Map

## 2.5 Agricultural Management

### 2.5.1 General Description

#### (1) San Pedro de Iguaque

This sub-project area has been known as a potato production area. Potato and wheat for cash crop and maize for home consumption are cultivated in the area. Many farmers show high interest in potato cultivation as a cash crop. Thus, double cropping of potato is common. In general, the first crop of potato is sown in June or July and harvested in December or January, and the second crop is sown in December or January with harvesting in June or July. Accordingly, the potato production is suffering from injury by continuous cropping. Therefore, introduction of other kinds of cash crop is contrived. Most of farmers desire to introduce vegetables as cash crop instead of at least one crop of potato. However, it is limited due to shortage of available irrigation water in dry season.

Cattles and sheep are the main livestock which are raising by year-round grazing or tether grazing for the home consumption.

#### (2) Santa Sofia

Cultivated land extends up to high altitude of around 2,700 m in the western part of this sub-project area. In the high land of more than 2,500 m in altitude, mixed type of agriculture with curuba and potato cultivation and livestock raising is conducted. Curuba is one of the most important cash crops. Potato and wheat for cash crop and maize for home consumption are also planted. Curuba is cultivated near the farmers' house and the grassland for livestock farming is located in periphery of these cultivated land.

Three to five heads of mainly cattles are raising, which are bred between local and dairy breed. They are grazing and tethered at the grassland and the cultivated land after harvesting. Produced milk is mainly consumed domestically.

The north-eastern part of Santa Sofia area is relatively high productive one because its altitude is low and soil condition is more fertile than the south-eastern part. In this sub-project area, maize and cassava (yuca) are cultivated mainly for home consumption, while vegetables such as potato (papa), wheat (trigo), sugar cane (cana de azucar), kidney bean (frijol) and green pea (arveja) are cultivated and supplied to the market as cash crops. The fruit growing in this area are plum (ciruela), peach (durazno), pear (pera) and apple (manzana). Coffee (cafe) is also cultivated, but in small scale of area. As for livestock, cattles are mainly raising same as in western part of the area, using the grassland under extensive management. The production is consumed for domestic use.

In the south-eastern part of the area, most of the land is desolated by erosion and the farmlands have serious problem of drought during dry season due to small water holding capacity of the soil compared with the other two areas, namely the western and north-eastern parts mentioned above. Presently, cultivated are maize and cassava for home consumption, and potato, wheat, broad bean, pea and onion for cash crops. Livestock production is minor due to lack of productive grassland.

Therefore, through the provision of the irrigation facilities in this area, the introduction of new crops and the stabilization of crop production are strongly expected.

### (3) Caqueza

Among all sub-project areas, this area has the lowest annual precipitation of 750 mm. Average farm size is small.

Maize is planted in large part of the farm land, but it is only for home consumption. For cash crops, cultivated are such vegetables as onion, tomato, kidney bean, snapbean (Habichuela) and pumpkin (ahuyama). Intercropping of maize, kidney bean and pumpkin is prevailing. The cultivation is mostly a single cropping during the

rainy season from April to December, and is rarely undertaken during dry season from January to March.

Some farmers conduct small scale irrigation farming by taking water from some streams and springs, mainly during drought period in the rainy season. However, irrigation farming in dry season is almost impossible due to water shortage. Therefore, their cropping pattern is also single cropping same as other farmers.

Livestock production is quite low because of small area of grassland. Most of farmers are raising one or two cattles each using the wasted vegetables and/or guatemala grass and elefante grass, etc. which are planted in the corner or boundary of the fields as small scale.

(4) Tibacuy

In this area, many kinds of crops are being cultivated including coffee with long cultivating history and other tropical tree crops under the moderate climate conditions due to the lowest altitude among the other areas.

Coffee is cultivated mainly in a low land where soil moisture content is relatively high, with average area per farmer of about one ha under poor farming technology. Recently, the international market price of coffee is raised. Therefore, more attention is paid to regeneration of coffee trees and introduction of new varieties of coffee for diversification in this area. However, the yield of coffee in this area is still depressed compared with other coffee production areas in Colombia.

Vegetables are mainly tomato, kidney bean and green pea. Main fruit trees in this area are cooking banana (platano), guava (guayaba), papaya, orange (naranja), guanabana and tree tomato (tomato de arbol), which are planted in the isolated small lot. Vegetables are planted year-round except dry season. The farmers in this area are generally in high commercial sense and showing strong interest in

market condition. However, cultivation of vegetable is limited due to water shortage during dry season.

Livestock farming is active in the upper and lower part of this area. In the upper part, livestock is carried out extensively by grazing in grassland, while in the lower part emphasis is put in dairy cattle raising.

### 2.5.2 Present Farming Conditions

Small scale farmers are prevailing in the sub-project areas and their surroundings.

Agriculture in the project area is undertaken by the small scale farmers. The results of the study on farm management example of the average farmer is shown in Table 2.5.1 (Present Farming Condition of the Average Farmer).

Farming area in San Pedro de Iguaque is 3.3 ha, of which 2.0 ha and 1.0 ha are used for field and grassland, respectively. Major crops in the field are potato, wheat and maize.

Area of farmland in Santa Sofia is 7.1 ha, which is larger scale than that of the other sub-project area. The total farmland area is consisted of 1.9 ha for field cropping and 5.0 ha for grassland which occupies most of the total area. Variety of crops is relatively diversified. They are maize, sugar cane, potato, cassava and vegetables.

Furthermore, in the higher area than in the project area, there are farmers who are cultivating curuba for cash crops.

In Caqueza, it is a specific feature that there are so many small scale farmers, of which average farmland is 1.3 ha. Most of the farmland except small scale of grassland (0.2 ha) is field, where vegetables and maize are mainly cultivated with single crop annually due to one rainy season in year round.

In Tibacuy, total farmland area is 6.7 ha, of which 4.3 ha, 1.3 ha and 0.6 ha are for grassland, coffee and field, respectively. Major cash crop is coffee. Vegetables (tomato and beans) are also cultivated in field.



Table 2.5.1 Present Farming Condition of the Average Farmer

Item	San Pedro de			
	Iguaque	Santa Sofia	Caqueza	Tibacuy
Member of Family	6	6	6	6
(No. of Farm Labor)	(4)	(3)	(3)	(3)
Farm Land (ha)				
Upland	2.0	1.9	1.1	0.6
Pasture	1.0	5.0	0.2	4.3
Orchard	-	0.1	-	0.3
Coffee	-	-	-	1.3
Others	0.3	0.1	-	0.2
Total	3.3	7.1	1.4	6.7
Planted Areas (ha)				
Potato	1.2	0.4	-	-
Maize	0.5	0.6	0.5	0.1
Wheat	0.5	0.1	-	-
Vegetables	-	0.2	0.6	0.6
Cassava	-	0.3	-	0.1
Sugarcane	-	0.5	-	0.2
Total	2.2	2.1	1.1	1.0
Animals (heads)				
Cattles	4	8	2	5
(including calf)	(2)	(4)	(1)	(3)
sheep	7	2	2	-
Pigs	2	2	-	-
Main Cash Crops				
	Potato, Wheat	Sugar cane, Potato, Wheat, Bean, Pea, Onion, Fruits	Snapbean, Onion, Tomato, Pumpkin, Bean, Pea	Coffee, Snapbean, Tomato, Fruits, Pea

### 2.5.3 Crops and Cultivation

#### (1) Crops

Crops cultivating in the sub-project areas and their surrounding areas are divided into home consumption use and cash crop, which are summarized as shown in the Table 2.5.2 (Cultivated Crops in the Sub-Project Areas).

Table 2.5.2 Cultivated Crops in the Sub-project Areas

Terms	San Pedro de Iguaque	Santa Sofia	Caqueza	Tibacuy
Cash crops	Potato, Wheat	Potato, Wheat Vegetables Curuba	Vegetables (onion, Tomato beans, etc.)	Coffee, Vegetables
Home consumption crops	Maize	Maize Cassava	Maize Cassava	Maize Cassava

#### (2) Cultivation

##### 1) Home consumption crops

Main crops for home consumption are maize and cassava.

- a) Maize: Maize of the conventional varieties is mostly being cultivated and neither new seed nor improved variety are introduced. The cooler is the climate, the longer is the growing period. 11 or 13 months are required in San Pedro de Iguaque, 9 or 11 months in Santa Sofia and 7 or 8 months in Caqueza.

area. To say generally, the sowing starts at onset of the rainy season avoiding dry season. The farm management is extensive. For example, weeding by hand is conducted only once during the growing period up to the harvest.

b) Cassava: Cassava is being cultivated in all sub-project areas and their surroundings except San Pedro de Iguaque. However, cassava is planted in the land with poor capability and cultivated under extensive farm management.

## 2) Cash crops

In the higher altitude areas with low temperature such as San Pedro de Iguaque and Santa Sofia, the main cash crop is potato, followed by wheat. In a part of Santa Sofia (mainly south-eastern part), Caqueza and Tibacuy with slightly moderate climate, cultivation of beans and vegetables are prevalent.

a) Potato: Parda Pastusa of local variety is dominated. New variety is scarcely introduced. Only a few farmers are trying to introduce the improved variety, despite potato is the most important cash crop in San Pedro de Iguaque. Planting of potato starts from January or February in dry season and harvesting is over in June or July, followed by the same cultivation schedule repeated in the rest of the year. Such planting in dry season tends to cause a delayed and erratic germination and lead to uneven growing and unstable production afterwards. Cultivation manner seems to be poor. For example, only two times of weedings by hand, insecticide and pesticide are applied throughout the growing period,

b) Wheat: The local variety is prevailing without any introduction of new variety. The sowing starts at the

beginning of the rainy season. Cultivation manner is so extensive as no weeding is conducted. The harvesting is often delayed because the harvesting period enters the next rainy season.

c) Beans: Among the various pulses, kidney bean is cultivated in many places. However, because of small scale of farm land, specially in Caqueza kidney beans are planted with maize as intercropping. Many local varieties of kidney bean are being cultivated and the seed is not renewed.

Secondary, green pea is popular in the moderate temperature zone such as a part of Santa Sofia and the whole area of Caqueza.

Currently, farmers intend to introduce snapbean in Tibacuy, Caqueza and a part of Santa Sofia. However, snapbean is not profitable in the market, because its cultivation is limited only during rainy season. More introduction of new varieties and more frequent application of chemicals are performed in cultivation of snapbeans compared with other kinds of beans. However, such chemicals are mixed with various chemicals which has same efficacy when spraying.

On this account, this can stand further improvement.

d) Onion: Onion production has been expanded after provision of irrigation system in Chiquiza. Therefore, farmers in this area desire to introduce irrigation facilities for onion cultivation. However, due to no irrigation facilities, cultivation of onion is currently limited only during rainy season. Although extension services of ICA are conducted, water shortage in drought period restricts the expansion of onion cultivation.

e) Tomato: Tomato is one of the most important cash crops and cultivated in Tibacuy and Caqueza, but limited during rainy season. At the onset of the rainy season, tomato is planted in stage basis in a small lot of farmland and cultivated with relatively intensive manners. Particularly, in some places, insecticide and pesticide is applied more than ten times. In many cases, various kinds of chemicals which has same efficacy are mixed for application.

f) Coffee: Coffee is cultivated in mainly Tibacuy. Though coffee cultivation has a long history, variety of coffee is started recently to renew. Therefore, there are so many old coffee trees and cultivation manners in application fertilizer and chemicals are extremely extensive.

#### 2.5.4 Cropping Pattern and Crop Yield

##### (1) Present Cropping Pattern

Based on information obtained through the field study, the present cropping patterns are summarized in Fig. 2.5.1 (Present Cropping Calendar).

##### (2) Yield of various crops

Based on information obtained through the field study, present yield of various crops are summarized in Table 2.5.3 (Yield of Crops). The table is set down with national and departmental level (Cundinamarca and Boyaca) on the basis of the statics of the Ministry of Agriculture.

According to the table, the yield of potato and wheat is slightly low, but the other crops are generally same level of it.

Table 2.5.3 Yield of Crops (Actual situation)

(ton/ha)

	Potato	Maize	Wheat	Onion	Kidney bean	Snap bean	Tomato
Present <u>1/</u> Yield	13	1.4	1.3	13	0.7	9	16
National <u>2/</u>	15	1.5	1.4	-	0.7	-	-
Departamento <u>2/</u> de Boyaca	14.5	1.2	2.0	-	0.7	-	-
Departamento <u>2/</u> de Cundinamarca	14	1.4	1.7	-	0.8	-	-

1/ : According to the interview carried out by the team and ICA Caja Agraria research.

2/ : According to "Anuario Estadísticas de Sector Agropecuario 1985.", Ministerio de Agricultura

According to the table, it is clear that the yield of each crop is lower than the results of the research carried out by ICA Caja Agraria, etc. The major causes of such low crop yield are unfavorable meteorological and land conditions, insufficient extension services, little amount of capital funds and so on.

Generally, though the climatic and topographic conditions are seriously affected to agricultural productivity, it seems that the improvement of productivity in the sub-project areas can be expected to the full through installation of irrigation facilities, guidance of farming technique, sufficiency of farming capital fund, etc. from point of view the results of progressive, innovative farmers and experimental station in and around the sub-project areas.

According to the document of Caja Agraria, the yield of crops under improved system of farming technique is as follows:

Porato	19.0 ton/ha
Maize	2.5 "
Wheat	2.3 "
Onion	20.0 "
Kidney bean	1.3 "

(3) Problems in Agricultural Production

Among the various conditions surrounding the agricultural production in the project areas, common conditions in the four sub-project areas are as follows:

- a) Intricate slope area
- b) Drought period in duration from January to March and from July to August. (refer to the paragraph 2.2.1 (6) 3)
- c) Cool climate in the area higher than E.L. 2,500 m. (average annual temperature is lower than 17°C)
- d) Distribution of acidic or slightly acidic loam and low water holding capacity of sandy loam.
- e) Many small scale farmers with less than 5 ha land holding.
- f) Deficiency in distribution system and necessity of transportation to the remote areas.

The low productivity of agriculture carried out under the above-mentioned conditions has been already stated. Furthermore, summary of these conditions are shown in Table 2.5.4 (Low Productivity Constraints).

Table 2.5.4 Low Productivity Constraints

Meteorological Condition	Rain fall	Average annual rainfall is low (750-1130 mm/year). Dry and rainy seasons are clearly divided. Those conditions restrict the cropping condition and make low productivity.
	Temperature	High altitude (1,200-3,100 m) causes cool temperature (12-19°C) and makes growing days longer.
Topography Land use Condition	Topography	Steep slope (17-20%) and land erosions. These constraints restrict the labor productivity and also the development of new irrigation system.
	Land use	Grassland covered by the soil containing boulders. It restricts the new farmland expansion.
Extension Services	Extension Services	Extension services by ICA, Caja Agraria and FEDECAFE, do not permeate among are not sufficiently disseminated farmers.
Farming Capital		Many subjects are remained as further extension services such as improving new plants, application as fertilizers and chemicals, grassland managements, and son on.  It's difficult to convert into intensive agriculture with the little capital stocks of the small scale farmers.



### 2.5.5 Livestock Farming

#### (1) Grassland

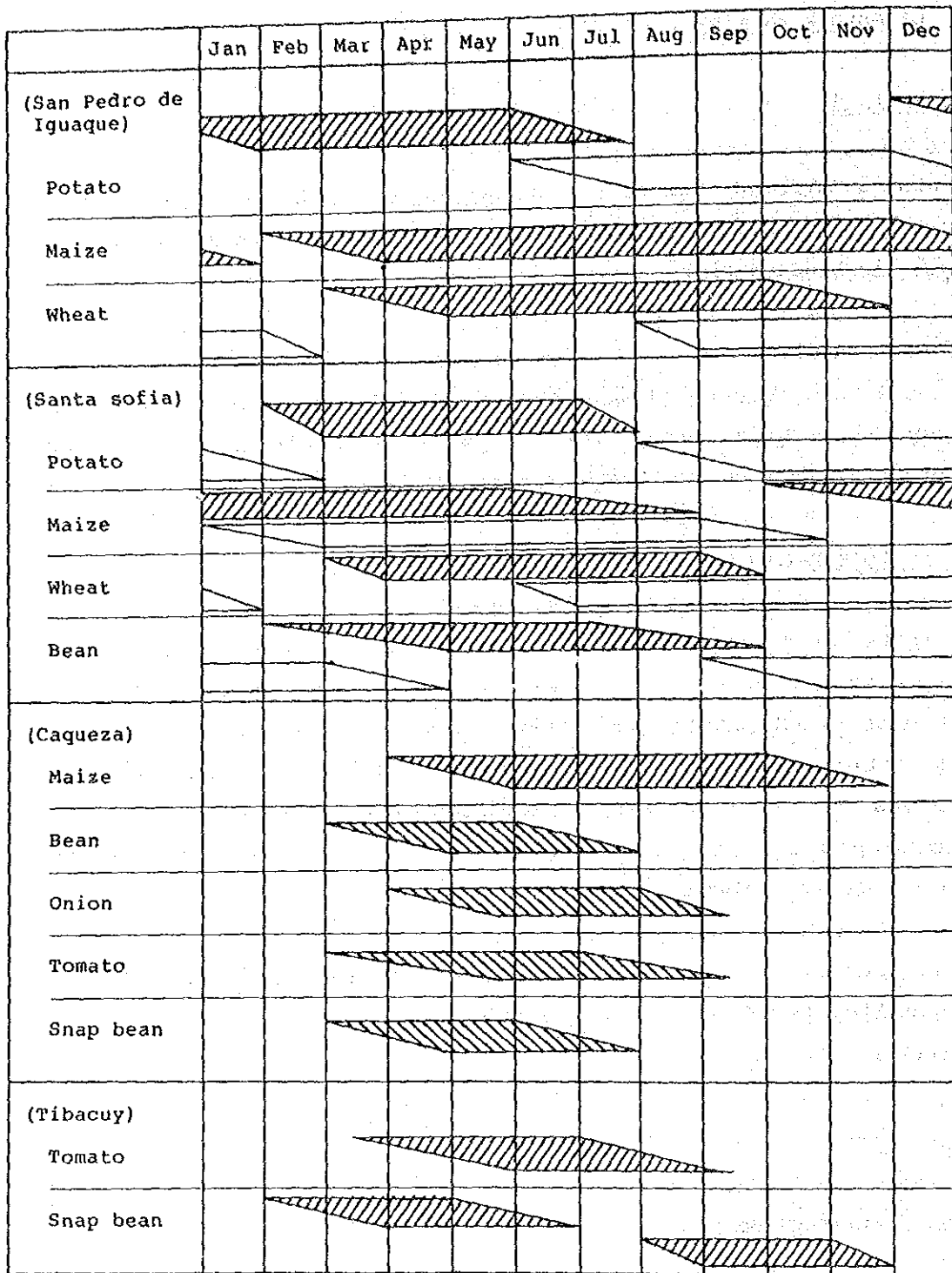
Total grassland area of the project area reaches up to 3,201 ha, which shares 32% of the whole area. (20% in San Pedro de Iguaque to 47% in Santa Sofia)

These grassland are mostly covered with Kikuyu grass. Some area of grassland contains gravel in its top soil and most of grassland is located in slope area. These conditions result in low grazing potential such as one head of animal per ha.

#### (2) Livestock Farming

Livestock farmings in all sub-project areas are for home consumption and have tendency to hold animal as assets. Therefore, livestock farming is not managed positively. Main animal in livestock farming is cattle, which is cross bred between local variety and Normando. Purpose of cattle raising is milk and meat production and draft works of farming equipment. All cattles are grazing in the grassland year round.

The productivity of this farming is low as; 1,000 Kg per head annually of milk production, approximately 30 months needed for stock raising to 400 Kg, etc.





 ----- Principal Period  
 ----- Occasion Period

Fig. 2.5.1 Present Cropping Calendar

## 2.6 Water Utilization

### 2.6.1 Present Condition of Water Utilization

Agriculture in all sub-project areas is carrying out under rain-fed. Almost no irrigation facility is provided in the project areas. Potable water for the villagers is taken from small streams, shallow well and rainfall. Present condition of water utilization in the project areas is as follows.

### 2.6.2 Water Utilization in each sub-project area

#### (1) San Pedro de Iguaque

##### 1) Water for agriculture

All cultivated land depends on rainfall. Among three streams flowing in the project area, the streams of Q. Carrizal and Q. Yerbabuena are partly used for raising livestock. Fish culture is also carrying out in upstream of Q. Yerbabuena. On the Q. Soavita, there are two intakes for Chiquiza and Sachica which are adjoining to the project area. Through these intake structures, irrigation water of 5 l/s and 6 l/s are taken for Chiquiza and Sachica area, respectively.

##### 2) Potable water

Approximately 60% of the farmers' houses (about 750 houses) in the project area are supplied potable water from stored rainfall in tanks or shallow wells. The remaining farmers' houses use stream water for drinking water through PVC pipelines which are connecting to the stream.

(2) Santa Sofia

1) Water for agriculture

All farmlands are cultivated under rain-fed. There are neither utilization of stream water nor stored facilities of rainfall.

2) Potable water

Stream water is used for the water supply in the urban area of Santa Sofia through small scale of diversion weirs which are constructed in upstream of the Q. EL Moral, Q. Palonegro and Q. La Cruz. In addition, the farmers use water from tanks where rainfall is stored and partly from streams.

However, the existing water right permitted by INDERENA are as follows.

Total intake water amount permitted

---

Q. La Laja	4.50 l/s
Q. Camelo	0.50 l/s
Q. El Moral	6.38 l/s
Q. Bengala	6.00 l/s

(3) Caqueza

1) Water for agriculture

All farmlands relies basically on rainfall. There is a shallow well in this area. Supplemental irrigation water in emergency for the neighboring farmland of 1.0 ha was taken from the shallow well by a pump with manual operation. However, currently the shallow well is out of use due to breakage of the pump.

Additionally, there exist four small scale of reservoirs (estimated storage capacities are 3,000 m<sup>3</sup> for No.1, 1,000 m<sup>3</sup> for No.2 900m<sup>3</sup> for No.3 and 300 m<sup>3</sup> for No.4) in high and intermediate parts of the area. These reservoirs are used only for raising livestock.

A few farmers take stream water for sprinkler irrigation in case of the ensuing no rain days during rainy season.

## 2) Potable water

Most of the farmers use water from stored rainfall and streams for potable water. Some of the farmers living in periphery of swamp area which is situated in eastern side of intermediate elevation area use spring water for drinking. Water of 2.4 l/s is taken from Q. Negra under permission of INDERENA.

## (4) Tibacuy

### 1) Water for agriculture

Cultivation in this area is mainly carried out under rain-fed. There are the existing four reservoirs (estimated stored capacities are 1,000 m<sup>3</sup> for No.1, 200 m<sup>3</sup> for No.2, 300 m<sup>3</sup> for No.4 300 m<sup>3</sup> for No.4) in higher part of San Jose. One of these reservoirs, of which capacity is 1,000 m<sup>3</sup> supplies irrigation water for the neighboring farmland of about 4.0 ha. However, there is leakage water from dam body due to poor construction. Other reservoirs are used mainly for raising livestock as well as domestic water of the neighboring farmers.

Some of the farmers take stream water for irrigation during dry season through a simple diversion weir constructed on Q. Boza.

## 2) Potable water

Potable water in San Jose is taken from many places of the streams including tributaries. Water of 10.3 l/s is taken from the streams under permission of INDERENA. The representative one among them is the simple water supply system in middle reach of Q. San Jose, which distribute the water to the farmers' house (159 houses) who cultivated coffee for domestic use. Rest of the farmers use rainfall water stored in tanks or stream water for drinking water.

Stream water of Q. San Jose is used also for washing coffee beans. The water used for washing is being wasted into the nearby streams. Therefore, the stream water downstream from there can not be used for drinking water without treatment because the downstream water is polluted with bacteria which arises from organic matter containing wasted water.

## 2.7 Agricultural Economy

### 2.7.1 Land Holding and Land Tenure

According to the cadaster, about 93% of farmers have less than two (2) plots of which about 78% of farmers have just one (1) plot and very few farmers hold farmland scattered.

Table 2.7.1 (Number of Farmer by Land Holding) shows the frequency distribution of farm households by land holding size. About 92% of the total farm householders own less than ten (10) ha, and it is nothing but occupy 55% of the whole areas. In San Pedro de Iguaque and Tibacuy sub-project areas, there are some big farm plots compared with other two sub-project areas. Livestock farming is generally conducting in their big farm plots.

Accordingly, the above fact shows that at present almost all of farmers in the project area operate less than 10 ha of land holding size; 3.0 ha in San Pedro de Iguaque, 2.4 ha in Santa Sofia, 1.4 ha in Caqueza and 2.0 ha in Tibacuy. (refer to Annex C, Table C.4.1 Number of Farmers and Hectarage of Farmland per Farm Size)

As for the situation of land tenure, almost all farmlands are possessed by land owner. Rate of ownership is summarized as follows; (refer to Annex C.8)

Municipio	%
Chiquiza	100
Santa Sofia	90
Caqueza	79
Tibacuy	88

Table 2.7.1 Number of Farmer by Land Holding

(Unit : No. of Families)

	Land Holding (ha)									Total
	0-1.0	2.1-3.0	5.1-7.5	10.1-20.0	50.1-					
	1.1-2.0	3.1-5.0	7.6-10.0	20.1-50.0						
San Pedro										
de Iguaque	193	177	118	136	101	53	88	38	17	921
(%)	(21)	(19)	(13)	(15)	(11)	(6)	(9)	(4)	(2)	(100)
Santa Sofia	683	474	272	328	170	79	78	29	3	2,116
(%)	(32)	(22)	(13)	(16)	(8)	(4)	(4)	(1)	(0)	(100)
Caqueza	430	138	83	52	27	8	22	3	0	763
(%)	(56)	(18)	(11)	(7)	(4)	(1)	(3)	(1)	(0)	(100)
Tibacuy	184	86	48	65	28	12	33	14	4	474
(%)	(39)	(18)	(10)	(14)	(6)	(2)	(7)	(3)	(1)	(100)
Total	1490	875	521	581	326	152	221	84	24	4,274
(%)	(35)	(20)	(12)	(13)	(8)	(4)	(5)	(2)	(1)	(100)

Note: Figures in the parenthesis show a portion for total family (farmer's house) in the sub-project areas.



## 2.7.2 Marketing

### (1) Crop production

The main crops produced in the project area are shipped to consuming area except maize and some kind of vegetable for home consumption.

Present productions of major crops in the project area are summarized as shown in the Table 2.7.2 (Main Crop Productions in the Sub-Project Areas and Its Surroundings).

Table 2.7.2 Main Crop Productions in the Sub-Project Areas and Its Surroundings

(Unit: ton)

Farm Products	San Pedro de Iguaque	Santa Sofia	Caqueza	Tibacuy	Total
Potato	1,356	780	-	52	2,188
Maize	53	67	334	11	465
Onion	-	-	532	-	532
Tomato	-	-	646	135	781
Snap Bean	-	-	342	104	446
Kidney Bean	-	65	230	18	313

### (2) Marketing channel

Destination of agricultural products which are produced in the project area is shown in the Table 2.7.3 (Destination of Agricultural Products).

There are following marketing centers around the project area of which the most important centers are Bogota D.E.

Table 2.7.3 Destination of Agricultural Products

Project Area	Market
San pedro de iguaque	: Bogota, Tunja, Bucaramanga
Santa Sofia	: Bogota, Tunja, Moniquira Chiquiquira
Caqueza	: Bogota, Caqueza, Villavicencio
Tibacuy	: Girardot, Ibague

Source) Farm Economic Survey

According to the investigation of DRI (Fondo de Desarrollo Rural Integrado), marketing channels of crops which are produced in and around the project areas is different depending upon their features.

In Tunja and its surrounding of Departamento de Boyaca, generally, they are dealing in form of traditional commercial behavior, such as collecting, storage, transport and wholesale business through shipping agencies, middle men and wholesalers.

In neighboring area of Municipio de Fusagasuga which is adjacent to Tibacuy, they also are dealing in form of the same commercial behavior, besides, direct dealings from middle men to retail store can be rarely found.

Agricultural products from the sub-project area to the markets are usually transported by bus, jeep or truck. Besides, there are some cases which wholesalers or middleman come and buy the agricultural products directly from farmers at farmgate.

### (3) Prices of agricultural products

The average wholesale prices of CORABASTOS in June 1986 is summarized as follows;

(refer to Annex C, Table C.3.1 Wholesale Prices of Farm Products in CORABASTOS)

The wholesale prices of agricultural products fluctuate widely and seasonally.

Seeing the tendency of past 5 years in wholesale price of main agricultural products, the price of potato reaches at 140% of annual average in May and decline to 75% in January.

Similarly, in case of kidney bean; 140% in June, 80% in January to March, and onion; 150% in August, 70% in April.

From these fluctuation, it is clear that the price of agricultural products is reasonably affected by the dealing volume. (refer to Annex C, Table C.5.5 Gross and Net Production Value of Farm Products in Pilot Area)

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	Potato	Kidney bean	Pea	Onion	Tomato
Wholesale price (Col.\$/kg)	31	288	152	42	47

---

#### (4) Prices of agricultural Inputs

Farmers usually purchase farm inputs such as fertilizer, chemicals, seeds and so on from Provision Agricola where is a distributing sector of Caja Agraria. The prices of farm inputs which are provided from Provision Agricola are set under Caja Agraria control. Besides, in the city around the project area, there are some private distributors of agricultural inputs and farmers can buy farm inputs at almost some price.

Retail prices of farm inputs dealt in Caja Agraria are shown in Annex C, Table 3.4 (Financial and Economic Prices of Farm Inputs).

(5) Processing and storage facilities

Except coffee producer in Tibacuy sub-project area, farmers in the project area cultivate potato or vegetables. They do not possess any processing and/or storage facilities. In result, agricultural products have to be shipped soon after harvesting, even if the prices fluctuate downward.

On the other hand, coffee producers themselves in Tibacuy sub-project area have drying yard and small size of pulper. Under farmer's level, washing, pulping and drying of coffee beans after harvesting are carried out by themselves.

2.7.3 Production Cost

Production costs of major crops which are produced in the project area are shown in Table 2.7.4 (Production Cost).

Table 2.7.4 Production Cost  
(Unit: 1,000 Col.\$/ha)

Crops	San Pedro de			
	Iguaque	Santa Sofia	Caqueza	Tibacuy
Potato	140	143	-	143
Maize	18	-	-	-
Wheat	20	21	-	-
Onion	-	-	110	-
Tomato	-	-	161	158
Pea	-	84	85	85
Kidney bean	-	44	44	43
Coffee	-	-	-	22

Note: Family labor force is excluded.

#### 2.7.4 Agricultural Household Economy

##### (1) Labor force for farming practices

Farming practices are carried out depending on man and animal power under slope condition in the project area. Besides, each sub-project area has two seasons such as dry and wet seasons. In fact, through dry season, farmers can't cultivate crops because of water shortage. As a result, this fact results in increase of surplus labor force.

Monthly labor balance for farming practices of average farmers (refer to Table 2.5.1 Farming Conditions of the Average Farmer) in each sub-project area is shown in Fig. 2.7.1 (Monthly Farm Labor Force). (refer to Annex C.4.4 Labor Requirements and Its Distribution)

Monthly working rate;

San Pedro de Iguaque	20-55%
Santa Sofia	25-40%
Caqueza	20-50%
Tibacuy	30-60%

##### (2) Income

Having the estimated of actual farm management balance for typical farmers is summarized in the Table 2.7.5 (Farm Management Balance).

The net income in Tibacuy sub-project area is estimated approximately 20,000 Co.\$/year, and other areas are 4,000-7,000 Col.\$/year.

The reason of which the income of farmer in Tibacuy is higher than the other areas is that they are mainly cultivated high profited crops such as coffee and vegetables due to the favorable location of economical or climatic conditions.

Table 2.7.5 Farm Management Balance

(Unit: 1,000 Col.\$)

Item	San Pedro de			
	Iguaque	Santa Sofia	Caqueza	Tibacuy
I. Gross Income	426	272	303	340
- Farm Income	316	122	303	340
- From livestock	110	150	-	-
II. Gross Outgo	420	268	296	320
- Farming expenses	210	65	93	80
- Living expenses	210	203	203	240
III. Net Income	6	4	7	20

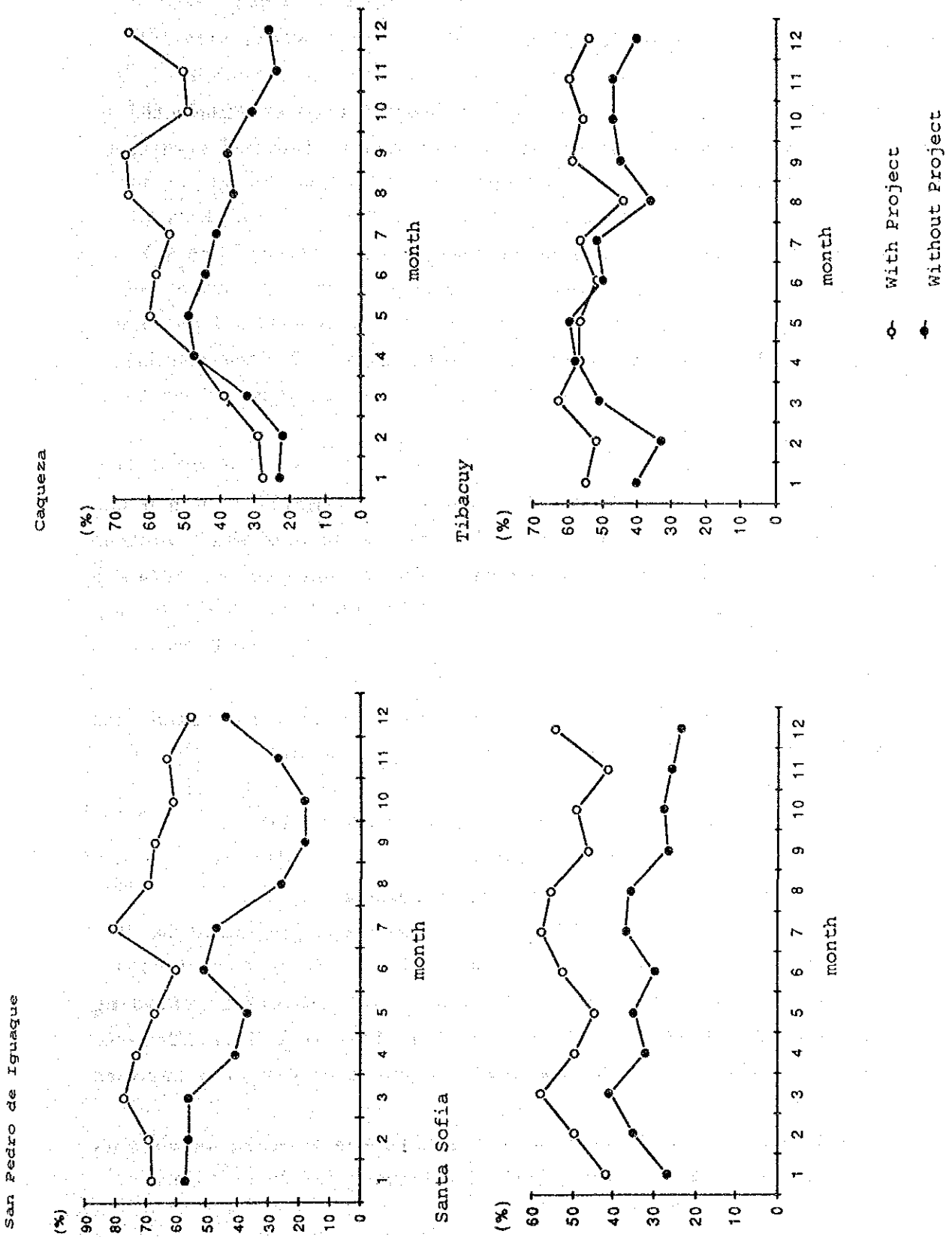


Fig.2.7.1 Monthly Farm Labor Force

## 2.8 Related Agricultural Institution

### 2.8.1 Agricultural Support Services

Agricultural support services in the project area are conducted in each sector of extension services, rural development, farmers' credit, by following institutions.

- i) ICA (Instituto Colombiano Agropecuario)
- ii) DRI (Fondo de Desarrollo Rural Integrado)
- iii) Caja Agraria
- iv) FEDECAFE (Federacion Nacional de Cafeteros)

#### (1) Extension Services

Extension services to general farmers in Colombia are conducted mainly by ICA. Besides, coffee producers receive extension services mainly from FEDECAFE. Extension services in the project area are summarized as follows;

-ICA-

The activities of ICA concerning extension services are summarized as follows:

- i) Variety tests and cultivation experiments
- ii) Extension of improved varieties
- iii) Extension of efficient farming techniques
- iv) Supporting concerned with rural development program of DRI

In general, each extension officer is responsible for providing agricultural extension services to farmers in 5 or 6 Municipios, so that each officer serves a group of farmers or directly farmers themselves.

Definite ICA's programs of activities to the farmers as well as extension services are summarized as follows;



- i) Extension of some agricultural informations by means of radio, newspaper, pamphlets and so on
- ii) Farm production Plans for credit applications
- iii) Campaigns for disease and insect control
- iv) Guidance of practical farming techniques in the farmer's plot

Municipio of Chiquiza and Caqueza are belonged to the target district for ICA's extension services, while Municipio of Santa Sofia and Tibacuy are not belonged to the target area at present. But, extension services to the farmers in Municipio of Santa Sofia will be launched from next year because Municipio of Santa Sofia is included with district of ICA. Furthermore, extension services of ICA are given priority to the target area for services of DRI.

If farmers request some services of ICA to some problems on farming practices, ICA conducts extension services to general farmers in a non-target area as well as target area of ICA. Furthermore, protection campaigns concerned with specific diseases or insects as non-periodic extension services have been conducted to whole farmers in each Municipio.

-DRI-

In order to improvement of living standards in rural area, DRI conducts activities concerned with promotion of agro-industries, rehabilitation of social infrastructure, establishment of farmer's group and so on.

At present, Municipios of Chiquiza and Caqueza are included with the target area of DRI's services. As a result, supporting services concerned with management of farmers' group as well as agricultural extension services have been carried out in both Municipios.

-FEDECAFE-

FEDECAFE has conducted following activities to the coffee producers in Municipio of Tibacuy.

- i) Distribution of Coffee seedling
- ii) Extension services (Guidance for farming practices, application of fertilizer and agro-chemicals and so on)

(2) Agricultural Credit

In the project area, the main sources of farm credit are Caja Agraria and FEDECAFE. Caja Agraria and FEDECAFE mainly finances some credits for increase of agricultural production and improvement of living standards of small farmers. Present condition of financing of Caja Agraria to general farmers in the four Municipios is shown in Annex C, Table C.6.2, Summarized Credit Condition: for annual crops; within one year of credit period, 18-23% of annual interest and for perturn crops; 1-4 years, 18-29%, respectively.

As mentioned in Annex C, members of credit of Caja Agraria in rural area of Municipios of Chiquiza and Santa Sofia are more than 60% as 1983, while, in Municipios of Caqueza and Tibacuy, less than 40%. In Tibacuy, FEDECAFE contributes to farm management through the financing to coffee producers. The credit condition of FEDECAFE is 22-24% of annaul interest in short period (within one year) and 20-22% in long period (6 years).

2.8.2 Farmer's Organization

In the project area, there exists following three farmer's organizations.

(1) Cooperative Agropecuaria Multiactiva de San Pedro de Iguaque

- Crop : Potato
- Area : Municipio of Chiquiza, Departamento de Boyaca
- Objectives: - Improvement of distribution channel
- Increase of living standard of potato farmers
- Diminishing of marketing cost

Summary : This farmers' group was established in 1981.  
At present, number of members are 126 farmers in 7 veredas concerned. Dealing volume of potato to the market is about 900 tons. Usually, middleman come and buy potatoes at farm gate.

(2) Cooperativa Multiactiva de Santa Sofia y Stamarchan

Crop : Curuba  
Area : Municipios of Santa Sofia and Stamarchan, Departamento de Boyaca

Objectives: - Diminishing of number of middle men  
- Increase of Curuba production

Summary : In 1976, this shipping cooperative of Curuba was established. At present, members are around 80 farmers.

(3) Cooperativa de Production y Mercade de Oriente Ltda

Crops : Vegetables (Onion, Tomato, Red Pepper, etc.)  
Area : Municipio Caqueza, Departamento de Cundinamarca  
Objectives: Stable supply of high quality vegetables to Bogota D.E.  
Summary : In 1981, this cooperative was established in order to stable supply of high quality vegetables to Bogota D.E., especially major supermarkets. At present, members are 38 farmers in 10 veredas concerned. Supply system of vegetables has not been operated sufficiently. In result, at present, improvement of cooperative management is conducting under supporting services of DRI.

## 2.9 Problems of the Project and Necessity of Development

The natural conditions of the project area are shown in Table 2.9.1 (Specific Features in Sub-Project Areas) and summarized below.

- Elevation of the project area is high.
- Slope of the area is steep.
- Soil is slightly acid.
- Temperature is low and cool.
- Sunshine hour is short.
- Climate is clearly divided into rainy season and dry season.

Under such conditions, the farmers are suffering from various problems in their farming management. Among the problems, the common problems of the four sub-project areas are pointed out as follows.

- Due to low temperature and lack of enough sunshine hour, growing period of the products (particularly of maize) is relatively long.
- Top soil of the farm is vulnerable to be eroded due to steep slope.
- Farm mechanization is difficult because of topographic conditions.
- No rainfall day continues for long period during dry season. Accordingly, crop cultivation during this season is impossible in case of no irrigation facilities.
- In this case, the price of agricultural productions is fluctuated depending upon the season.
- During dry season, excess labor force is produced.

### Others

- San Pedro de Iguaque sub-project area has disadvantage in shipment of agricultural production to the market compared with other sub-project areas because its location is far from the main roads.

- In Tibacuy sub-project area, coffee is planting. However, the international market price is quite variable.
- Coffee production in the Colombia has disadvantage in natural conditions compared with other coffee production countries. Fluctuation of the coffee price is affected directly to the coffee production farmers in this area.

The above-mentioned conditions press economy of the farmers in this area where agriculture is an exclusive industry, particularly small scale of farmers (farmers holding less than 10 ha of farm occupy 90% of total farmers in the project area). Therefore, taking necessary action to remove such constraints in urgent.

Among the possible countermeasures, priority is given to "assurance of irrigation water during dry season by provision of irrigation facilities". Through provisions of irrigation facilities, cropping intensity in the project area will be increased by irrigating during dry season, stable production can be secured even in drought year and employment opportunity in agriculture sector will be expanded in the project area during dry season.

Table 2.9.1 Specific Features in Sub-Project Areas

Item	San Pedro de Iguaque	Santa Sofia	Caqueza	Tibacuy
Location (Distance from Bogota)	135 km	165 km	44 km	60 km
Altitude	2,800-3,100 m	2,200-2,400 m	1,600-2,100 m	1,200-1,800 m
Climate	Cold or cool	Cool	Warm	Warm
Rainfall distribution	Rainy and dry season occurs twice a year	Rainy and dry season occurs twice a year	Rainy and dry season occurs once a year	Rainy and dry season occurs twice a year
Topography	Undulated hill	Undulated hill	Concaved slope	Concaved slope
Relation between water sources and benefited area				
Disatnce Head	3.5 km Low	1.0 km High	0.3-0.5 km High	0.3-0.5 km High
Quantities of water source	Not sufficient	Relatively large	Not sufficient	Relatively large
	Exist a place for reservoir		Exist a place for reservoir	
Farming area	3 ha	7 ha	1-1.5 ha	7 ha
Including ordinary cultivated land	2 ha	2 ha	1 ha	0.6 ha
Main crops (excluding home consumption crops)	Potato	Potato Curuba Beans	Vegetable Maize Beans	Coffee Vegetable Beans
Distance from main roads	19 km	Pass in the area	4 km	Pass in the area

### **CHAPTER 3. DEVELOPMENT SCHEME**





## CHAPTER 3. DEVELOPMENT SCHEME

### 3.1 Basic Policy on Project Formulation

In course of the project formulation, based on the purpose of the project, the following are taken into consideration.

- The project should be of appropriate scope and scale in order to be materialized as early as possible.
- The project should be of the least construction cost as possible using domestic construction materials and equipment, and utilizing excess labor force of the farmers.
- Under the project, water should be distributed to as many farmers as possible, particularly to the small scale farmers in the project area.
- It is desirable to construct the possible reservoirs in the project area in order to secure irrigation water during dry season. However, construction of reservoirs should be fully examined on their technical feasibility and economic viability because most of the project area have topographical constraints for construction of the reservoirs such as steep slope.  
And an introduction of high head pump shall not be considered in the irrigation systems owing to mount up the operation and maintenance cost.
- Though the water utilization plan of the Palmar river shall be considered as one of the water source of Caqueza sub-project area, its plan shall be left over in this project due to the tangle of problems on existing water right.

The sub-project areas have specific characteristics respectively in the conditions of elevation, climate, farming pattern, economic location, volume of water source, location between water source and benefited area, etc(refer to Table 2.9.1 Specific Features of Sub-

Project Areas). Therefore, this project will make a model of the small scale irrigation project in slope area which will be implemented in future.

(1) San Pedro de Iguaque

- The sub-project area is situated in high elevation, cool climate zone (cold climate zone in some places) and unfavorable conditions in view of economic location. (long distance from main road)
- Volume of water source is scarce.
- The distance between water source and benefited area is long, and the difference of their elevations is small. But it is possible to construct new reservoirs in carrizal and Yerbabuena system.

(2) Santa Sofia

- The sub-project area is situated in high elevation and cool climate zone.
- The water source has comparatively ample amount of water. The distance between water source and benefited area is short, and the difference of their elevations is large.
- No appropriate site for reservoir exists except Palonegro river basin.

(3) Caqueza

- The climate is warm and mild.
- The farming scale is extremely small. (1.3 ha/farm-household in average)
- Dry and rainy seasons occur once a year in each, but dry season extends over long period. (a specific features in eastern slope