

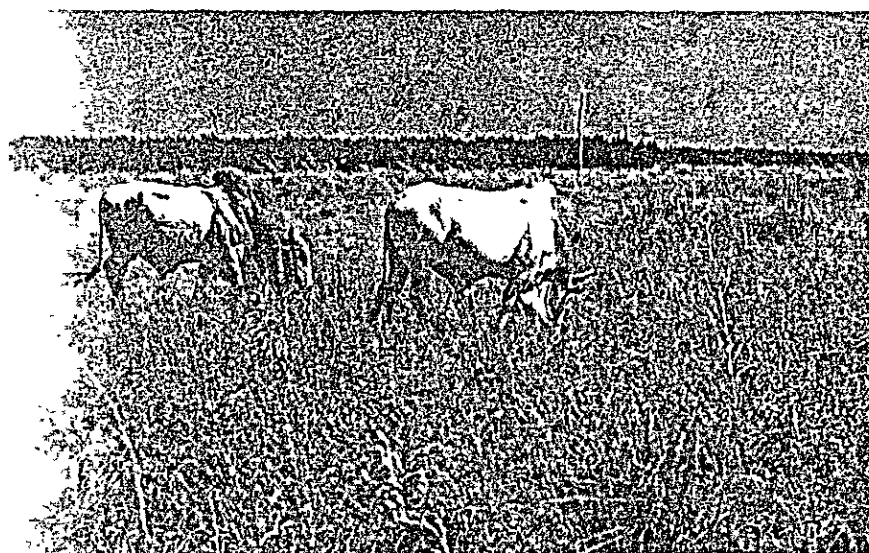
**THE REPUBLIC OF COLOMBIA**



**FEASIBILITY STUDY ON**


**AGRICULTURAL DEVELOPMENT PROJECT**

**FINAL REPORT MAIN**



**JUNE, 1984**

**JAPAN INTERNATIONAL COOPERATION AGENCY  
(JICA)**

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**THE REPUBLIC OF COLOMBIA**

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**FEASIBILITY STUDY ON**

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**THE PAMPLONITA RIVER BASIN**

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**AGRICULTURAL DEVELOPMENT PROJECT**

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**JUNE, 1984**

**JAPAN INTERNATIONAL COOPERATION AGENCY  
(JICA)**

国際協力事業団

|          |           |      |
|----------|-----------|------|
| 受入<br>月日 | '84. 8. 3 | 705  |
| 登録No.    | 10580     | 80.7 |
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## PREFACE

In response to the request of the Government of the Republic of Colombia, the Government of Japan decided to conduct a feasibility study on the Pamplonita River Basin Agricultural Development Project and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Colombia a survey team headed by Mr. K. Shiraishi from June 1983 to January 1984.

The team exchanged views on the project with the officials concerned of the Government of the Republic of Colombia and conducted a rainy-season survey and a dry-season survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Colombia for their close cooperation extended to the team.

June, 1984



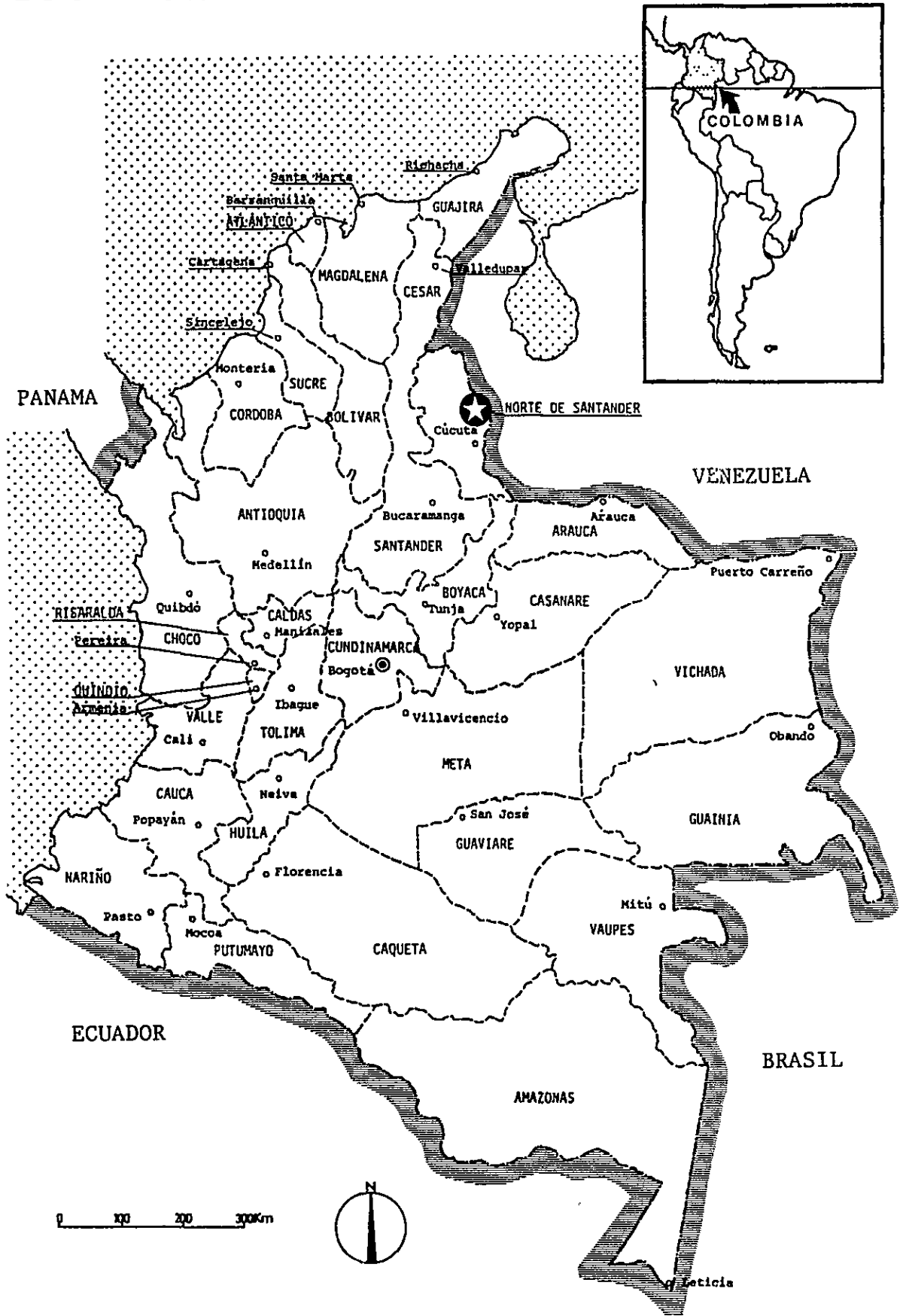
Keisuke Arita

President

Japan International Cooperation Agency

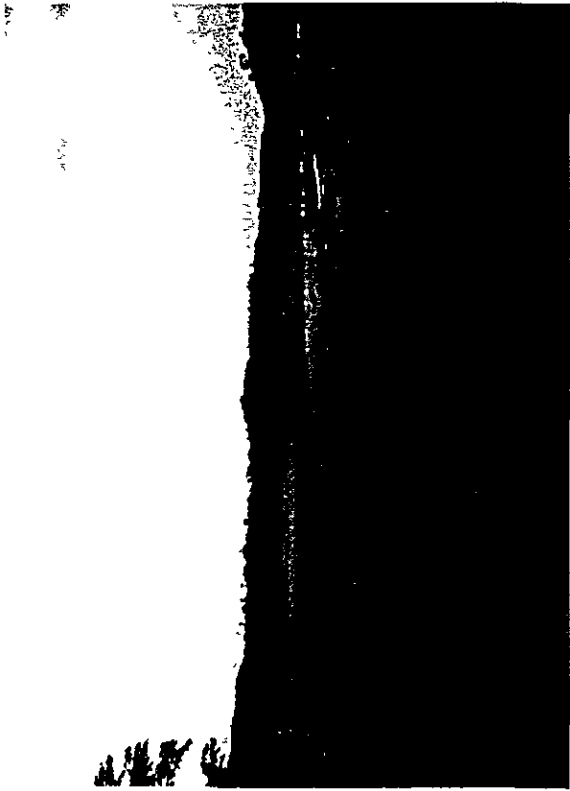


# LOCATION OF THE PROJECT









Distant View of the Study Area.  
計画地区遠望



Farmer's house in the Study Area.  
計画地区内農家（洪水対策用立床）



The Pamplonita River nearby Agua Clara  
計画地区内 Pamplonita 川（Agua Clara 附近）



The Guaramito River in the Study Area.  
計画地区内 Guaramito 川（左側コロンビア国、右側ベネズエラ国）





Soil Survey.  
土壤調查



New Gauging Station at Puerto Santander.  
新設測水所 ( Puerto Santander )



Cacao Beans (Drying in the sun).  
カカオ栽培農家 ( 天日乾燥 )



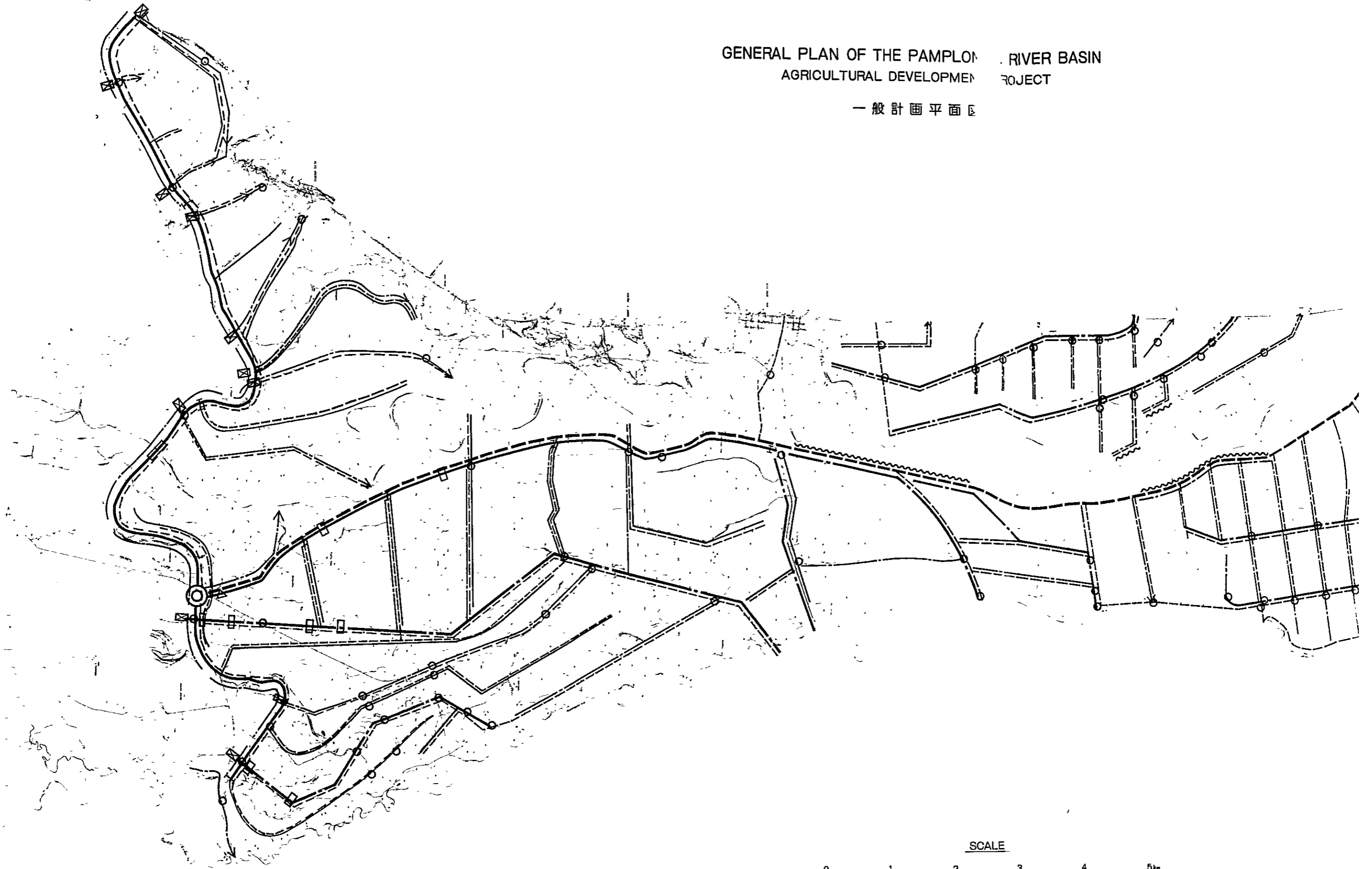
Public Market in Cucuta city.  
Cucuta 市市場





GENERAL PLAN OF THE PAMPLON RIVER BASIN  
AGRICULTURAL DEVELOPMENT PROJECT

一般計画平面図

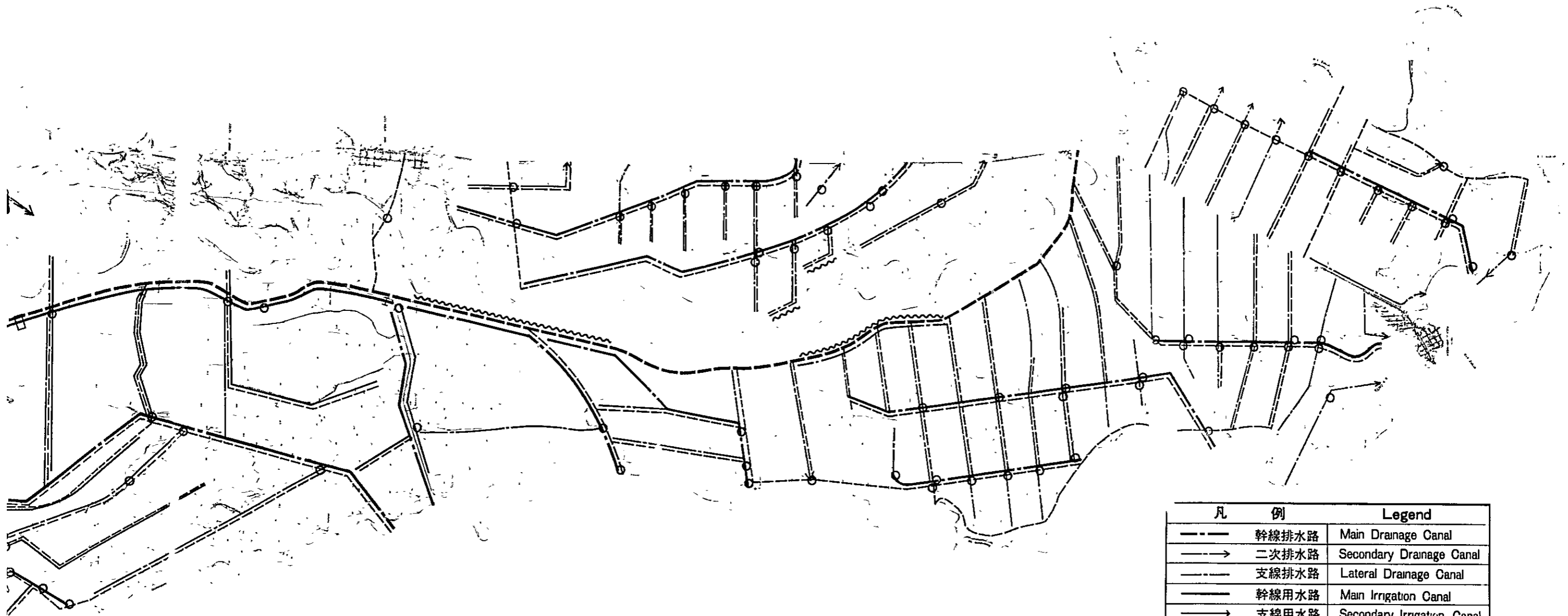
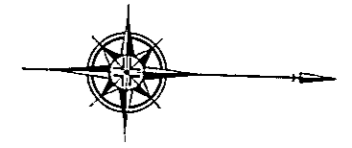


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GENERAL PLAN OF THE PAMPLONITA RIVER BASIN  
 AGRICULTURAL DEVELOPMENT PROJECT

一般計画平面図



| 凡 例                                 | Legend                     |
|-------------------------------------|----------------------------|
| --- (thick dashed line)             | Main Drainage Canal        |
| --- (medium dashed line)            | Secondary Drainage Canal   |
| --- (thin dashed line)              | Lateral Drainage Canal     |
| --- (thick solid line)              | Main Irrigation Canal      |
| --- (medium solid line)             | Secondary Irrigation Canal |
| --- (thick dashed line)             | Main Farm Road             |
| --- (thin dashed line)              | Secondary Farm Road        |
| ▭ (rectangle with horizontal lines) | Siphon                     |
| ⊙ (circle with dot)                 | Diversion Work             |
| △ (triangle)                        | Shute                      |
| □ (square)                          | Drop                       |
| — — (line with vertical bar)        | Check Gate                 |
| ○ (circle)                          | Bridge                     |
| ~~~~~ (wavy line)                   | Overflow Zone              |
| ▭ (rectangle with diagonal lines)   | Cross Culvert              |

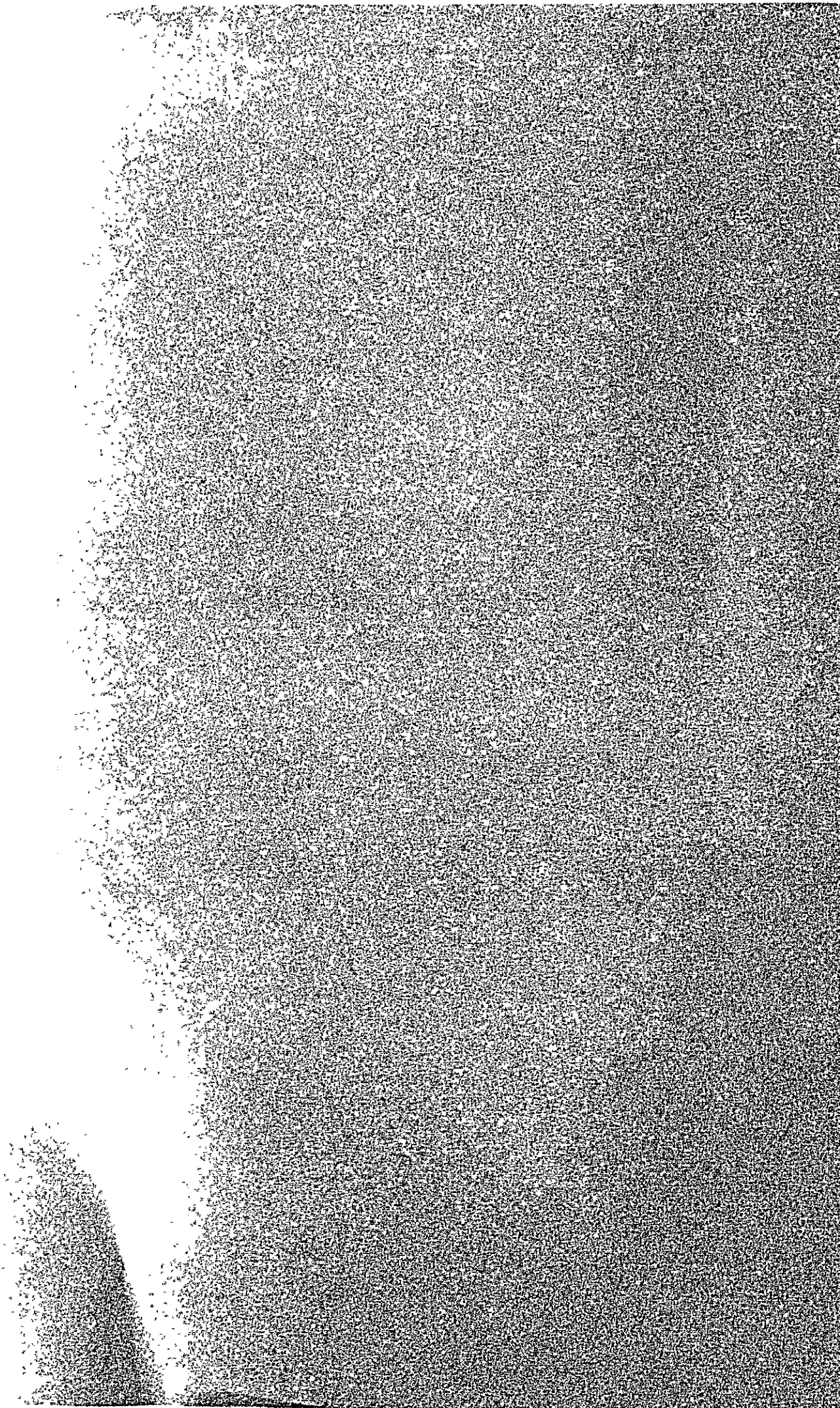
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## **SUMMARY AND RECOMMENDATIONS**



## 1. Introduction

- 1.1 This is the summary of the Feasibility Study on The Pamplonita River Basin Agricultural Development Project. The report of the feasibility study consists of SUMMARY AND RECOMMENDATIONS, MAIN REPORT, DRAWINGS and APPENDIXES as shown below:

|      |   |
|------|---|
| I    | BACKGROUND  |
| II   | METEOROLOGY AND HYDROLOGY                                   |
| III  | DRAINAGE  |
| IV   | IRRIGATION  |
| V    | SOIL, LAND CLASSIFICATION, GROUNDWATER<br>AND WATER QUALITY |
| VI   | AGRICULTURE   |
| VII  | COST ESTIMATE   |
| VIII | PROJECT EVALUATION  |

- 1.2 High priority is placed on housing, education, agriculture and livestock in the economic development policy of The Republic of Colombia (hereafter referred to as The Republic). The objectives for development of agriculture and livestock have been increased in production and attainment of sound rural economy through efficient utilization of available water and land resources. Agriculture and livestock are also recognized as one of the most important production sectors in the National Economic Development Plan (1983-1986) (DNP 1983).

The area of approximately 35,000ha in the downstream catchment area of the Pamplonita, the Zulia and the Grita River were identified for the Norte de Santander Project consisting of 4 stages where an immigration project was implemented by INCORA in the early 1960s. A land improvement project was also executed in the area of the first stage (Zulia Project), the second and a part of the third stage.

HIMAT which is responsible for land improvement in The Republic since reorganization of the Government structures, determined to undertake a feasibility study in part of the area in the second and the third stage of the Norte de Santander Project which remain to be developed.

- 1.3 For this purpose the Government of The Republic requested to the Government of Japan for technical cooperation to undertake this feasibility study.

In response to the above request, the Government of Japan despatched the mission to The Republic in January, 1983. After site reconnaissance and discussions with the Government officials concerned of The Republic, the mission determined the policy of the feasibility study and exchanged the agreed Scope of Work.

1.4 Objectives of this feasibility study are:

- a. To propose solution to drainage problems,
- b. To propose irrigation and the land improvement plans including land reclamation, and
- c. To evaluate technical and economic aspects of the proposed development plans.

2. Brief Description of the Study Area and Problems

2.1 The study area covers about 13,500ha located in the catchment area of the downstream part of the Pamplonita River in the north eastern part of the Norte de Santander Department. The central village of the study area is Agua Clara which is approximately 40km to the north from Cucuta.

2.2 There are two rainy seasons (in the months from April to May and from September to December ) and the rest of the year corresponds to the dry seasons.

The average annual rainfall is about 2,500mm and the average air temperature is about 27°C in the study area.

Monthly average air temperature and rainfall is shown in the following table with the study area represented by the meteorological station at Santa Isabel.

| Month<br>Description                       | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    | 12    | Year   |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Average Monthly Air temperature °C '69-'83 | 26.2  | 26.2  | 26.7  | 26.9  | 27.4  | 27.3  | 27.2  | 27.3  | 27.3  | 27.2  | 26.8  | 26.2  | 26.9   |
| Average Monthly Rainfall mm '71-'81        | 116.3 | 126.0 | 169.8 | 292.7 | 229.4 | 125.9 | 130.4 | 174.7 | 253.2 | 300.4 | 331.3 | 240.3 | 2490.4 |

2.3 Major rivers in the study area are the Pamplonita, the Zulia and the Grita. Hydrological dimensions are summarized in the following table.

| Name       | Catchment Area           | Length    | Average Discharge       | Drough Discharge       | Flood Discharge                             |
|------------|--------------------------|-----------|-------------------------|------------------------|---|
| Pamplonita | km <sup>2</sup><br>2,060 | km<br>170 | m <sup>3</sup> /s<br>22 | m <sup>3</sup> /s<br>3 | m <sup>3</sup> /s<br>300 -<br>at Agua Clara |
| Zulia      | 5,360                    | 193       | 114                     | 28                     | 500 -<br>at Puerto Leon                     |
| Grita      | 1,500                    | -         | -                       |                        |   |

2.4 Topography in the study area consists of alluvial plain in the northern and the central areas and river terraces in the southern part.

The soil series distributing in the study area are Classified into three groups.

| Distribution of Soil Series | Area                   | Productivity             |
|-----------------------------|------------------------|--------------------------|
| On the natural river levee  | (ha) (%)<br>3,880 28.7 | Generally high           |
| On the central low plain    | 6,870 50.9             | Low due to poor drainage |
| On the river terrace        | 2,030 15.1             | Fair to low              |

Note: The rest of the area (720ha, 5.3%) is settlement area and rivers.

- 2.5 The existing land use is shown in the table below. The 95% of agricultural land is used for pasture of beef cattle raising. The cultivated land is used mainly for cultivation of cacao. Other crops like cassava, maize and cashew nut are cultivated only in a limited area.

(ha)

| Agricultural Land |                     |                     |                     | Non Agricultural Land |           |            |                | Total     |            |
|-------------------|---------------------|---------------------|---------------------|-----------------------|-----------|------------|----------------|-----------|------------|
| Cultivated Land   | Pasture             |                     |                     | Sub-total             | Forest    | Urban Area | Road and River |           | Sub-total  |
|                   | Artificial          | Natural             | Total               |                       |           |            |                |           |            |
| 510               | 2,890               | 6,740               | 9,630               | 10,140                | 2,640     | 270        | 450            | 3,360     | 13,500     |
| %<br>(5.0)<br>3.8 | %<br>(28.5)<br>21.4 | %<br>(66.5)<br>49.9 | %<br>(95.0)<br>71.3 | %<br>(100.0)<br>75.1  | %<br>19.6 | %<br>2.0   | %<br>3.3       | %<br>24.9 | %<br>100.0 |

- 2.6 Total number of households in the study area is 320. Distribution of land ownership of households is summarized in the table below. The average size of landholding is 32ha.

| Land Size            | Less than 5 ha | 5-25 ha | 25-45ha | 45-65ha | More than 65 ha | Total |
|----------------------|----------------|---------|---------|---------|-----------------|-------|
| Number of households | 2              | 100     | 153     | 37      | 28              | 320   |

- 2.7 Infrastructure in the study area is insufficient, especially farm road density is very low. The study area receives much influence from the Venezuelan economy since the area borders Venezuela.
- 2.8 The area has a moderate ground surface gradient and is surrounded by heavily meandering river courses. In addition, the density of drainage canals is extremely low, which results in long periods of

land inundation from rainwater and river flooding. The inundation caused by rainfall lasts 5 days to all the year round and the flooding from river overflow lasts 7 days at maximum.

The groundwater level rises 0.3 - 1.0m from the ground surface during the rainy season which produces chronic poor drainage problems in the area.

Daily rainfall in the magnitude of 100mm occurs every year and poor drainage problems are brought on over the area of approximately 10,000ha. In the poor drainage area, about 2,700ha is the area with an inundation over 30cm depth and 10 days' duration.

Flooded area caused by the Zulia and the Pamplonita River in different return periods is shown in the table below:

| Return Period     | 2 years | 5 years | 10 years |
|-------------------|---------|---------|----------|
| Flooded Area (ha) | 1,050   | 4,300   | 6,560    |

The area with poor drainage distribute wider in the northern area than in the southern area.

There are some drainage canals at Campo Alegre and El Dave, but these canals function unsatisfactorily due to poor maintenance.

Major agricultural products in the area are beef cattle and cacao. The average unit yield of these crops are:

|             |                                |
|-------------|--------------------------------|
| Beef cattle | 0.14 t/ha (52 t/ha of pasture) |
| Cacao       | 0.52 t/ha                      |

The above yields are 42% and 67% each of the unit yield in the farms well drained area.

- 2.9 The study area is classified into four zones based on topography, drainage conditions, land ownership and land use.

These factors have a large influence on the drainage plan and the production plan, therefore the above zone classification is also used as basis of the development plan. Characteristics of each zone are summarized in the table below.

- 2.10 The project area is located along the national border with Venezuela. The market in Venezuelan territory is not taken into account of the project formulation due to the significant recession since February 1983.

Zone Characteristics

| Zone  | Acreage (ha) | Agricultural Land (ha)                   | Number of Farm (house)     | Acreage per Farm (ha/house) | Topography (Elevation) Average Slope | Soil Texture (Productivity)                      | Drainage and Flood Condition              |                               |   | Principal Land Ownership | Principal Land Use      |
|-------|--------------|--|----------------------------|-----------------------------|--------------------------------------|--|---|-------------------------------|---|--------------------------|-------------------------|
|       |              |  |                            |                             |                                      |  | Flood Day <sup>3/</sup> and Flooding Area | Flood <sup>4/</sup> Area (ha) | Annual Average to Groundwater Level (m) |                          |                         |
| A     | 1,930        | C: 10<br>P: 1,510<br>O: 0<br>T: 1,520    | I: 34<br>P: 4<br>T: 38     | 40                          | Alluvial plain (47 to 55 m) 1.5%     | Low plain soil Medium to fine (Moderate to high) | 5 days 1,570 ha                           | 44                            | 60 to 110                               | INCORA's parceleros      | Pasture                 |
| B     | 4,750        | C: 40<br>P: 3,130<br>O: 90<br>T: 3,260   | I: 42<br>P: 60<br>T: 102   | 32                          | Alluvial plain (51 to 75 m) 2%       | Low plain soil Medium to fine (Moderate to high) | 3 days 1,760 ha                           | 25                            | 60 to 140                               | Particu-lars             | Pasture                 |
| C     | 4,860        | C: 30<br>P: 3,450<br>O: 260<br>T: 3,740  | I: 123<br>P: 14<br>T: 117  | 27                          | Alluvial plain (63 to 81 m) 2%       | Low plain soil Medium to fine (Moderate to high) | 1 day 880 ha                              | 14                            | 90 to 200                               | INCORA's Parceleros      | Pasture Partially Cacao |
| D     | 1,960        | C: 10<br>P: 1,540<br>O: 70<br>T: 1,620   | I: 3<br>P: 40<br>T: 43     | 38                          | River terrace (75 to 100 m) 7%       | Terrace soil Coarse (Moderate to low)            | 1 day 90 ha                               | 0                             | 170 to 310                              | Particu-lars             | Pasture                 |
| Total | 13,500       | C: 90<br>P: 0,630<br>O: 420<br>T: 10,140 | I: 202<br>P: 118<br>T: 320 | 32                          | (47 to 100 m) 2%                     |  | 4,300 ha                                  |                               |   |                          |                         |

Notes: 1/ C: Cultivated Land

P: Pastures

O: Orchard

T: Total

2/ I: INCORA's Parceleros

P: Particulars

T: Total

3/ Consecutive flood days and area by flood of 5 years return period

4/ Topographic slope < 1/500, Ponding depth 30 cm and period more than 10 days

5/ Below the ground surface

### 3. Comparison of Development Levels

3.1 Objectives of this project are to attain sound productivity of agriculture and household economy and to raise living standards of farmers through:

- a. Improvement of drainage conditions, and
- b. Optimum utilization of irrigation water.

For this purpose the project consists of

- a. Drainage Improvement Plan,
- b. Irrigation Plan, and
- c. Improvement of Related Social Infrastructures.

Introducing any drastic change into the existing farming pattern would require a large capital investment, large number of labours and a long implementation period. Therefore, the basis of the project focuses on existing beef cattle raising.

For this purpose the analyses are made of the following three different development levels:

#### Development Plan I

On the basis of existing beef cattle raising, the drainage conditions will be improved to the same level as lands where pasture is managed in a favourable conditions in the area at present. By the improvement of drainage conditions, the productivity of beef cattle raising will be increased.

#### Development Plan II

By extension of better pasture, beef cattle raising productivity will be increased above that of development Plan I. Drainage Conditions will be improved to the level of cacao and cassava extension under the appropriate crops' condition.

#### Development Plan III

On the basis of development Plan II, the cropping area of field crops will be extended by introduction of irrigation.

Proposed development plans for each development level are summarized in the following table.



3.2 Economic evaluations of the three proposed plans are summarized in the table below:

| Alternative<br>Cost Item | Plan I          | Plan II         | Plan III        |
|--------------------------|-----------------|-----------------|-----------------|
| Project Cost             | Col\$ 2.26 Bil. | Col\$ 2.67 Bil. | Col\$ 3.48 Bil. |
| Project Benefit          | Col\$ 5.88 Bil. | Col\$10.54 Bil. | Col\$15.95 Bil. |
| EIRR                     | 7.1%            | 11.1%           | 13.4%           |

Evaluation of financial aspects of the project are summarized below:

The Plan I :

Produces insufficient incremental benefit for farmers to repay the construction cost.

The Plan II :

Produces sufficient incremental benefit for farmers to repay for construction cost. However, there is some limitation in variety of crops and potential production in this case.

The Plan III :

Produces abundant products with a variety of crops. The potential to adapt to future requirements will be high.

It is, therefore, proposed to select Plan III as the optimum development plan for the project.

3.3 In Plan III, however, the cropping area of some crops with which some farmers are not familiar needs to be extended. For this reason, it is indispensable to support these farmers with technical extension services and agricultural credits.

## Comparison of Development Plan

| Development Plan   | Land Improvement Plan          |   |  |  | Production Plan                                 |   |   |   | Remarks |
|--|--------------------------------|---|--|--|---|---|---|---|---------|
|  | Land Improvement               | Level of Improvement  | Land Improvement Condition   | Beef Cattle  | Cacao   | Cultivated Crops  | Others  |   |         |
| Plan I<br>Improvement of agricultural productivity based on the existing beef cattle business pattern                    | Improvement of drainage system | Level of good drainage site in study area.                                | Groundwater level from ground surface; more than 0.8 m. Submergence; once every 2 years. Ponding; no exist. Design rainfall; 2 years return period. Drainage capacity; for peak discharge.                                 | Improvement of pasture existing (Braquaria) plowing of pasture once in 5 years. Being exhaustive of vaccination. Amplification of fattening of beef cattle.                                    | Extension of B, C Zones (1,000 ha).             | Extension in cultivable land (170 ha). Remaining of existing maize (40 ha).                   | Remaining of existing cashewnuts.               | Consequences of backwater by the Zulia River  |         |
|  | Improvement of farm road       |   |  |  |   |   |   |   |         |
| Plan II<br>Amplification of cacao and cassava on the appropriate drainage condition and introduction of superior pasture | Improvement of drainage        | Improvement of drainage condition for cacao, cassava and superior pasture | Groundwater level from ground surface; more than 1.0 m. Submergence less than once in the 5 years by river flood and rainfall. Design rainfall; 5 years <sup>2/</sup> return period. Drainage capacity for peak discharge. | Improvement of pasture by superior species (Tropical Kudzu & Angleton). Plowing once in the 5 years and fertilization. Being exhaustive of vaccination. Extension of fattening of beef cattle. | Extension in proposed area of approx. 2,000 ha. | Extension of cassava in proposed area (640 ha). Remaining of existing maize.                  | Same to Plan I.                                 | Consequences of backwater by the Zulia River  |         |
|  | Improvement of farm roads      |   |  |  |   |   |   |   |         |
| Plan III <sup>1/</sup><br>Intensification of farming by introduction of irrigation                                       | Improvement of drainage        | Same to Plan II   | Same to Plan II.   | A, B, Zones; Same to Plan II.  | Same to Plan II.                                | A, B Zones; Extension of cassava in proposed area acreage (280 ha)                            | Introduction of papaya and pineapple in D Zone. | Consequences of backwater by the Zulia River. |         |
|  | Irrigation                     | Same to level of arrangement in Zulia District.                           | Brought discharge; once in the 5 years.  | C, D Zones; Establishment of rotated grazing by irrigation   |   | C, D Zones; Planning two crops a year of maize and sorghum (2,660 ha) and watermelon (100 ha) |   |   |         |
|  | Improvement of farm roads      |   |  | Rotation of pasture and cultivated crops.  |   | Doing rotation with pasture.  |   |   |         |

<sup>1/</sup> Irrigation zones; C, D Zones only therefore development level of A, B Zones will be same as Plan II.

<sup>2/</sup> 5 years return period is used for projects of Zulia, Sibunday, Ichrija, Tollma, etc.

#### 4. Contents of the Project

The contents of the Development Plan III recommended for the project are summarized as below.

4.1 The proposed land use and cropping plan is summarized in the following table:

(Unit : ha)

| Plan<br>Zone          | Present Condition   | Plan III   | Land re-<br>clamation | Right<br>of way |
|-----------------------|---|--|-----------------------|-----------------|
| A<br>38<br>farms      | Pasture 1,510<br>Cassava 10   | Pasture 1,220<br>Cassava 80<br>Cacao 260   | 120                   | 80              |
|                       | Sub-total 1,520   | Sub-total 1,560  |                       |                 |
| B<br>102<br>farms     | Pasture 3,130<br>Cassava 30<br>Maize 10<br>Cacao 90                   | Pasture 2,610<br>Cassava 200<br>Maize 10<br>Cacao 720  | 460                   | 180             |
|                       | Sub-total 3,260   | Sub-total 3,540  |                       |                 |
| C<br>137<br>farms     | Pasture 3,450<br>Cassava 10<br>Maize 20<br>Cacao 260                  | Pasture (I) 880<br>Maize &<br>Sorghum (I) 1,760<br>Cacao 960   | 260                   | 400             |
|                       | Sub-total 3,740   | Sub-total 3,600  |                       |                 |
| D<br>43<br>farms      | Pasture 1,540<br>Maize 10<br>Cashew nut 70                            | Pasture (I) 500<br>Maize &<br>Sorghum (I) 900<br>Watermelon (I) 100<br>Papaya (I)<br>(Pineapple) 100   | 60                    | 80              |
|                       | Sub-total 1,620   | Sub-total 1,600  |                       |                 |
| Total<br>320<br>farms | Pasture 9,630<br>Cassava 50<br>Maize 40<br>Cacao 350<br>Cashew nut 70 | Pasture 3,830<br>Pasture (I) 1,380<br>Cassava 280<br>Maize 10<br>Maize (I) 2,660<br>Sorghum (I) (2,660)*<br>Cacao 1,940<br>Watermelon (I) 100<br>Papaya (I)<br>(Pineapple) 100 | 900                   | 740             |
|                       | Total 10,140  | Total 10,300   |                       |                 |

(I) : Irrigation

\* : Double cropping

4.2 A comparison is made between present production and the proposed production as shown below.

| Crop                            | Comparison | Cropping Area (ha)    | Unit Yield (t/ha)  | Production (t)      | Farm Gate Price (10 <sup>3</sup> COL\$/kg) | Gross Production (10 <sup>3</sup> COL\$) | Unit Production (COL\$/ha) | Net Production (10 <sup>3</sup> COL\$) |
|---------------------------------|------------|-----------------------|--------------------|---------------------|--|--|----------------------------|--|
| Beef Cattle (Pasture)           | Present    | 9,630                 | 0.14 <sup>1)</sup> | 1,335               | 90   | 121,968                                  | 6,300 <sup>1)</sup>        | 60,984                                 |
|                                 | Proposed   | 3,830                 | 0.31               | 1,172               | 90   | 105,478                                  | 12,358                     | 58,147                                 |
| Deef Cattle (Irrigated pasture) | Present    | -                     | -                  | -                   | -  | -  | -                          | -                                      |
|                                 | Proposed   | 1,380                 | 0.60               | 829                 | 90   | 71,899                                   | 15,662                     | 52,285                                 |
| Cassava                         | Present    | 50                    | 6.00               | 300                 | 15   | 4,500                                    | 10,180                     | 3,991                                  |
|                                 | Proposed   | 280                   | 15.00              | 4,200               | 10   | 42,000                                   | 54,350                     | 26,782                                 |
| Maize                           | Present    | 40                    | 2.00               | 80                  | 17   | 1,360                                    | 10,160                     | 953                                    |
|                                 | Proposed   | 10                    | 3.00               | 30                  | 17   | 510                                      | 27,150                     | 238                                    |
| Maize (Irrigated)               | Present    | -                     | -                  | -                   | -  | -  | -                          | -                                      |
|                                 | Proposed   | 2,660                 | 4.00               | 10,640              | 17   | 180,880                                  | 32,300                     | 94,962                                 |
| Sorghum (Irrigated)             | Present    | -                     | -                  | -                   | -  | -  | -                          | -                                      |
|                                 | Proposed   | (2,660) <sup>3)</sup> | 4.00               | 10,640              | 15   | 159,600                                  | 30,700                     | 77,938                                 |
| Cacao                           | Present    | 350                   | 0.52               | 182                 | 125  | 22,750                                   | 26,000                     | 13,650                                 |
|                                 | Proposed   | 1,940                 | 0.90               | 1,746               | 125  | 218,250                                  | 48,600                     | 123,966                                |
| Watermelon (Irrigated)          | Present    | -                     | -                  | -                   | -  | -  | -                          | -                                      |
|                                 | Proposed   | 100                   | 15.00              | 1,500               | 10   | 15,000                                   | 91,250                     | 5,875                                  |
| Papaya (Pineapple) (Irrigated)  | Present    | -                     | -                  | -                   | -  | -  | -                          | -                                      |
|                                 | Proposed   | 100                   | 17.50              | 1,750               | 10   | 17,500                                   | 83,856                     | 9,114                                  |
| Total                           | Present    | 10,140 <sup>4)</sup>  |                    | 2,337 <sup>4)</sup> |  | 154,198 <sup>4)</sup>                    |                            | 80,719 <sup>4)</sup>                   |
|                                 | Proposed   | 10,300                |                    | 32,500              |  | 813,117                                  |                            | 449,307                                |

Note: 1) The overall average  
2) Estimated market price is same as the regional average price since large amount of product is expected.  
3) ( ) = Double cropping  
4) Including cashew nut

4.3 There are some drainage canals in a limited area, however, they are extremely insufficient to drain rainfall and river flooding.

The design rainfall return period for the drainage plan is proposed as 5 years with necessary adjustment to be made to accommodate flood overflow in the magnitude of 5 year return period.

Drainage method is to be gravitational drainage.

The 1,750ha of present flooded areas will be reduced by the provision of above drainage canals.

Proposed drainage facilities are summarized in the table below:

| Facility Dimension                 | Main Canal        | Secondary Canal   | Lateral Canal     | Tertiary Canal                   | Interception Canal |
|------------------------------------|-------------------|-------------------|-------------------|----------------------------------|--------------------|
| L: m<br>Canal Q: m <sup>3</sup> /s | 50,550<br>44-6.1  | 38,950<br>29-0.48 | 84,150<br>12-0.52 | 418,000<br>1.5-3.0<br>(standard) | 14,650<br>8.6-0.04 |
| I:<br>(earth canal)                | 1/310-<br>1/1,310 | 1/160-<br>1/1,310 | Approx.<br>1/700  | Approx.<br>1/700                 | 1/500-<br>1/2,000  |
| Drops(Place)                       | 7                 | 49                | 13                | -                                | -                  |
| Culvert<br>(Place)                 | 2                 | 7                 | 150               | 160                              | -                  |

4.4 Irrigation facilities are provided for 4,300ha of Zone C and D in the southern part of the project area.

The design drought return period is 5 year.

Border irrigation is proposed and the water requirements are estimated to be 6.0 m<sup>3</sup>/s which is within the limit of water source of 7.5 m<sup>3</sup>/s at the diversion of the Canal Zulia planned by HIMAT.

Proposed irrigation facilities are summarized as below.

| Facility                              | Driving Canal                            | Main Canal   | Secondary Canal                                | Tertiary Canal                              |
|---------------------------------------|--|--|--|---|
| Canal L:<br>(earth canal)<br>Q:<br>I: | 6,400m<br>6.0m <sup>3</sup> /s<br>1/2000 | 26,700m<br>5.9-1.5m <sup>3</sup> /s<br>1/1000-<br>1/2000 | 50,350m<br>0.06-5.7m <sup>3</sup> /s<br>1/1000 | 203,349m<br>0.02m <sup>3</sup> /s<br>1/1000 |
| Siphon                                | L:<br>(A) D                              | 180m<br>φ 2,000mm<br>Floresta R.                         | -  | -   |
|                                       | L:<br>(B) D                              | 320m<br>φ 2,000mm<br>Concepcion R.                       | -  | -   |
|                                       | (C)                                      | - L = 250m<br>φ 1,900mm<br>Pamplonita R.                 | -  | -   |
| Diversion                             | 1 place                                  |  |  |   |
| Chute                                 | 1 place                                  |  |  |   |
| Drop                                  | 2 places                                 |  |  |   |
| Wasteway                              | 1 place                                  |  |  |   |
| Check Gate                            | 7 places                                 |  |  |   |
| Intake                                | 20 places                                |  |  |   |
| Culvert                               | 1 place                                  | 196 places   |  |   |

4.5 Existing road density in the project area is extremely low especially in the area on the right bank of the Pamplonita River.

In the project it is proposed to construct a main road along the higher ground surface than the surround area on the right bank of the Pamplonita River making fully use of the alignment of existing farm road.

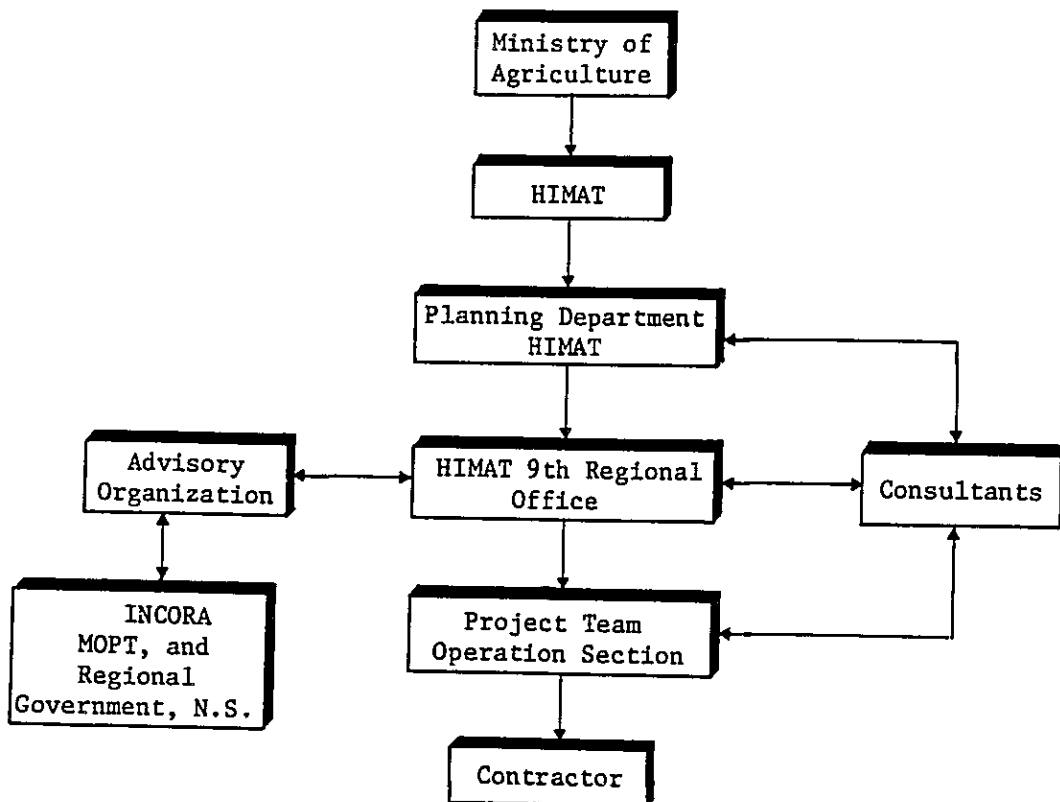
Construction of one bridge (100m in length) is proposed to connect the areas on the right bank of the Pamplonita River with the existing national road at Agua Clara.

Proposed roads and bridge are summarized as below:

| Dimension \ Facility | Main Road        |             | Secondary Road | Tertiary Road | Bridge Crossing Pamplonita River | Farm Road Bridge |
|----------------------|------------------|-------------|----------------|---------------|----------------------------------|------------------|
|                      | New construction | Improvement |                |               |                                  |                  |
| Length m             | 14,500           | 6,250       | 250,000        | 418,000       | 100                              | -                |
| Width m              | 6.0              | 6.0         | 4.0            | 3.0           | 6.0                              | 4.0 or 6.0       |
| Road Density m/ha    | 3.6              |             | 18.5           | 31.0          | -                                | -                |
| Nos. of Places       | -                | -           | -              | -             | 1                                | 96               |

## 5. Project Implementation and Evaluation

- 5.1 Construction period is to be 5 years including the period of preparatory work.
- 5.2 HIMAT is to be the executing agency of construction for the project and the proposed organization chart is illustrated below.



The project term is to be organized in the existing Conservation Section in the 9th Regional office, HIMAT. No new project office is to be established.



5.3 After commencement of the project, HIMAT is to keep close cooperation with INCORA and ICA to provide farmers with progressive technical extension services and training.

5.4 Construction cost is estimated to be COL\$ 2,079,970,000 consisting of COL\$ 1,366,450,000 of foreign portion and COL\$ 713,520,000 of local portion as shown in the table below.

Unit 10<sup>3</sup> COL\$ (10<sup>3</sup> US\$)

| Item                            | Foreign Portion       | Local Portion      | Total                 |
|---------------------------------|-----------------------|--------------------|-----------------------|
| 1. Preparatory Work             |                       | 14,852<br>(186)    | 14,852<br>(186)       |
| 2. Civil Works                  | 886,355<br>(11,080)   | 566,671<br>(7,083) | 1,453,026<br>(18,163) |
| 3. Procurement of O/M Machinery | 91,768<br>(1,147)     |                    | 91,768<br>(1,147)     |
| 4. Buildings                    |                       | 6,000<br>( 75)     | 6,000<br>( 75)        |
| 5. Administration               |                       | 33,480<br>(418)    | 33,480<br>(418)       |
| 6. Engineering Services         | 264,112<br>(3,301)    | 27,650<br>(346)    | 291,762<br>(3,647)    |
| Sub Total                       | 1,242,235<br>(15,528) | 648,653<br>(8,108) | 1,890,888<br>(23,636) |
| 7. Physical Contingency         | 124,223<br>(1,553)    | 64,865<br>(811)    | 189,088<br>(2,364)    |
| Total                           | 1,366,458<br>(17,081) | 713,518<br>(8,919) | 2,079,976<br>(26,000) |

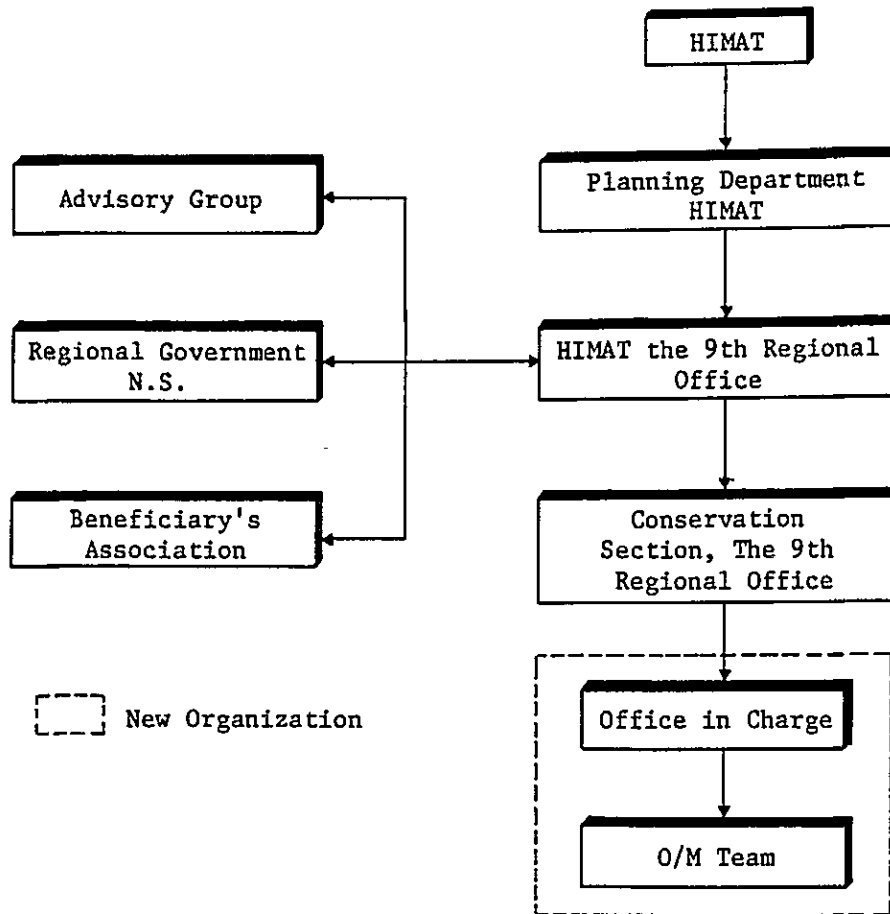
Note: Exchange Rate 1 US\$ = 80 COL\$

The total construction cost including price escalation is estimated to be COL\$ 3,098,520,000 consisting of COL\$ 1,786,900,000 of foreign portion and COL\$ 1,311, 620,000 of local portion.

Percentage of the foreign and the local portions are 58% and 42%, respectively.

The disbursement schedule is proposed as shown in the table below.

5.5 Operation and maintenance services are required for the irrigation and drainage canals, roads and other facilities. The operation and maintenance of the 9th Regional Office of HIMAT and other organization are shown below.



For this project, one sub-section is to be established under the conservation section of the 9th Region Office of HIMAT.

5.6 Annual operation and maintenance cost is estimated to be:

| Item                       | Cost COL\$ Million/year |
|----------------------------|-------------------------|
| Operation of Machinery     | 29.14                   |
| Repair Works of Facilities | 2.91                    |
| Administration Cost        | 5.45                    |
| Total                      | <hr/> 37.51             |

5.7 The project life is 50 years including 18 months preparatory period and 42 months construction period.

Economic construction cost is estimated to be COL\$ 2,043.15 million excluding the administration cost.

Annual benefit of the project at matured stage is estimated to be COL\$ 352.44 million.

Economic internal rate of return (EIRR) of the project is estimated to be 13.4% which exceeds the 12% of capital opportunity cost in The Republic.

5.8 Sensitivity analyses are made in respect to construction cost, gross production value and production cost. It is found that economic returns of the project are influenced by these factors in the order of magnitude, construction cost, gross production value, and production cost as follows:

| Factors of sensitivity analyses            | EIRR  |
|--|-------|
| (a) 10% increase in construction cost      | 12.3% |
| (b) 10% decrease in gross production value | 11.0% |
| (c) 10% increase in production cost        | 12.4% |

5.9 According to the results of financial analyses, it is concluded that the project will produce sufficient benefit for farmers under average farming condition to permit their repayment of the construction cost.

The capital investment condition is 8% interest rate with 8% annual inflation for the foreign portion and 20% interest with 20% inflation for the local portion. Repayment condition for farmers is 20% interest rate within a term of 15 years after 5 years grace period.

## 6. Conclusion

As the result of feasibility study, it is concluded that the Plan III is justified in economical, financial, technical and social aspects.

## 7. Recommendations

### 7.1 Earlier Implementation of The Project

Considering economic and social effects of the project not only for the project area but also the nation, it is recommended that implementation of the project should be made immediately. The project involves many aspects, the close coordination among the related public institutions should be made.

### 7.2 Construction

- a. For land acquisition of the right-of-way, prudent negotiation should be made with land owners in advance.
- b. Construction should be started on irrigation/drainage facilities since earlier commencement of production.
- c. Farmers who can not cultivate their farms due to construction should have priority to be employed as construction labourers.
- d. Soil and topographic surveys should be made before designing of the major structures.

### 7.3 Project Management and Operation & Maintenance

- a. The successful results from the project largely depend on the management, operation and maintenance of the project facilities. For this purpose HIMAT has to play a leading role in coordinating related public institutions and establishment of the management organization.
- b. Operation and Maintenance  
Main and secondary irrigation/drainage canals are to be maintained by HIMAT, however, tertiary irrigation canals are to be maintained by benefiting farmers.

### 7.4 Extension Services

- a. For successful extension of new crops with which farmers are not familiar, intensive technical extension services are indispensable. For this purpose HIMAT has to maintain close coordination with ICA and INCORA.
- b. For the project implementation, credit will be required for production cost. HIMAT has to make the necessary arrangements with Caja Agraria and F.F.A.P. to meet the farmer credit requirements.

### 7.5 Continuation of Hydro-meteorological Observation

Hydro-meteorological observation undertaken in the project area and its vicinity should be continued in the future since these data will provide important information for the project and other similar projects.

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## ABBREVIATION AND SYMBOL

|              |  |  |
|--------------|--|--|
| ACIC         | Asociación Colombiana de Ingenieros Constructores  | Colombian Construction Engineers' Association                      |
| AZURCA       | Agroindustrias Zulía Ureña C.A.  | Zulía Ureña Agroindustry Company                                   |
| BIRD         | Banco Internacional de Reconstrucción y Desarrollo   | World Bank   |
| CAR          | Corporación Autónoma Regional de la Sabana de Bogotá y de los Valles de Ubaté y Chiquinquirá | Bogota, Ubaté and Chiquinquirá Valley Autonomy Corporation         |
| CAVECINAL    | Fondo Nacional de Caminos Vecinales  | National Road Fund   |
| Caja Agraria | Caja de Crédito Agrario Industrial y Minero  | Credit Bank of Agro-Industry and Mining                            |
| CIAT         | Centro Internacional de Agricultura Tropical   | International Tropical Agriculture Center                          |
| CORABASTOS   | Corporación de Abastos de Bogotá S.A.  | Supply Corporation of Bogota                                       |
| CECORA       | Central de Cooperativas de la Reforma Agraria Ltda   | Agricultural Reform Cooperation Center                             |
| CAMACOL      | Camara Colombiana de la Construcción   | Colombian Chamber of Construction                                  |
| DANE         | Departamento Administrativo Nacional de Estadística  | Department of National Statistics                                  |
| DNP          | Departamento Nacional de Planeación  | Department of National Planning                                    |
| DRI          | Desarrollo Rural Integrado   | Integrated Rural Development                                       |
| F.F.A.P.     | Fondo Financiero Agropecuario  | Agriculture and Livestock Financial Fund                           |
| FEDECACAO    | Federación Nacional de Cacaoteros  | National Federation of Cacao Producer                              |
| HIMAT        | Instituto Colombiano de Hidrología, Meteorología y Adecuación de Tierras                     | Colombian Institute of Meteorology, Hydrology and Land Improvement |
| ICA          | Instituto Colombiano Agropecuario  | Colombian Institute of Agriculture and Livestock                   |

|            |  |  |
|------------|--|--|
| IDEMA      | Instituto de Mercadeo Agropecuario                                     | Institute of Agriculture and Livestock Marketing               |
| IGAC       | Instituto Geográfico Agustín Codazzi                                   | Institute of National Geography                                |
| ICEL       | Instituto Colombiano de Energía Eléctrica                              | Colombian Institute of Electric Energy                         |
| INCOMEX    | Instituto de Comercio Exterior   | Institute of External Commerce                                 |
| INCORA     | Instituto Colombiano de la Reforma Agraria                             | Colombian Institute of Agrarian Reform                         |
| INDERENA   | Instituto Nacional de los Recursos Naturales Renovables y del Ambiente | National Institute of Natural Resources                        |
| INGEOMINAS | Instituto Nacional de Investigaciones Geológico-Mineras                | National Institute of Geological and Mineral Investigation     |
| INAS       | Instituto Nacional de Salud  | National Institute of Health                                   |
| JICA       | Agencia de Cooperación Internacional de Japón                          | Japan International Cooperation Agency                         |
| MOPT       | Ministerio de Obras Públicas y Transporte                              | Ministry of Construction and Transport                         |
| OPSA       | Organización de Planeamiento del Sector Agropecuario                   | Agriculture and Livestock Planning Organization                |
| PAN        | Plan Nacional de Alimentación y Nutrición                              | National Food and Nutrition Plan                               |
| PROEXPO    | Fondo de Promoción de Exportaciones                                    | Export Promotion Fund  |
| SENA       | Servicio Nacional Aprendizaje  | National Technical Training Service                            |
| URPA       | Unidad Regional de Planeación Agropecuaria                             | Department of Regional Planning of Agriculture                 |
| USBR       |  | United States Bureau of Reclamation                            |
| USOCOELLO  | Asociación de Usuarios de Riego del Río Coello                         | Beneficiary's Association of Coello River Irrigation District  |
| USOSALDAÑA | Asociación de Usuarios de Riego del Río Saldaña                        | Beneficiary's Association of Saldaña River Irrigation District |

(Length)

|    |            |
|----|------------|
| mm | millimeter |
| cm | centimeter |
| m  | meter      |
| km | kilometer  |

(Weight)

|                |          |
|----------------|----------|
| g              | gram     |
| kg             | kilogram |
| t (= 1,000 kg) | ton      |

(Area)

|                               |                  |
|-------------------------------|------------------|
| m <sup>2</sup>                | square meter     |
| km <sup>2</sup>               | square kilometer |
| ha (= 10,000 m <sup>2</sup> ) | hectare          |

(Volume)

|                           |             |
|---------------------------|-------------|
| m <sup>3</sup> (=1,000 ℓ) | cubic meter |
| ℓ                         | liter       |

(Derived)

|                   |                        |
|-------------------|------------------------|
| m/s               | meter per second       |
| m <sup>3</sup> /s | cubic meter per second |
| t/ha              | ton per hectare        |

(Others)

|                 |                                  |
|-----------------|----------------------------------|
| %               | percent                          |
| °C              | centigrade                       |
| COL\$           | Colombia peso                    |
| US\$            | United States dollar             |
| M.A.S.L. (= EL) | meter above sea level            |
| EIRR            | Economic Internal Rate of Return |
| Parceleros      | Settle or Immigrate Farms        |
| Particulares    | Particular Farms                 |

(Conversion)

|         |         |
|---------|---------|
| libra   | 460 g   |
| carga   | 125 kg  |
| bulto   | 62.5 kg |
| galon   | 4.5 ℓ   |
| botella | 750 cc  |

**Related Organizations and Persons Concerned**

(at Bogotá)

| Organization   | Name                        | Post  |
|----------------|-----------------------------|---|
| DNP            | Nohora Bateman              | Director of International Technical Cooperation Department        |
|                | Ligia Rodriguez             | International Technical Cooperation Department                    |
| HIMAT          | Fabio Bermudez              | General Director  |
|                | Victor Gonzales             | Advisor   |
|                | Jaime Padilla               | Director of Planning Office                                       |
|                | Guillermo Diaz              | Ex-director of Planning Office                                    |
|                | Humberto Van Arcken         | Advisor of Planning Office  |
|                | Francisco Rueda             | Director of Inventory Study Section                               |
|                | Enrique Cepeda              | Ex-director of Inventory Study Section                            |
|                | Fabiola Enciso              | Sociologist, Survey Section                                       |
|                | Eugenia Molina              | Agriculturalist, Survey Section                                   |
|                | Pedro Perez                 | Geomorphologist, Survey Section                                   |
|                | Luis Fernando Santos        | Agriculturalist, Planning Section                                 |
|                | Edmundo Mejia               | Agriculturalist, Planning Section                                 |
|                | Agusto Acosta               | Agronomist, Operation Section, Livestock Expert, Planning Section |
|                | Hector Guzman               | Hydro-geographer, Survey Section                                  |
|                | Alfonso Suarez              | Planning Section  |
|                | Jorge I. Valencia           | Department of Meteorology   |
|                | Octavio Serrano             | Director of Department of Hydrology                               |
| José Ojeda     | Administration Department   |   |
| Jaime Ramo     | Administration Department   |   |
| Alberto Duque  | Economist, Survey Section   |   |
| Liliana Freyre | Economist, Planning Section |   |
| FEDECACAO      | Iván García                 | General Director of FEDECACAO                                     |



Other organizations

|              |         |                           |
|--------------|---------|---------------------------|
| ACIC         | DANE    | INDERENA                  |
| Caja Agraria | ICA     | INGEOMINAS                |
| CIAT         | IDEMA   | MOPT                      |
| CORABASTOS   | IGAC    | OPSA                      |
| CECORA       | INDOMEX | Ministerio de Agricultura |
| CAMACOL      | INCORA  | LUKER                     |

(At Cucuta)

| Organization               | Name                | Post  |
|----------------------------|---------------------|---|
| HIMAT<br>Regional<br>No. 9 | Fernando Ortega     | Director of No. 9 Regional Office               |
|                            | Jaime Monroy        | Director of Agricultural Engineering Section    |
|                            | Carlos Fernandes    | Director of Agricultural Section                |
|                            | Jose Miguel Lazaro  | Director of Conservation Section                |
|                            | Oscar Prieto        | Director of Operation Section                   |
|                            | Amin Turbay         | Chief of Laboratory                             |
|                            | Alberto Dominguez   | Director of Hydro-Meteorology Section           |
| Gobierno<br>Departamental  | Rosa Morgarita Nino | Director of Planning Department                 |
| URPA                       | Fernando Jaramillo  | Director of URPA                                |
| INCORA                     | Ramilo Escobar      | Director of Branch Office                       |
| ICA                        | Jaime Salazar       | Regional Director                               |
| INDERENA                   | Jorge Maldonado     | Regional Director                               |
| FEDECACAO                  | Hugo Gonzales       | Director of Branch Office                       |
| INCOMEX                    | Luis Fernando Amaya | Director of Administration and Finance Division |
| AGROZULIA                  | Rafael Sanchez      |   |
| MOPT                       |                     |   |
| Banco de la<br>Republica   | Nelson Turgillo     | Director of FFAP Cucuta Division                |
| DRI                        | Armando Mantilla    | Regional Director                               |
| Municipalidad<br>de Cucuta | Jairo de Viveros    | Director of Public Works Department             |

Other Organizations

Secretaria de Desarrollo

IDEMA

Secretaria de Educacion

COAGRONORTE

Secretaria de Salud

Secretaria de Transporte

INAS

IGAC

Member List of Supervisory Group

| Assignment            | Name            | Position  |
|-----------------------|-----------------|---|
| Chairman              | Mr. Y. KUNIHRO  | Director of Irrigation and Drainage Division, Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry & Fisheries (MAFF)     |
| Deputy Chairman       | Mr. M. HIDAKA   | Director of Toyokawa Integrated Waterway Project Office<br>Tokai Regional Agricultural Administration Bureau, MAFF                                |
| Irrigation & Drainage | Mr. T. HIRASE   | Deputy Director of Agricultural Survey Division, Agriculture and Fisheries Department, Hokkaido Development Agency                                |
| Agroeconomy           | Mr. Y. OGAWA    | Director of Regional Planning Division, Tohoku Agricultural Administration Bureau, MAFF   |
| Economic Evaluation   | Mr. H. TANIMOTO | Deputy Director of 2nd Technical Appraisal Division, Economic Research and Technical Appraisal Department, The Overseas Economic Cooperation Fund |

### Feasibility Study Team Member List

| Speciality    | Name             | Assignment  |
|---------------|------------------|---|
| Team Leader   | Mr. K. SHIRAISHI | Coordination and Management,<br>Planning of Irrigation and<br>Drainage System               |
| Deputy Leader | Mr. A. TOGO      | Coordination and Management,<br>Planning of Drainage, Hydrology<br>and Water Quality Survey |
| Soil Science  | Mr. H. ISHIKAWA  | Soil Survey, Land Use and Agri-<br>culture  |
| Hydrology     | Mr. T. KURAUCHI  | Hydrology, Meteorology, Planning<br>of Irrigation and Drainage System                       |
| Irrigation    | Mr. Y. SHIONO    | Planning of Irrigation, Topo-<br>survey   |
| Construction  | Mr. H. TAKADA    | Design of Structure, Road and<br>Planning of Works  |
| Hydro-geology | Mr. K. YOSHIDA   | Geological and geomorphological<br>Survey, Drainage   |
| Livestock     | Dr. T. NAGAMITSU | Livestock, Farm Management, and<br>Land Use   |
| Agronomy      | Mr. M. SHIBATA   | Farm Management, Agroecology and<br>Financial Evaluation                                    |
| Economy       | Mr. Y. NOZAKI    | Soil Survey, Environmental Study,<br>Economic Evaluation, Ecological<br>Survey              |
| Topography    | Mr. H. HIRATA    | Topo-survey   |
| Topography    | Mr. I. MAKUTA    | Topo-survey   |

