

Replacement cost

Sprinkler set on farm	: Every 7 years	Col.\$15,000/ha
Hose for sprinkler set	: Every 5 years	Col.\$ 5,000/ha

Cost of repairs

Open canal	: To make allowance for 4% of construction cost at every year after 7 years
Diversion weir	: - ditto -
Reservoir	: - ditto -
Tank	: - ditto -

6.4 Economic Internal Rate of Return (EIRR) and Benefit Cost Ratio (B/C)

The economic internal rate of return of each sub-project area is calculated based on the cost and benefit as mentioned above.

The prerequisite conditions of the calculation are as follows:

- Project life is assumed to be 30 years.
- Target yield will be achieved at the fourth year after completion of the project.
- Production cost is paid in selling time of agricultural products of the farmer's income.

Results of the calculation are 24-57% as shown in Table 6.4.1, then the benefit/cost ratio of 2.0-6.4 is estimated in case of 12% of discount factor.

Table 6.4.1 EIRR, NPV and B/C

<u>Sub-project area</u>	EIRR (%)	<u>12% of discount factor</u>	
		B/C (%)	NPV(Col.\$1000)
San Pedro de Iguaque	24	2.0	45,946
Santa Sofia	56	6.4	299,500
Caqueza	57	5.5	350,914
Tibacuy	41	3.9	153,539

## 6.5 Sensitivity Analysis

Sensitivity analysis of each sub-project area has been made considering the case such as increase of project cost, reduction of benefit, and delay of target yield.

Results of the calculation are as follows:

San Pedro de Iguaque	18 - 24 %
Santa Sofia	37 - 56 %
Caqueza	36 - 57 %
Tibacuy	28 - 41 %

Table 6.5.1 Variation of EIRR by Sensitivity Analysis

Item	San Pedro de Iguaque (%)	Santa Sofia (%)	Caqueza (%)	Tibacuy (%)
1) Original	24	56	57	41
2) 10% decrease in price of crops (10% reduction in production)	18	50	49	35
3) 10% increase in production cost	20	54	53	39
4) 15% increase in construction cost	22	52	52	37
6) Two-year delay in target yield	18	37	36	28

## 6.6 Financial Analysis of Farm Household

### 6.6.1 Profit and Loss

Taking into consideration the cropping pattern, farm scale and local condition, the farm management of the model farmers at target year under the proposed cropping pattern can be analyzed.

- The agricultural products to be put into the commercial base is assumed as the balance of the products deducting home-consumption amount of farmers from the total agricultural production. (the home-consumption is based on Annex C, Table C.5.8 Amount of Self Consumption in the Project Area)
- Family labor is excluded from production cost.
- Annual interest of the credit for farm production cost is to be 18% including banker's commission, and credit term is decided to the cultivated period.

The results of the calculation is summarized as follows and its detail is shown in Annex C, Table C.4.12-C.4.13 (Profit and Loss Statement and Cash Flow of Model Farmer). As the results indicated, sharp improvement of farm household economy will be expected for farm conditions of the model farmers in each sub-project area after completion of the project.

Table 6.6.1 Increased Income of Model Farmers

Sub-Project Area	Without Project	Unit: 1,000 Col.\$
		With Project (as target year)
San Pedro de Iguaque	6	100
Santa Sofia	4	250
Caqueza	7	239
Tibacuy	20	180

Note: O/M cost and interest of credit have been excluded from the income as costs.

### 6.6.2 Possible Capacity of Farmers for Payment of O/M Cost

It is the farmers in the project area to gain a lot of profit from the project through the project implementation. The irrigation facilities to have been constructed under the project will be transferred to the water user's organization in each sub-project area after completion of the project, and the cost of operation and maintenance for these facilities will be borne by the beneficiaries as member of the organization.

As mentioned in the paragraph 5.3 (Operation and Maintenance Cost), annual average cost and cost per per ha of operation and maintenance in each sub-project area after completion of project are estimated as follows:

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Sub-project area	Annual O/M cost	O/M Cost per ha	Model per farmer
San Pedro de Iguaque	1,662,000	1010,262	30,000
Santa Sofia	2,118,000	8,862	19,000
Caqueza	3,119,000	7,480	10,000
Tibacuy	2,003,000	7,765	14,000

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In view of the results in financial analysis of the model farmers, it is considered that the beneficiaries will be able to bear the estimated operation and maintenance cost.



## **CHAPTER 7. CONCLUSION AND RECOMMENDATION**



## CHAPTER 7. CONCLUSION AND RECOMMENDATION

### 7.1 Conclusion

The study on necessity, feasibility and viability of the small scale irrigation project in San Pedro de Iguaque, Santa Sofia, Caqueza and Tibacuy sub-project areas resulted in the following conclusion.

- (1) Taking into consideration the present land use and availability of water resources from the streams, the irrigable area of each sub-project area was studied and decided as follows:

San Pedro de Iguaque	162 ha
Santa Sofia	239 ha
Caqueza	417 ha
Tibacuy	258 ha
Total	1,076 ha

All of the above mentioned irrigable area are currently under cultivation.

- (2) Considering the available water amount from the stream, it will be possible that cropping intensity of the ordinary farm during dry season in San Pedro de Iguaque, Santa Sofia and Tibacuy sub-project areas can be increased. As for Caqueza sub-project area and coffee plantation in Tibacuy sub-project area, it is preferable to make water use plan aiming at preventing drought damage during wet season.

- (3) When irrigation facilities are provided, the cropping intensity in each sub-project area can be increased from 100-110% which is presently prevailing to 160-190%.

In addition to the major crops which have been cultivating, it is desirable to introduce to the proposed cropping pattern the vegetables such as welsh onion, carrot for San Pedro de Iguaque,



The project cost of each sub-project area is as follows:

Sub-project area	Construction Cost		Project Cost	
	Total Amt. (Col.\$000)	Per ha (US\$)	Total Amt. (Col.\$000)	Per ha (US\$)
San Pedro de Iguaque	27,412	850	35,519	1,100
Santa Sofia	39,320	820	44,631	930
Caqueza	54,708	660	63,684	760
Tibacuy	34,392	670	42,178	820
Total/Average	155,832	720	186,012	860

(7) After completion of the project, increment of the gross income attributed to the increasing agricultural production is anticipated at Col.\$367 million and the benefit of the project will be expected at Col.\$200 million.

(8) The results of the trial estimation on the model farmers' economy show that the income of each model farmer is augmented from Col.\$4,000-20,000 per annum at present to Col.\$100,000-250,000 per annum at target year.

The working days for farming is increased from 378-580 man-day/year at present to 606-985 man-day/year.

(9) Based on the invested cost to the project and benefit attributed to the project, the internal rate of return of the project was calculated. The internal rate of return of each sub-project area is as follows:

San Pedro de Iguaque	24 %
Santa Sofia	56 %
Caqueza	57 %
Tibacuy	41 %

Sensitivity analysis of the internal rate of return is also examined taking into account the possible fluctuation of commodity price and productivity. The result of the analysis is 18-54 %.

## 7.2 Recommendation

- (1) The Government of the Republic of Colombia is requested to prepare necessary action for commencement of the project implementation as early as possible.

At the first stage of the project implementation, development of the pilot areas using a part of irrigation system in all sub-project areas except Caqueza sub-project area should be implemented. Subsequently, development of the remaining irrigation systems should be carried out.

<u>ub-project area</u>	<u>Irrigation system</u>	<u>Irrigable area (ha)</u>
San Pedro de Iguaque	Yerbabuena No.1	26
Santa Sofia	Camelo	28
Tibacuy	San Jose No.2	15

- (2) Development of the pilot areas should be conducted aiming at demonstration of the effect and technology in irrigation farming. Therefore, the concerned agencies of the government should give appropriate instruction to the cooperatives and individual farmers regarding to establishment of water users' association, water management and farming technology.
- (3) The project will be adopted in response to the request from the concerned farmers. Upon adoption, the beneficiaries of the project shall offer labor and land necessary for the project implementation. Therefore, in order to facilitate the project implementation, it is needed to establish a cooperation system of the farmers for the project as early as possible.

- (4) In order to materialize the project benefit successfully, establishment of the comprehensive farming technology including O/M of the project and water management, etc. after completion of the project, and extension services for the concerned farmers on farming technology are indispensable.

The development of the pilot areas as mentioned before is one of the above indispensable items. Additionally the following items are also proposed.

- Organization of water users' association and instruction of technology to the concerned technicians.
- Strengthening of the supporting organization for the farmers coordinating the existing supporting organization.
- Training of instructors on farm management including water management and soil conservation.
- Strengthening of the cooperatives (particularly regarding to distribution system).

- (5) Regarding the project, items to be studied in the future are as follows:

- Because the discharge water amount of the Q. Palonegro is enough to irrigate all existing farmland, construction of new reservoir is not proposed in this study. However, there is a possible dam site with storage capacity of about 10,000 m<sup>3</sup> in a depression area which is located in downstream and right side bank of Q. Palonegro. Construction of this reservoir shall be considered when the water demand is increased in the future.
- As one of the alternatives for Caqueza sub-project area, utilization of discharge water of the Palmar River is considered. This alternative is not included in the project due to water right. However, the discharge water of the Palmar River can be diverted

to the highest elevation area in the northern part of Caqueza sub-project area with gravity through a intake weir (EL. which will be constructed at Pueblo Viejo 2,300 m and 60.5 km<sup>2</sup> of catchment area) and a driving channel with length of 8,500 m. When this scheme comes into use, about 600 ha of all farmland in Caqueza area including the area which is excluded from the sub-project area.

- Scattered farm of small lot and high elevation area where irrigation water can not be applied with gravity from the nearby streams are excluded from the project area. It should be considered that small scale of reservoirs are constructed by the concerned farmers and water is stored in the reservoir during rainy season which will be able to use for irrigation in this area. Irrigation water amount per ha required for one or two months of sowing and planting period of the crops will be about 400 m<sup>3</sup>.
- A large scale of eroded areas are not existed in the project area. However, wasted area due to soil erosion can be seen in the neighboring area. Necessary action should be taken in this area in order to prevent further damage caused by extending erosion.
- Vehicular traffic through the connecting roads from main roads to the project areas are practicable. However, in order to accelerate the development of rural area, pavement and up-grade of the roads should be carried out in the future.
- In Tibacuy sub-project area, washing water of coffee beans can easily be secured after provision of irrigation facilities. On the contrary, water quality of the stream will be polluted by wasted water after washing coffee beans. Therefore, in order to prevent pollution caused by peeling and washing coffee beans, necessary countermeasures such as provision of common facilities including sewage treatment plant should be taken.

(6) Items to be carried out continuously by HIMAT

- Observation of precipitation and stream discharge in the project area

In order to contribute better detailed design and operation and maintenance of irrigation facilities, observation of precipitation and stream discharge should be continued, using the triangular and rectangular weirs which were installed during the previous field study.

- Ownership of farmland and land holding condition

Under the project, only the existing farmland is irrigated due to lack of enough irrigation water available. However, detailed survey on ownership and utilization condition of farmland owned by each farmer (location and area of farms to be irrigated) should be carried out before the forthcoming detailed design.

(7) Others

On account of the objectives of the project, the duration spent for study and plan of the Small Scale Irrigation Package Project in Slope Areas is desirable to be short as much as possible. Therefore, it is preferable to standardize the contents of the project to a certain degree.

The Small Scale Irrigation Package Project in Slope Areas is composed of four sub-project areas which characterize in their area condition and collected data. Therefore, in the course of formulating the project, particular analysis methods were applied to each sub-project area. It is considered that the particular analysis methods can be applied to the similar projects.

Major points of the analysis methods are as follows:

- Analysis method in case that discharge records of the concerned streams are available.
- Analysis method in case that discharge records of the concerned streams are not available.
- Determination of the irrigable area of the project.
- Determination of reasonable size and type of irrigation facilities.
- Methods applied to pipeline system in slope area and irrigation manners.

## Appendix



## 1 PERSONEL ENGAGED IN THE FEASIBILITY STUDY

### (1) Advisory Committee

#### 1. Chairman

Mr. Yoshikazu YOSHIDA      Director,  
Land Improvement & Consolidation Div.,  
Agricultural Structure Improvement Bureau,  
Ministry of Agriculture, Forestry &  
Fisheries. (MAFF)

#### 2. Irrigation/Drainage Expert

Mr. Akira NAKAZAWA      Assistant Chief,  
Design Div.,  
Construction Dep.,  
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Ministry of Agriculture, Forestry &  
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#### 3. Agriculture Expert

Mr. Masayuki TSUCHIYA      Advisor,  
Policy Div.,  
Agricultural Production Bureau,  
Ministry Agriculture, Forestry &  
Fisheries. (MAFF)

### (2) Supervisory Team of the Field Study

( Phase I Study , Feb. 1986 )

Leader

Mr. Akira NAKAZAWA      Same as preceding

Mr. Shiro KANATAMA      JICA

( Phase II Study ,Jul. 1986 )

Leader

Mr. Yoshiyuki YOSHIDA Same as preceding

Mr. Toshiyuki KUROYANAGI JICA

(3) Feasibility Study Members

- |                             |                        |
|-----------------------------|------------------------|
| 1. Team Leader              | Mr. Narao TAKEMURA     |
| 2. Irrigation/Drainage      | Mr. Kunio TAKAGAKI     |
| 3. Project Evaluation       | Mr. Yoshihiro UCHIDA   |
| 4. Agronomy                 | Mr. Saburo NAKANISHI   |
| 5. Meteorology/Hydrology    | Mr. Nobuya SARUWATARI  |
| 6. Soil & Land Use          | Mr. Akio MOTOHASHI     |
| 7. Civil Work               | Mr. Kazunari NAGATA    |
| 8. Survey/Sturucture Design | Mr. Sadao TAKADA       |
| 9. Agro-Economy             | Mr. Yoshiyuki ISHIZAKI |

(3) Officials (counterparts) of the Government of Colombia

Director General	Dr. Fabio Bermudez Gomez
Jefe Planeacion	Dr. Jaime Padilla Reyes
Subdirector Estudio e Investigaciones	Dr. Jorge Ivan Valencia
Jefe de Divicion de Estudios de Factibilidad	Dr. Juan Francisco Galindo
Jefe de Divicion Proyectos Especiales	Dr. Joaquin Miranda
Jefe Seccion de Lagos y Riego en Laderas	Dr. Elibardo Cuellar
Ingeniero Civil	Dr. Alfonzo Suarez
Ingeniero Civil	Dra. Gabby Vega
Sueros Agricolas	Dr. Luis Eduardo Ortiz
Economista	Dra. Martha Lucia Quintero
Economista	Dr. Alberto Duque
Ing. Agronomo	Dr. Luis Carlos Sanchez
Zootecnista	Dr. Augusto Acosta
Sociologa	Dra. Fabiora Enciso
Hidrologo	Dr. Alvaro Lanhero
Meteorologa	Dra. Clara Ines Mateus
Cartografo	Dr. Guillermo Larrota
Agrologo	Dr. Norberto Garavito
Topografo	Ing. Carlos Albaracin
Topografo	Ing. Miguel Gallo





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