The net profit of garlic is the highest of all the crops, followed by potato and onion. Though profitability of kidney bean is not high, it is indispensable as a food crop, and it should not be evaluated solely from profitability.

Total gross profit, cost and net profit in the project area are shown in Table 4.3.2-7. Comparing with the "Present", the gross profit increases by 30% and the net profit 31% after the project implementation.

Table 4.3.2-7 Gross Profit, Cost and Net Profit

Unit: RD$1,000

| | Gross Profit | Cost | Net Profit |
|---|---|---|---|
| (1) Present | 157,438 | 74,169 | 83,269 |
| (2) Without | 173,351 | 88,487 | 84,864 |
| (3) With | 204,109 | 95,124 | 108,985 |
| (3) - (2) | 30,758 | 6,637 | 24,121 |

In the above table, the distinction between the "Without" and "With", i.e. RD$24,120 thousand is the crop benefit by the project.

## 4.3.3 Farm Management Plan

### (1) Farm Scale

The cropping area of each farmer will not change even after the project implementation. Here typical farmers are selected for small scale, medium scale and large scale, and small scale is 0.6ha, medium scale 3.0ha and large scale 13.0ha. Table 4.3.3-1 shows cropping hectarage of each crop by different scales.

Table 4.3.3-1 Cropping Area according to Farm Scale

Unit: ha

| | Small Scale | | Medium Scale | | Large Scale | |
|---|---|---|---|---|---|---|
| | Present | With Project | Present | With Project | Present | With Project |
| Cropping area | 0.6 | 0.6 | 3.0 | 3.0 | 13.0 | 13.0 |
| Garlic | 0.4 | 0.5 | 2.5 | 2.8 | 11.0 | 12.0 |
| Potato | 0.5 | 0.5 | 1.5 | 1.5 | 3.0 | 4.0 |
| Kidney bean | 0.2 | 0.2 | 1.0 | 1.0 | 2.0 | 2.0 |
| Onion | 0.2 | 0.2 | 1.0 | 1.0 | 2.0 | 3.0 |
| Lettuce | 0.1 | 0.1 | 0.3 | 0.2 | 1.0 | 1.0 |
| Other vegetables | 0.1 | 0.1 | 0.1 | 0.2 | 0.5 | 2.0 |
| Graminae | - | 0.1 | - | 0.5 | - | 2.0 |
| Total | 1.5 | 1.7 | 6.4 | 7.2 | 19.5 | 26.0 |
| Cropping rate % | 250 | 283 | 213 | 240 | 150 | 200 |

Note: Export vegetable is included in the category of other vegetables.

(2) Cropping Plan

The cropping rate of the "Present" is 250% in small scale, 213% in medium scale and 150% in large scale, and it decreases against the farm scale. The most profitable garlic is grown by 66.7% of small scale farmer, 83.3% of medium scale farmer and 84.6% of large scale farmer because of its production cost, irrigation water and irrigation equipments.

The area of each crop is planned as shown in Table 4.3.3-1, considering the present cropping rate. The planned cropping rate is 283% for small scale, 240% for medium scale and 200% for large scale.

(3) Cultivation Technique

The plan employs techniques discussed in the section of Agricultural Production Plan for seeding, manuring, agricultural chemical spray, herbicide application, etc.

(4) Agricultural Economy Plan

1) Agricultural balance

Table 4.3.3-2 shows agricultural balance. Almost all the farmers do not gain non-agricultural income from the farmers investigation. Agricultural net profit is obtained by subtracting production cost from gross agricultural profit. Comparing gross agricultural profit between the "Without" and "With", it increases by 35% in small scale farmer, 32% in medium scale and 47% in large scale. And agricultural net profit increases by 49% in small scale farmer, 43% in medium scale and 104% in large scale.

Table 4.3.3-2 Agricultural Balance

Unit: RD$

| | | Gross profit | Production cost | Net profit |
|---|---|---|---|---|
| Small | Present | 71,526 | 33,691 | 37,835 |
| | Without | 78,763 | 40,254 | 38,509 |
| | With | 106,517 | 49,163 | 57,354 |
| Medium | Present | 332,934 | 200,239 | 132,695 |
| | Without | 366,832 | 220,263 | 146,569 |
| | With | 484,760 | 275,071 | 209,689 |
| Large | Present | 1,162,563 | 909,108 | 253,455 |
| | Without | 1,281,679 | 1,000,019 | 281,660 |
| | With | 1,883,592 | 1,307,949 | 575,643 |

(5) Farmer's Economic Surplus

Farmer's economic surplus is obtained by substracting living costs from agricultural net profit. The present living costs are obtained from JICA's medium scale farmer's living costs investigation from 1981 to 1985. The living costs for a medium scale farmer is set at RD$45,424, multiplying the consumable price index to the above data. Proposed living costs is estimated as 1.5 times as greater than that of the "Present". Farmer's economic surplus of the "with" increases by 47 - 230%, comparing with the "without".

Table 4.3.3-3 Farmer's Economic Surplus

Unit: RS$

| | | Net Profit | Living Costs | Economic Surplus |
|---|---|---|---|---|
| Small | Present | 37,835 | 22,712 | 15,123 |
| | Without | 38,509 | 22,712 | 15,797 |
| | With | 57,354 | 34,068 | 23,286 |
| Medium | Present | 132,695 | 45,424 | 87,271 |
| | Without | 146,569 | 45,424 | 101,145 |
| | With | 209,689 | 68,136 | 141,553 |
| Large | Present | 253,455 | 90,848 | 162,607 |
| | Without | 281,660 | 90,848 | 190,812 |
| | With | 575,643 | 136,272 | 439,371 |

4.3.4 Marketing Plan of Agricultural Products

(1) Demand of Vegetables and Forecast of the Export

Annual consumption per capita of potato increased by 2.2 times and kidney bean by 1.34 times in the past 9 years, and 20,000t of kidney bean and 100t of garlic which are the the principal crops in Constanza were planned to be imported for the whole country in 1989. The principal crops of Constanza at present, i.e., garlic, potato, kidney bean and onion are the basic crops necessary for

the Dominican recipe. Garlic and onion are basic seasoning, potato is one of the staple food crops and kidney bean is taken together with rice. Their demand, therefore, is thought to increase according to the improvement of the living standard and the increase of population.

The export of sugar which was the biggest earner has declined to half since 1985 of the conventional principal export crops, i.e., sugar, coffee, cacao and tobacco. Therefore, the export of horticultural crops is highly expected by the country. Though vegetables are not exported from Constanza, various vegetables are exported from the other areas.

But there are problems of Thrimps palmi and pesticide residue in the largest importer, U.S.A., which should be solved if export crops are grown in Constanza in the future. Though difficult, if the problems are solved, export of vegetables is very hopeful with the advantage of the natural conditions in Constanza as the export of pod snow pea was successful in the past.

(2) Marketing of Agricultural Products

At present, almost all the agricultural products in Constanza are sold through a middle man except a few farmers who sell them directly to the market, supermarket and hotel. Market information is disseminated orally, therefore the information is unsure and there are cases that the products are sold cheaply. In order to improve the marketing system, it is foundamental that farmers should be involved in marketing. But judging from the present state it is difficult that a farmer takes part individually in marketing.

Therefore, the best way is that the Agricultural Development Union (Refer to 4.3.6) integrated from the existing farmer's associations steers marketing. Concretely, Agricultural Development Union establishes market information network (including export market), the market information is disseminated systematically to farmers and the union collects, prepares,

transports and sells product to the market. If it is done so, it is possible to control quality of products and regulate shipment to some extent, and it helps for the stability of price. And it may be considered that the union establishes system for direct sale of Constanza vegetables to consumers in Santo Domingo and Santiago.

### 4.3.5 Agricultural Supporting System

In order to improve the productivity of crops in Constanza, it requires various improvement plans such as improvement of soil fertility, improvement of seed, improvement and extension of cultivation techniques, improvement of pesticide usage, ratification of marketing, effective use of irrigation water, etc. Agriculture supporting system is also improved to achieve the above improvement plans. Partically, Horticultural Experiment Station, SEA-Constanza and INDRHI-Constanza will play a core role. Therefore, the organizations should be well equipped and intensification of the system is indespensable factor with improving facilities. In order to include farmer's voice for the development of agriculture in the area, a farming committee is proposed to be established newly.

### 4.3.6 Farmers' Organization

There exist farmers' associations in Constanza at present. But each association has small number of members and its activities are limited. In the plan, an agricultural development system is proposed to develop agriculture in Constanza and heighten the productivity as shown in Fig. 4.3.6-1. The aim of the proposal is to cooperate together in the common activities on agriculture such as production, marketing and water management and to improve the production in the whole area. The organization is largely divided into Water Management Division and Agricultural Production Division. Water Management Division is under the guidance and direction of INDRHI and Agricultural Production Division is under SEA. The existing farmer's associations are reorganized into a block of farmer's association and the whole area can carry out activities systemically.

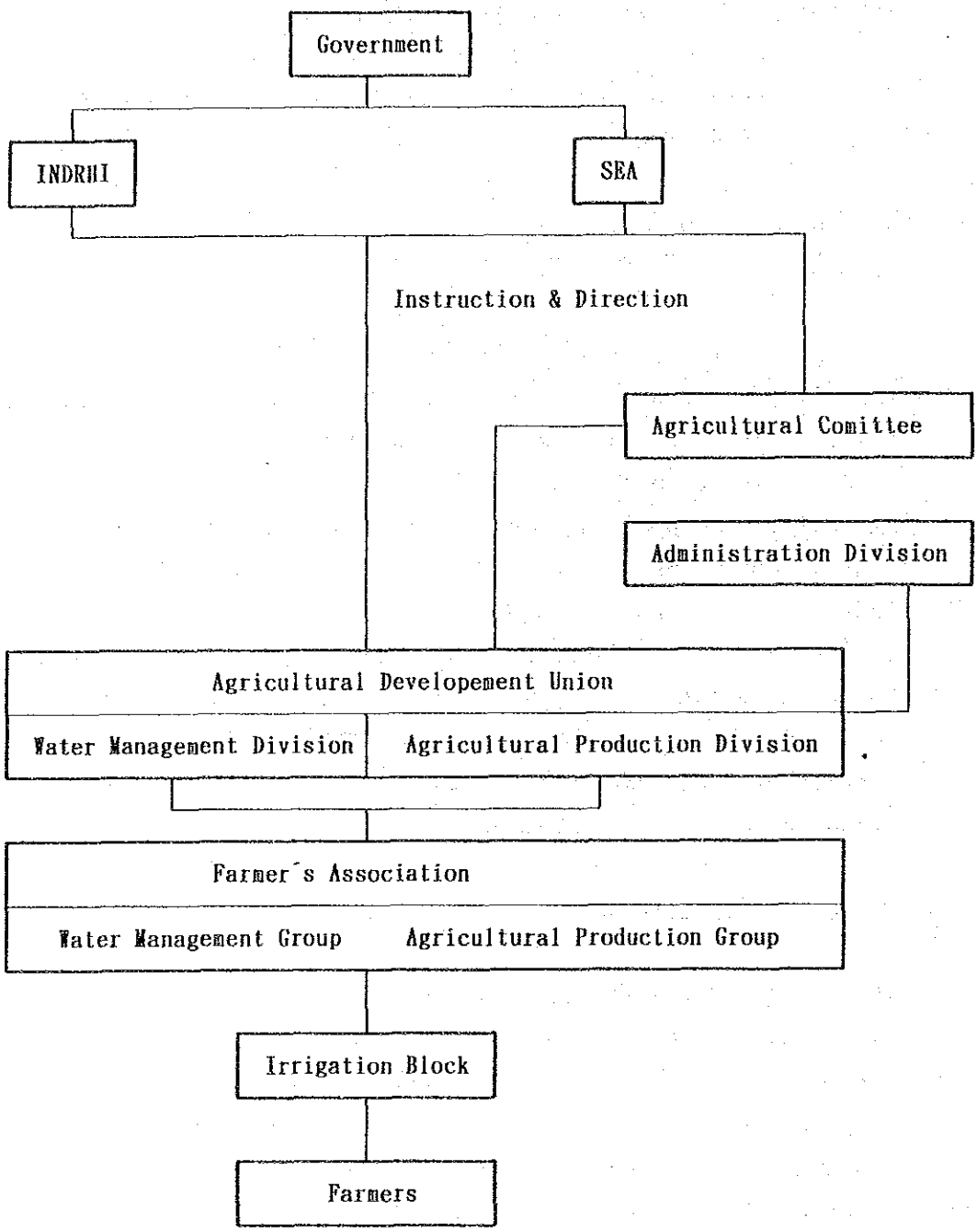



Fig. 4.3.6-1 Organization of Agricultural Development Union in Constanza

## 4.4 Irrigation Facilities Arrangement Plan

Arrangement plan of irrigation facilities is planned as the canal construction plan based on the evaluation of the most suitable development plan. The arrangement plan of irrigation facilities in the Valley is shown in Fig. 4.4.1-1.

### 4.4.1 Benefit Area

The benefit area has been determined as 1,510ha which does not have geographical problems of water distribution in the present cultivated area of 1,660ha except the breeding stock farm of 20ha (Fig.4.4.1-1).

| | | | |
|---|---|---|---|
| Arable land | 1,680ha | | |
| Upland crops | 1,625ha | Benefit area : | 1,510ha |
| Horticulture under structure | 30ha | Non-Benefit area: | 170ha |
| Orchard | 5ha | | |
| Breeding stock farm | 20ha | | |

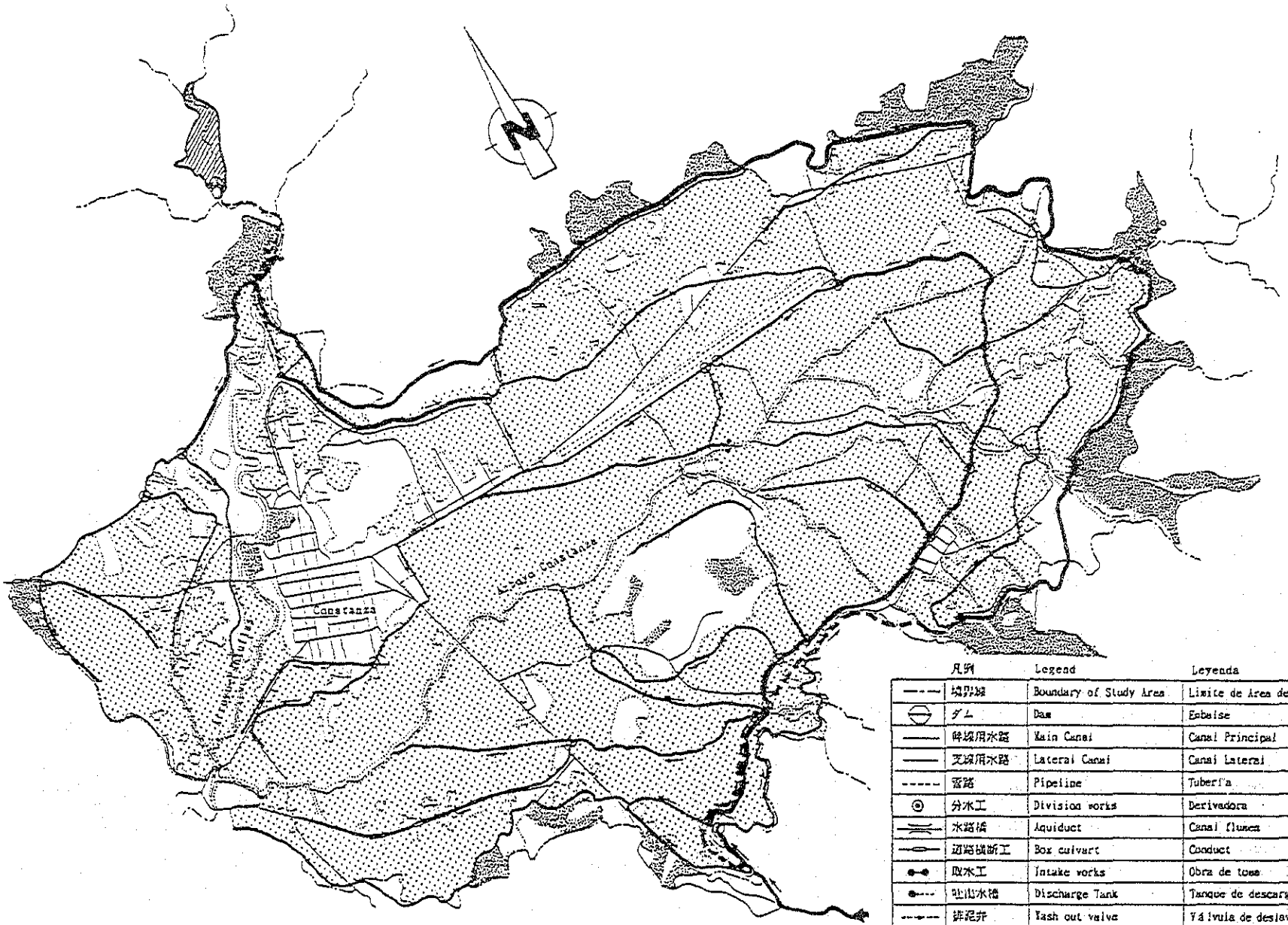
The non-benefit area is the arable land of 145ha which is at an elevation of higher than EL1,240m and an area of 25ha including problems of water distribution.

By the irrigation plan, the benefit area will be improved as follows;

| | | |
|---|---|---|
| Present benefit area | : | 1,275ha |
| Planned benefit area | : | 1,510ha |
| Increased benefit area | : | + 235ha |

### 4.4.2 Water Resources Development Plan

The water resources development plan is carried out on the basis of Alternative A (Pantuflas dam + Rehabilitation of the intake facilities), which was selected in the comparison study of the water resources.




| 凡例 | Legend | Leyenda |
|---|---|---|
| 境界線 | Boundary of Study Area | Limite de Area del Estudio |
| ダム | Dam | Embalse |
| 幹線用水路 | Main Canal | Canal Principal |
| 支線用水路 | Lateral Canal | Canal Lateral |
| 管路 | Pipeline | Tubería |
| 分水工 | Division works | Derivadora |
| 水路橋 | Aquiduct | Canal Puente |
| 道路横断工 | Box culvert | Conducto |
| 取水工 | Intake works | Obra de toma |
| 吐出水槽 | Discharge Tank | Tanque de descarga |
| 排泥弁 | Wash out valve | Válvula de desjave |
| 河川 | River | Río |
| 排水路 | Drainage | Canal de drenaje |

Fig. 4.4.1-1 Constanza Valley Development Plan

The basic countermeasure of the water resources development plan are as follows;

- Main water resources of the project is the Rio Grande

- Construction of new head works and rehabilitation of the head race will be carried out to improve the conveyance efficiency.

- Pantuflas dam will be constructed in order to supplement the irrigation water in the dry season.

- Discharge of small rivers in the Valley will be taken by the intake gates for the irrigation, but these water resources will not be included for the calculation of the water resources development plan, since these discharge are insignificant for the the project.

- Groundwater resources will not be included for the plan.

Details of the water resource development plan are shown in the following.

(1) Rio Grande Water Resources Development Plan

This water resources will be developed by the construction of new head works and the rehabilitation of the head race.

The present site condition, discharge, economicity and its operation/maintenance were studied for the evaluation of the structure and type of the new head works. The bar screen back stream diversion works was selected as its result. Its comparison study is shown in the Annex.
It is very important that the structure of the head works should have the capacity to take the available discharge efficiently, especially in the dry season.

The maximum design discharge is $1.0m^3/s$. The head race is to be re-studied in order to improve the conveyance efficiency.

(2) Pantuflas Dam Plan

The Pantuflas dam will be constructed at 200m upstream of the confluence between the Canada Casiano and the Arroyo Pantuflas which is selected by the optimum dam site study, in order to supplement the irrigation water in dry season. The storage capacity is calculated as follows.

| | |
|---|---|
| Available storage capacity | $V = 980,000m^3$ |
| Sediment volume | $V = 70,000m^3$ |
| Total storage capacity | $V = 1,050,000m^3$ |

The Pantuflas dam will supplement the irrigation water to the following area.

| | |
|---|---|
| January | A = 550ha |
| February | A = 510ha |
| March | A = 160ha |

In January and February, the water of the Pantuflas dam will be alimented to the Canal Constanza in order to supplement the shortage volume of the Canal Constanza. The irrigation to the Canal Pantuflas will be realized during January to March. The Pantuflas dam will store the discharge of the Arroyo Pantuflas. The total annual runoff of the dam site is approximately 250 x $10^4m^3$/year. The total storage capacity of the Pantuflas dam of 105 x $10^4m^3$ is equivalent to 41% of the annual runoff.

(3) Other Countermeasures

The rehabilitation of the existing small water gates and construction of the water gates will be realized for efficient utilization of the water resources of arroyos in the Valley.

- Rehabilitation of the intake works at the Arroyo Pantuflas for efficient utilization of the water resources of the Arroyo Pantuflas. This intake works aliment to the Canal Pantuflas.

- Rehabilitation of the intake works at the Arroyo Palero in order to aliment to the Canal Nueva Constanza.

- Rehabilitation of the intake works at the Canal Abud in order to aliment the Canal Abud and to catch the drained water.

### 4.4.3 Irrigation Plan

Irrigation water volume was estimated by Penman's method using the meteorological data at Constanza Meteorological Station based on 5 year return period of draught year. The details of the irrigation plan is shown below.

#### (1) Irrigation Water Requirement

##### 1) Crop water requirement

Table 4.4.3-1 Monthly Crop Water Requirement

(Unit:mm/month)

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETo | 77.5 | 75.6 | 105.4 | 99.0 | 108.5 | 105.0 | 117.8 | 111.6 | 99.0 | 93.0 | 72.0 | 71.3 |
| K c | 0.68 | 0.76 | 0.48 | 0.26 | 0.51 | 0.77 | 0.68 | 0.37 | 0.15 | 0.32 | 0.76 | 0.74 |
| ETcrop | 52.7 | 57.5 | 50.6 | 25.7 | 55.3 | 80.9 | 80.1 | 41.3 | 14.9 | 29.8 | 54.7 | 52.8 |

##### 2) Estimation of irrigation water requirement

The irrigation water requirement is estimated considering the crop water requirement, effective rainfall and irrigation efficiency. The effective rainfall and irrigation efficiency are determined as follows.

a. Effective rainfall

The effective rainfall was estimated by the Evaporation and Precipitation Method (USDA Method) based on the available data, rainfall characteristics, etc.

Table 4.4.3-2 Effective Rainfall

(Unit:mm/month)

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall | 15.8 | 24.9 | 26.6 | 54.0 | 152.1 | 83.9 | 59.0 | 125.6 | 108.1 | 89.0 | 52.4 | 39.9 | 831.3 |
| Effective rainfall | 10.3 | 16.5 | 17.2 | 25.3 | 55.3 | 55.9 | 40.8 | 41.3 | 14.9 | 29.8 | 34.1 | 25.8 | 367.2 |

b. Irrigation efficiency

The irrigation efficiencies have been determined as follows based on the geography, structure of canal, water distribution method, irrigation method in accordance with the FAO standard.

| | |
|---|---|
| Application efficiency (Ea) | 0.7 |
| Field canal efficiency (Eb) | 0.8 |
| Conveyance efficiency (Ec) | 0.9 |
| Irrigation efficiency (Ep) | 0.5 |

c. Irrigation water requirement

The irrigation water requirement calculated from the crop water requirement, the effective rainfall, cropping area and irrigation efficiency as follows.

Table 4.4.3-3 Irrigation Water Requirement

( (Unit:mm/month) )

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETcrop | 52.7 | 57.5 | 50.6 | 25.7 | 55.3 | 80.9 | 80.1 | 41.3 | 14.9 | 29.8 | 54.7 | 52.8 |
| Effective rainfall | 10.3 | 16.5 | 17.2 | 25.3 | 55.3 | 55.9 | 40.8 | 41.3 | 14.9 | 29.8 | 34.1 | 25.8 |
| N.W.R. | 42.4 | 41.0 | 33.4 | 0.4 | — | 25.0 | 39.5 | — | — | — | 20.6 | 27.0 |
| G.W.R. | 84.8 | 82.0 | 66.8 | 0.8 | — | 50.0 | 79.0 | — | — | — | 41.2 | 54.0 |

N.W.R.=Net water requirement
G.W.R.=Gross water requirement

(2) Irrigation Method

Sprinkler irrigation is determined as the irrigation method suitable for the project area considering the natural, farming and economical conditions. The main reasons are as follows.

a. Geographical slope and block reformation of farm land are suitable for both surface irrigation and sprinkler irrigation. However, the sprinkler irrigation has an advantage that it is not limited by the geographical conditions. Actually, the sprinkler irrigation is practiced in many parts of the Valley.

b. The sprinkler irrigation is profitable because of its higher irrigation efficiency in the conditions of continuous water storage and restricted water resource.

(3) Irrigation Water Volume, Irrigation Interval and Rotation Block

The irrigation interval of each crop is calculated from the TRAM value of 33mm and daily water consumption as follows.

Table 4.4.3-4 Irrigation Interval of Crop

| Crop | TRAM (mm) | Maximum daily water consumption (mm/day) | | Interval (day) | Ratio |
|---|---|---|---|---|---|
| Graminae | 33 | 3.88 | Ave. | 8 | 60/260 |
| Vegetable 1,3 | 33 | 2.11 | | | |
| 2 | 33 | 2.38 | 2.56 | 13 | 20/260 |
| 4 | 33 | 3.19 | | | |
| Onion | 33 | 2.85 | | 12 | 20/260 |
| Potato 1 | 33 | 3.23 | 3.26 | 10 | 60/260 |
| 2 | 33 | 3.29 | | | |
| Kidney bean | 33 | 3.72 | | 9 | 20/260 |
| Green Manure | 33 | 1.91 | | 17 | 20/260 |
| Garlic 1,2,3 | 33 | 2.13 | | 16 | 60/260 |
| Average | 33 | | | | 12 |

Based on the result mentioned above, the irrigation interval is determined as 12 days in average. The irrigation water volume is 33mm from the TRAM value.

(4) Design Irrigation Water Volume

The irrigation is to be carried out with rotation block in the irrigation block and irrigation interval is calculated as 12 days. The capacity of facilities is determined as follows.

- Net irrigation volume = 80.9/30 x 12 = 32.4mm = 3.75 ℓ/s/ha
- Field irrigation volume = 32.4/0.7 = 46.2mm = 5.36 ℓ/s/ha
- Capacity of lateral canal = 80.9/30/0.5 = 5.4mm = 0.625 ℓ/s/ha

(5) Water Distribution Plan

a. Network of irrigation canal

The network of irrigation canal in Constanza Valley is shown in Fig. 4.4.3-1. The canal network is designed to distribute irrigation water to the whole area equally by considering the existing canal network and effective utilization of water resource.

The benefit area is divided into the following three networks.

- Network by Canal Nueva Constanza: 469ha
- Network by Canal Constanza : 884ha
- Network by Canal Pantuflas : 157ha

The area irrigated by the Canal Nueva Constanza is 469ha and outside of the area of the Canal Constanza. The upstream area of 356ha is irrigated by the discharge from the Rio Grande throughout the year. The downstream area of 113ha is irrigated by the Rio Grande water resource in wet season, but irrigated by the discharge from the Pantuflas dam in dry season.

The network by the Canal Pantuflas is irrigated by water from the Rio Grande throughout the year, but supplemented by water

from the Pantuflas dam in dry season. The irrigation water is distributed from the Rio Grande through the Canal Nueva Constanza. The area of the blocks are 157ha in total.

The area irrigated by the Canal Constanza is 884ha and located in both sides along the Arroyo Constanza. The upstream area of 602ha is irrigated by the discharge from the Rio Grande throughout the year. The downstream of 282ha is irrigated by the Rio Grande water resource in wet season, but irrigated by the discharge from the Pantuflas dam in dry season.

The design discharge of each canal is shown in Fig. 4.4.3-3.

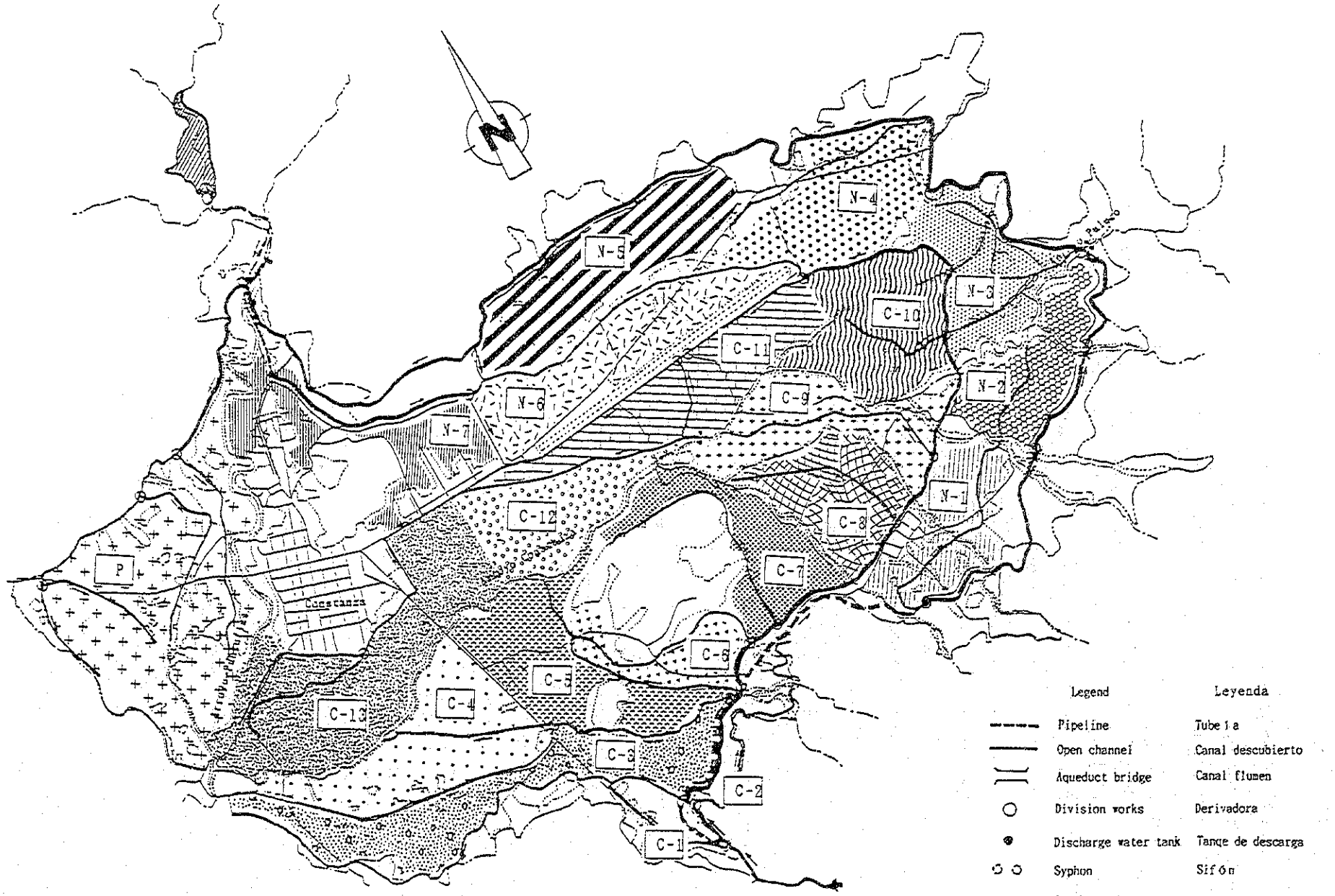



Fig. 4.4.3-1 Irrigation Block

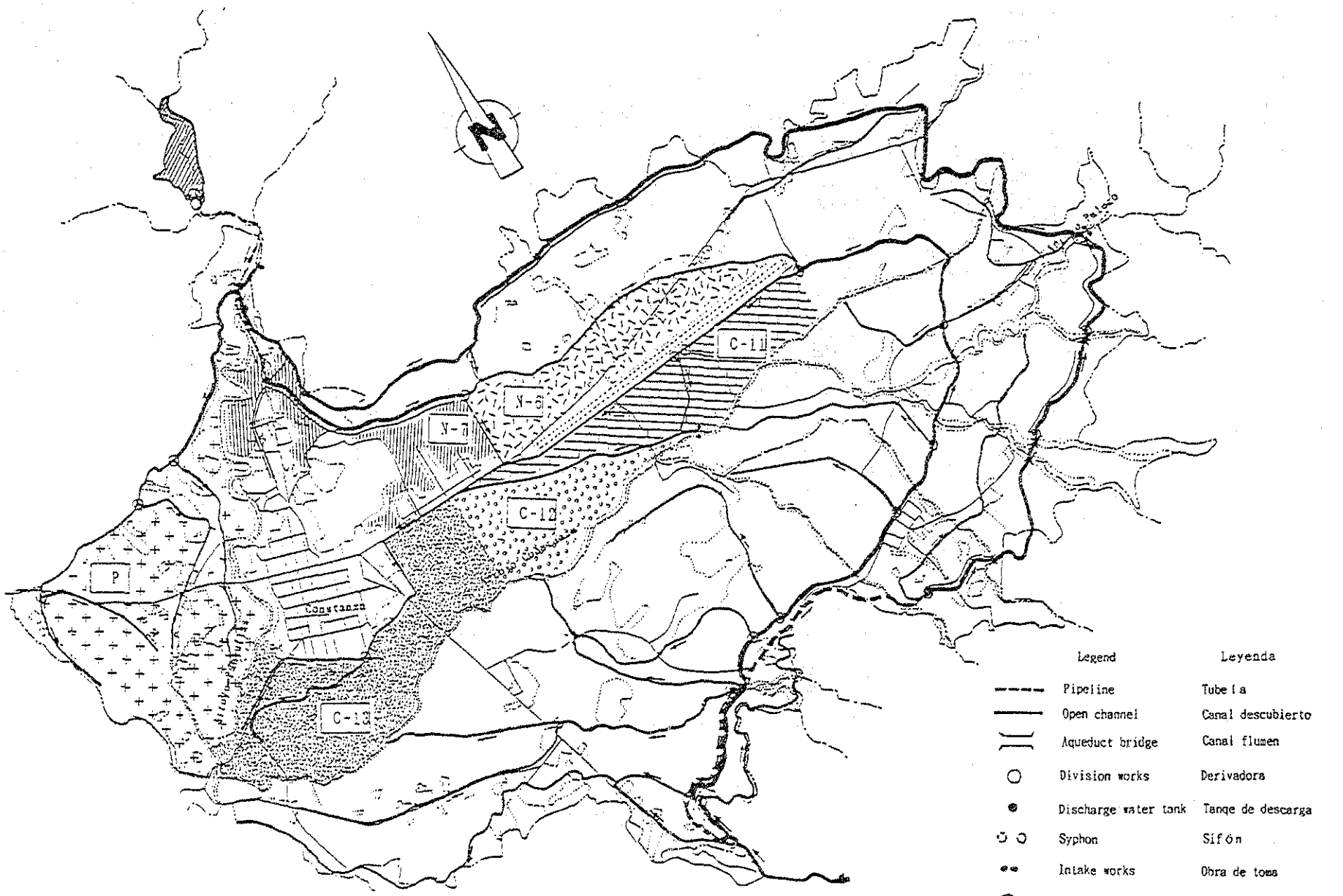
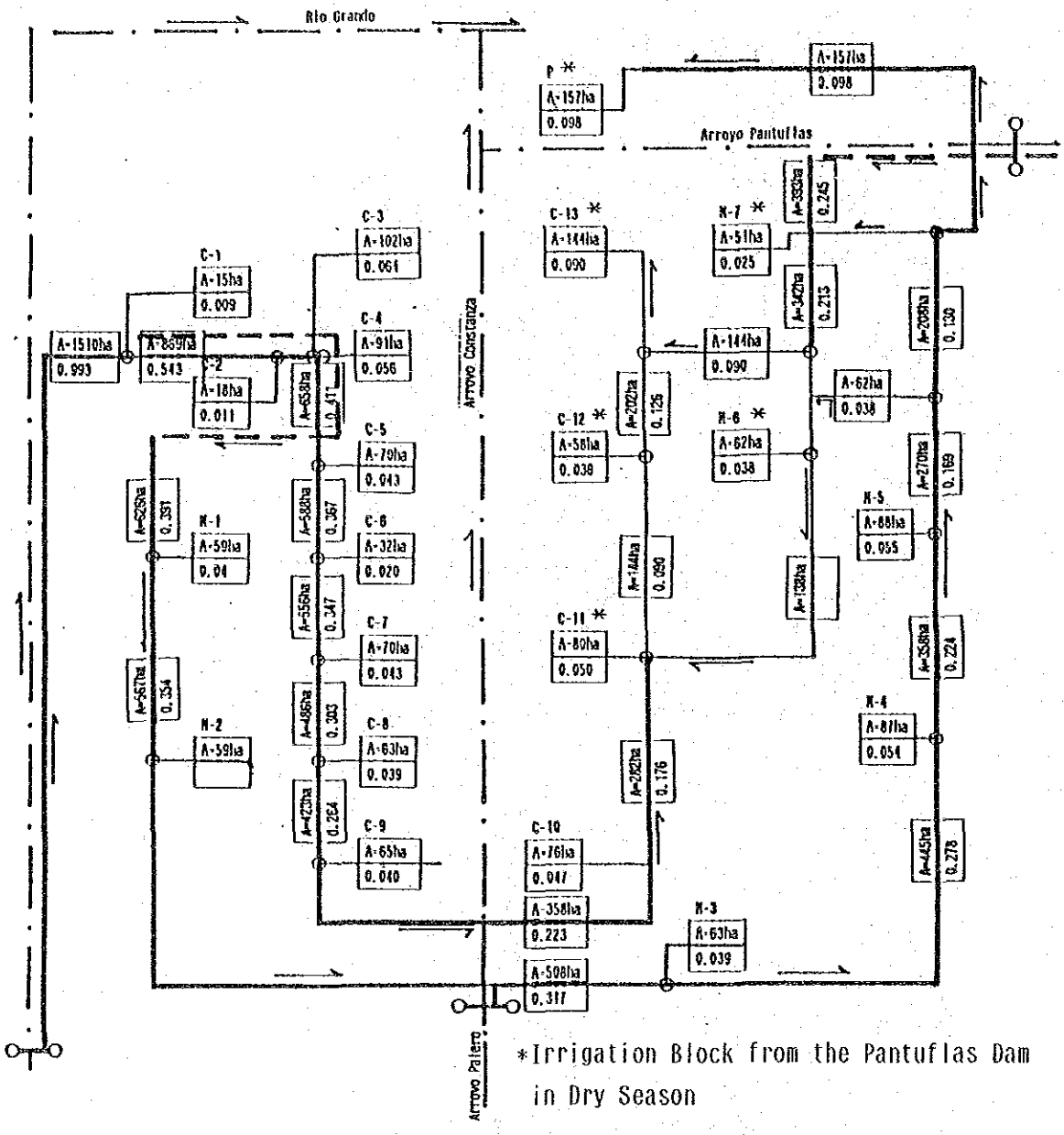



Fig.4.4.3-2 Irrigation Block from the Pantuflas Dam in Dry Season




*Irrigation Block from the Pantuflas Dam in Dry Season

Fig.4.4.3-3 Network of Irrigation Canal

## 4.5 Facilities Plan

Facilities plan is designed based on the Canal Construction Plan. The designed items are as follows.

Facilities for water resources:

- Pantuflas dam
- Head works in the Rio Grande
- Head race

Facilities for water distribution

- Canal Nueva Constanza
- Canal Constanza
- Canal Pantuflas

Facilities for drainage

- Drainage canal

### 4.5.1 Summary of Facilities

The work scope of the facilities plan in the project is the facilities till the entrance of farmlands. Facilities in the farmlands such as sprinklers and pumps are not included in the project. Summary of the facilities included in the project is as follows.

(1) Facilities for water resources

| Facilities | Item | Description |
|---|---|---|
| Pantuflas dam | Type | Central core type rockfill dam |
| | Height of dam | 29.8m |
| | Dam crest length | 162m |
| | Crest width | 7.5m |
| | Slope of dam | upstream 1 : 2.5<br>downstream 1 : 2.0 |
| | Dam volume | 214,000$m^3$ |
| | Total storage capacity | 1,050,000$m^3$ |
| | Available storage capacity | 980,000$m^3$ |
| | Sediment | 70,000$m^3$ |
| | Full water level | FWL 1,258.8m |
| | High water level | HWL 1,260.8m |
| | Sediment level | LWL 1,241.4m |
| Head works in the Rio Grande | | |
| a. Mountain stream diversion works | Type | Bar screen back stream diversion works |
| | | Fixed type |
| | Length | 15.3m |
| | Fall | 2.0m |
| | Level of crest | EL 1,295.3m |
| | Level of water intake | EL 1,293.3m |
| | Width of intake | 6.0m |
| b. Existing head works | Rehabilitation method | Installation of gabions, etc. |
| c. Head race | Type | Box culvert and canal with wet mason lining |
| | Maximum discharge | 1.0$m^3/s$ |
| | Length | Construction of box culvert: 310m |
| | | Rehabilitation of box culvert: 1,400m |
| | | Canal with wet mason lining: 1,600m |

(2) Facilities for Water Distribution

| | Canal Nueva Constanza | Canal Constanza | Canal Pantuflas |
|---|---|---|---|
| Type | ϕ600 pipeline canal with wet mason lining | ϕ300, ϕ400 pipeline canal with wet mason lining | |
| Maximum discharge | $0.39m^3/s$ | $0.54m^3/s$ | $0.10m^3/s$ |
| Length | ϕ600 pipeline: 2,900m<br>Main canal : 10,700m<br>Laterals : 12,800m | ϕ400 pipeline: 750m<br>ϕ300 pipeline: 850m<br>Main canal : 5,700m<br>Laterals : 26,650m | Main canal : 1,600m<br>Laterals : 5,400m |
| Supplemental facilities | *Division works/*<br>Confluence works: 8ea.<br>Chute: 1ea.<br>Small intake gate: 1ea.<br>Farm pond: 8ea.<br>Siphon: 1ea.<br>Aqueduct: 6ea. | *Division works/*<br>Confluence works: 14ea.<br>Chute: 1ea.<br>Small intake gate: 10ea.<br>Farm pond: 11ea. | *Diversion works/*<br>Confluence works: 4ea.<br>Small intake gate: 1ea.<br>Farm pond: 2ea. |

(3) Facilities for drainage

| Facilities | Item | Description |
|---|---|---|
| Drainage canal | Type | Unlined canal |
| | Numbers | 5ea. |
| | Total length | 5,000m |

4.5.2 Water Resource Facilities Plan

(1) Pantuflas Dam

1) Location

The location of Pantuflas dam was decided as 650m upstream of the existing intake gate in the Arroyo Pantuflas based on the geological and geographyical conditions. Reasons for its selection are as follows.

- The dam volume is the minimum at the site of the dam whose storage capacity is approximately 1,000,000m$^3$.

- The compensation problem for the submerged locations can be reduced since its location is a little upstream of the village.

- The geology at the site is better than the other places.

2) Design Criteria of Dam

The following values were used for the design of dam.

| | | |
|---|---|---|
| Horizontal coefficient of earthquake | : | k = 0.1 |
| Design flood discharge | : | Q = 100m$^3$/s |
| Design discharge of temporary diversion channel | : | Q = 10m$^3$/s |

3) Dimensions of Dam

The dimensions of the Pantuflas dam are as follows.

a. Dimensions of dam

| | | |
|---|---|---|
| Type | : | Central core type rock fill dam |
| Crest length | : | 162m |
| Top level of dam | : | 1,261.8m |
| High water level | : | 1,260.8m |
| Full water level | : | 1,258.8m |
| Sediment level | : | 1,241.4m |
| River bed altitude | : | 1,232.0m |
| Height of dam | : | 29.8m |
| Available water depth | : | 17.4m |
| Crest width | : | 7.5m |
| Slope of dam, upstream | | 1:2.5 |
| Slope of dam, downstream | | 1:2.0 |
| Dam volume | : | 214,000m$^3$ |

b. Material of dam body

| | |
|---|---|
| Core material | 23,540m$^3$ |
| Filter material | 8,560m$^3$ |
| Transition material | 107,000m$^3$ |
| Crushed rock material | 74,900m3 |
| Total | 214,000m3 |

c. Spillway

i. Design flood discharge

Design flood discharge of 200 years probability was set.
(Q = 100m$^3$/s)

ii. Route and type

The spillway is to be installed at the left bank from geological and geographical conditions.
The reasons are as follows.

- The geographical condition of the left bank is suitable for the installation of the spillway. The river was also diverted to the left at the site.
- The geological condition of the right bank does not fit with the installation of the spillway.

The spillway is designed as the side channel type.

iii. Scale of spillway

Length of spillway: 20m
Overflow depth : 2.0m

4) Outlet works

The outlet works of inclined conduit type is designed at the left bank and water is conducted from the inclined conduit to the steel pipe inside the temporary diversion channel.

5) Temporary diversion channel

The box culvert with inner dimension of 2.0m x 2.0m is to be constructed as temporary diversion channel at the right bank of the Arroyo Pantuflas during the construction period. It will be used as driving channel from the outlet works after the construction. The design flood discharge for the temporary diversion works in set as $10m^3/s$ of 10 years probability.

(2) Head Works in the Rio Grande

1) Mountain Stream Diversion Works

a. Location

The location of stream diversion works has been evaluated by considering the following conditions.

- Place of narrow river width to minimize the concrete volume of the diversion works.
- Place neare to the existing head works to shorten the length of new head race.
- Place where rocks exist on both sides.

Considering these conditions a place at 310m upstream from the present head works is selected for the stream diversion works. The altitude of the river bed is 1,292.3m and the slope of the river bed between the place and the head works is about 1/75. The deposit at the place is estimated to be about 3m deep.

b. Type of stream diversion works

The bar screen back stream diversion works is judged as the suitable one for the following reasons.

- Possible to secure a stable design water discharge of $1.0m^3/s$.
- Water intake will not to be harmed much by flowing earth and floats.

- Strong enough against friction and damage
- Easy for operation and maintenance

There are two types of diversion works; viz. fixed type and flating type. The fixed type to make the shielding zone by grout pouring is adopted in this case since the deposit is estimated to be several meters deep and basic rock is anticipated underneath at the place.

c. Water Level

The water level of the stream diversion works is designed to be the same as the river bed of the place, EL 1,293.3m.

d. Dimension of Diversion Works

The dimension of diversion works is designed as follows:

- The height is designed as 2.0m based on the past experience and can expect a discharge of 0.2 - 0.3$m^3$/s/m.
- The width is designed as 6.0m adding some surplus in order to secure the designed discharge of 1.0$m^3$/s.

2) Rehabilitation of Existing Head Works

The present head works was constructed 42 years ago and deteriorated with broken apron for 15m width at the left river side.

If the head works is left as it is, it may get fractured, cause lowering of the river bed and effect on the structure at the upstream side. So rehabilitation work should take place.

3) Head race

a. Head Race Between the Stream Diversion Works and the Existing Head Works

The head race which conducts water to the existing head race should satisfy the following requirements.

- It should be strong enough against flown stones, wood and other flowage.
- It should not reduce flow area of the river.
- Its maintenance cost should be cheap.

The following head race is planned to satisfy the above requirements.

- The head race is to be burried under the dry river bed in order to maintain flow area of the river and avoid flowage.
- It is to be box culvert of reinforced concrete which is strong against abrasion and flowage.
- It is to be constructed at the right side of the river to connect with the existing head race at the downstream.

Inner dimension of the cross section of the head race is 1.0m x 1.0m which can afford planned water discharge.
Manhole which is mainly for removing segments is designed near the existing head works.

b. Rehabilitation of the existing head race

The following rehabilitation works should take place in order to improve the conveyance efficiency.

- The portion of box culvert will be used successively. Leakages are to be found and repaired.
- The portion of unlined canal will be substituted to the canal with wet mason lining.

### 4.5.3 Facilities for Water Distribution

(1) Canal Plan

Three main canals viz Canal Nueva Constanza, Canal Constanza and Canal Pantuflas, are planned for water distribution. The water distribution is summarized as follows:

1) Canal Nueva Constanza

- ø600 pipeline is to be installed till Colonia Hungara in order not to pass steep slope of mountains in the north of Constanza Valley.

- The open canal flows the eastern area of the Valley, passes the Arroyo Pantuflas by the siphon and connect to the Canal Pantuflas. The canal is with wet mason lining and its mean slope is 1/1,000.

- Six aqueducts and eight division works are to be constructed on the way of the open canal.

- Box culvert is to be constructed at the road crossing.

- The existing intake gate in the Arroyo Palero is to be rehabilitated and utilized as supplemental water resource.

- Chute is to be constructed where slope of the canal is large.

2) Canal Constanza

- Cleaning, repairing of damaged portions, modification of sectional dimension and substitution from unlined canal to the canal with wet mason lining are to be taken place.

- New channel of ø300 pipeline and open canal is to be constructed to conduct irrigation water from Pantuflas dam in dry season.

- Fourteen division works are to be constructed on the way of the open canals.

- The existing intake gate for the Canal Abud is to be rehabilitated and used as supplemental water resource.

- Chute is to be constructed where slope of the canal is large.

3) Canal Pantuflas

- Cleaning, repairing of damaged portions and extension of the canal is to take place.

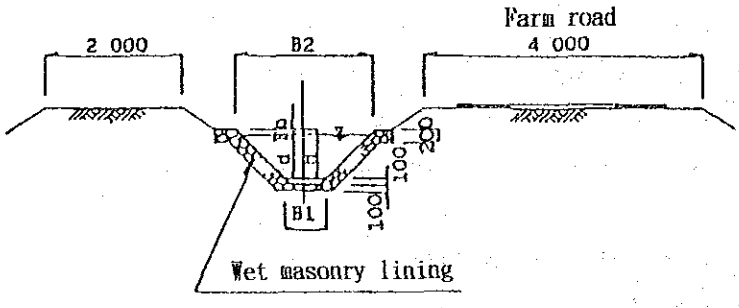
- Four division works are to be constructed on the way of the open canals.

- The existing intake gate in the Arroyo Pantuflas is to be rehabilitated and used as supplemental water resource.

(2) Section of Open Canal

Sections of open canals are designed based on the design water discharge. The following conditions are applied for their designs.

- Open canal is to be lined with wet mason lining
- Standard gradient of open canal is 1/1,000
- Manning's formula is applied. The coefficient of roughness for wet mason lining is 0.025.
- The slope of open canal is 1:1



The dimensions of the open canals are shown in Table 4.5.3-1.

Table 4.5.3-1 Dimensions of Open Canal

| | Design discharge ($m^3$/S) | Bottom slab length B (m) | Water depth H' (m) | Hydraulic radius R (m) | Sectional area A ($m^2$) | Mean velocity V ($m^3$/s) | Mean discharge Q ($m^3$/s) |
|---|---|---|---|---|---|---|---|
| A | 0.6> | 1.0 | 0.8 | 0.44 | 0.44 | 0.73 | 1.05 |
| B | 0.6 ~0.4 | 0.8 | 0.65 | 0.36 | 0.94 | 0.64 | 0.60 |
| C | 0.4 ~0.3 | 0.7 | 0.55 | 0.30 | 0.69 | 0.57 | 0.39 |
| D | 0.3 ~0.2 | 0.6 | 0.50 | 0.27 | 0.55 | 0.53 | 0.29 |
| E | 0.2 ~0.1 | 0.5 | 0.45 | 0.24 | 0.43 | 0.49 | 0.21 |
| F | <0.1 | 0.4 | 0.35 | 0.19 | 0.26 | 0.42 | 0.11 |

(3) Drainage Plan

The outputs at the ill-drained areas judged by soil survey are expected to hike by improvement of drainage.
Therefore, the drainage improvement works are to be carried out.

The cross section of the drainage canal is to be trapezoidal and its mean depth is 1.0 meter.

4.5.4 Construction Plan

(1) Basic Condition for Construction

1) Workable days

The workable days per month are determined considering daily rainfall data in the latest 10 years obtained from Constanza meteorological station as shown below.

| Work item | Workable days |
|---|---|
| Embankment of impervious zone | 20 days |
| Embankment except impervious zone | 22 days |
| Normal works | 22 days |
| Grout works | 22 days |

2) Main construction equipment

a. Excavation

| Item | Dam | | Canal | |
|---|---|---|---|---|
| Excavation | Bulldozer | 21t | Bulldozer | 9t |
| | Ripper bulldozer | 32t | Back hoe | $0.6m^3$ |
| | | | Back hoe | $0.2m^3$ |
| Loading | Crawler tractor shovel | $1.8m^3$ | Back hoe | $0.6m^3$ |
| | | | Back hoe | $0.2m^3$ |
| | | | Tractor shovel | $0.4m^3$ |
| Hauling | Dump truck | 11t | Dump truck | 6t |
| Spoil bank & stock yard | Bulldozer | 21t | Bulldozer | 11t |

b. Embankment works

| Work item | Dam | | Canal | |
|---|---|---|---|---|
| Excavation of borrow area | Back hoe | $0.6m^3$ | | - |
| Excavation of randam material | Ripper bulldozer | 32t | | - |
| Loading | Crawler tractor shovel | $1.8m^3$ | Back hoe | $0.2m^3$ |
| Spoiling | Crawler tractor shovel | $1.8m^3$ | | |
| Hauling | Dump truck | 11t | Dump truck | 6t |
| Spreading | Bulldozer | 21t | Bulldozer | 9t |
| Compaction: | | | | |
| Impervious material | Pulling tamping roller | 20.7-34.5t | | - |
| | Pulling bulldozer | 21t | | |
| Random material | Bulldozer | 32t | | - |
| Rock material | Bulldozer | 32t | | - |
| Filter material | Roller with vibration | 15-18t | | - |
| Canal banking | - | | Bulldozer Tamper | 9t |

c. Thickness of spreading and passing number

| Item | Thickness of spreading | Passing number |
|---|---|---|
| Impervious material | 20cm | 12 |
| Random material | 50cm | 6 |
| Rock material | 50cm | 6 |
| Filter | 20cm | 6 |
| Canal banking | 30cm | 5 |

(2) Construction Method

1) Pantuflas Dam

a. Temporary diversion channel

During the period of construction of dam and its ancillary facilities, temporary diversion channel should be constructed in order to discharge the flood at the dam site. This construction of temporary diversion channel should be carried out first and foremost. The excavation is commenced from the downstream in order to carry construction materials to the site and obtain safety to flood. The temporary diversion channel is to be used us driving channel of the dam after the construction. Grout works should be carried out after finishing of concrete works of the box culvert.

b. Excavation works

Excavation works are carried out at dam foundation, the foundation of structures and borrow area, etc..

Materials to be excavated are classified as follows:

- Stripping is to excavate and remove earth materials of 0.5 to 1.0m deep which include vegetable or organic matter by leg hammer with gunpowder.

- Common excavation is to excavate and remove earth materials at the foundation of dam, structures and borrow area, etc. after stripping by leg hammer with gunpowder.

- Rock excavation is to excavate and remove earth materials by leg hammer with gunpowder at the foundation of dam, structures, etc.. The excavated materials should be spoiled because of low welded tuff.

c. Foundation treatment

After the completion of a part of core trench excavation blanket concrete works of 1.0m thickness and as the water stop treatment works of the foundation. The blanket concrete works should be used as the bench concrete for grouting works. The two type of grout works those are contact grout works and curtain grout works should be performed.

d. Embankment works

After the completion of foundation works and excavation of spillway, dam embankment should be commenced. The range contacting with the blanket concrete should be closed adherence by contact clay before the dam embankment. Embankment surface of each zone should be as the same elevation as much as possible.

e. Concrete works

The concrete volume used for the dam construction becomes approximately 10,400$m^3$ including spillway and intake facilities, etc.. Automatic remove type concrete mixers (0.35$m^3$) are installed on the site in several places since there is no ready mixed concrete factory in the vicinity of the Study area.

2) Irrigation facilities

Main irrigation facilities include the diversion weir, driving canal, irrigation canal, etc.

The diversion weir is constructed by the half-cofferdam system. A concrete cofferdam is planned by use of pebbles, which are available at the site composed of sandy gravel layers including pebbles.

The irrigation canal is constructed mainly by earth work and wet masonry work.

For earth work, cutting is balanced to banking for each route, and cutting is reused for filling. Excavation depends mainly on bulldozers. The back hoe is used where the bulldozer is not serviceable.

In places where cutting is not balanced to filling for the topographical reason as in the branch canal, the bulldozer collects required soil along the canal.

Embanking is compacted by the bulldozer. If impossible, filling is manually compacted with a tamper. Concrete work depends on an automatic remove type concrete mixer ($0.35m^3$) placed in each construction site. Concrete is poured mainly through chute, and pump truck is used if necessary. The construction schedule should be planned so as not to disturb the water distribution which influence on the present cropping us much as possible.

## 4.6 Estimation of Project Cost

The project cost consists of civil works cost, project facilities cost, project administration, pre-engineering, consulting service, physical contingency and price escalation (escalation by inflation). The cost of Land Acquisition and Compensation is not included in the construction cost, based on the low and regulation concerned of the Dominican Republic.

### 4.6.1 Estimation Method

The project cost is estimated based on the following Conditions.

- Civil works will be carried out on the contact basis. The contractor is responsible for heavy equipment necessary for civil works. Therefore, the construction equipment cost is estimated as depreciation cost.

- The basic cost such as labor wage, material cost, and equipment cost are estimated on the basis of market price in December, 1989.

- The unit price is expressed in foreign currency and in local currency for each work item. The reference foreign currency value is CIF price in 1989, and reference local currency value is actual price in the same period.

- The applicable foreign exchange rate is US$1.00 = RD6.35 = ¥143, the official rate in December, 1989.

### 4.6.2 Project Cost

(1) Project cost

The project cost is summarized as shown below. The project cost including physical contingency amounts to RD$83,984 million (US$13,226 million) which includes RD$30,025 million (US$4,728 million) of local currency portion and RD$53,959 million (US$8,498 million) of foreign currency portion. The share of local currency portion is 35.8% while that of foreign currency portion is 64.2% (Table 4.6.2-1).

Table 4.6.2-1 Total Project Cost

| | RD$ (X 1000) | | | US$ (X 1000) | | |
|---|---|---|---|---|---|---|
| | Foreign currency | Local currency | Total | Foreign currency | Local currency | Total |
| Project cost | 49,933 | 27,383 | 77,316 | 7,864 | 4,312 | 12,176 |
| Physical contingency | 4,026 | 2,642 | 6,668 | 634 | 416 | 1,050 |
| Sub-total | 53,959 | 30,025 | 83,984 | 8,498 | 4,728 | 13,226 |
| Price escalation | 5,660 | 16,130 | 21,790 | 891 | 2,540 | 3,431 |
| Total | 59,619 | 46,155 | 105,774 | 9,389 | 7,268 | 16,657 |

The investment plan of this project is as enumerated below, including the price escalation.

Table 4.6.2-2 Project Investment Plan

| Year | Foreign Currency RD$ (X 1000) | Local Currency RD$ (X 1000) | Total RD$ (X 1000) |
|---|---|---|---|
| 1990 | 575 | 65 | 640 |
| 1991 | 11,600 | 6,126 | 17,726 |
| 1992 | 29,710 | 20,197 | 49,909 |
| 1993 | 17,732 | 19,767 | 37,499 |
| Total | 59,619 | 46,155 | 105,774 |

(2) Components of project cost

The project cost consists of the following component.

1) Civil works

a. Preparatory works

The preparatory works which is generally called as indirect construction cost is divided into two categories, one is the common temporary works and the other is technical control works.

The cost of common temporary works includes (1) preparation cost (topographical, geological, and soil mechanical survey and temporary access road for construction), (2) mobilization cost of equipment, (3) building and repairs expenses such as, labour camp, laboratory, motor pool, work shop, etc., (4) safety control facilities, etc. Technical Control work cost includes quality, progress and work schedule control. The preparatory work cost is estimated as a proportion to the civil works cost.

b. Dam

Foundation treatment, dam body, spillway, outlet works, etc.

c. Diversion and driving facilities

Diversion facilities such as weir, sand sluice way settling basin, and driving facilities.

d. Canal

Excavation, embanking, wet masonry lining, siphon, division work, pipe line, aqueduct, cross works, etc.

2) Project facilities cost

Installation cost of construction office, camp, etc.

3) Administrative expenses

Allowance for construction personnel, miscellaneous office expenses, expenses for fuel, light, and water, etc. during the construction term.

4) Pre-engineering and consulting services expenses

Expenses for consultants for pre-engineering, detailed design, and supervision during the construction term.

5) Physical contingency

Construction cost unforeseeenable at the point of the study or subject to an increase; 10% of total construction cost is allowed.

6) Price escalation

Expenses due to escalation by inflation from the point of design to completion of construction. For the foreign currency, the average of consumer price index (last three years) of five advanced countries is adopted. For the local currency, consumer price index by ONAPLAN is employed. The escalation rate for each year of the project is shown below.

| | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|
| Foreign currency (%) | 3.3 | 6.7 | 10.2 | 13.9 |
| Local currency (%) | 14.1 | 30.2 | 48.5 | 69.5 |

(3) Construction unit price

The unit price of construction work is obtained by the sum-up system. The unit price of labor and material has been researched in Santo Domingo and the study area, and collected data is used for computation of project cost.

(4) Content of project cost

Table 4.6.2-3, 4.6.2-4 shows the content of the project cost for each component and disbursement schedule, respectively.

Table 4.6.2.-3 Summary of Project Cost

(Unit: 1,000RD$)

| Item | Foregin Currency | Local Currency | Total |
|---|---|---|---|
| 1. Civil Engineering Works | | | |
| 1-1. Preparatory Works | 1,917 | 1,258 | 3,175 |
| 1-2. Dam | | | |
| (a) Foundation Treatment | 1,359 | 5,552 | 6,911 |
| (b) Dam body | 20,612 | 3,739 | 24,351 |
| (c) Spillway | 1,263 | 2,725 | 3,988 |
| (d) Outlet Works | 333 | 455 | 788 |
| Sub-total [ 1-2. ] | 23,567 | 12,471 | 36,038 |
| 1-3. Diversion System | | | |
| (a) Head works | 181 | 307 | 488 |
| (b) Head Race | 647 | 710 | 1,357 |
| Sub-total [ 1-3. ] | 828 | 1,017 | 1,845 |
| 1-4. Canal System | | | |
| (a) Main Canal | 8,989 | 4,900 | 13,889 |
| (b) Lateral Canal | 4,658 | 6,739 | 11,397 |
| (c) Drainage Canal | 303 | 32 | 335 |
| Sub-total [ 1-4. ] | 13,950 | 11,671 | 25,621 |
| Total [ 1. ] | 40,262 | 26,417 | 66,679 |
| 2. Project Facilities | 100 | 300 | 400 |
| 3. Project Administration | --- | 360 | 360 |
| 4. Pre-engineering | 557 | 27 | 584 |
| 5. Consulting service | 9,014 | 279 | 9,293 |
| Total [ 1. ~ 5.] | 49,933 | 27,383 | 77,316 |
| 6. Physical Confingency (10%) | 4,026 | 2,642 | 6,668 |
| Total [ 1. ~ 6.] | 53,959 | 30,025 | 83,984 |
| 7. Price Escalation | 5,660 | 16,130 | 21,790 |
| Grand total | 59,619 | 46,155 | 105,774 |

Table 4.6.2-4 Summary of Annual Disbursement Schedule (1/2)

Base Year 1989 Cost Unit 1000RD$

| Item | 1990 F.C | 1990 L.C | 1990 Total | 1991 F.C | 1991 L.C | 1991 Total | 1992 F.C | 1992 L.C | 1992 Total |
|---|---|---|---|---|---|---|---|---|---|
| 1.Civil Works | | | | | | | | | |
| 1-1.Preparatory Works | ----- | ----- | ----- | 1,917 | 1,258 | 3,175 | ----- | ----- | ----- |
| 1-2.Dam | | | | | | | | | |
| (a) Foundation Treatment | ----- | ----- | ----- | 272 | 1,110 | 1,382 | 1,087 | 4,442 | 5,529 |
| (b) Dam body | ----- | ----- | ----- | 4,122 | 748 | 4,870 | 16,490 | 2,991 | 19,481 |
| (c) Spillway | ----- | ----- | ----- | 253 | 545 | 798 | 1,010 | 2,180 | 3,190 |
| (d) Intake Facilities | ----- | ----- | ----- | 67 | 91 | 158 | 266 | 364 | 630 |
| Sub-Total [1-2.] | ----- | ----- | ----- | 4,714 | 2,494 | 7,208 | 18,853 | 9,977 | 28,830 |
| 1-3.Diversion System | | | | | | | | | |
| (a) Head Works | ----- | ----- | ----- | 36 | 62 | 98 | 145 | 245 | 390 |
| (b) Head Race | ----- | ----- | ----- | ----- | ----- | ----- | 647 | 710 | 1,357 |
| Sub-Total [1-3.] | ----- | ----- | ----- | 36 | 62 | 98 | 792 | 955 | 1,747 |
| 1-4.Canal Network System | | | | | | | | | |
| (a) Main Canal | ----- | ----- | ----- | ----- | ----- | ----- | 2,247 | 1,225 | 3,472 |
| (b) Lateral Canal | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| (c) Drainage | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Sub-Total [1-4.] | ----- | ----- | ----- | ----- | ----- | ----- | 2,247 | 1,225 | 3,472 |
| Sub-Total [1. ] | ----- | ----- | ----- | 6,667 | 3,814 | 10,481 | 21,892 | 12,157 | 34,049 |
| 2.Project Facilities | ----- | ----- | ----- | 100 | 300 | 400 | ----- | ----- | ----- |
| 3.Project Administration | ----- | 30 | 30 | ----- | 120 | 120 | ----- | 120 | 120 |
| 4.Pre-engineering | 557 | 27 | 584 | ----- | ----- | ----- | ----- | ----- | ----- |
| 5.Consulting Services | ----- | ----- | ----- | 3,438 | 90 | 3,528 | 2,881 | 108 | 2,989 |
| Sub-Total [1. to 5.] | 557 | 57 | 614 | 10,205 | 4,324 | 14,529 | 24,773 | 12,385 | 37,158 |
| 6.Physical Contingency(10% of 1) | ----- | ----- | ----- | 667 | 381 | 1,048 | 2,189 | 1,216 | 3,405 |
| Sub-Total [1. to 6.] | 557 | 57 | 614 | 10,872 | 4,705 | 15,577 | 26,962 | 13,601 | 40,563 |
| 7.Price Escalation | 18 | 8 | 26 | 728 | 1,421 | 2,149 | 2,750 | 6,596 | 9,346 |
| Grand Total | 575 | 65 | 640 | 11,600 | 6,126 | 17,726 | 29,710 | 20,197 | 49,909 |

Table 4.6.2-4 Summary of Annual Disbursement Schedule (2/2)

Base Year 1989 Cost Unit 1000RD$

| Item | 1993 F.C | 1993 L.C | 1993 Total | 1994 F.C | 1994 L.C | 1994 Total | Grand Total F.C | Grand Total L.C | Grand Total Total |
|---|---|---|---|---|---|---|---|---|---|
| 1.Civil Works | | | | | | | | | |
| 1-1.Preparatory Works | ----- | ----- | ----- | ----- | ----- | ----- | 1,917 | 1,258 | 3,175 |
| 1-2.Dam | | | | | | | | | |
| (a) Foundation Treatment | ----- | ----- | ----- | ----- | ----- | ----- | 1,359 | 5,552 | 6,911 |
| (b) Dam body | ----- | ----- | ----- | ----- | ----- | ----- | 20,612 | 3,739 | 24,351 |
| (c) Spillway | ----- | ----- | ----- | ----- | ----- | ----- | 1,263 | 2,725 | 3,988 |
| (d) Intake Facilities | ----- | ----- | ----- | ----- | ----- | ----- | 333 | 455 | 788 |
| Sub-Total [1-2.] | ----- | ----- | ----- | ----- | ----- | ----- | 23,567 | 12,471 | 36,038 |
| 1-3.Diversion System | | | | | | | | | |
| (a) Head Works | ----- | ----- | ----- | ----- | ----- | ----- | 181 | 307 | 488 |
| (b) Head Race | ----- | ----- | ----- | ----- | ----- | ----- | 647 | 710 | 1,357 |
| Sub-Total [1-3.] | ----- | ----- | ----- | ----- | ----- | ----- | 828 | 1,017 | 1,845 |
| 1-4.Canal Network System | | | | | | | | | |
| (a) Main Canal | 6,742 | 3,675 | 10,417 | ----- | ----- | ----- | 8,989 | 4,900 | 13,889 |
| (b) Lateral Canal | 4,658 | 6,739 | 11,397 | ----- | ----- | ----- | 4,658 | 6,739 | 11,397 |
| (c) Drainage | 303 | 32 | 335 | ----- | ----- | ----- | 303 | 32 | 335 |
| Sub-Total [1-4.] | 11,703 | 10,446 | 22,149 | ----- | ----- | ----- | 13,950 | 11,671 | 25,621 |
| Sub-Total [1. ] | 11,703 | 10,446 | 22,149 | ----- | ----- | ----- | 40,262 | 26,417 | 66,679 |
| 2.Project Facilities | ----- | ----- | ----- | ----- | ----- | ----- | 100 | 300 | 400 |
| 3.Project Administration | ----- | 90 | 90 | ----- | ----- | ----- | ------ | 360 | 360 |
| 4.Pre-engineering | ----- | ----- | ----- | ----- | ----- | ----- | 557 | 27 | 584 |
| 5.Consulting Services | 2,695 | 81 | 2,776 | ----- | ----- | ----- | 9,014 | 279 | 9,293 |
| Sub-Total [1. to 5.] | 14,398 | 10,617 | 25,015 | ----- | ----- | ----- | 49,933 | 27,383 | 77,316 |
| 6.Physical Contingency(10% of 1) | 1,170 | 1,045 | 2,215 | ----- | ----- | ----- | 4,026 | 2,642 | 6,668 |
| Sub-Total [1. to 6.] | 15,568 | 11,662 | 27,230 | ----- | ----- | ----- | 53,959 | 30,025 | 83,984 |
| 7.Price Escalation | 2,164 | 8,105 | 10,269 | ----- | ----- | ----- | 5,660 | 16,130 | 21,790 |
| Grand Total | 17,732 | 19,767 | 37,499 | ----- | ----- | ----- | 59,619 | 46,155 | 105,774 |

# CHAPTER 5 PROJECT IMPLEMENTATION PLAN, OPERATION AND MAINTENANCE PLAN

# CHAPTER 5 PROJECT IMPLEMENTATION PLAN, AND OPERATION AND MAINTENANCE PLAN

## 5.1 Project Implementation Plan

### 5.1.1 Project Implementation System

In the light of implementation and smooth management of the project, organizations responsible for the design work plan and supervision must be centralized. Existing irrigation facilities in this area were excecuted by INDRHI, and therefore INDRHI serves as the organization in charge. INDRHI has sufficient experience and capability in carrying out detailed design, construction, and O&M of the irrigation and drainage facilities. In implementing the project, the present organization of INDRHI should be utilized to a maximum and strengthened further.

In view of the project oriented to agricultural development, INDRHI is expected to keep close interrelation with SEA, IAD, etc. In addition, the local government of La Vega and Municipality of Constanza should also give proper guidance to farmers to cope up with the project since the dam and irrigation facilities are constructed mainly in existing upland field.

Fig. 5.1.1-1 shows the organization of authorities in charge of implementation of the project.

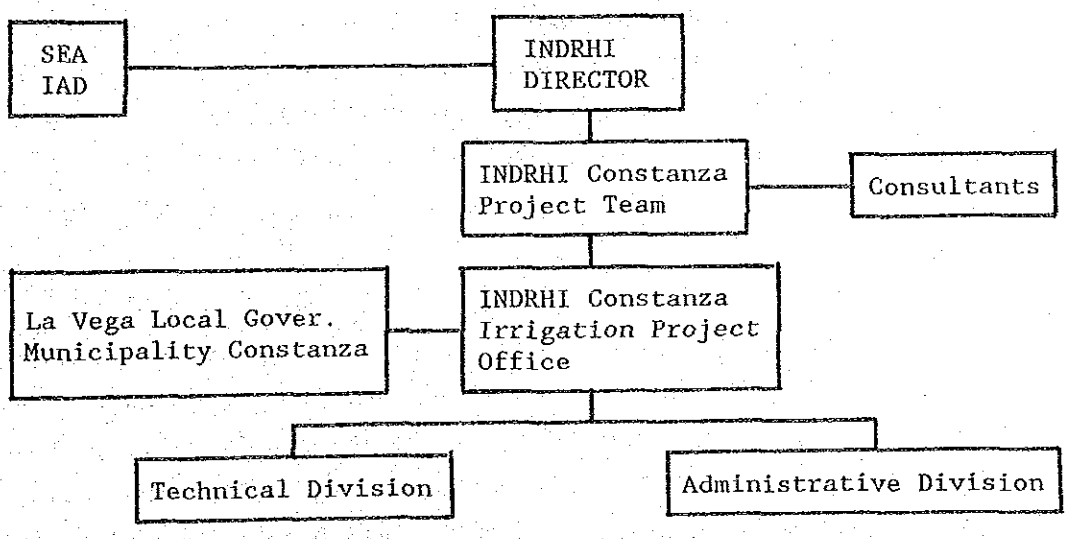



Fig. 5.1.1-1 Organization for Project Implementation

### 5.1.2 Project Implementation Method

This project consists of various types of civil works for the dam, diversion weir, canal, road, etc.

Generally, this type of construction work is kept under the direct control and management of the government or is contracted with contractor(s) who assumes the responsibility of construction. The previous executing mode of projects similar to this in the Dominican Republic shows that most of the large scale projects were carried out on a contract basis with the exception of some small scale projects which were on a force account basis. Therefore, it is considered that a contract basis will be appropriate for the construction of this Project. The work should be started earlier by means of the contract basis. Practically, candidate contractors are invited to an open tender, screened by prequalification, and listed as bidders. In the open bid, a successful tenderer is nominated.

### 5.1.3 Project Implementation Plan

The project implementation program is roughly divided into pre-engineering, detail design, tender, and construction work. In the pre-engineering period, things to be carried out are preparation of topographic map of the project area, the plan survey of main structure points, canal route survey, boring survey of the dam site and diversion weir site, embankment material test, etc. all of which are necessary for detail design and kept under technical control of consultant. Pre-engineering is scheduled to start in October, 1990 for 3 months in preparation for detail design.

Detail design is started on completion of the pre-engineering. Detail design includes documents necessary for a tender, such as the general specification, special specification, technical specification, drawings, estimation of quantity and cost, work plan, and work program. Detail design is scheduled to start in January, 1991 for 6 months.

On completion of detail design, candidate contractors are invited by publications and qualified in prequalification. Qualified candidate contractors are registered in the short list and approved as tenderers. Prequalification and selection of tenderers are scheduled to start in June 1991 and continue for 3 months.

Civil works are started after a 3 month preparatory period that starts on completion of the tender. The scheduled construction term is 24 months, including the preparatory period.

Consultants provide technical services through the period of the pre-engineering, detail design, tender, and construction term, and are expected to be on duty for 36 months, including the settlement of services that remain at completion of the whole work.

5.1.4 Project Implementation Work

The construction period is set at 2 years, considering total amount of construction, similar scale of previous projects in the adjacent area and similar kinds of construction works.

Construction period of each civil works are arranged so as to generate the economic benefits of the Project as early as possible by relaxing the water shortage in the existing upland field. Also important are considerations regarding the quantity and disposition of the proposed construction equipment and coordination among each item of civil works. Fig. 5.1.4-1 shows the project implementation schedule and the outlined schedule of civil works.

| Description | 1989 | 1990 | 1991 | 1992 | 1993 | Remarks |
|---|---|---|---|---|---|---|
| Feasibility Study | | | | | | |
| Pre-Engineering | | | | | | |
| Detail Design | | | | | | |
| Tendering | | | | | | |
| Construction | | | | | | |
| 1 Project Facilities | | | | | | |
| 2 Project Administration | | | | | | |
| 3 Consulting Services | | | | | | |
| 4 Civil Works | | | | | | |
| 4.1 Preparatory Works | | | | | | |
| 4.2 Dam | | | | | | |
| (a) Foundation Treatment | | | | | | |
| (b) Dam body | | | | | | |
| (c) Spillway | | | | | | |
| (d) Intake Facilities | | | | | | |
| 4.3 Diversion System | | | | | | |
| (a) Head Works | | | | | | |
| (b) Head Race | | | | | | |
| 4.4 Canal Network System | | | | | | |
| (a) Main Canal | | | | | | |
| (b) Lateral Canal | | | | | | |
| (c) Drainage Canal | | | | | | |
| 4.5 Others | | | | | | |

Fig. 5.1.4-1 Constanza Valley Irrigation Project Implementation Schedule

## 5.2 Operation and Maintenance Plan

### 5.2.1 Operation and Maintenance Policy

This project intends for the enlargement of irrigation facilities at the present irrigated area in Constanza Valley. Therefore the present irrigation system which is mainly controlled by INDRHI should be considered as the basic for the operation and maintenance. On the other hand, voluntary intension of farmers who obtain the irrigation benefit are to be highly esteemed. Agricultural Development Union is to be established in the Valley and operation and maintenance of this system is to be trusted to the Water Management Division of the Union.

INDRHI will have the role of advisory organization. Collection of water charge is to be taken place by the association. The cost for the operation and maintenance is to be furnished as the water charge as much possible and burden of cost for INDRHI is to be lightened.

The organization including agricultural production and guidance of circulation is to be established for the purpose of permanent management of the project. The organization is to manage the project smoothly not only from the aspect of facilities but also for agricultural management. Basically the operation and maintenance of the project is to be executed by the beneficiaries. Its organization chart is shown in Fig. 5.2.1-1.

Organization Chart of Agricultural Production and Water Management

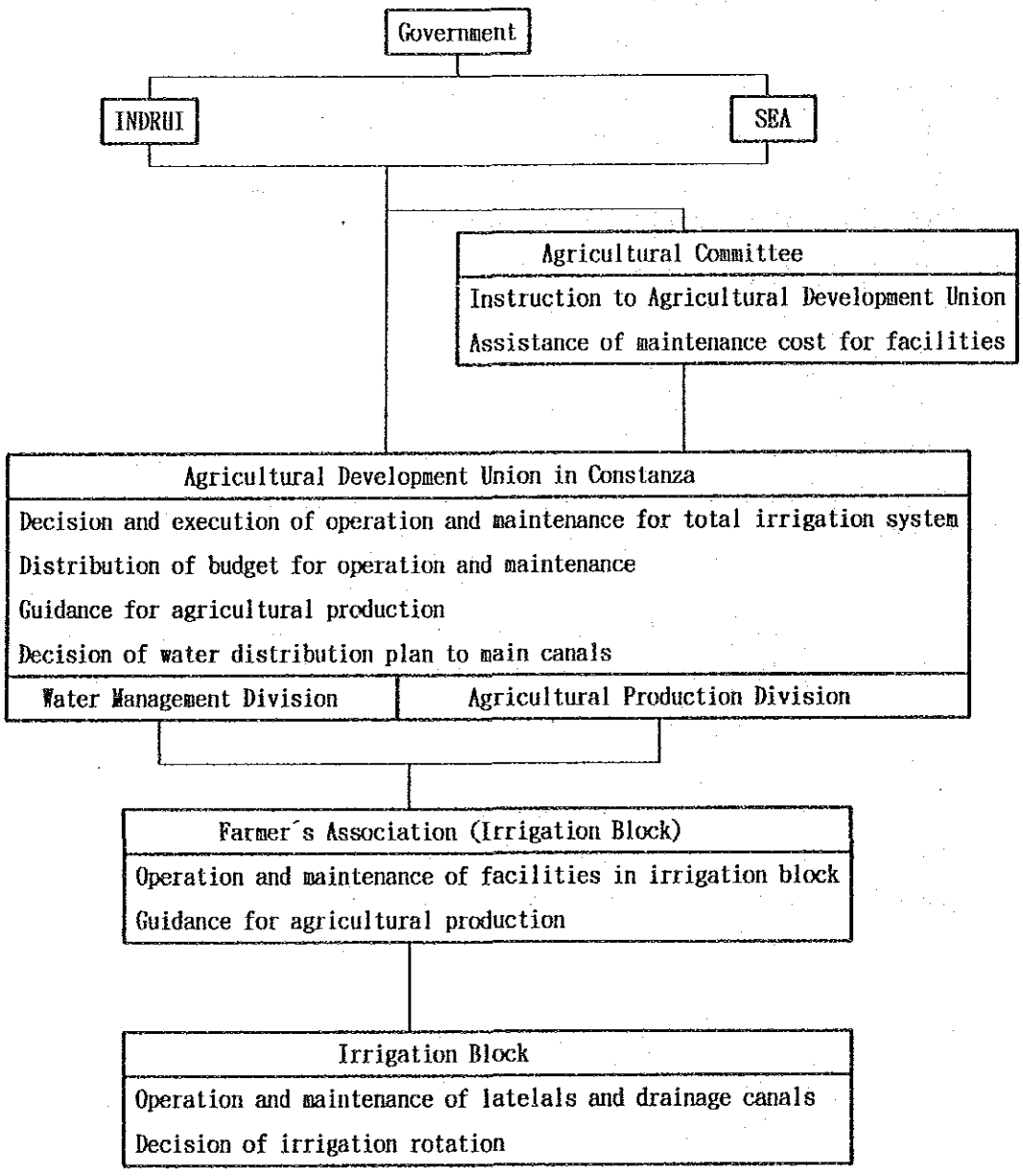



Fig. 5.2.1-1 Organization Chart of Operation and Maintenance

### 5.2.2 Operation and Maintenance System

The system for operation and maintenance is to be organized in order to make adequate use of project facilities. The agricultural committee which is constituted by INDRHI, Ministry of Agriculture and Agriculture Development Union in Constanza, decides the direction of the project. The cost for operation and maintenance is to be furnished by beneficiaries in principle, but the rate of assistance by the government is to be decided by the committee in case that the burden charge of the beneficiaries is too high. It also guides and gives advice to the problems which is difficult to be solved by the Agricultural Development Union.

The Agricultural Development Union in Constanza is the organization responsible to carry out the project. It has two sections of water management and guidance of agricultural production.

Each section carries out the following works.

(1) Water Management Division

- Control of irrigation area and water demand.
- Collection of water charge and necessary informations for its control.
- Analysis of information and planning of water distribution plan.
- Discharge from Pantuflas dam.
- Control of water distribution and division of budget for operation and maintenance.
- Guidance and indication to the farmer's association.
- Operation and maintenance of water resource facilities and main canals.

(2) Agricultural Production Division

- Guidance for technical improvement of crop production.
- Guidance for common purchase of productive materials.
- Guidance for common sales of agricultural products.
- Collection of market information.

The organization chart and number of personnel for operation and maintenance is shown in Fig. 5.2.2-1.

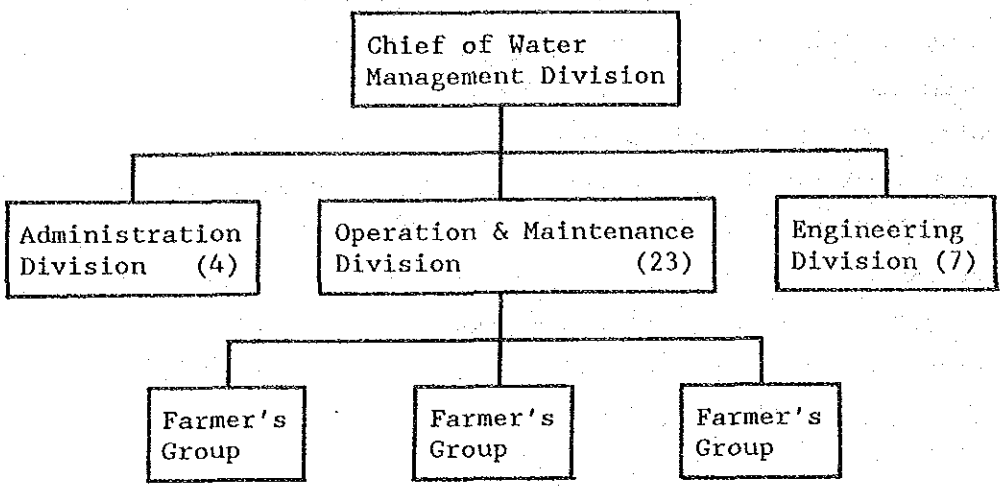



Fig. 5.2.2-1 Organization for Operation and Maintenance Office

5.2.3 Operation and Maintenance Cost

The annual operation and maintenance cost for the project would amount to about RD$732,568 and RD$202 per hectare.

Annual Operation and Maintenance Cost

| Items | Amount(RD$) |
|---|---|
| Salary and Wage | 380,250 |
| Equipment | 261,224 |
| Material and Supplies | 34,056 |
| Administration and General Expenditure | 57,038 |
| Total | 732,568 |
| per ha | 202 |

5.3 Consulting Services

Consultants provide technical services on the contract basis with the project implementation organization. Consulting services consist of all services for the period of the pre-engineering and detail design, qualification of tender, and supervisory services during the construction work term such as technique control, process control,

and safety control. The consultant team consists of engineers and experts who have wide knowledge and long experience in the sector of the plan, design, facilities, geology, civil engineering, agriculture, etc. They serve to ensure the top-quality work progressed in smooth process while keeping close contact with the project implementation organization and the contractor. In addition, consultants transfer techniques to government staff of the project implementation organization through their services. In particular, consultants should place emphasis on work quality control, agricultural village development, and irrigation water control, and execute them including training.

The man-month schedule of consulting services requires 217 man-months. The contents of such man-month is as follows:
39 man-months for foreign consultant and 39 for local consultant during pre-engineering and detailed design, and 67 man-months for foreign consultant and 72 man-months for local consultant during construction period.

# CHAPTER 6 EVALUATION OF THE PROJECT

# CHAPTER 6 EVALUATION OF THE PROJECT

## 6.1 Evaluation Policy

The evaluation is carried out to assess the validity of project implementation which includes economic evaluation, financial evaluation and socio-economic evaluation (effect). Economic evaluation is to evaluate the economical effect of the project on the basis of economic benefit and economic cost as converted market price to economic price in light of national economy. Financial evaluation is to evaluate the soundness of financial state of the project from the view point of the project implementation. Socio-economic evaluation is to be judged by the indirect effect of unquantifiable benefit, caused by the project implementation.

Evaluation of benefit and cost are made using Dominican market price which was collected during the site investigation and prices of trade goods which are not imported to Dominican Republic are calculated using Japanese market price. Local currency is used for the evaluation and the applicable foreign exchange rate is US$1.00 = RD$6.35.

The project life is 50 years including preparation period and construction work period.

## 6.2 Project Benefit

### 6.2.1 Benefit Calculation Policy

The benefit to be obtained by the project is the production benefit of agricultural crops by developing constant supply of irrigation water, increasing the cropping rate with improvement of agricultural production techniques and increasing the unit yield.

The project benefit refers to the difference of net profit between with project and without project which is the estimated profit at

the time of construction completion by means of agricultural production improvement and increase of unit yield during the construction period.

After implementation of the project, the effect of unquantifiable benefits such as foreign exchange acquisition, stabilized food supply and creation of employment opportunities is evaluated as socio-economic effect.

6.2.2 Crop Production Benefit

(1) Crop revenue

Crop revenue was calculated by multiplying production volume and unit price. Crop yield depends on the effect of irrigation water since an obvious difference of yield was noticed in the study between the area with sufficient irrigation water supply and area with shortage of irrigation water. Crop revenue increases by technical improvement effect such as using organic materials, improvement of fertilizer application and crop rotation etc.

The selling price of each crop is applied using the average for the last 3 years (1987 to 1989) taking into account of consumable price index during the same period. (Refer to Annex Q Table 1.1 - 1.2) The economic prices of exported vegetables are calculated by this market price by multiplying with the conversion factor of 1.33 based on the guideline of "Fondo de Inversiones para el Desarrollo Economico (FIDE)", Central Bank.

(2) Crop production cost

Production materials and labor force which are estimated based on the result of site survey and production cost analysis, 1989 of Banco Agricola, are increased corresponding to the planned production of without project and with project. The cost is applied accoridng to the price of production cost analysis of Banco Agricola.

Labor cost for skilled and unskilled labor is set at RD$40.00/man-day and RD$20.00/man-day respectively and farmer is considered as skilled labor. The water charge after completion of the construction work is defrayed by beneficiaries, which includes the maintenance cost for water management and cost of sprinkler units.

The economic price of trade goods for production cost such as seeds, chemical fertilizers, pesticides, sprinkler units and maintenance equipment and machines are multiplied by the conversion factor of 1.33 under the guideline of FIDE. The conversion factor of 0.44 is applied to the economic price of unskilled laborer's wage based on the guideline of FIDE.

(3) Crop benefit

Crop revenue and production cost of each crop are shown in Tables 1.1 and 1.2 of Annex Q, and annual crop benefit after completion of the construction work is as follows:

- Crop benefit at financial price RD$24,120,840.00
- Crop benefit at economical price RD$27,919,937.00

6.2.3 Annual Variation of Benefit Accrual

The construction work will be completed by 4th year after commencement of the project, the project benefit accrues gradually from 5th year by means of improvement of agricultural techniques and establishment of water management organization etc. The targeted benefit is attained at the 8th year as shown in Table 6.2.3-1. During the construction work period, sufficient temporary construction measures will be taken so as to prevent any obstacle for supplying existing irrigation water to arable land. However, sometimes the irrigation water supply may be affected.

The construction of Pantuflas Dam will be carried out in the third year and the shortage of irrigation water caused by this construction will be less, since the water from Pantuflas river

will be distributed to Canal Pantuflas by temporary construction works and the project benefit is considered as -10% accounting for this shortage of irrigation water. However, during the construction of canals will be carried out in the 4th year and the shortage of irrigation water will be higher than the 3rd year and therefore the project benefit is accounted as -30%. Rate of benefit attainment for 10 years period is shown in Table 6.2.3-1.

Table 6.2.3-1 Rate of Benefit Attainment

(Unit: %)

| Year | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th- |
|---|---|---|---|---|---|---|---|---|---|---|
| Rate of Attainment | 0 | 0 | -10 | -30 | 70 | 80 | 90 | 100 | 100 | 100 |

## 6.3 Project Cost

The project cost of the study includes the rehabilitation of the canals, operation and maintenance after completion of the construction works, and procurement of sprinkler units.

### 6.3.1 Construction Cost

As shown in the details of project cost (Table 4.6.2-3) and summary of annual disbursement schedule (Table 4.6.2-4), the main construction works are dam, diversion facilities and canal system. Cost of these civil works is estimated as RD$66,679,000.00 (Foreign currency portion RD$40,262,000.00, Local currency portion RD$26,417,000.00).

Total cost of construction including construction facilities, administration, engineering services, price escalation and contingency is RD$105,774,000.00 (Foreign currency portion RD$59,619,000.00, Local currency portion RD$46,155,000.00). For economic evaluation a conversion factor of 1.33 is applied to foreign portion of construction cost except contingency.

### 6.3.2 Operation and Maintenance Cost

Equipment and machines for operation and maintenance (O & M) is introduced at the 3rd year of commencement of the project, and its amount is estimated as RD$2,548,000.00. The same conversion factor of 1.33 is applied here also. Annual O & M costs for financial evaluation includes liquid expenses such as personnel expenditure and fuel etc., and depreciation expenses of O & M equipment and machines (durable period: 10 years).

For economic evaluation, annual O & M costs are liquid expenses and replacement cost of equipment and machines added in each 10 years.

### 6.3.3 Procurement Cost of Sprinkler Units

One irrigation rotation block (12 ha) should be provided with one sprinkler unit, and hence 126 sprinkler units are to be introduced in the whole beneficial area. At present, mainly large scale farmers are adopting the sprinkler system on their own. In this study, it is proposed that the farmer is responsible for water management and for this purpose these sprinkler units should be owned and used in common and necessary units for the whole irrigated area should be arranged.

Investment amount for 126 units is RD$7,497,000.00. About 1,000ha of the project area becomes irrigable in 4th year after the commencement of the project and after 5th year, the whole beneficial area is irrigable. Therefore, 80 units (RD$4,760,000.00) are introduced in 3rd year and the other 46 units (RD$2,737,000.00) are introduced in 4th year.

Annual expenses after the introduction of sprinkler unit is depreciation expenses of equipment and is calculated by crop benefit including water charge.

## 6.4 Economic Evaluation

As a result of calculation based on the above mentioned policy, Economic Internal Rate of Return (EIRR), Economic Net Present Value (ENPV) and Benefit-Cost Ratio (B/C) are shown in Tables 6.4.1-1 and 6.4.1-2. The EIRR is 15.17%, ENPV is RD$35,183,000.00 and B/C is 1.37. ENPV and B/C are calculated using the discount rate of 12% under the guideline of FIDE. It is judged that implementation of the project is economically valid since the EIRR exceeds the discount rate (12%) of guideline of FIDE.

## 6.5 Financial Evaluation

### (1) Financial evaluation

Financial Internal Rate of Return (FIRR), Financial Net Present Value (FNPV) and Benefit-Cost Ratio (B/C) are shown in Tables 6.5.1-1 and 6.5.1-2. The FIRR is 13.24%, ENPV is RD$13,463,000.00 and B/C is 1.14, the project is judged to be financially sound. FNPV and B/C are calculated using the discount rate of 12%, similar to economic evaluation.

### (2) Farmer's economic analysis

The Government of the Dominican Republic, generally attempts to introduce foreign fund and governmental budget for the implementation of this kind of the project, and the Dominican government is responsible for the repayment of project cost. In case that the beneficial farmer will repay the foreign portion of the project cost, the result will be as follows.

If foreign fund will be provided by the international finance organization to cover mainly the foreign currency portion of the project cost, then the loan conditions are annual interest rate of 3%, amortization period of 30 years and grace period of 10 years.

Table 6.4.1-1 Cash Flow of Economic Cost and Benefit

(Unit : RD$ 1,000)

| Year In Order | Cost | | | | Benefit | Present Value | | |
|---|---|---|---|---|---|---|---|---|
| | Const. Cost | O/M Cost | Replacement Cost | Total | | Discount Rate | Cost | Benefit |
| 1 | 798 | 0 | 0 | 798 | 0 | 1.000 | 798 | 0 |
| 2 | 19165 | 0 | 0 | 19165 | 0 | 0.868 | 16641 | 0 |
| 3 | 59180 | 0 | 0 | 59180 | -8430 | 0.754 | 44617 | -6355 |
| 4 | 36007 | 316 | 0 | 36323 | -25290 | 0.655 | 23777 | -16555 |
| 5 | 0 | 478 | 0 | 478 | 19544 | 0.568 | 272 | 11109 |
| 6 | 0 | 478 | 0 | 478 | 22336 | 0.494 | 236 | 11023 |
| 7 | 0 | 478 | 0 | 478 | 25128 | 0.429 | 205 | 10768 |
| 8 | 0 | 478 | 0 | 478 | 27920 | 0.372 | 178 | 10388 |
| 9 | 0 | 478 | 0 | 478 | 27920 | 0.323 | 154 | 9020 |
| 10 | 0 | 478 | 0 | 478 | 27920 | 0.281 | 134 | 7832 |
| 11 | 0 | 478 | 0 | 478 | 27920 | 0.244 | 116 | 6800 |
| 12 | 0 | 478 | 0 | 478 | 27920 | 0.211 | 101 | 5904 |
| 13 | 0 | 478 | 0 | 478 | 27920 | 0.184 | 88 | 5127 |
| 14 | 0 | 478 | 3389 | 3867 | 27920 | 0.159 | 617 | 4451 |
| 15 | 0 | 478 | 0 | 478 | 27920 | 0.138 | 66 | 3865 |
| 16 | 0 | 478 | 0 | 478 | 27920 | 0.120 | 57 | 3356 |
| 17 | 0 | 478 | 0 | 478 | 27920 | 0.104 | 50 | 2914 |
| 18 | 0 | 478 | 0 | 478 | 27920 | 0.091 | 43 | 2530 |
| 19 | 0 | 478 | 0 | 478 | 27920 | 0.079 | 38 | 2197 |
| 20 | 0 | 478 | 0 | 478 | 27920 | 0.068 | 33 | 1908 |
| 21 | 0 | 478 | 0 | 478 | 27920 | 0.059 | 28 | 1656 |
| 22 | 0 | 478 | 0 | 478 | 27920 | 0.052 | 25 | 1438 |
| 23 | 0 | 478 | 0 | 478 | 27920 | 0.045 | 21 | 1249 |
| 24 | 0 | 478 | 3389 | 3867 | 27920 | 0.039 | 150 | 1084 |
| 25 | 0 | 478 | 0 | 478 | 27920 | 0.034 | 16 | 941 |
| 26 | 0 | 478 | 0 | 478 | 27920 | 0.029 | 14 | 817 |
| 27 | 0 | 478 | 0 | 478 | 27920 | 0.025 | 12 | 710 |
| 28 | 0 | 478 | 0 | 478 | 27920 | 0.022 | 11 | 616 |
| 29 | 0 | 478 | 0 | 478 | 27920 | 0.019 | 9 | 535 |
| 30 | 0 | 478 | 0 | 478 | 27920 | 0.017 | 8 | 465 |
| 31 | 0 | 478 | 0 | 478 | 27920 | 0.014 | 7 | 403 |
| 32 | 0 | 478 | 0 | 478 | 27920 | 0.013 | 6 | 350 |
| 33 | 0 | 478 | 0 | 478 | 27920 | 0.011 | 5 | 304 |
| 34 | 0 | 478 | 3389 | 3867 | 27920 | 0.009 | 37 | 264 |
| 35 | 0 | 478 | 0 | 478 | 27920 | 0.008 | 4 | 229 |
| 36 | 0 | 478 | 0 | 478 | 27920 | 0.007 | 3 | 199 |
| 37 | 0 | 478 | 0 | 478 | 27920 | 0.006 | 3 | 173 |
| 38 | 0 | 478 | 0 | 478 | 27920 | 0.005 | 3 | 150 |
| 39 | 0 | 478 | 0 | 478 | 27920 | 0.005 | 2 | 130 |
| 40 | 0 | 478 | 0 | 478 | 27920 | 0.004 | 2 | 113 |
| 41 | 0 | 478 | 0 | 478 | 27920 | 0.004 | 2 | 98 |
| 42 | 0 | 478 | 0 | 478 | 27920 | 0.003 | 1 | 85 |
| 43 | 0 | 478 | 0 | 478 | 27920 | 0.003 | 1 | 74 |
| 44 | 0 | 478 | 3389 | 3867 | 27920 | 0.002 | 9 | 64 |
| 45 | 0 | 478 | 0 | 478 | 27920 | 0.002 | 1 | 56 |
| 46 | 0 | 478 | 0 | 478 | 27920 | 0.002 | 1 | 48 |
| 47 | 0 | 478 | 0 | 478 | 27920 | 0.002 | 1 | 42 |
| 48 | 0 | 478 | 0 | 478 | 27920 | 0.001 | 1 | 37 |
| 49 | 0 | 478 | 0 | 478 | 27920 | 0.001 | 1 | 32 |
| 50 | 0 | 478 | 0 | 478 | 27920 | 0.001 | 0 | 28 |
| Total | 115150 | 22304 | 13556 | 151010 | 1233848 | 7.585 | 88604 | 88674 |

B / C =1.000790
B - C =69.99711
E I R R = 0.1517

Table 6.4.1-2 Economic Net Present Value and Benefit Cost Ratio (discount rate 12%)

(Unit : RD$ 1,000)

| Year In Order | Cost | | | | Benefit | Present Value | | |
|---|---|---|---|---|---|---|---|---|
| | Const. Cost | O/M Cost | Replacement Cost | Total | | Discount Rate | Cost | Benefit |
| 1 | 798 | 0 | 0 | 798 | 0 | 1.000 | 798 | 0 |
| 2 | 19165 | 0 | 0 | 19165 | 0 | 0.893 | 17112 | 0 |
| 3 | 59180 | 0 | 0 | 59180 | -8430 | 0.797 | 47178 | -6720 |
| 4 | 36007 | 316 | 0 | 36323 | -25290 | 0.712 | 25854 | -18001 |
| 5 | 0 | 478 | 0 | 478 | 19544 | 0.636 | 304 | 12421 |
| 6 | 0 | 478 | 0 | 478 | 22336 | 0.567 | 271 | 12674 |
| 7 | 0 | 478 | 0 | 478 | 25128 | 0.507 | 242 | 12731 |
| 8 | 0 | 478 | 0 | 478 | 27920 | 0.452 | 216 | 12630 |
| 9 | 0 | 478 | 0 | 478 | 27920 | 0.404 | 193 | 11276 |
| 10 | 0 | 478 | 0 | 478 | 27920 | 0.361 | 172 | 10068 |
| 11 | 0 | 478 | 0 | 478 | 27920 | 0.322 | 154 | 8989 |
| 12 | 0 | 478 | 0 | 478 | 27920 | 0.287 | 137 | 8026 |
| 13 | 0 | 478 | 0 | 478 | 27920 | 0.257 | 123 | 7166 |
| 14 | 0 | 478 | 3389 | 3867 | 27920 | 0.229 | 886 | 6399 |
| 15 | 0 | 478 | 0 | 478 | 27920 | 0.205 | 98 | 5713 |
| 16 | 0 | 478 | 0 | 478 | 27920 | 0.183 | 87 | 5101 |
| 17 | 0 | 478 | 0 | 478 | 27920 | 0.163 | 78 | 4554 |
| 18 | 0 | 478 | 0 | 478 | 27920 | 0.146 | 70 | 4066 |
| 19 | 0 | 478 | 0 | 478 | 27920 | 0.130 | 62 | 3631 |
| 20 | 0 | 478 | 0 | 478 | 27920 | 0.116 | 55 | 3242 |
| 21 | 0 | 478 | 0 | 478 | 27920 | 0.104 | 50 | 2894 |
| 22 | 0 | 478 | 0 | 478 | 27920 | 0.093 | 44 | 2584 |
| 23 | 0 | 478 | 0 | 478 | 27920 | 0.083 | 40 | 2307 |
| 24 | 0 | 478 | 3389 | 3867 | 27920 | 0.074 | 285 | 2060 |
| 25 | 0 | 478 | 0 | 478 | 27920 | 0.066 | 31 | 1839 |
| 26 | 0 | 478 | 0 | 478 | 27920 | 0.059 | 28 | 1642 |
| 27 | 0 | 478 | 0 | 478 | 27920 | 0.053 | 25 | 1466 |
| 28 | 0 | 478 | 0 | 478 | 27920 | 0.047 | 22 | 1309 |
| 29 | 0 | 478 | 0 | 478 | 27920 | 0.042 | 20 | 1169 |
| 30 | 0 | 478 | 0 | 478 | 27920 | 0.037 | 18 | 1044 |
| 31 | 0 | 478 | 0 | 478 | 27920 | 0.033 | 16 | 932 |
| 32 | 0 | 478 | 0 | 478 | 27920 | 0.030 | 14 | 832 |
| 33 | 0 | 478 | 0 | 478 | 27920 | 0.027 | 13 | 743 |
| 34 | 0 | 478 | 3389 | 3867 | 27920 | 0.024 | 92 | 663 |
| 35 | 0 | 478 | 0 | 478 | 27920 | 0.021 | 10 | 592 |
| 36 | 0 | 478 | 0 | 478 | 27920 | 0.019 | 9 | 529 |
| 37 | 0 | 478 | 0 | 478 | 27920 | 0.017 | 8 | 472 |
| 38 | 0 | 478 | 0 | 478 | 27920 | 0.015 | 7 | 422 |
| 39 | 0 | 478 | 0 | 478 | 27920 | 0.013 | 6 | 376 |
| 40 | 0 | 478 | 0 | 478 | 27920 | 0.012 | 6 | 336 |
| 41 | 0 | 478 | 0 | 478 | 27920 | 0.011 | 5 | 300 |
| 42 | 0 | 478 | 0 | 478 | 27920 | 0.010 | 5 | 268 |
| 43 | 0 | 478 | 0 | 478 | 27920 | 0.009 | 4 | 239 |
| 44 | 0 | 478 | 3389 | 3867 | 27920 | 0.008 | 30 | 214 |
| 45 | 0 | 478 | 0 | 478 | 27920 | 0.007 | 3 | 191 |
| 46 | 0 | 478 | 0 | 478 | 27920 | 0.006 | 3 | 170 |
| 47 | 0 | 478 | 0 | 478 | 27920 | 0.005 | 3 | 152 |
| 48 | 0 | 478 | 0 | 478 | 27920 | 0.005 | 2 | 136 |
| 49 | 0 | 478 | 0 | 478 | 27920 | 0.004 | 2 | 121 |
| 50 | 0 | 478 | 0 | 478 | 27920 | 0.004 | 2 | 108 |
| Total | 115150 | 22304 | 13556 | 151010 | 1233848 | 9.301 | 94895 | 130078 |

B / C =1.370768

B - C =35183.93

Table 6.5.1-1 Cash Flow of Financial Cost and Benefit

(Unit : RD$ 1,000)

| Year In Order | Cost | | | | Benefit | Present Value | | |
|---|---|---|---|---|---|---|---|---|
| | Const. Cost | O/M Cost | Replacement Cost | Total | | Discount Rate | Cost | Benefit |
| 1 | 640 | 0 | 0 | 640 | 0 | 1.000 | 640 | 0 |
| 2 | 17726 | 0 | 0 | 17726 | 0 | 0.883 | 15653 | 0 |
| 3 | 57217 | 0 | 0 | 57217 | -8486 | 0.780 | 44620 | -6618 |
| 4 | 40236 | 484 | 0 | 40720 | -25459 | 0.689 | 28042 | -17532 |
| 5 | 0 | 732 | 0 | 732 | 16884 | 0.608 | 445 | 10268 |
| 6 | 0 | 732 | 0 | 732 | 19296 | 0.537 | 393 | 10363 |
| 7 | 0 | 732 | 0 | 732 | 21708 | 0.474 | 347 | 10295 |
| 8 | 0 | 732 | 0 | 732 | 24120 | 0.419 | 307 | 10101 |
| 9 | 0 | 732 | 0 | 732 | 24120 | 0.370 | 271 | 8920 |
| 10 | 0 | 732 | 0 | 732 | 24120 | 0.327 | 239 | 7877 |
| 11 | 0 | 732 | 0 | 732 | 24120 | 0.288 | 211 | 6956 |
| 12 | 0 | 732 | 0 | 732 | 24120 | 0.255 | 186 | 6143 |
| 13 | 0 | 732 | 0 | 732 | 24120 | 0.225 | 165 | 5425 |
| 14 | 0 | 732 | 0 | 732 | 24120 | 0.199 | 145 | 4790 |
| 15 | 0 | 732 | 0 | 732 | 24120 | 0.175 | 128 | 4230 |
| 16 | 0 | 732 | 0 | 732 | 24120 | 0.155 | 113 | 3736 |
| 17 | 0 | 732 | 0 | 732 | 24120 | 0.137 | 100 | 3299 |
| 18 | 0 | 732 | 0 | 732 | 24120 | 0.121 | 88 | 2913 |
| 19 | 0 | 732 | 0 | 732 | 24120 | 0.107 | 78 | 2573 |
| 20 | 0 | 732 | 0 | 732 | 24120 | 0.094 | 69 | 2272 |
| 21 | 0 | 732 | 0 | 732 | 24120 | 0.083 | 61 | 2006 |
| 22 | 0 | 732 | 0 | 732 | 24120 | 0.073 | 54 | 1772 |
| 23 | 0 | 732 | 0 | 732 | 24120 | 0.065 | 47 | 1565 |
| 24 | 0 | 732 | 0 | 732 | 24120 | 0.057 | 42 | 1382 |
| 25 | 0 | 732 | 0 | 732 | 24120 | 0.051 | 37 | 1220 |
| 26 | 0 | 732 | 0 | 732 | 24120 | 0.045 | 33 | 1077 |
| 27 | 0 | 732 | 0 | 732 | 24120 | 0.039 | 29 | 951 |
| 28 | 0 | 732 | 0 | 732 | 24120 | 0.035 | 25 | 840 |
| 29 | 0 | 732 | 0 | 732 | 24120 | 0.031 | 23 | 742 |
| 30 | 0 | 732 | 0 | 732 | 24120 | 0.027 | 20 | 655 |
| 31 | 0 | 732 | 0 | 732 | 24120 | 0.024 | 18 | 579 |
| 32 | 0 | 732 | 0 | 732 | 24120 | 0.021 | 16 | 511 |
| 33 | 0 | 732 | 0 | 732 | 24120 | 0.019 | 14 | 451 |
| 34 | 0 | 732 | 0 | 732 | 24120 | 0.017 | 12 | 398 |
| 35 | 0 | 732 | 0 | 732 | 24120 | 0.015 | 11 | 352 |
| 36 | 0 | 732 | 0 | 732 | 24120 | 0.013 | 9 | 311 |
| 37 | 0 | 732 | 0 | 732 | 24120 | 0.011 | 8 | 274 |
| 38 | 0 | 732 | 0 | 732 | 24120 | 0.010 | 7 | 242 |
| 39 | 0 | 732 | 0 | 732 | 24120 | 0.009 | 6 | 214 |
| 40 | 0 | 732 | 0 | 732 | 24120 | 0.008 | 6 | 189 |
| 41 | 0 | 732 | 0 | 732 | 24120 | 0.007 | 5 | 167 |
| 42 | 0 | 732 | 0 | 732 | 24120 | 0.006 | 4 | 147 |
| 43 | 0 | 732 | 0 | 732 | 24120 | 0.005 | 4 | 130 |
| 44 | 0 | 732 | 0 | 732 | 24120 | 0.005 | 3 | 115 |
| 45 | 0 | 732 | 0 | 732 | 24120 | 0.004 | 3 | 101 |
| 46 | 0 | 732 | 0 | 732 | 24120 | 0.004 | 3 | 90 |
| 47 | 0 | 732 | 0 | 732 | 24120 | 0.003 | 2 | 79 |
| 48 | 0 | 732 | 0 | 732 | 24120 | 0.003 | 2 | 70 |
| 49 | 0 | 732 | 0 | 732 | 24120 | 0.003 | 2 | 62 |
| 50 | 0 | 732 | 0 | 732 | 24120 | 0.002 | 2 | 54 |
| Total | 115819 | 34156 | 0 | 149975 | 1061103 | 8.536 | 92750 | 92759 |

B / C =1.000096
B - C =8.980800
F I R R = 0.1324

Table 6.5.1-2 Financial Net Present Value and Benefit Cost Ratio
(discount rate 12%)

(Unit : RD$ 1,000)

| Year in Order | Cost | | | | Benefit | Present Value | | |
|---|---|---|---|---|---|---|---|---|
| | Const. Cost | O/M Cost | Replace ment Cost | Total | | Discount Rate | Cost | Benefit |
| 1 | 640 | 0 | 0 | 640 | 0 | 1.000 | 640 | 0 |
| 2 | 17726 | 0 | 0 | 17726 | 0 | 0.893 | 15827 | 0 |
| 3 | 57217 | 0 | 0 | 57217 | -8486 | 0.797 | 45613 | -6765 |
| 4 | 40236 | 484 | 0 | 40720 | -25459 | 0.712 | 28984 | -18121 |
| 5 | 0 | 732 | 0 | 732 | 16884 | 0.636 | 465 | 10730 |
| 6 | 0 | 732 | 0 | 732 | 19296 | 0.567 | 415 | 10949 |
| 7 | 0 | 732 | 0 | 732 | 21708 | 0.507 | 371 | 10998 |
| 8 | 0 | 732 | 0 | 732 | 24120 | 0.452 | 331 | 10911 |
| 9 | 0 | 732 | 0 | 732 | 24120 | 0.404 | 296 | 9742 |
| 10 | 0 | 732 | 0 | 732 | 24120 | 0.361 | 264 | 8698 |
| 11 | 0 | 732 | 0 | 732 | 24120 | 0.322 | 236 | 7766 |
| 12 | 0 | 732 | 0 | 732 | 24120 | 0.287 | 210 | 6934 |
| 13 | 0 | 732 | 0 | 732 | 24120 | 0.257 | 188 | 6191 |
| 14 | 0 | 732 | 0 | 732 | 24120 | 0.229 | 168 | 5528 |
| 15 | 0 | 732 | 0 | 732 | 24120 | 0.205 | 150 | 4935 |
| 16 | 0 | 732 | 0 | 732 | 24120 | 0.183 | 134 | 4407 |
| 17 | 0 | 732 | 0 | 732 | 24120 | 0.163 | 119 | 3934 |
| 18 | 0 | 732 | 0 | 732 | 24120 | 0.146 | 107 | 3513 |
| 19 | 0 | 732 | 0 | 732 | 24120 | 0.130 | 95 | 3137 |
| 20 | 0 | 732 | 0 | 732 | 24120 | 0.116 | 85 | 2800 |
| 21 | 0 | 732 | 0 | 732 | 24120 | 0.104 | 76 | 2500 |
| 22 | 0 | 732 | 0 | 732 | 24120 | 0.093 | 68 | 2233 |
| 23 | 0 | 732 | 0 | 732 | 24120 | 0.083 | 60 | 1993 |
| 24 | 0 | 732 | 0 | 732 | 24120 | 0.074 | 54 | 1780 |
| 25 | 0 | 732 | 0 | 732 | 24120 | 0.066 | 48 | 1589 |
| 26 | 0 | 732 | 0 | 732 | 24120 | 0.059 | 43 | 1419 |
| 27 | 0 | 732 | 0 | 732 | 24120 | 0.053 | 38 | 1267 |
| 28 | 0 | 732 | 0 | 732 | 24120 | 0.047 | 34 | 1131 |
| 29 | 0 | 732 | 0 | 732 | 24120 | 0.042 | 31 | 1010 |
| 30 | 0 | 732 | 0 | 732 | 24120 | 0.037 | 27 | 902 |
| 31 | 0 | 732 | 0 | 732 | 24120 | 0.033 | 24 | 805 |
| 32 | 0 | 732 | 0 | 732 | 24120 | 0.030 | 22 | 719 |
| 33 | 0 | 732 | 0 | 732 | 24120 | 0.027 | 19 | 642 |
| 34 | 0 | 732 | 0 | 732 | 24120 | 0.024 | 17 | 573 |
| 35 | 0 | 732 | 0 | 732 | 24120 | 0.021 | 16 | 512 |
| 36 | 0 | 732 | 0 | 732 | 24120 | 0.019 | 14 | 457 |
| 37 | 0 | 732 | 0 | 732 | 24120 | 0.017 | 12 | 408 |
| 38 | 0 | 732 | 0 | 732 | 24120 | 0.015 | 11 | 364 |
| 39 | 0 | 732 | 0 | 732 | 24120 | 0.013 | 10 | 325 |
| 40 | 0 | 732 | 0 | 732 | 24120 | 0.012 | 9 | 290 |
| 41 | 0 | 732 | 0 | 732 | 24120 | 0.011 | 8 | 259 |
| 42 | 0 | 732 | 0 | 732 | 24120 | 0.010 | 7 | 231 |
| 43 | 0 | 732 | 0 | 732 | 24120 | 0.009 | 6 | 207 |
| 44 | 0 | 732 | 0 | 732 | 24120 | 0.008 | 6 | 185 |
| 45 | 0 | 732 | 0 | 732 | 24120 | 0.007 | 5 | 165 |
| 46 | 0 | 732 | 0 | 732 | 24120 | 0.006 | 4 | 147 |
| 47 | 0 | 732 | 0 | 732 | 24120 | 0.005 | 4 | 131 |
| 48 | 0 | 732 | 0 | 732 | 24120 | 0.005 | 4 | 117 |
| 49 | 0 | 732 | 0 | 732 | 24120 | 0.004 | 3 | 105 |
| 50 | 0 | 732 | 0 | 732 | 24120 | 0.004 | 3 | 93 |
| Total | 115819 | 34156 | 0 | 149975 | 1061103 | 9.301 | 95382 | 108845 |

B / C =1.141149
B - C =13463.06

Under the loan condition, the maximum amortization will be 11th year after implementation of the project, which amounts to RD$9,554,000.00 including annual interest. This amount for the unit beneficial area will be RD$6,300.00/ha. In accordance with the result of farm management plan as discussed in section 4.3.3 the economic surplus of small scale farmer (0.6 ha) is RD$23,286.00 and the amortization of loan (RD$6,300.00/ha) can be compensated by the economic surplus.

## 6.6 Sensitivity Analysis

Sensitivity analysis of economic and financial evaluation are made under the following conditions:

Case 1 : Increase of construction cost by 10%
Case 2 : Decrease of project benefit by 10%
Case 3 : Increase of production cost by 10%

The result of calculation is shown in Table 6.6.1-1 (refer to Annex Q Tables 3.1 to 3.6).

Table 6.6.1-1 Sensitivity analysis

| Item | EIRR (%) | FIRR (%) |
|---|---|---|
| Standard | 15.2 | 13.2 |
| Case 1 | 14.2 | 12.4 |
| Case 2 | 15.0 | 12.0 |
| Case 3 | 15.2 | 13.2 |

Sensitivity analysis has proved that a change of project benefit has stronger influence on economy and finance of the project than a change of construction cost and production cost.

## 6.7 Socio-economic Evaluation

Project effect of the development plan consists direct quantifiable benefit and the secondary or indirect unquantifiable benefit which is expected by the following aspects.

(1) Contribution to national development plan

The implementation of the project contributes for the national development in promoting the development of agriculture sector which is one of the important tasks in national development plan and expand impact on other similar regions.

(2) Stable supply of vegetables

Constanza area is a big production zone of vegetables which supply vegetables to principal cities such as Santo Domingo and Santiago. After implementation of the project, it can supply vegetables of better quality and low price.

(3) Expansion of exportation

After implementation of the project it is possible to produce vegetables during dry season (January to March). During the period, the season in USA which is the main export country from Dominican Republic is winter and export of vegetables to USA will be expanded. The export of vegetables will contribute to Dominican economy in acquiring foreign exchange.

(4) Increase of employment opportunity

The employment opportunity increases during the construction period and also in dry season due to the increase of cropping rate and crop cultivation. Implementation of the project absorbs excess labor in and around the project area, reduces unemployed laborers, and improves the living standard of employed laborers, thus contributes for the stabilization of living conditions in the project area.

(5) Improvement of living standard

As a result of Farm Management Plan, the implementation of the project contributes to increase the farmer's economic surplus, improve the living standard and increase the farmer's capital saving for high level farm management.

(6) Economic stimulation

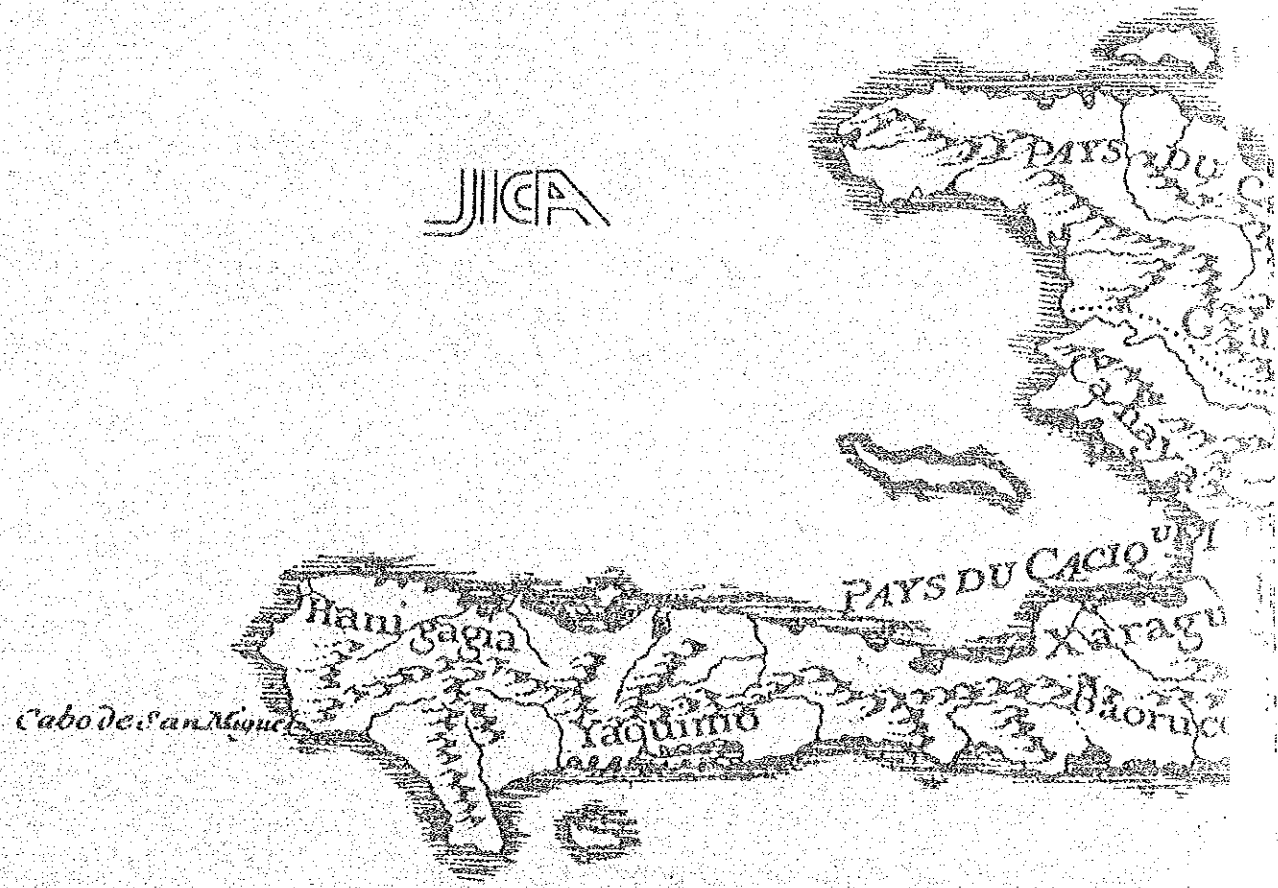
The increase of farm income contributes for improving the purchasing power of farmer and participation in local commercial activities.

## 6.8 Overall Evaluation

According to the results of economic evaluation, financial evaluation and socio-economic evaluation, the implementation of the project contributes for improvement of farm economy, development of project area, stabilization of living standard and improvement of national economy.

The project is expected to be implemented promptly considering the superannuated existing intake and canal facilities since it is the fundamental necessity of agriculture in Constanza.

The implementation of the project attaches importance to promote the National Development Plan considering the present economic situation in Dominican Republic.


PAYS DU CACIQUE
Rami Gagia
Xaraguá
Yaquimo
Cabo de San Miguel