2. Evaluation of the Present Agriculture

Though farming in Constanza Valley is classified into intensive agriculture aiming at commercial production, there is still room for improvement. In this study, the following problems have been identified in the study area. Especially pests and diseases on the crops stalk the Valley by continuous cropping for many years, and it is thought that the use of pesticides in a large quantity against the pests and diseases and reliance of farming solely on chemical fertilizers put agriculture in the Valley into a vicious cycle.

(1) Decline of Soil Fertility

The farm land has been exposed to intensive cropping as revealed by 214% of land utilization, and is not fallowed except for special reasons. Nutrition in the soil is supplemented largely with chemical fertilizers, and only a little organic matter is supplied to the soil.

It is clear that the way of farming has been impoverishing soil fertility. Though farms are deeply plowed by a big tractor, the plowing is carried out without consideration of soil erosion. Heavy use of big tractors have caused compaction of the soil in addition to clayey soil by the nature and therefore the permeability of water is relatively low.

(2) Simple Cropping Pattern

Though the cropping patterns of the study area seem complex at a glance, a typical cropping pattern of growing garlic in winter has been established, combining with potato, kidney bean and/or onion. The cropping patterns should be varied with more crops including graminous crop. A continuous cropping of the same sort of crops such as onion after garlic facilitates proliferation of pests and diseases, and it causes heavier injury of continuous cropping. The cropping pattern just for profit making should be turned to the crop rotation which will recover soil fertility.

(3) Countermeasures against Pests and Diseases

The heavy damages caused by pests and diseases because of continuous cropping have been rising, causing a serious problem to the farmers. Many pests and diseases such as nematode, soil borne diseases, mosca blanca, mites, etc., parasite on many crops. Particularly the pests and diseases which have been causing serious damages on the principal crops are Moho Blanco (Sclerotium cepivorum) on garlic and onion, Minador (phthorimaea opereulells) and Mosca Blanca (Trialeurodes vaprarorium) respectively, and their control is difficult. Chemical control has been the only measure followed, but the integrated pest control including method of cultivation should be taken into consideration.

(4) Problems of Seeds and Seedlings

Garlic seeds of TAIWAN variety causes a serious problem in 1988, since the variety did not fit to the nature of the Valley. Some problems of unhealthy seeds and seedlings were also observed during the study.
Farmers claimed that the distribution of seeds had been sometimes delayed for planting. Healthy seeds and seedlings promise high yield with resistance against pests and diseases. Handling of seeds should be more careful.

(5) Marketing and Market of Agricultural Products

Most of the products are sold to markets through a middle man at present. And farmers' associations have not so far dealt with marketing of the products. These associations are expected to play a role in marketing, setting up information network of vegetable prices in the market and planning production of crops. Only domestic market has been targeted because of pesticide residue, pests and other reasons. In the future, export market should be developed considering severe control of pesticide usage.

(6) Timing of Credit

During the hearing survey, 15 out of 50 farmers complained the delay of agricultural credit which were not in time for planting. Timely financing is necessary.

(7) Lacking of Irrigation Water

The biggest problem that the farmers keep in mind is the lack of irrigation water. During the hearing survey by the study team, 35 out of 50 farmers picked up this problem as the serious problem of the area. It is more serious for small scale farmers who can not drill wells than large scale farmers.

(8) Agricultural Supporting Services

The existing SEA Constanza office and Horticultural Experiment Station are well organized and the staffs have been working hard, but the services should be improved with more staffs, more facilities and more budget.

(9) Farming Senses and Quality of Labor

As discussed above, the farmers are conservative in farming, maintaining the traditional method and conventional crops. It causes rough farming that most of labor forces are rendered to casual employees.

3. Evaluation of the Existing Facilities

3.1 Irrigation and Drainage System

(1) Head Works

- Broken concrete apron of 15m width is found in the left river bank.

- The terrace in the upper reach of the head works belongs to early mature stage in landform. Since stock raising on the terrace is practiced extensively, vegetative cover is almost lost and sediment run off is strikingly much.
- Existing head works was constructed 42 years ago and has been damaged. Much repair and maintenance cost will be needed.

(2) Head Race Between the Head Works and the Division Works

- According to the flow measurement in Phase I field study, the flow volume after the head works was 0.52m^3/s and the one before the division works was 0.36m^3/s. It means that approximately 30% of water is lost during its transportation.
- Stagnation of water was observed at the unlined canal. This is due to luxuriant growth of plants and diminution of its section. It may be one factor for increasing water leakage.
- The head race passes steep slope of mountains for 300 meters after the head works. Hence, it is difficult to install new line or rehabilitate it with method accompanying excavation work in this section.

(3) Canals

- The operation and maintenance of the canals are insufficient and the following features are observed.

  a. Water leakage due to breakage of canals
  b. Luxuriant growth of plants in canals and stagnation of irrigation water accordingly.
  c. Diminution of sectional area and buried canals due to the sediment

- The plan of water rotation is not necessarily followed.

- There exists farm ponds and division works which are not included in the irrigation plan. Water is actually taken to these facilities from canals.

- Since the facilities in canals are decrepit, there exists considerable leakage and ineffective outflow. Irrigation water does not flow upto the end of canals due to this reason in addition to the shortage and the disorder of water discharge.

- Lateral No. 11 and No. 12 were not found. The routes of other laterals are different from the designed ones.

- A farm pond which can regulate the difference of time and volume between water demand of irrigated area and water supply of the water resource doesn't exist in the study area. Hence there is an increase of ineffective outflow in the area.

(4) Irrigation System with Groundwater

- The boring method of well does not always fit to the soil.

- Therefore some wells are considerably collapsed by seepage pressure, which is difficult to maintain.

- It is costly to pump up water from wells.

- There is heavy water loss on the process of its distribution.

(5) Small Scale Irrigation System with Stream in the Study Area

- Operation cost of pump is expensive.

(6) Drainage Facilities

- The operation and maintenance of drainage facilities are not sufficient. Sections of some drainage canals are not maintained and some canals have luxuriant growth of vegetation.

- Some drainage canals in the northern part of the Arroyo Constanza do not function well.

- The groundwater level is high in the middle and downstream of the Arroyo Constanza since the drainage facilities are not sufficient in the area.

3.2 Farm Facilities

- Since ridges on the farms are formed along field slope, surface soil run off is high.

- Some farms are cultivated on steep slopes of mountains. It causes a lot of losses of farming such as low efficiency of farming work, high irrigation cost, loss of surface soil and so on.

3.3 Farm Road

- Since the operation and maintenance of farm roads are not necessarily sufficient, the road surface tends to be rough. It disturbs smooth driving of vehicles on the farm roads.

- Farm road network is not arranged well. They are not connected well with the trunk roads. Especially there are only a few roads connecting the northern and southern areas of the Arroyo Constanza. Therefore, it takes a long time to carry out the agricultural products from the farms.

4. Evaluation of Present Water Resources

(1) Shortage of the Absolute Volume of Irrigation Water

There are 1,660ha farm lands in the Valley. On the other land, the catchment areas utilized for irrigation water resources are as follows.

a. 42 km^2 in the Rio Grande catchment area
b. 10 km^2 in the Arroyo Pantuflas catchment area
c. 4.8 km^2 in the Arroyo Palero catchment area

Only 56.8km^2 of catchment areas are utilized as irrigation water resources and these areas are not sufficient against the area of arable land.

(2) Shortage of Regulating Function for Outflow in the Upper Reaches.

In addition to the shortage of the catchment area as its water resource, those areas are utilized for cattle raising and their storage funtions are almost lost. Therefore the rain water is flown out as ineffective outflow.

II. PLANNING AND EVALUATION

ANNEX J : FORMULATION OF THE PROJECT

ANNEX J : FORMULATION OF THE PROJECT

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ANNEX J : FORMULATION OF THE PROJECT

1. Objectives of the Project and Policy of Development

1.1 Objectives of the Project

The Constanza Valley has been developed as a major production area of vegetables in the Dominican Republic. However, the shortage of irrigation water became serious and influence on the crop production. This is because of superannuation of the irrigation facilities which were constructed 42 years ago and enlargement of farm land area after its construction.

The shortage of irrigation water occurs during December to April. Especially it is serious at the downstream side of the canals during January to March. Solving this problem is important for the agricultural development of the Valley.

In addition to this, the government of the Dominican Republic is planning for stable supply of non-traditional farm products for domestic consumption, enlargement of cultivation area for vegetables/fruits and promotion of future exports so as to solve the stagnated economy which was caused by the deteriorated international commercial balance. The development of Constanza Valley has a great potential to improve the stagnated economy.

In light of the background mentioned above, the present project is to accomplish the following objectives by effective utilization of water resources to maximum through the introduction of irrigation facilities enough to cover the water shortage of the area in the dry season.

- Agricultural production throughout the year
- Increase of cropping ratio
- Increase of agricultural production
- Increase of farm income
- Increase of employment opportunities, etc.

Fulfillment of the above objectives will contribute for improving the regional economy, raising the living standard and stabilizing the civil administration.

1.2 Basic Policy

The basic policies of the project for establishing the project plan is summarized as follows.

- The plan should be based on the national development plan
- The plan should not have any bad influence on other projects
- Full utilization of water resources and guarantee of water supply
- Effective utilization of the existing irrigation facilities
- Upbringing of operation and maintenance association organized by beneficiaries.
- Guarantee of the stable agricultural management condition
- Selection of appropriate crops those farmers can cultivate with their present techniques
- Absorbing extra labor force and creating new employment opportunities.

The project formulation has been planned for not only the agricultural development of the Valley, but also promoting the economical development of the Dominican Republic.

Economical facilities plan considering effective utilization of the existing facilities is studied for the planning of facilities.

The dimension of the facilities has been studied on the basis of the 5 years return period which was applied by INDRHI for the agricultural facilities.

Guarantee of water supply is planned by effective utilization of water resources and as a rule gravity intake method is applied in order to minimize the operation and maintenance cost.

Regarding the farm management plan, the cropping pattern was planned on the basis of the present prevalent cropping and aiming at the domestic consumption, as a rule. The plan includes the soil improvement, the extension of the cropping techniques and the security of the rational cropping pattern for the stable agricultural management.

Educating the beneficiaries regarding the operation & maintenance of facilities is included in the operation & maintenance plan.

In the agricultural improvement plan, the participation of the beneficiaries for the agricultural development plan of the Valley has been recommended in order to extend the market and agricultural technical informations, rapidly to all the beneficiaries.

On the basis of these considerations, the formulation of the project was carried out, aiming at the smooth and stable maintenance of the project.

The basic development policy aims at realizing the most reasonable investment through the study of the development possibility on several aspects of the project. The development policy will be divided into 2 major categories as follows:

(1) Irrigation Facility Plan

The most suitable investment effect is the basic target for establishing the irrigation facility plan.

1) Irrigation plan

In the irrigation plan, canal network system is proposed for the development of the project area. But some areas will be omitted from the project, where it is judged as uneconomical.

2) Water resources development plan

The water resources development plan should focus on the most effective investment based on the technical and economical studies. The basic concept of the plan is to solve the constraints and water shortage, examining the existing facility conditions.
Under the present irrigation system, water shortage occurs during December to April. On the other hand, excessive water in the other seasons are discharged as ineffective outflow. The effective utilization of the excessive water should be studied and the water resources plan should be designed such that it have no effect on El Salto mini-hydropower station project.

(2) Agricultural Production Plan

This project should satisfy the following conditions:

1. Realization of effective water utilization
2. Expansion of agricultural production
3. Increase of agricultural income
4. Stabilization of agricultural management
5. Introduction of highly profitable crops

Agricultural production plan consists of two phases; short-term plan and long-term plan.
The short-term plan should propose the ideas those farmers can apply easily to modify and solve the constraints for the time being.
The long-term plan should suggest the ideas of approaching & solving the basic constraints those exist in the present farming system.

1.3 Methodology of Project Formulation

The project formulation was carried out by the following method, aiming at solving the irrigation water shortage problem which is the main limitation for the agricultural development in the Valley.

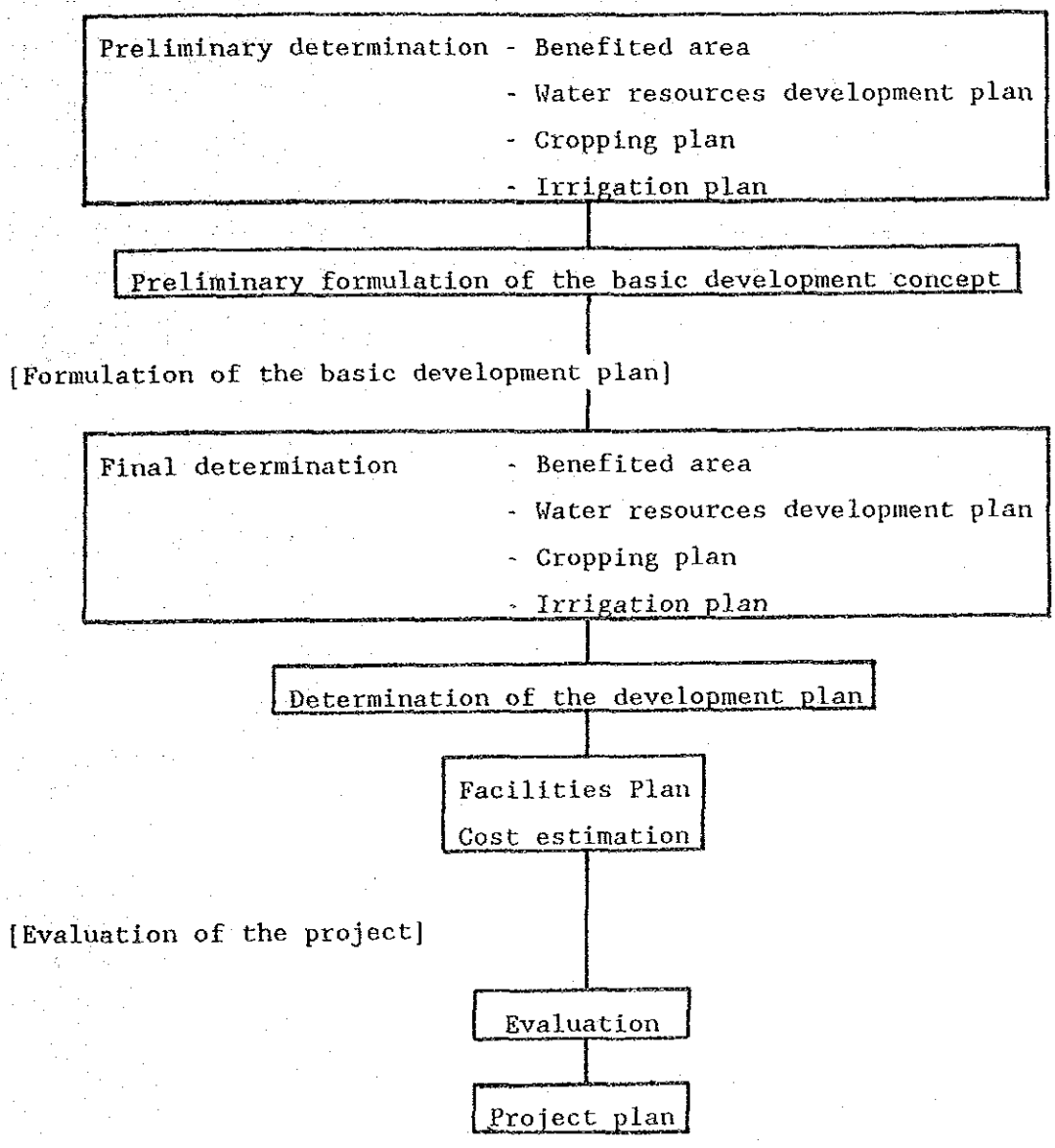


Fig. 1.3.1-1 Flow Chart of Project Formulation

Principally the formulation of the basic development concept was carried out in order to solve the irrigation water shortage problem, focussing on the possibility of water resources development in the study area and outside the study area.

On the basis of the basic development concept, three alternatives which consists of the existing canal rehabilitation plan, canal construction plan and pipeline plan were formulated, mainly considering the distribution systems. The most appropriate plan was selected among the three alternatives, considering the facilities construction cost, farm equipment cost and operation and maintenance cost.

On the basis of the selected alternative, the basic development plan of the land utilization, irrigation, water resources, agriculture and facilities plans were studied in detail.

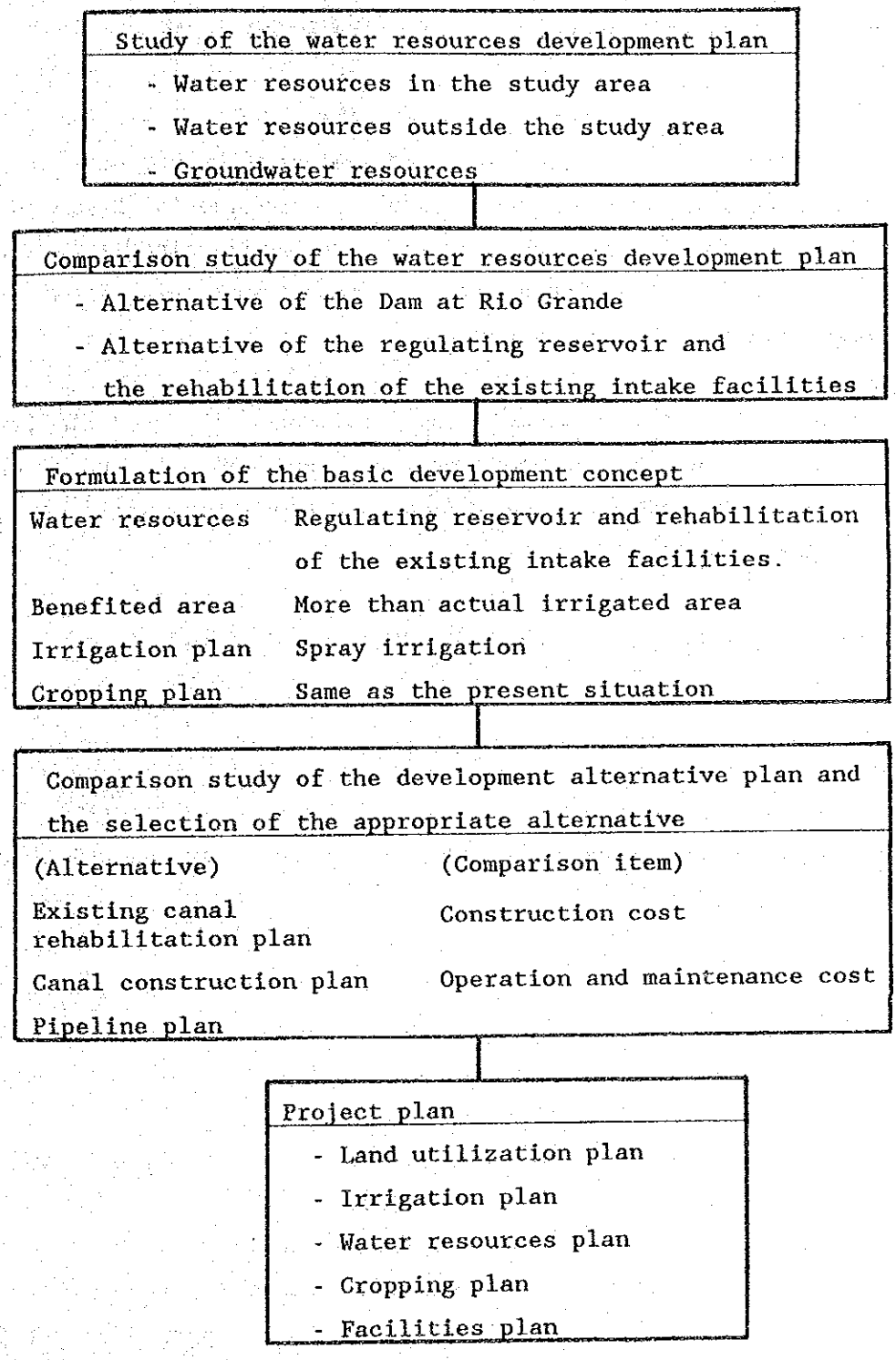


Fig. 1.3.1-2 Determination of Project Formulation

2. Basic Development Plan

2.1 Benefit Area

In the study area of 2,140ha, approximately 1,660ha of upland is cultivated at present and 1,275ha of upland is irrigated by the irrigation facilities. Judging from the land classification, all of the cultivated lands are in the Class 1 - 3 which has no limitation for the agriculture.

In the project the benefit area includes the present irrigated area and new area considering topographical and economical factor. Some area which is judged as uneconomical will be omitted from the project.

2.2 Basic Concepts of Water Resource Development Plan

2.2.1 Basic Concepts

The following concepts are considered for establishing the development plan.

- The water demand for irrigation varies with respect to irrigated area and irrigation method. In this case, the proposed alternatives should be evaluated based on the following conditions:
    1. Irrigated area is 1,510ha which is below 1,240m A.S.L. and can supply water easily.
    2. Sprinkler irrigation system is applied.
- The water resources plan is studied to satisfy the water demand for irrigation in this area in 5 year return period of rainfall.
- Plans of low economical efficiency should be omitted, although it is possible to obtain large amount of water using these plans.
- The optimum plan should be selected based on the technical and economical studies of available alternative.

- The plan should have no effect on the existing plan (El Salto mini-hydro power station) and the water service facilities.

The flow chart for evaluation of water resources development plans is shown in Fig. 2.2.1-1.

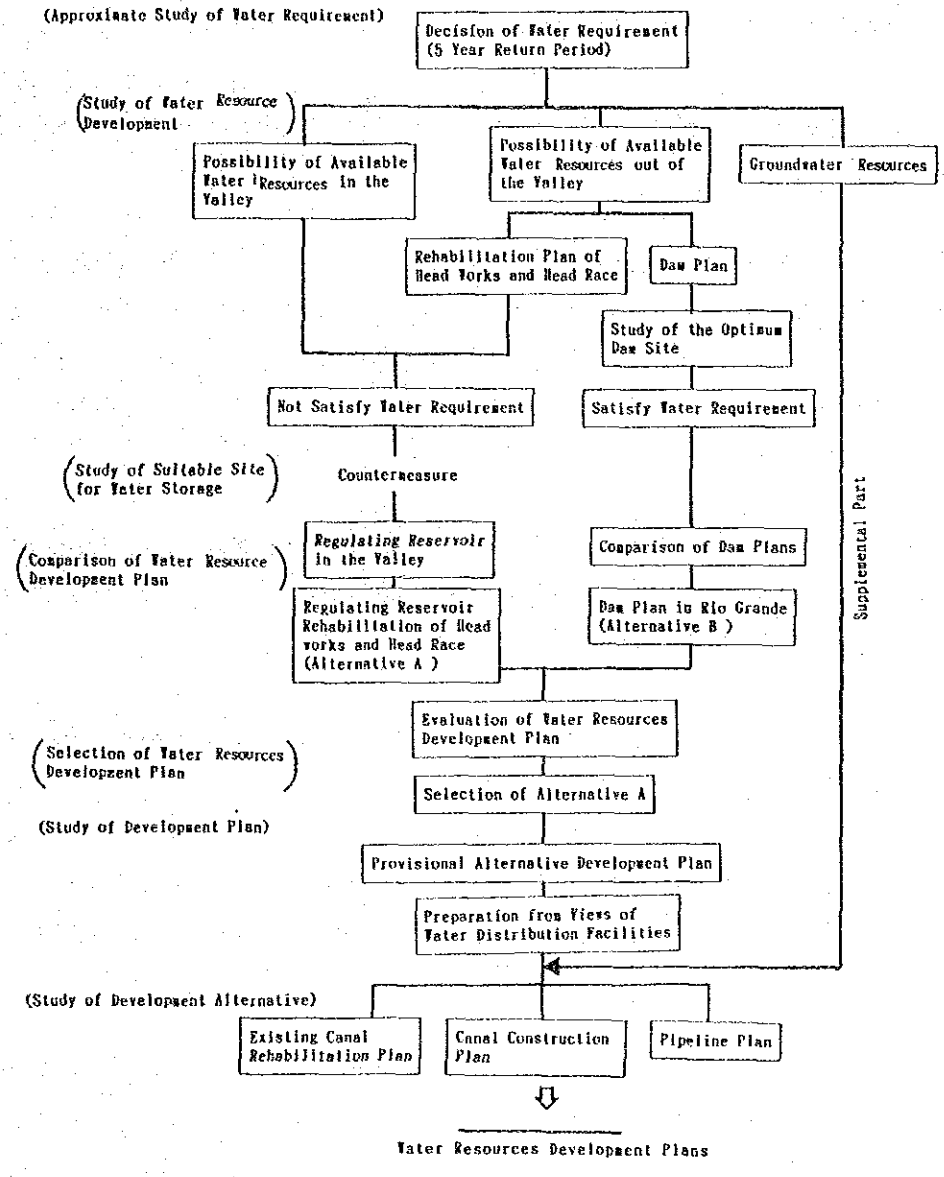


Fig. 2.2.1-1 Flow Chart for Evaluation of Water Resources Development Plans

2.2.2 Water Resource Development Plan

The following three water resources are studied for the water resource development plan in the study area.

- Development of water resource in the Valley
- Development of water resource out of the Valley
- Development of groundwater resource

The summary of water resources development potentiality is shown in Table 2.2.2-1.

Both of the Pantuflas and the Palero basins have high potentiality for the water resources development in the Valley. Especially there is a suitable pocket as a dam site at Arroyo Arriba in the Pantuflas basin to store sufficient water volume in order to solve the water shortage during December to March.

The lower reach of the Arroyo Constanza has high potentiality of water discharge. However, the development potentiality is low because of its topological constrains.

Both of the Arroyo Hondo and the Rio Grande are proposed as the water resources outside the Valley.

In case of the Arroyo Hondo, it becomes clear that the conveyance canal construction cost will be too high to apply it for the project.

In case of the Rio Grande basin development, the following two plans are proposed.

a. Dam construction plan
b. Intake facilities rehabilitation plan

Although 4 dam site alternatives in the Rio Grande are proposed and evaluated, it is clear that plan D-3 which is located at the Pinar Bonito is considered to be the optimum plan.

Groundwater development potentiality is judged to be low considering the thin aquifer thickness.

Table 2.2.2-1 Summary of Water Resources Development Potentiality

Water Resources	Water Resources Capacity	Suitability	Definite Proposed Plan	Plan Selection
(Valley Interior)				
Arroyo Constanza	Good	Poor	-	-
Arroyo Pantuflas	Good	Fine	. Dam	Good
Arroyo Palero	Good	Fine	. Dam	-
(Valley Exterior)				
Arroyo Hondo	Good	Poor	-	-
Rio Grande	Good	Fine	. Dam-1	
			. Dam-2	-
			. Dam-3	Good
			. Dam-4	-
			. Redressing facilities	Good
(Groundwater)				
Wells in Valley	Poor		. Wells	Supplementary

2.2.3 Selection of Appropriate Water Resources Development Alternatives

On the basis of the water resources development study and the study of the optimum dam site, two alternatives for water resources development are evaluated in order to select the appropriate plan.

Alternative A: Dam at the Arroyo Pantuflas + rehabilitation of the head works and the head race.

Alternative B: Dam at the Rio Grande

Alternative A is to improve the conveyance efficiency of the Rio Grande water resources by the rehabilitation of the existing intake facilities, and to construct the dam at the Arroyo Pantuflas in order to supplement the insufficient water during December to April.

Alternative B is to construct the dam at the Rio Grande which was selected as the optimum dam site and to irrigate the arable area lower than 1,240m A.S.L.
In the comparison study, it is assumed that the capacity of the dam for each alternative is to irrigate 1510ha of the upland which is lower than 1240m A.S.L.

The storage capacity of the dam for each alternative is as follows:

Alternative A: Pantuflas dam

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

Alternative B: Rio Grande dam

Required storage capacity	$V = 410,000m^3$
Sediment volume	$V = 4,840,000m^3$
Total storage capacity	$V = 5,250,000m^3$

The result of the comparison study is shown in Table 2.2.3-1.

Table 2.2.3-1 Comparison of the Water Resources Alternative Plan

	Alternative - A (Pantuflas Dam)	Alternative - B (Dam at the Rio Grande)
Dimension of the Facility		
Type	Rockfill Dam	Rockfill Dam
Volume content of dam	220,000 m^3	380,000 m^3
Height of dam	30 m	36 m
Length of crest	164 m	175 m
Available water level	1,241 m	1,253 m
Full water level	1,261 m	1,254 m
Available storage capacity	98 x 10^4 m^3	41 x 10^4 m^3
Other facilities	Spillway (A =6.7 km^2) Rehabilitation of head works and head race	Canal tunnel l=400m Spillway (A =62km^2) Cartain Grouting
Benefit Area	less than EL 1,240m	less than EL 1,240m
Water shortage problem	No	No
Construction Cost	RD$35,900,000	RD$101,300,000
Technical problem of construction	No	Canal tunnel is difficult.
Geological problem	No	Fault in the right bank
Problem for potable water	No	Transfer of the existing water line
Problem for the El Salto Hydropower station	No	Advantageous
Evaluation	○	△

As a result of the comparison study, the advantage of the Alternative A (Pantuflas dam and rehabilitation of the existing intake facilities) was justified, and is applied for the formulation of the development plan.

2.2.4 Water Resources Development Plan

The water resources development plan is carried out on the basis of Alternative A. The water demand and available water resources is calculated for 5 years return period.

1) Available water discharge

The available water discharges for 5 year return period is shown in Table 2.2.4-1 considering available discharge of the Arroyo Palero.

Table 2.2.4-1 Available Water Discharge

Unit: m³/s

Month	1	2	3	4	5	6	7	8	9	10	11	12
Arroyo Pantuflas	0.05	0.06	0.06	0.09	0.17	0.11	0.09	0.15	0.14	0.12	0.09	0.07
Arroyo Palero	0.03	0.04	0.04	0.05	0.10	0.07	0.05	0.09	0.08	0.07	0.05	0.04
Rio Grande	0.33	0.38	0.38	0.51	0.96	0.66	0.53	0.84	0.77	0.67	0.51	0.41
Total	0.41	0.48	0.48	0.65	1.23	0.84	0.67	1.08	0.99	0.86	0.65	0.52

In the planning, the efficient utilization of these resources is considered.

The estimated available discharge to be conveyed into the Valley is shown in Table 2.2.4-2.

Table 2.2.4-2 Available Conveyed Discharge

(Unit: m³/s)

Month	1	2	3	4	5	6	7	8	9	10	11	12
Canal Pantuflas	0.05	0.05	0.05	0.08	0.15	0.10	0.08	0.14	0.13	0.11	0.08	0.05
Canal Palero	0.02	0.03	0.03	0.04	0.08	0.06	0.04	0.07	0.06	0.06	0.04	0.03
Canal Constanza	0.21	0.24	0.24	0.32	0.60	0.42	0.33	0.53	0.49	0.42	0.32	0.28
Total	0.28	0.32	0.32	0.44	0.83	0.58	0.45	0.74	0.68	0.59	0.44	0.36

The shortage of the water occurs in January, February, March, April and July and water surplus occurs in May, August, September and October. It is impossible to satisfy the water demand in the present situation.

The following items will be necessary for the water resources development plan:

- To improve the efficiency of the intake capacity of the Rio Grande head works and the conveyance capacity of the head race
- Storage of ineffective outflow of the Arroyo Pantuflas
- Efficient water resources utilization of the Arroyo Pantuflas and Palero

In the water resources development plan, the following countermeasures will be carried out.

- Rehabilitation or construction of the head works at the Rio Grande
- Rehabilitation of the head race between the head works and the division works
- Construction of the Pantuflas dam

At present, the conveyance efficiency is low due to the deterioration of the head race and the water is not conveyed efficiently to the Valley. In the planning, the rehabilitation of the head works and the head race will be carried out. Actual conveyance efficiency was estimated as approximately 62%. In the planning, the efficiency will be improved to 90%.

The water demand and the conveyed water discharge after the improvement of the efficiency are shown in Fig. 2.2.4-3. The insufficient water volume will be supplemented by the Pantuflas dam.

Table 2.2.4-3 Water Discharge after Improvement of the Conveyance Efficiency

Unit : m³/s

Month	1	2	3	4	5	6	7	8	9	10	11	12
Canal Pantuflas	0.05	0.05	0.05	0.08	0.15	0.10	0.18	0.14	0.13	0.11	0.08	0.05
Canal Palero	0.02	0.03	0.03	0.04	0.08	0.06	0.04	0.07	0.06	0.06	0.04	0.03
Canal Constanza	0.30	0.34	0.34	0.46	0.86	0.57	0.48	0.76	0.69	0.60	0.46	0.37
Total	0.37	0.42	0.42	0.58	1.09	0.73	0.60	0.97	0.88	0.77	0.58	0.45

2.3 Cropping Pattern

A production program is planned, aiming at increasing the outputs and income with improvement of productivity, enlargement of cropping areas with profitable crops and introduction of export crops by construction of new irrigation facilities.

Cropping pattern is prepared in such a way, so as to avoid from injuries which were caused by continuous cropping with crop protection from the prevalence of pests and diseases and maintenance of soil fertility by a crop rotation avoiding continuous cropping of the same family, introduction of cleaning crops and green manure crops.

2.3.1 Selection of Crops

Crops are selected as shown below. Utilizing a highly elevated climate in Constanza, profitable crops are planned in winter season.

Winter cropping	Garlic, Vegetables
Summer cropping	Potato, Kidney bean, Onion, Graminae, Vegetables, Green manure crops
Non-irrigated area	Fruit trees

2.3.2 Cropping Plan

(1) Ideas on Planning

The following are the basic ideas to plan cropping.

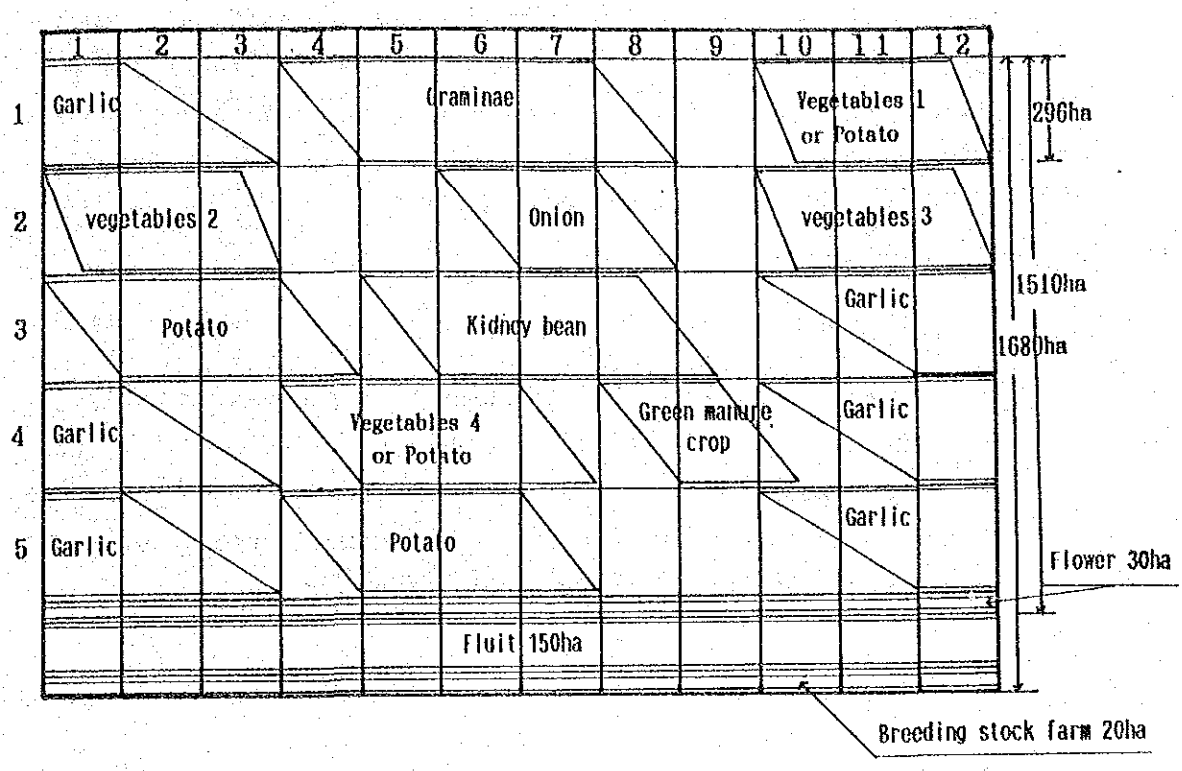
a. Crop rotation as one cycle for 5 years
b. To avoid continuous cropping of the same family
c. To introduce graminae as a cleaning crop
d. To introduce green manure crops and plow them into the soil.
e. To increase the cropping rate

(2) Cropping Pattern

The cropping pattern is planned as shown below.
On comparing the cropping rates of the "present" and "plan", it can be seen that graminae is introduced newly. And there is a slight increase in the cropping rate of garlic and vegetables.

Crops	Present	Plan
Garlic	54.3%	60.0%
Potato	60.0	60.0
Kidney bean	25.7	20.0
Onion	20.0	20.0
Vegetables	54.0	60.0
Graminae	0	20.0
(Green manure crop)	(0)	(20.0)
Total	214.0	240.0
		(260.0)

Note: A green manure crop produces no profit.



Note: Vegetables 1, 2, 3 ... Lettuce, Carrot, Beet, Export vegetables, Other vegetables
Vegetables 4 ..... Lettuce, Carrot, Beet, Other vegetables
Graminae ..... Sweet Corn, Upland rice, Wheat, etc.
Green manure crop .... Some graminae which is plowed into the soil while green

Fig. 2.3.2-1 Cropping Pattern(Plan)

3. Selection of Appropriate Development Alternative

The selection of the appropriate development alternative was carried out among the following three alternatives plans, by efficient utilization of the water resources of the Rio Grande.

1. Existing canal rehabilitation plan
2. Canal construction plan
3. Pipeline plan

The existing canal rehabilitation plan proposes rehabilitation of existing canal, the canal construction plan proposes a new canal near the area of EL 1,240m, and the pipeline plan proposes installation of pipe for the water distribution, using the water head energy for the sprinkler irrigation.

3.1 Basic Concepts for Selection

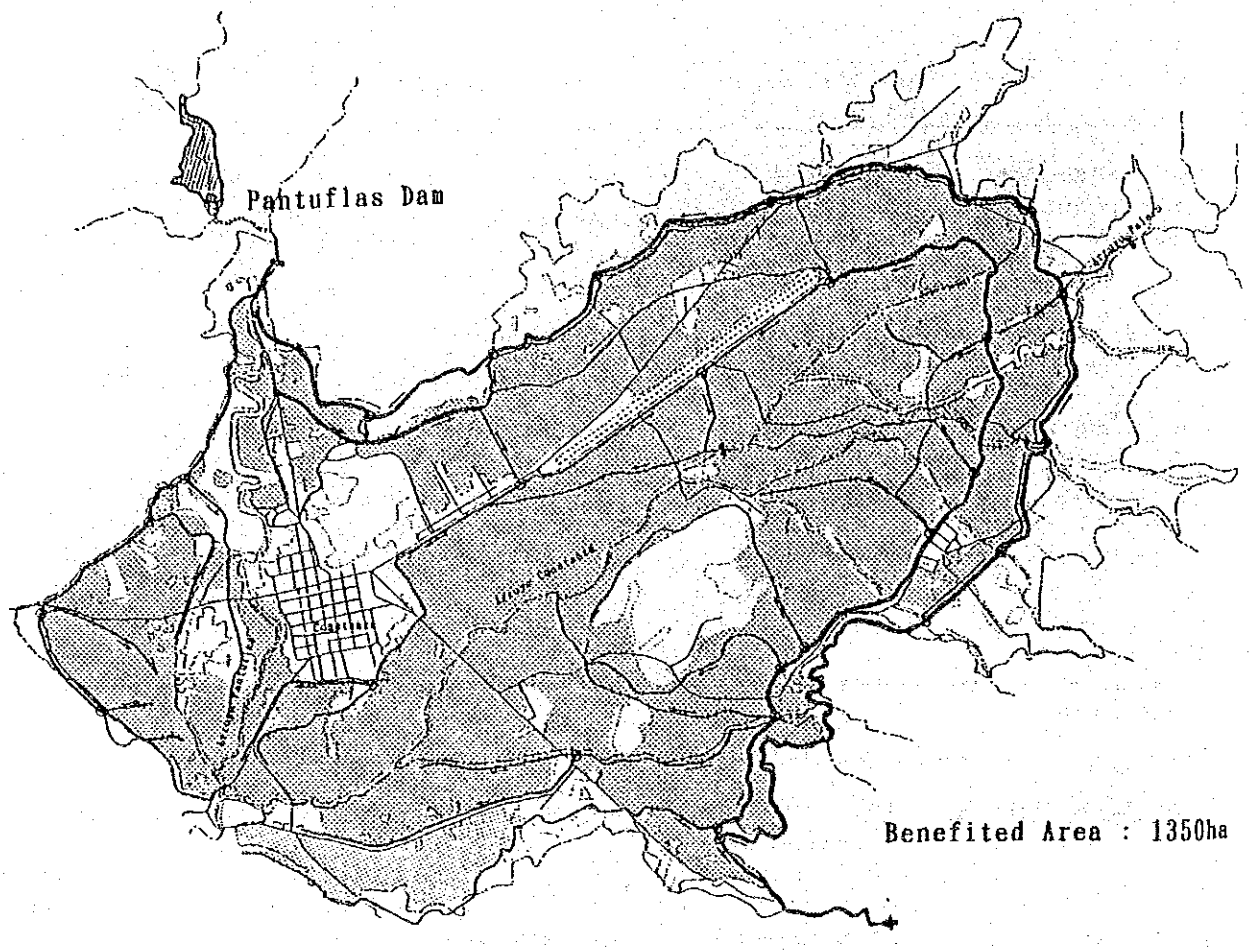
The common concepts among the three alternatives are as follows.

- Main water resource is the Rio Grande
- To construct a dam in the Arroyo Pantuflas which is more suitable to store water than the other rivers. The dam acts as a supplementary water resource in dry season.
- To rehabilitate the existing head works or construct new head works as the intake facilities from the Rio Grande.
- To rehabilitate the head race in order to improve the conveyance efficiency.

The selection of the appropriate alternative was determined considering the construction cost of the facility and operation cost. The result of the comparison study is shown in Table 3.1.1-1.

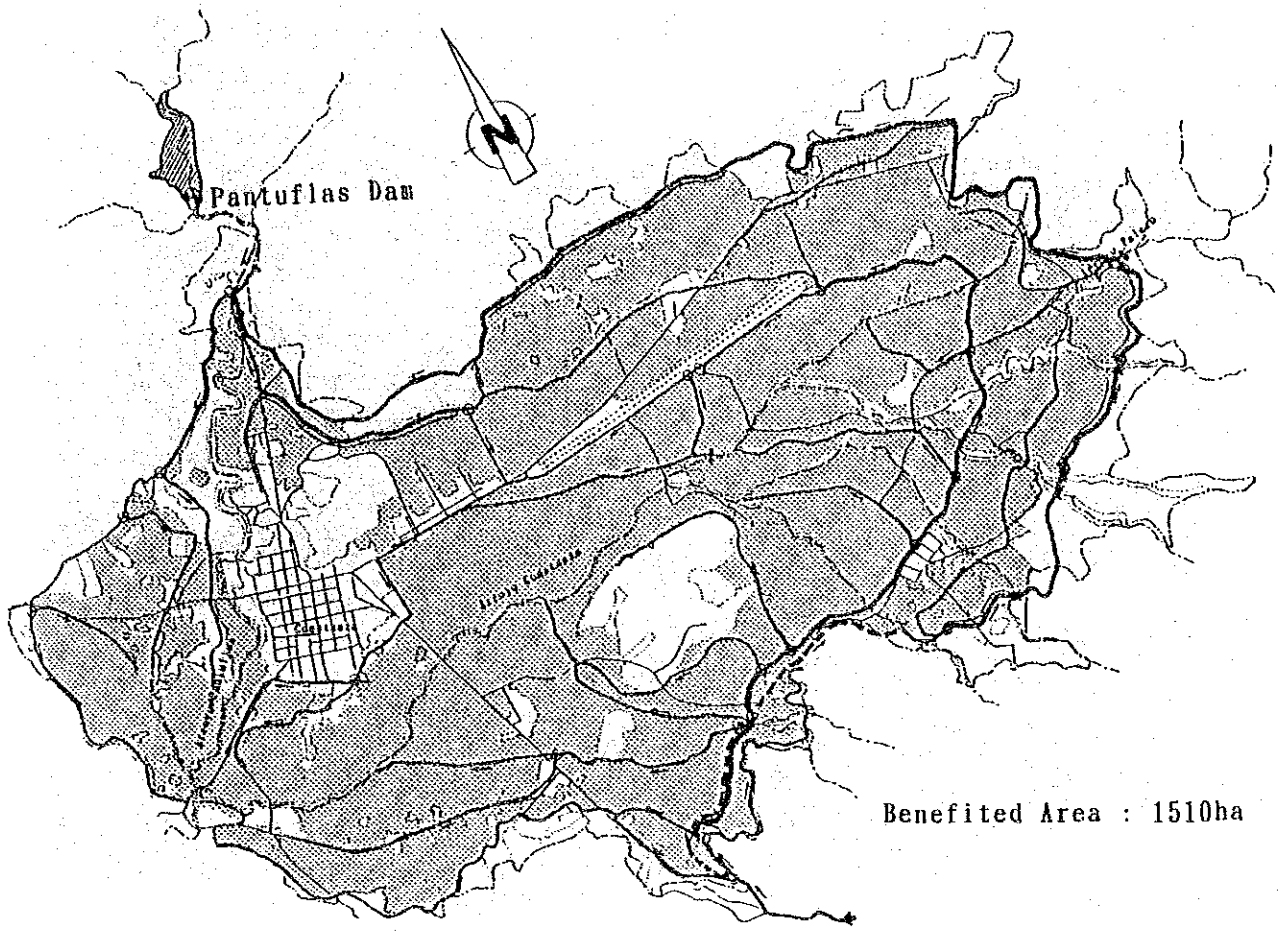
Table 3.1.1-1 Results of the Comparison Study of Development Alternatives

	Rehabilitation plan (Alternative A)	Construction plan (Alternative B)	Pipeline (Alternative C)
Water resources development facility	Head works at Rio Grande/Pantuflas Dam (Storage volume V = 710,000m^3)	Head works at Rio Grande/Pantuflas Dam (Storage volume V = 1,050,000m^3)	Head works at Rio Grande/Pantuflas Dam (V = 610,000m^3)
Distribution Facility	Open channel (l = 58km)	Open channel (l = 67km)	Pipeline (l = 60km)
Benefited area	1,350ha	1,510ha	1,510ha
Total Cost (Discount rate 10%)	RD$66,030,000	RD$81,260,000	RD$109,470,000
Unit cost (RD$/ha)	RD$48,911	RD$53,815	RD$72,497
Evaluation	△	○	×
Justification	- The open canal distribution system is more economical than pipeline system - The operation system of the pipeline is more complex than open canal system and the maintenance cost is more expensive. - Alternative A is more economical in the view of the cost; however considering the economical effect, the alternative B is more feasible.		



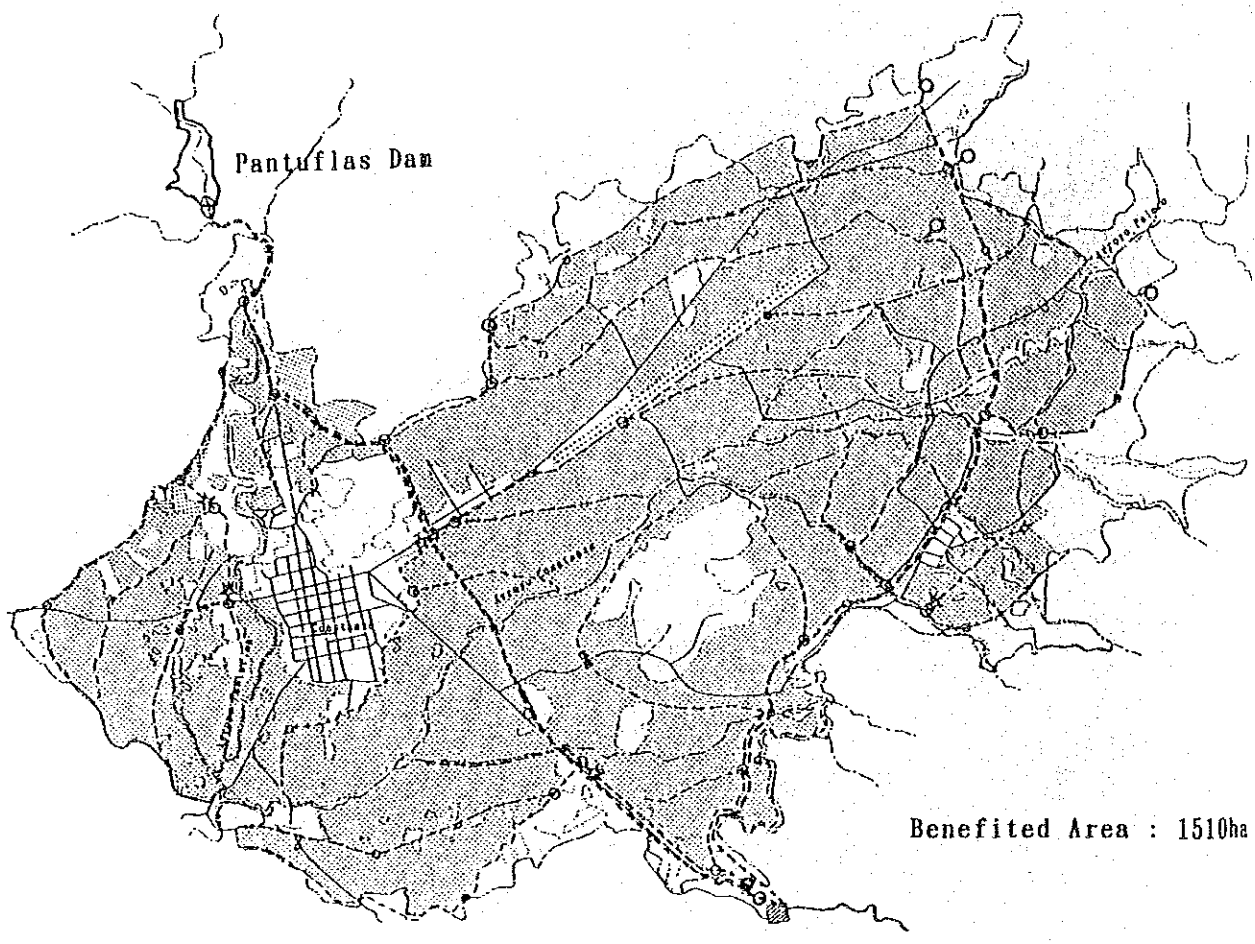
	凡例	Legend	Leyenda
----	境界線	Boundary of Study Area	Limite de Area del Estudio
⊖	ダム	Dam	Embalse
———	幹線用水路	Main Canal	Canal Principal
———	支線用水路	Lateral Canal	Canal Lateral
- - - - -	管路	Pipeline	Tuberia
◉	分水工	Division works	Derivadora
═══	水路橋	Aquiduct	Canal flumen
═══	道路横断工	Box culvert	Conduct
●-●	取水工	Intake works	Obra de toma
●----	吐出水槽	Discharge Tank	Tanque de descarga
---+---	排泥弁	Wash out valve	Válvula de desiave
———	河川	River	Rio
———	排水路	Drainage	Canal de drenaje

Fig. 3.1.1-1 Alternative A : Existing Canal Rehabilitation Plan



	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	Tuberia
◎	分水工	Division works	Derivadora
=—=	水路橋	Aquiduct	Canal flumen
—▭—	道路横断工	Box culvart	Conduct
●-●	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 deslave
——	河川	River	Río
——	排水路	Drainage	Canal de dreneje

Fig. 3.1.1-2 Alternative B : Canal Construction Plan



	凡例	Legend	Leyenda
———	幹線水路（鋼管）	Main line (steel pipe)	Linea principal (tubo acero)
— — —	地幹線水路（塩ビ管）	Sub line (PVC pipe)	Linea sub-principal (tubo PVC)
– – –	支線水路（塩ビ管）	Branch line (PVC pipe)	Linea lateral (tubo PVC)
▨	ファームポンド	Farm pond	Almacenamiento regulador
◎	減圧水槽	Pressure reducing susp	Sumidero
☆	減圧バルブ	Pressure reducing valve	Valvula de control depresion
■	排泥弁	Wash-out valve	Valvula de destave
□	空気弁	Air valve	Valvula de aire
○	分水工	Divition works	Derivador

Fig. 3.1.1-3 Alternative C : Pipeline Plan

3.1.1 Benefit Area

The benefit area of each alternative is determined as follows, considering the irrigation networks.

Alternative	Benefited area (ha)	Out of the planning	Upland area
Existing canal rehabilitation plan	1,350ha	310ha	1,660ha
Canal construction plan	1,510ha	150ha	1,660ha
Pipeline plan	1,510ha	150ha	1,660ha

3.1.2 Irrigation Plan

The water requirement for irrigation in the area is calculated based on the proposed cropping pattern which considers the crop rotation as one cycle for 5 years and the spray irrigation system. The crop water requirement calculated by Penman's method and the effective rainfall calculated by USDA method in 5 years return periods are shown in Table 3.1.2-1.

Table 3.1.2-1 Irrigation Water Requirement and Crop Water Requirement

Month	1	2	3	4	5	6	7	8	9	10	11	12
ETo(mm/month)	77.5	75.6	105.4	99.0	108.5	105.0	117.8	111.6	99.0	93.0	72.0	71.3
Crop coefficient kc	0.68	0.76	0.48	0.26	0.51	0.77	0.55	0.37	0.14	0.30	0.82	0.73
ETcrop(mm/month)	52.7	57.5	50.6	25.7	55.3	80.9	64.8	41.3	13.9	27.9	59.0	52.0
Effective rainfall(mm/month)	10.3	16.5	17.2	25.3	55.3	55.5	39.2	41.3	13.9	27.9	34.5	25.8
Net water requirement(mm/month)	42.4	41.0	33.4	0.4	-	25.4	25.6	-	-	-	24.5	26.2

Irrigation efficiency of the three alternatives are shown below:

Table 3.1.2-2 Irrigation Efficiency

	Alternative A	Alternative B	Alternative C	Existing facilities
Conveyance efficiency (Ec)	0.9	0.9	0.9	0.65
Field canal efficiency(Eb)	0.8	0.8	0.9	0.7
Application efficiency(Ea)	0.7	0.7	0.7	0.6
Irrigation efficiency (Ep)	0.5	0.5	0.57	0.27

Note: Ep=Ea X Eb X Ec

The gross water requirement considering the irrigation efficiency is shown in Table 3.1.2-3.

Table 3.1.2-3 Gross Water Requirement

unit: mm/month

Month	1	2	3	4	5	6	7	8	9	10	11	12
Net water requirement	42.4	41.0	33.4	0.4	-	25.4	25.6	-	-	-	24.5	26.2
Existing canal rehabilitation plan	84.8	82.0	66.8	0.8	-	50.8	51.2	-	-	-	49.0	52.4
Canal construction plan	84.8	82.0	66.8	0.8	-	50.8	51.2	-	-	-	49.0	52.4
Pipeline plan	74.7	71.9	58.6	0.7	-	44.6	44.9	-	-	-	43.0	46.0

3.1.3 Water Resources Development Plan

The main water resources of this project depend on the water resources of the Rio Grande which improve the conveyance efficiency by the rehabilitation of the conduction canal and the construction of the head works at the Rio Grande, and the storage volume depend on the Pantuflas dam. In the Alternatives A and B, the intake at the Arroyo Palero is considered for the water resources. However in the Alternative C, the discharge of the Arroyo Palero is not taken into consideration.

The shortage volume for each alternative is shown in Table 3.1.3-1.

Table 3.1.3-1 Shortage Volume for Each Alternative

Month	1	2	3	4	5	6	7	8	9	10	11	12
Available discharge	0.30	0.34	0.34	0.46	0.86	0.57	0.48	0.76	0.69	0.60	0.46	0.40
Existing canal rehabilitation plan												
Water demand (m^3/s)	0.43	0.46	0.34	0.04	-	0.26	0.25	-	-	-	0.26	0.26
Shortage demand (m^3/s)	0.13	0.12	-	-	-	-	-	-	-	-	-	-
Inefficient area (ha)	410	370										
Canal construction plan												
Water demand (m^3/s)	0.47	0.51	0.38	0.05	-	0.30	0.29	-	-	-	0.29	0.30
Shortage demand (m^3/s)	0.17	0.17	0.04	-	-	-	-	-	-	-	-	-
Inefficient area (ha)	550	550	160	-	-	-	-	-	-	-	-	-
Pipeline plan												
Water demand (m^3/s)	0.41	0.44	0.33	0.04	-	0.26	0.25	-	-	-	0.27	0.26
Shortage demand (m^3/s)	0.11	0.10	-	-	-	-	-	-	-	-	-	-
Inefficient area (ha)	410	350										

For each alternative, the irrigation water is to be supplemented from the Pantuflas dam from January to March when water discharge from the Rio Grande alone is not sufficient.

The irrigation plan for each alternative is as follows.

Table 3.1.3-2 Irrigation Plan for Each Alternative

	Existing canal Rehabilitation plan	Canal Construction plan	Pipeline plan
Total irrigated area	1,350ha	1,510ha	1,510ha
Irrigated area by the Rio Grande water resources	940ha	960ha	1,100ha
Irrigated area by Pantuflas Dam	410ha	550ha	410ha
Pantuflas Dam	640,000m^3	980,000m^3	540,000m^3

(1) Patuflas Dam

The Pantuflas dam will be constructed at the place of 200m upstream in the Arroyo Pantuflas from the junction of the Arroyo Pantuflas and Cañada Casiano. The type of the dam is a central core type rock fill dam. The required dam storage volume including the dead volume are as follows:

Existing canal rehabilitation plan V = 710,000m^3
Canal construction plan V = 1,050,000m^3
Pipeline plan V = 610,000m^3

The dimension of the dam is determined by the storage curve of Pantuflas dam.

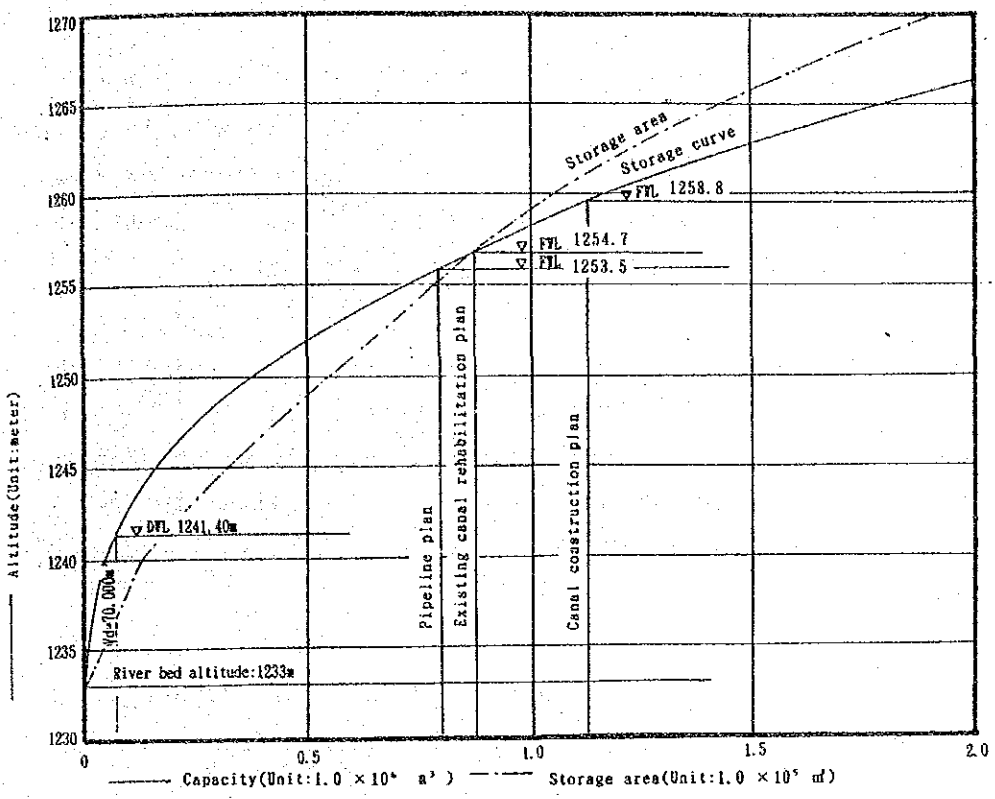


Fig. 3.1.3-1 Storage Curve of Pantuflas Dam

Table 3.1.3-3 Dimension of the Pantuflas Dam

	Alternative A	Alternative B	Alternative C
Total storage capacity (m^3)	710,000	1,050,000	610,000
Water depth (m)	21.7	25.8	20.5
Bedrock excavation (m^3)	1.0	1.0	1.0
Overflow depth (m)	2.0	2.0	2.0
Dam freeboard (m)	1.0	1.0	1.0
Total height of dam (m)	25.7	29.8	24.5
Dam crest length (m)	146.0	162.0	143.5
Crest width (m)	7.5	7.5	7.5

The volume content of dam in each alternative is calculated as follows.

Existing canal rehabilitation plan	$V = 160,000m^3$
Open canal construction plan	$V = 214,000m^3$
Pipeline plan	$V = 140,000m^3$

3.2 Existing Canal Rehabilitation Plan

In this plan, the canal network will be placed in the same place of the existing canal network and will be rehabilitated to improve the conveyance efficiency of the canal. The main water resource is the water resource of the Rio Grande and is to be supplemented by Pantuflas dam when the irrigation water shortage occur.

For this purpose, the conveyance canal from the Pantuflas dam to the external parts of the Canal Constanza will be constructed for supplemental irrigation in dry season. The Lateral Constanza will be rehabilitated and connected to the Canal Pantuflas in order to irrigate the Canal Pantuflas area by the Rio Grande water resources.

The Canal Constanza will be rehabilitated and new canal will be constructed in order to irrigate El Valle, El Gramoso and Las Auyamas zones. In wet season, all of the area will be irrigated by the water resources of the Rio Grande, but in dry season, at the external points of the Canal Constanza, the water of the Pantuflas dam will be supplemented in order to cover the shortage demand of the area. The irrigation scheme of the existing canal rehabilitation plan is illustrated in Fig. 3.2.1-1.

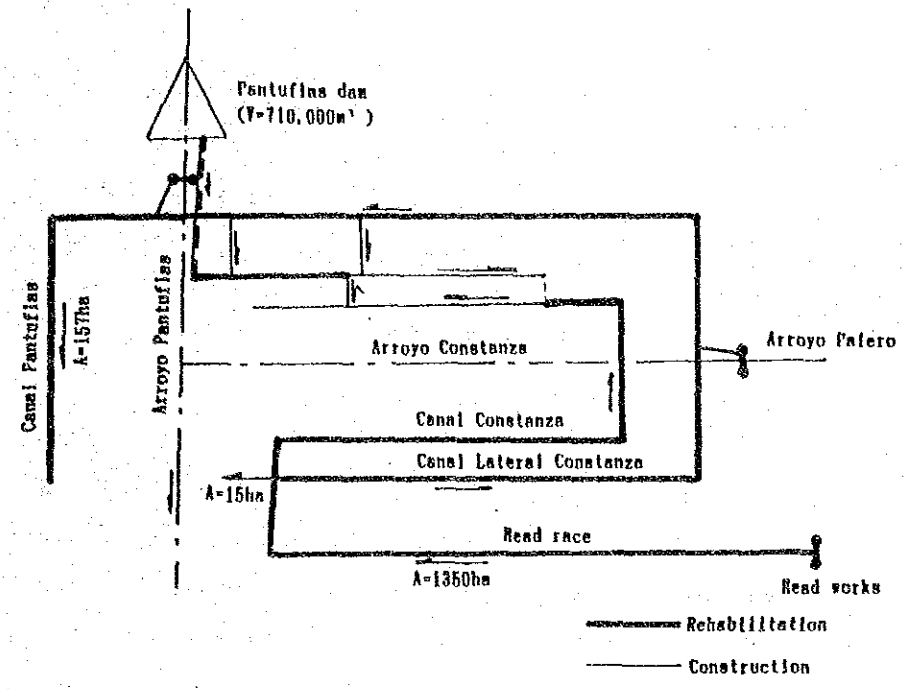


Fig. 3.2.1-1 Irrigation Scheme of the Existing Canal Rehabilitation Plan

3.2.1 Proposed Facilities

Proposed facilities for the existing canal rehabilitation plan are as follows.

- Construction of the Pantuflas dam (Storage volume V = 710,000m^3)
- Construction of the head works at the Rio Grande
- Rehabilitation of the head race
- Rehabilitation of the Canal Constanza
- Rehabilitation of the Lateral Constanza
- Rehabilitation and construction of branch canals
- Rehabilitation and extension of the Canal Pantuflas
- Construction of canal from the Pantuflas dam

The construction details of this alternative are as follows.

Dam - 1 Site (Storage volume V = 710,000m^3)
Head works - Site
Head race l = 3.0km (Rehabilitation Q = 0.74m^3/s)
Distribution canal (Total length l = 54.6km)
Division works

a. Rehabilitation of the Canal Constanza

The Canal Constanza in the Valley is 10.0km long and a part of it for a length of 3.0km was constructed with wet mason and the remaining 7.0km is unlined. This unlined part is to be reconstructed with wet mason of three dimensions in order to increase the conveyance efficiency. And the part with wet mason is to be reconstructed removing the present wet mason, since water is leaking due to poor construction and deterioration.

The terminal part of the existing Canal Constanza will be supplemented the irrigation water in the dry season, in order to irrigate the lower reach of the Arroyo Constanza.

b. Rehabilitation of the Lateral Constanza

The Lateral Constanza in the Valley extends for about 14.7km length. At present, only 4.5km of the lateral after the division works functions as a canal, but after a part of the lateral is burried, it does not function as a canal. The wet mason of three dimensions is in good condition since its construction was relatively new (1967).

Rehabilitation is just to reconstruct the damaged parts where the lateral still works. Burried parts should be excavated, removed and rehabilitated completely since most of the parts are damaged.

This canal will be connected to the Canal Pantuflas in order to irrigate by the water resources of the Rio Grande in wet season. In dry season, the water of the Pantuflas dam supplement the Canal Pantuflas.

The Canal Pantuflas is about 3.7km long and was constructed in 1972. The canal is of wet mason of three dimensions and is in good condition. Rehabilitation is to reconstruct the damaged parts. Branch canals are to be studied again, and the plan is to be recorrected.

c. Rehabilitation of branch canals

There are 12 branch canals in the plan. But actually some branches have not been found or changed their routes.

In rehabilitation plan, the routes of branches are to be studied again in order to irrigate effectively. The branch canals are to be constructed with wet mason of three dimensions. Branch canals are to be constructed with wet mason of three dimensions, and the total length is 24.3km.

d. Construction of canal from the Pantuflas dam for dry season

Shortage of irrigation water occurs at most in January over 410ha of the total irrigated area which is to be irrigated with water from the Pantuflas dam. The area irrigated by the Canal Pantuflas is 157ha.

3.3 Canal Construction Plan

In this plan, the irrigation will be realized by two main canals. The Canal Nueva Constanza will be constructed at an elevation of 1240m in order to irrigate the fields of elevation lower than 1240m.

The Canal Constanza will be rehabilitated. The main water resources is the Rio Grande and is supplemented by Pantuflas dam when the shortage of irrigation water occurs. The conveyance canal from the Pantuflas dam to the Canal Constanza will be constructed for supplemental irrigation in dry season.

The total irrigated area by the Canal Nueva Constanza will be 469ha.

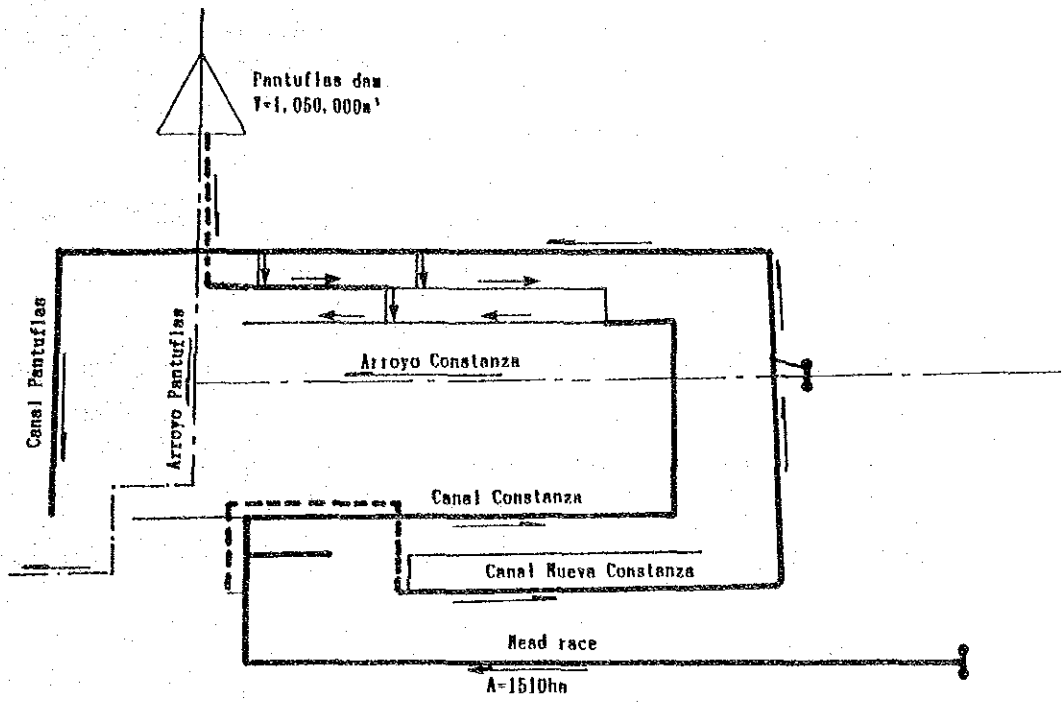


Fig.3.3.1-1 Irrigation Scheme of the Canal Construction Plan

3.3.1 Proposed Facilities

Proposed facilities for the canal construction plan are as follows:

- Construction of the Pantuflas dam
  (Storage volume V = 1,050,000m^3)
- Construction of the Head works at the Rio Grande
- Construction of the Canal Nueva Constanza
- Rehabilitation of the Canal Constanza
- Rehabilitation, extension and construction of branch canals
- Rehabilitation and extension of the Canal Pantuflas
- Construction of a canal from the Pantuflas dam

The construction details of this alternative are as follows:

a. Construction of the Canal Nueva Constanza

A new canal (Canal Nueva constanza) is to be constructed in order to irrigate fields which is lower than 1240m of altitude.

The starting part of the canal for some length need to be constructed by pipeline in order to introduce to the upland of 1240m elevation, since the topographic condition of this place is not appropriate for the construction of the open canal.

The following facilities are necessary in the other locations.

- Pipeline and supplementaly works
- Aqueduct
- Drop structure
- Box culvert crossing a road
- Construction of division works

b. Rehabilitation of the Canal Constanza

Rehabilitation of the Canal Constanza is similar to the existing canal rehabilitation plan mentioned in section 3.2.1.a.

c. Construction of sub-canals and branch canals

Sub-canals are to be constructed along the main canal. Water is distributed through the sub-canals and the Lateral Constanza is to be utilized effectively.
The routes of branch canals are planned to utilize irrigation water effectively. Both the sub-canals and the branch canals are to be lined with wet mason of three dimensions.

d. Construction of canal from the Pantuflas dam

Shortage of irrigation water occurs at most in January as shown in Table 3.2.3-8. 550ha of the area which occupies over 40% of the total irrigated area relies on water from the Pantuflas dam in January. The area irrigated by the Canal Pantuflas is 157ha.

Adding to the area, water shortage can be solved by distributing water to the Canal Constanza by constructing a pipeline. The length of the pipeline is estimated as 750m with 400mm diameter pipe and 850m with 300mm pipe.

3.4 Pipeline Plan

The irrigation scheme of the Pipeline plan is shown in Fig. 3.4.1-1. Water is distributed by pipeline networks and hence is possible to equalize water distribution throughout the area. Pump operation cost for sprinklers will be reduced by utilizing the gravity energy.

The external energy of the pipeline will be controlled to be constant (2.5kg/cm^2) by regulating facilities in order to equalize water distribution.

Pantuflas dam and the farm pond will be connected by pipeline in order to utilize the water resources efficiently and to supplement the shortage of irrigation water in dry season.

The main water resource in wet season is the Rio Grande and in dry season the water shortage will be supplemented by the Pantuflas dam.

The total irrigated area will be 1510ha.

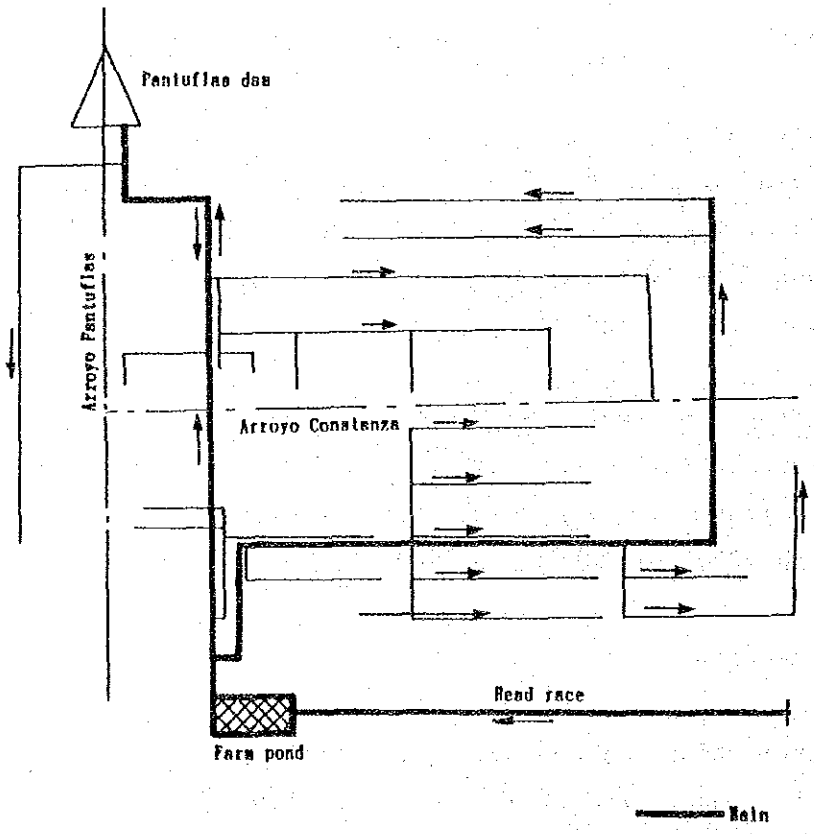


Fig.3.4.1-1 Irrigation Scheme of the Pipeline Plan

3.4.1 Proposed Facilities

Proposed facilities for the pipeline plan are as follows:

- Construction of the Pantuflas dam
  (Storage volume V = 610,000m^3)
- Construction of the head works at the Rio Grande
- Rehabilitation of the head race
- Construction of the farm pond
- Construction of the pipeline system and the supplementary works

The construction details of this alternative are as follows:

Dam	1 site (Volume of content V = 140,000m^3)
Head works	1 site
Head race	1 = 3.0km (Rehabilitation Q = 0.83m^3/s)
Distribution canal	

Steel pipe	1 = 13,600m
ø200	500m
ø300	1,700m
ø400	2,100m
ø500	5,200m
ø600	3,800m
ø700	300m

CV Pipe	1 = 46,000m
ø200	32,050m
ø300	13,950m

3.5 Comparison Study of Development Alternatives Plans

The comparison study was carried out considering the following three items.

- Construction cost
- Farming facilities cost
- Operation cost

3.5.1 Cost

(1) Construction Cost

The construction cost of each alternative is as follows:

	Construction Cost	
	Total (RD$)	Unit (RD$/ha)
Existing canal Rehabilitation plan	62,490,000	46,290/ha
Canal Construction plan	77,300,000	51,190/ha
Pipeline plan	109,470,000	72,500/ha

Existing Canal Rehabilitation Plan

	Item	Quantity	Unit Cost	Cost (RD$1,000)
1.	Civil works			
1.1	Preparatory works	1 unit	3,180,000	3,180
1.2	Dam			
	Foundation	1 unit	6,900,000	6,900
	Dam volume	160,000m^3	110	17,600
	Flood way	1 unit	4,000,000	4,000
	Intake facility	1 unit	940,000	940
	(Subtotal 1 & 2)			29,400
1.3	Intake works	1 unit	490,000	490
1.4	Head race	3,000m	450,000	1,350
1.5	Canal networks			
	Main open canal	17,400m	234	4,070
	Pipeline	1,600m	1,400	2,240
	Lateral Canal	35,650m	200	7,130
	Supplementary Facilities	L.S	3,610	3,610
	Drainage canal	1 unit	340,000	340
	(Subtotal 1 to 5)			17,390
Subtotal				
2.	Construction Facilities	L.S	400	400
3.	Administration Cost	L.S	360	360
4.	Engineering Services	L.S	9,880	9,880
	Total			62,490

Canal Construction Plan

	Item	Quantity	Unit Cost	Cost (RD$1,000)
1.	Civil works			
1.1	Preparatory works	1 unit	3,180,000	3,180
1.2	Dam			
	Foundation	1 unit	6,900,000	6,900
	Dam volume	220,000m^3	110	24,200
	Flood way	1 unit	4,000,000	4,000
	Intake facility	1 unit	940,000	940
	(Subtotal 1 & 2)			36,040
1.3	Intake works	1 unit	490,000	490
1.4	Head race	3,000m	450,000	1,350
1.5	Canal networks			
	Main open canal	18,000m	234	4,210
	Pipeline	4,500m	1,400	6,300
	Lateral Canal	44,900m	200	8,980
	Supplementary Facilities	L.S	5,770	5,770
	Drainage canal	1 unit	340,000	340
	(Subtotal 1 to 5)			25,600
Subtotal				
2.	Construction Facilities	L.S	400	400
3.	Administration Cost	L.S	360	360
4.	Engineering Services	L.S	9,880	9,880
	Total			77,300

Pipeline Plan

	Item	Quantity	Unit Cost	Cost (RD$1,000)
1.	Civil works			
1.1	Preparatory works	1 unit	3,300,000	3,300
1.2	Dam			
	Foundation	1 unit	6,900,000	6,900
	Dam volume	140,000m^3	110	15,400
	Flood way	1 unit	4,000,000	4,000
	Intake facility	1 unit	800,000	800
	(Subtotal 1 & 2)			27,100
1.3	Intake works	1 unit	490,000	490
1.4	Head race	3,000m	450,000	1,350
1.5	Canal networks	L.S	7,000,000	7,000
	Main Pipeline (Steel Pipe)	13,600m	1,400	19,040
	C.V. Pipeline	46,000m	420	19,320
	Supplementaly Facilities	L.S	21,000	21,000
	Drainage canal	1 unit	340,000	340
	(Subtotal 1 to 5)			59,700
Subtotal				
2.	Construction Facilities	L.S	400	400
3.	Administration Cost	L.S	420	420
4.	Engineering Services	L.S	10,200	10,200
	Total			109,470

(2) Farm Facilities (Equipment) Cost

For the comparison study of farm equipment cost, the pump equipment cost was considered for the open canal alternatives (Existing canal rehabilitation plan and open canal construction plan).

The pump capacity is estimated as follows:

$$Q_p = h.A.D/360T.E$$

where: Qp: Designed pump capacity (m^3/s)

h: Net irrigation water requirement (mm/day) h = 2.7mm/day

A: Area A = 1.0ha

D: Irrigation internal D = 12 day

T: Operation period T = 17 hour

E: Application efficiency E = 0.7

$Qp = 0.008m^3/s$

$= 0.45m^3/min.$

The required pump capacity is Qp=$0.45m^3$/min, H=25m and P=5.5kw. The necessary number of the pumps for each alternative is as follows.

Existing canal rehabilitation plan: 113 sets

Open canal construction plan : 126 sets

Note: In the calculation, the following presumptions were made

- The irrigation capacity of the pump is 1ha
- The irrigation interval is 12 days
- One irrigation pump set cover 12 ha

(3) Operation Cost

In case of the irrigation realized by the pump (P=5.5kw) annual operation period and electric power consumption were calculated as follows.

	Required irrigation volume (m3/year)	Total Operation Time (hour)	Electric consumption (kw)
Existing canal rehabilitation plan	V = 4,221,450m^3	156,350	859,925
Open canal construction plan	V = 4,221,450m^3	174,880	961,840
Pipeline plan	V = 4,721,770m3	-	-

Note: Total operating time is calculated with 0.45m^3/min. capacity.

Construction cost, farm equipment cost and operation cost for each alternative is shown in the following Table.

	Existing canal rehabilitation plan	Open canal construction plan	Pipeline plan
(1) Construction Cost	RD$62,490,000	RD$77,300,000	RD$109,470,000
Unit construction cost	RD$46,290/ha	RD$51,900/ha	RD$72,500/ha
(2) Farm equipment cost	RD$243,000	RD$272,000/year	-
(3) Operation cost	RD$237,000/year	RD$266,000/year	-
(4) Total cost (Present value) (20 years)			
with Discount rate 0%	71,610,000	87,522,000	109,470,000
with Discount rate 6%	67,835,000	83,296,000	109,470,000
with Discount rate 10%	66,504,000	81,796,000	109,470,000
with Discount rate 12%	66,030,000	81,260,000	109,470,000
(5) Unit cost			
with discount rate 0%	53,040	57,960	72,500
with discount rate 12%	48,910	53,810	72,500

Cost for Open Canal Construction Plan

(Unit: RD$1,000)

Year	Capital	Operation Cost	Discount-rate (6%)	Cost	Discount-rate (10%)	Cost	Discount-rate (12%)	Cost
1	77,300	-	1.000	77,300	1.000	77,300	1.000	77,300
2	-	538,000	0.943	507	0.909	489	0.893	480
3	-	538,000	0.890	478	0.826	444	0.797	428
4	-	538,000	0.840	451	0.751	404	0.712	383
5	-	538,000	0.792	426	0.683	367	0.636	342
6	-	538,000	0.747	401	0.621	334	0.567	305
7	-	538,000	0.705	379	0.564	303	0.507	272
8	-	538,000	0.665	358	0.513	275	0.452	243
9	-	538,000	0.627	337	0.467	251	0.404	217
10	-	538,000	0.592	318	0.424	228	0.360	194
11	-	538,000	0.558	300	0.386	207	0.332	173
12	-	538,000	0.526	282	0.350	188	0.287	154
13	-	538,000	0.497	267	0.319	171	0.257	138
14	-	538,000	0.469	252	0.290	156	0.229	123
15	-	538,000	0.442	238	0.263	141	0.205	110
16	-	538,000	0.417	224	0.239	129	0.183	98
17	-	538,000	0.394	212	0.218	117	0.163	88
18	-	538,000	0.371	200	0.198	107	0.146	79
19	-	538,000	0.350	188	0.180	97	0.130	70
20	-	538,000	0.331	178	0.164	88	0.116	63
Total				83,296		81,796		81,260

Cost for Existing Canal Rehabilitation Plan

(Unit: RD$1,000)

Year	Capital	Operation Cost	Discount-rate (6%)	Cost	Discount-rate (10%)	Cost	Discount-rate (12%)	Cost
1	62,490	-	1.000	62,490	1.000	62,490	1.000	62,490
2	-	480	0.943	453	0.909	436	0.893	429
3	-	480	0.890	427	0.826	396	0.797	383
4	-	480	0.840	403	0.751	360	0.712	342
5	-	480	0.792	380	0.683	328	0.636	303
6	-	480	0.747	359	0.621	298	0.567	272
7	-	480	0.705	338	0.564	271	0.507	243
8	-	480	0.665	319	0.513	246	0.452	217
9	-	480	0.627	301	0.467	224	0.404	194
10	-	480	0.572	275	0.424	203	0.360	173
11	-	480	0.558	268	0.386	185	0.332	159
12	-	480	0.526	253	0.350	168	0.287	138
13	-	480	0.497	239	0.319	153	0.257	123
14	-	480	0.469	225	0.290	139	0.229	110
15	-	480	0.442	212	0.263	126	0.205	98
16	-	480	0.417	200	0.739	114	0.183	88
17	-	480	0.394	189	0.218	104	0.163	78
18	-	480	0.371	178	0.198	95	0.146	70
19	-	480	0.350	168	0.180	86	0.130	62
20	-	480	0.331	159	0.164	79	0.116	56
Total		71,610		67,836		66,501		66,030

For the existing canal rehabilitation plan and open canal construction plan, the farm equipment cost (1 pump set for each 12ha) and the operation cost (within 20 years) were considered for the comparison study.

Comparing the unit cost, the existing canal rehabilitation plan is more economical than the other alternatives and the pipeline plan is the most expensive.

The economical comparison was carried out considering 20 years of operation of the farm facility.

The cost of the alternative A and B include one pump cost for each 12ha and operation cost for 20 years.

Comparing the unit cost of the project, the existing canal rehabilitation plan and the open canal construction plan is advantageous compared to the Pipeline plan.

The priority of the alternative A and B was carried out on the basis B/C ratio, since the benefited area is different. The difference between the two alternatives are shown below:

	Existing canal Rehabilitation plan (A)	Open canal construction plan (B)	Difference (A - B)
Benefited area	1,350ha	1,510ha	-160ha
Total cost (RD$1,000) with 12% of discount rate	66,030ha	81,260ha	-15,230ha

The total cost of alternative B increase by RD$15,230,000 in order to increase 160ha of the benefited area. This increased valve is equivalent to RD$95,188/ha of the cost.

For the open canal construction plan with a discount rate of 12% and 20 year durable period, it can cover the investment amount with an annual benefit of RD$12,905. This value is equivalent to 0.94t/ha of the garlic production, with the farm price of RD$13.8/kg.

Considering the agricultural production cost, the alternative of the open canal construction plan has been justified as the most appropriate plan for the Constanza Vally irrigation plan.

ANNEX K : AGRICULTURAL DEVELOPMENT PLAN

ANNEX K: AGRICULTURAL DEVELOPMENT PLAN

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ANNEX K: AGRICULTURAL DEVELOPMENT PLAN

1. Agricultural Development Plan

1.1 Agricultural Improvement Plan

By the reconnaissance study, the agriculture in Constanza Valley is evaluated as the commercial collective agriculture. But there are various problems as listed below. Unless these problems are solved or improved, the study area will not be expected to be developed fully and it may be said that it holds the key to succeed in this project. The problems, therefore, are clarified here, and agricultural improvement plan is proposed based on the clarification of these problems.

(1) Problems

a. Soil fertility has declined.
b. Irrigation water is lacking.
c. Low quality seeds are used for some crops.
d. Injury by continuous cropping and maintenance of soil productivity are not considered in the present cropping pattern.
e. There are problems of proliferation of pests and diseases, and uses of pesticides.
f. It is necessary to rectify marketing of agricultural products.
g. Agricultural supporting organizations should be improved.
h. Agricultural credit delays often.
i. Farmers are conservative and the work efficiency is comparably low since most workers are employed.

(2) Improvement Plan

Based on the above problems, the improvement plan is devided into improvement plan of organizations which carry out the plans and improvement plan of agricultural techniques. Technical improvement plan is further divided into short term plan and long term plan.

The plans which not only make effect in a short term but also solve the fundamental problems in a long term are proposed in both of the plans.

The Constanza Agricultural Development Organization will play a central role in carrying out the agricultural development plan. The plan should include farmer's voice by involving them in planning, and it should be disseminated thoroughly to farmers.

As organizational improvement is described later, only the main items are listed here.

- Foundation of Agricultural Development Union
- Establishment of Farming Committee
- Repletion of Horticultural Experiment Station
- Intensification of Extensional Organization

Technical improvement plan

This plan proposes the short term plan that farmers can put into practice in a short run and the long term plan that is difficult to practise for a short time but is necessary for the stable development of agriculture in Constanza in the future.

1) Short term plan

a. Improvement of soil fertility

Crops are grown mainly with chemical fertilizer at present, and only little amount of organic matter is applied to soil. Together with applying poultry manure, bagasse and rice straw, organic matter is recirculated to soil by introduction of graminae and green manure crop into cropping pattern and plowing the remanants into soil after harvest.

At present, plowing and ridging are practised parallel to the slope, which facilitates soil erosion. Therefore, the slope should be plowed and cultivated along the contour line. Fruit trees are to be introduced on a slopy farm and grown with grass mulch to protect soil from erosion.

b. Improvement of seed

There occurred a serious damage to garlic from introducing a variety that did not fit to Constanza in the past. In order to avoid such a problem, newly introducing varieties should go through adaptability test by Horticultural Experiment Station. The procedure is required not only for garlic but also for other crops.

The seed of root crops such as garlic and potato which are propagated vegetatively should be renewed once in 3 - 4 years. It is also necessary to renew other seeds periodically to protect crops from resistant pests and diseases to a pesticide. There is a necessity to establish a system of seed inspection, propagation and distribution.

c. Improvement of cropping pattern

As proposed in cropping plan, it is necessary to establish better crop rotation avoiding injuries from continuous cropping and introducing graminae.

d. Control of pests and diseases

Pests and diseases proliferate much and give heavy damage to crops in the study area at present. And it is real that pesticides need to be sprayed very often to control them. Various pesticides have been introduced by private firms so far without inspecting their effectiveness. The following services are necessary at least to guide farmers by Horticultural Experiment Station as a core.

- Investigation on genesis and ecology of pests and diseases, and investigation of damages
- Elucidation on action characteristics of pesticides and proper usage

There are some successful reports of physical, biological and cultural control as shown in Table 1.1.1-1. It is proposed to pick up other successful methods than chemical application in the other areas or countries and adopt the method to the study area.

e. Countermeasures to pesticide problem

Pod snow pea had bean exported successfully from Constanza to U.S.A. a few years ago. However it was stopped because of peticide residue (insecticide : methamidophos), and pod snow pea is grown little at present.

There remains a problem to control pesticide use such as parathion prohibited in Japan for example. There is Pesticide Control Law in Dominican Republic, but it is now observed seriously. It is necessary at least to observe thoroughly the already established law and regulations. It is, therefore, proposed that education and campaign on pesticide use are to be held by SEA as a core.
For reference a briefing of some laws in Japan is shown in Table 1.1.1-2.

f. Water management

At present farmers consider water management easy since they think that water is given by the state. They also take irrigation water as one of required production materials and do not think seriously to maintain and manage irrigation facilities as common ones. It is necessary to establish an organization and improve farmers' awareness to water management as written in the section of 'Farmer's organization and water management organization'.

2) Long term plan

a. Improvement of soil fertility

The counter plan stated in the short term plan is to be practiced continuously.

b. Diversification of crops

The introduction of fruit trees are proposed in the non-irrigated area in this project plan. On the other hand, it is thought that the proposed cropping pattern in the benefit area does not solve fundamental problems such as soil fertility, pests, diseases and so on. The introduction of several crops may be possible in the project area due to its good soil and meteorological conditions. Fruit trees are thought to be the most hopeful crops. The hopeful fruit trees are nuts, passion fruits, plum, grape, etc. The Horticultural Experiment Station should proceed selection of proper variety including other fruit trees and develop their growing method, storage method and transportation method.

It is proposed to enlarge the cropping area of export crops. Vegetables of winter cropping to U.S.A may be hopeful.

Pesticide residue will be a problem for export vegetables and the counter plans stated in the item of control of pests and diseases are to be proceeded. Its guidance system should also be strengthened.

c. Integrated control of pests and diseases

The important aspect in a vegetable producing area is the proper countermeasures to soil fertility and pests and diseases. The integrated control is a method to control pests and diseases combining cultural, physical, biological and chemical controls. In any country, the technical development of the integrated control has bean required and tackled to avoid depending solely on pesticides. The integrated control is composed practically of combination of crops, introduction of repellent crop, use of heat and light, use of natural enemy, use of attractive substance and pesticide.

The integrated control adapted to the area is required to be established utilizing successful methods in other areas or countries. In order to succeed in it, organization of Horticultural Experiment Station is to be strengthened.

d. Preparation and processing of products

Selling products to middle man is an ordinary practice carried out at farm. The system to sell the products adding some value by preparation or processing is not practiced at present. Direct transportation from producing area to consuming cities by contacting supermarkets is proposed in the improvement plan. Preparation and processing according to the demand of consumers are required. It is required to study the arrangement of preparation and processing factory managed directly by the agricultural development union.

Table 1.1.1-1 Some Successful Examples of Non-Chemical Control of Pests and Diseases

1. Control of Soil-borne diseases and pests (Fusarium, Nematoda) by plastic film cover

   - Deep plowing, ridging, applying sufficient organic matters and water
   - Apply calcium cyanamide to be effective further
   - Cover total field with plastic film for 30 days
   - More effective when practised in hot season
   - Used in Japan

2. Burning soils by a gas-burner, etc.

   - Plow and burn soils and repeat it
   - A problem in this method is to remain unburnt parts by all means
   - Used in Japan

3. Control of mosca blanca (Trialeurodes vaporarorium) with yellow sticky tape

   - Mosca blanca is attracted to yellow color
   - Sticky tape catches and kills mosca blanca
   - Used in Japan

4. Use of parasitic pathogen on mosca blanca

   - Reported that verticillium lecanii is effective to control mosca blanca in Soviet Union, France and England.
   - This pathogen is commercialized under the name of Mycotal
   - Reported that Aschersonia aleyrodes is effective in Holland

5. Use of parasitic insect on mosca blanca

   - Reported that Euearsia formosa is effective on mosca blanca in England and Soviet Union

6. Use of predator of mosca blanca

- Insects such as Orius leavigatus, Chrysopa rufilabris, Campylomma sp., Adalia sp., Hippodamia converggens and Syrphidae family eat mosca blanca

7. Control of Plutella maculipennis parasiting on cabbage

- Pheromone tape attracts and kills male, then becomes impossible to copulate
- Uses of pheromone tape induces reduction of pesticides in Japan

8. Uses of white or blue color to control thrips (Thrips palmi)
- Blue sticky tape is used to control the thrips
- White sticky trap, white water bowl and blue sticky tape are used for investigation of seasonal prevalence of thrips

9. Use of a mite eating thrips (Thrips tabaci)

- It is under test to use Amblyseius mckeziei and A.eucumeris to control Thrips tabaci

10. Use of Phytoseiulus persimilis against Tetranychus ulticae

- Combination of P.persimilis and pesticide is used widely to protect fruit vegetables from T.utilicae

Table 1.1.1-2 Pesticide Laws in Japan

LAW	PURPOSE OF THE LAW	RELATED PESTICIDES AND PROVISIONS ON PESTICIDES	AUTHORITIES CONCERNED
ACT ON THE JUDGE OF CHEMICAL SUBSTANCES AND CONTROL OF THE PRODUCTION	Protection against environmental pollution by chemical substances.	Organochlorine compounds related deeply with pesticide. (Polychloronaphthalene, Hexachlorobenzene, DDT, Dieldrin, Aldrin, Endrin, Chlorden, etc.) They are nominated as "SPECIFIC CHEMICAL SUBSTANCE" and prohibited to use.	Ministry of International Trade and Industry
FOOD HYGENE ACT	To keep the safety of food	The maximum permissible amount of residue pesticides (residue standard) to agricultural products and other food is set. If the amount is over the standard, sale of the pesticide is prohibited, and an offender is punished according to the penal regulations. The "Residue standards" of 25 pesticides to 56 crops are set at the year of 1987.	Ministry of Health

LAW	PURPOSE OF THE LAW	RELATED PESTICIDES AND PROVISIONS ON PESTICIDES	AUTHORITIES CONCERNED
POISONS AND POWERFUL CHEMICALS CONTROL ACT	To control chemicals with acute toxicity.	Especially toxic chemicals are nominated as "Specific poison" and the following pesticides are nominated. Parathion, Methylparathion, TEPP, Methyldimeton, Shradan, Fluoroacetate amide, Fluoro-acetate, Alminium phosphide. Poisons are Ethylthiometon, Zinc phosphide, DNBP, DSMA, etc. Powerful chemicals are Chlorate, Chlorpyriphos, Methylbromide, Diazinon, BPMC, DDVP, PCP, etc.	Ministry of Health
PESTICIDE CONTROL ACT	Registration, sale, utiliza-tion control and proper usage of pesticides, health of people, and preservation of environment.	Production, sale and use of pesticides are generally controlled. Non-registered pesticides are not allowed to sell. Application for registration requires: 1) Name and Address 2) Name of the kind of pesticide, physical and chemical properties, active ingredients, other ingredients and their contents.	Ministry of Agri-culture, Forestry and Fisheries

LAW	PURPOSE OF THE LAW	RELATED PESTICIDES AND PROVISIONS ON PESTICIDES	AUTHORITIES CONCERNED
		3) Applicable insects and diseases, method of use, and test data on the effectiveness and damage. 4) Name of manufacturing factory and address. 5) Method of production and name of responsible person on the pesticides which are produced or processed.	

2. Agricultural Production Plan

2.1 Cropping Pattern

A production program plans improvement of productivity, enlargement of cropping areas with profitable crops and introduction of export crops by construction of new irrigation facilities. It aims at increasing the outputs and income. The cropping pattern is developed considering crop rotation avoiding continuous cropping of the same family, introduction of cleaning crops and green manure crops. It aims to avoid prevalence of pests and diseases and maintenance of soil fertility. It also intends avoiding injuries by continuous cropping.

Fruit trees are to be planted in non-irrigated areas.

(1) Selection of Crops

Crops are selected as shown below. Utilizing a highly elevated climate in Constanza, profitable crops are planned in winter season.

Winter cropping	Garlic, Vegetables
Summer cropping	Potato, Kidney bean, Onion, Graminae, Vegetables, Green manure crops
Non-irrigated area	Fruit trees

The reasons for the above selection are as follows:

a. Garlic

At present, garlic is the most profitable crop among the crops grown in Constanza and demand in domestic markets is stable. Since garlic requires low temperatures, there are few other producing areas than Constanza. It is well adapted to the local conditions, and garlic is given a central role in winter cropping. It is storable, and shipment can be regulated to some extent.

b. Potato

A demand for potato is stable as a food crop, and it is one of the principal crops cultivated at present. The recent cropping areas with potato show a rapid increase. Its profitability is at the middle among the crops, and it is well adapted to the local conditions.

c. Kidney bean

Kidney bean is taken together with a staple rice, and it is always necessary in Dominican recipe. Kidney bean is used as matured bean, and not as young pod bean. It is also important for family use of farmers. Since the production cost is lowest among the crops grown in Constanza, it is easy to grow for the small scale farmers.

d. Onion

Since onion can be stored dry for a certain period, it is possible to sell onion judging the fluctuation of its prices. Small-bulb seedling from lower areas are planted and may be harvested for a short period. Onion is one of the principal crops grown at present and well adapted to the local conditions. Onion is used as basic seasoning and salad material and its demand is stable.

e. Vegetables

Vegetables other than the principal crops such as lettuce, carrot, beet and other vegetables are planned utilizing the locality. Profitable export crops will be introduced as winter cropping in the future. Cropping rate of vegetables is heightened in the cropping pattern in order to diversify the risks of income and kind of crop.

Chinese vegetables are hopeful as export crops because it is difficult to grow them in U.S.A because of high labor cost for cultivation.

f. Graminae and green manure crop

Though profitability may decrease, graminae as a cleaning crop and green manure crops for supplying organic matters to the soil are to be introduced. Sweet corn is thought to be the most hopeful crop among graminae.

Green manure crop is not introduced in the Valley at present, however it is highly required in an area with poor organic matter such as the project area. Sweet corn is proposed as the green manure crop for a time being although it is not suitable for its sales.

g. Fruit trees

Non-irrigated areas out of the planned canal are at the higher areas and the slopes are steep. Vegetable cultivation is not suitable since water is lacking and the soil is eroded easily. Therefore fruit trees are planned. Nuts (pecan, macadamia nut, etc.), passion fruit, plum etc. are thought to be hopeful.

Vegetables which are shipped in winter and spring when they are lacking in U.S.A and labor-collective are hopeful as export vegetables. Furthermore, vegetables which are difficult to grow in other areas is also advantageous because of hot temperature. For these reasons, Chinese vegetables are thought to be the most hopeful for export crops. Expected vegetables are listed below.

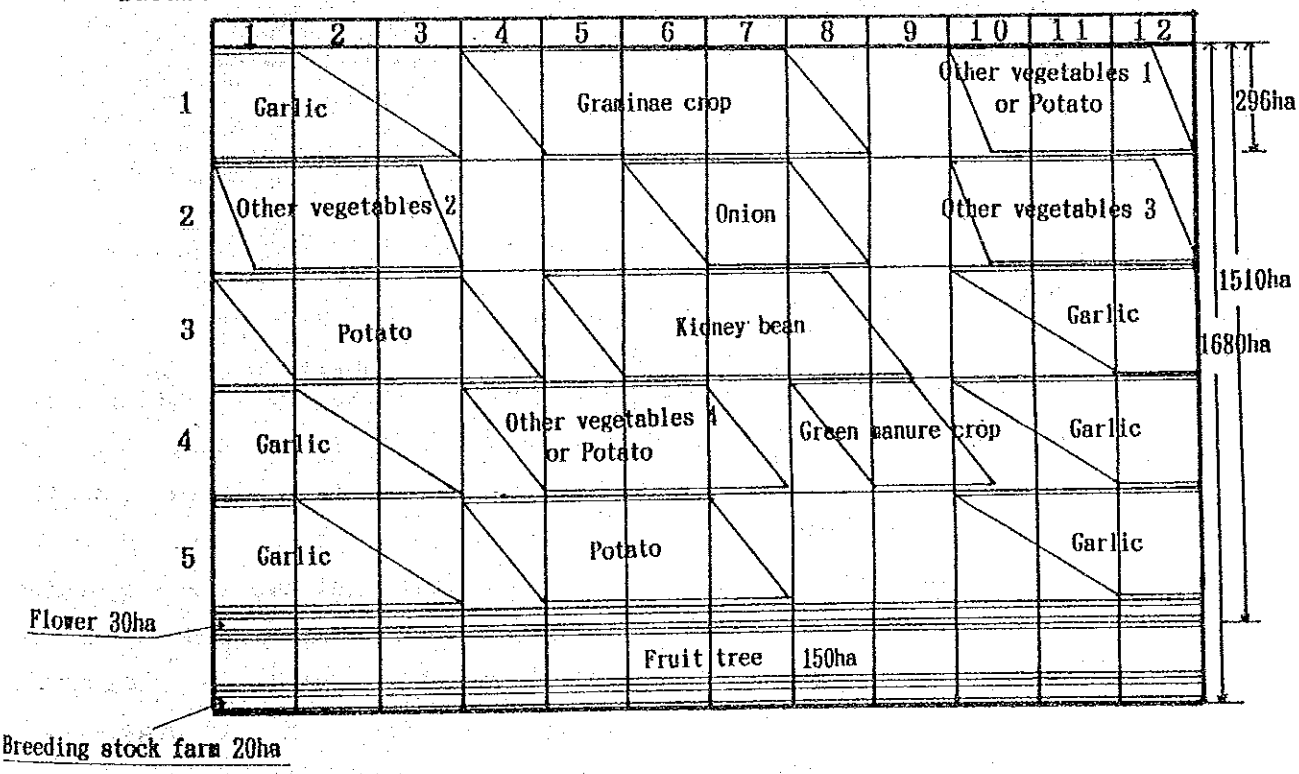
Pak choi (Brassica chinensis var. chinensis)
Peking cabbage (Brassica pekinensis)
Snow cabbage (Brassica juncea)
Mustard cabbage (Brassica juncea)
Baby mustard (Brassica juncea)
Shanghai cabbage (Brassica sp.)
Chrysanthemum greens (Chrysanthemum coronarium)
Snow pea pod (Pisum sativum)
Green bean (Phaseolus Vulgaris)
White radish (Rhaphanus sativus var. longipinnatus)
Kohlrabi (Brassica oleracea var. gougylodes)
Watercress (Nasturtium officinale)
Chayote (Sechium edule)
Luffa squash (Luffa acutangula)
Po cua (Lagenaria sinceraria)
Bitter melon (Momordica charantis)
Leaf coriander (Coriandrum sativum)
False coriander (Erynglum foutidum)
Celery (Apium gravolena)

(2) Cropping Plan

The following are the basic ideas to plan cropping.

a. Crop rotation as one cycle for 5 years
b. To avoid a continuous cropping of the same family
c. To introduce graminae as a cleaning crop
d. To introduce green manure crops and plow them into the soil
e. To increase the cropping rate
f. To plant fruit trees in non-irrigated areas

Cropping pattern is planned as Fig. 2.1.1-1 based on the above ideas.



Note: Vegetables 1, 2, 3 ... Lettuce, Carrot, Beet, Export vegetables, Other vegetables

Vegetables 4 ..... Lettuce, Carrot, Beet, Other vegetables

Graminae ..... Sweet Corn, Upland rice, Wheat, etc.

Green manure crop .... Some graminae which is plowed into the soil while green

Fig. 2.1.1-1 Planned Cropping Pattern

Comparing the cropping rates between the "present" and "plan" except fruit trees, graminae is introduced newly and there is an increase for vegetables and garlic.

Crops	Present	Plan
Garlic	54.3%	60.0%
Potato	60.0	60.0
Kidney bean	25.7	20.0
Onion	20.0	20.0
Vegetables	54.0	60.0
Graminae	0	20.0
(Green manure crop)	(0)	(20.0)
Total	214.0	240.0
		(260.0)

2.2 Cropping Area

At present, the area of farm growing vegetables is 1,660ha, its cropping rate is 214%, and the annual total cropping area is 3,488ha. Vegetables are cultivated also on steep slopes above the existing irrigation canal. In these area it is necessary to modify the farming style from vegetable cultivation to fruits trees. Since water is lacking even after the project implementation in the area above the irrigation canal and vegetable cultivation on the steep slopes facilitates soil erosion. As these areas belong to non-irrigated area on the irrigation plan, the total benefited area is 1,510ha. Cropping area for garlic, potato, etc. excluding 30ha of flower growing is 1,480ha. As the above cropping plan, cropping rate is 240%, the annual total vegetable area is 3,552ha, fruit tree 150ha, flower 30ha, and the total is 3,732ha, as shown in Table 2.2.1-1.

Table 2.2.1-1 Planned Cropping Area

Unit: ha

Crop	Present	With Project	Difference
Garlic	855	888	3
Potato	978	888	-90
Kidney bean	419	296	-123
Onion	326	296	-30
Lettuce	233	182	-51
Carrot	280	219	-61
Beet	186	145	-41
Other vegetables	181	142	-39
Export vegetables	-	200	200
Graminae	-	296	296
Green manure	-	(296)	(296)
Fruit tree	-	150	150
Flower	30	30	0
Total	3,518	3,732	214

Note: Green manure is not counted in cropping area.

2.3 Production

(1) Yield

The yields at present are based on the data by SEA Constanza branch and the site survey of farmers. They are calculated into hectarage. Yields are compared "Present", "Without project" and "With project". The yield of "Without" includes the increase with general improvement of agricultural techniques without implementation of the project. The yield of "With" is planned based on the increase with sufficient water by the implementation of the project, proper control of pests and diseases and total improvement of techniques including improvement of seeds. The planned yields are shown in Table 2.3.1-1.

Comparing with the yields of "Present", the yield of garlic which is affected most by water shortage becomes 1.4 times, potato follows it with 1.3 times and the other crops 1.2 times. Other vegetables includes cabbage, cauliflower, brocolli, capsicum, tomate, etc., and the yield of cabbage represents them. Figures are used from chinese cabbage for export vegetable, sweet corn for graminae and pecan for fruit tree.

Table 2.3.1-1 Yield per Unit Area

Unit: t/ha

Crop	Present	Without Project	With Project
Garlic	5.8	6.4	8.1
Potato	18.1	19.9	23.5
Kidney bean	1.1	1.2	1.3
Onion	10.9	12.0	13.1
Lettuce	19.6	21.6	23.5
Carrot	16.3	17.9	19.6
Beet	25.4	27.9	30.5
Other vegetable	20.4	22.4	26.2
Export vegetable	-	-	26.2
Graminae	-	-	26.2
Fruit tree	-	-	4.9

(2) Total Production

The total production of each crop is shown in Table 2.3.1-2. In the planned production after the project implementation, comparing with the "Present", garlic increases 40%, potato 18%, onion 9%, but other crops stay at the same level or decrease a little. Since export vegetables and graminae are newly introduced, their yields will increase directly.

Table 2.3.1-2 Planned Production

Crop	Present	Without Project	With Project
Garlic	5,133	5,664	7,193
Potato	17,702	19,462	20,868
Kidney bean	461	503	385
Onion	3,553	3,912	3,878
Lettuce	4,567	5,033	4,277
Carrot	4,564	5,012	4,292
Beet	4,724	5,189	4,423
Other vegetables	3,692	4,054	3,720
Export vegetables	-	-	5,240
Graminae	-	-	2,368

2.4 Production Materials

A plan for production materials is briefed below.

Seed : Newly introduced varieties should be tested for adoptability by Horticultural Experiment Station. Production management and storing of seed potato shall be improved. Self-collected seeds shall be renewed once in 3 - 4 years. Seeding rate is planned as same as the present rate.

Fertilizer : Chemical fertilizer is increased by 15% of the present level and organic matter shall be applied.

Pesticide : Since pesticides are sprayed generally too much, ineffective spray should be abolished and only indispensable sprays shall be carried out. But present frequency of spray is also considered in the plan, considering damages by pests and diseases.

Herbicide : Weed will be controlled by both chemical and mechanical methods.

Sprinkler : One unit of sprinkler is planned for one irrigation block (12ha).

Input of main production materials for each crop is shown comparing "Present", "Without" and "With" at the upper column of Table 2.4.1-1 (1), (2), (3).

Table 2.4.1-1(1) Production Materials, Labor per Unit Area

Unit:ha

Item	Unit	Garlic			Potato			Kidney bean		
		Present	Without Project	With Project	Present	Without Project	With Project	Present	Without Project	With Project
Main Materials										
Seed	kg.	846	846	846	1,758	1,758	1,758	105	105	105
Fertilizer										
Organic	t	-	-	5	-	-	5	-	-	5
Chemical	kg.	1,452	1,580	1,658	1,089	1,230	1,290	363	399	416.8
Pesticide										
Herbicide	l	2.4	2.4	2.4	-	-	-	-	-	-
Insecticide	l	16.9	16.9	16.9	24.6	24.6	24.6	1.7	1.7	1.7
Fungicide	kg.	20.6	20.6	20.6	23.6	23.6	23.6	6.8	6.8	6.8
Labor										
Preparation of seed, seedling	man-day	20	20	20	5	5	5	-	-	-
Plowing, Ridging	"	5	5	5	4	4	4	4	4	4
Sowing, Planting	"	104	104	104	18	18	18	9	9	9
Apl. of fertilizer										
Organic	"	-	-	10	-	-	10	-	-	10
Chemical	"	5	5	6	3	3	3	2	2	2
Spraying										
Herbicide	"	5	5	5	-	-	-	-	-	-
Pesticide	"	38	38	38	26	26	26	4	4	4
Intertillage	"	105	105	105	31	31	31	24	24	24
Harvest, Prep.	"	129	142	181	80	88	104	24	26	29
Irrigation	"	91	91	73	33	33	27	23	23	19
Total		502	515	547	200	208	228	90	92	101

Table 2.4.1-1(2) Production Materials, Labor per Unit Area

Unit:ha

Item	Unit	Onion			Lettuce			Carrot		
		Present	Without Project	With Project	Present	Without Project	With Project	Present	Without Project	With Project
Main Materials										
Seed	kg.	5.288	5.288	5.288	0.605	0.605	0.605		6.54	6.54
Fertilizer										
Organic	t	-	-	5	-	-	5	-	-	5
Chemical	kg.	1,089	1,228	1,284	726	797	835	757	833	871
Pesticide										
Herbicide	l	2	2	2	-	-	-	2.9	2.9	2.9
Insecticide	l	6.8	6.8	6.8	3.1	3.1	3.1	7.3	7.3	7.3
Fungicide	kg.	17.8	17.8	17.8	5.3	5.3	5.3	27.5	27.5	27.5
Labor										
Preparation of seed, seedling	man-day	4	4	4	80	80	80	-	-	-
Plowing, Ridging	"	4	4	4	5	5	5	5	5	5
Sowing, Planting	"	56	56	56	52	52	52	5	5	5
Apl. of fertilizer										
Organic	"	-	-	10	-	-	10	-	-	10
Chemical	"	3	3	4	2	2	2	4	4	4
Spraying										
Herbicide	"	4	4	4	-	-	-	5	5	5
Pesticide	"	32	32	32	6	6	6	44	44	44
Intertillage	"	52	52	52	37	37	37	83	83	83
Harvest, Prep.	"	114	125	137	120	132	144	110	121	132
Irrigation	"	32	32	27	37	37	30	46	46	37
Total		301	312	330	339	351	366	302	313	325

Table 2.4.1-1(3) Production Materials, Labor per Unit Area

Unit:ha

Item	Unit	Beet			Other vegetables			Graminae		
		Present	Without Project	With Project	Present	Without Project	With Project	Present	Without Project	With Project
Main Materials										
Seed	kg.	17.41	17.41	17.41	0.990	0.990	0.990	-	-	1.72
Fertilizer										
Organic	t	-	-	5	-	-	5	-	-	5
Chemical	kg.	914	1,006	1,051	1,512	1,663	1,739	-	-	293
Pesticide										
Herbicide	l	2.1	2.1	2.1	-	-	-	-	-	2.7
Insecticide	l	0.4	0.4	0.4	19.2	19.2	19.2	-	-	0.7
Fungicide	kg.	12.1	12.1	12.1	12.8	12.8	12.8	-	-	-
Labor										
Preparation of seed, seedling	man-day	-	-	-	80	80	80	-	-	-
Plowing, Ridging	"	4	4	4	3	3	3	-	-	-
Sowing, Planting	"	1	1	1	24	24	24	-	-	4
Apl. of fertilizer										
Organic	"	-	-	10	-	-	10	-	-	10
Chemical	"	2	2	2	4	5	5	-	-	2
Spraying										
Herbicide	"	-	-	-	-	-	-	-	-	2
Pesticide	"	26	26	26	38	38	38	-	-	3
Intertillage	"	48	48	48	28	28	28	-	-	24
Harvest, Prep.	"	120	132	144	284	312	341	-	-	23
Irrigation	"	36	36	29	40	40	32	-	-	11
Total		237	249	264	501	530	561	-	-	79

2.5 Required Labor Force

(1) Required Labor Force per Unit Area

Required labor force per ha is shown crop by crop for "Present", "Without" and "With" at the lower column of Table 2.4.1-1 (1), (2), (3). Required labor force does not change for ridging, sowing, planting, intertillage, etc. even after project implementation. Application of organic fertilizer needs 10 men per ha and increase of yield requires more labor accordingly. On the other hand, man power for irrigation is anticipated to decrease 20% by improving irrigation facilities.

(2) Monthly required labor force

In the plan, annual required labor force is 1,167 thousand men and it increases by 11% comparing with the present one (Table 2.5.1-1). Since there are many labor-collective crops in winter, more labors are required from October till March. Required average monthly laborers are approximately 97,000 man-day. Assuming that a person works for 25 days a month, 3,880 laborers are necessary. And assuming 80% of them are employed, 3,104 people are given the opportunity of employment.

Table 2.5.1-1 Monthly Required Labor Force

Unit: man·day

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Present(a)	101.277	128.120	115.461	107.184	117.042	89.169	52.234	34.593	87.268	104.736	80.664	51.975	1,069,923
With(b)	113.966	149.547	136.606	98.411	152.556	140.688	69.484	39.326	82.714	118.083	65.966	19.964	1,167,311
(b)-(a)	12.689	21.427	21.145	▲8.773	35.514	51.519	17.250	4.733	▲ 4.554	13.347	▲14.698	▲32.012	117,388

2.6 Crop Profit

(1) Price of Product and Input

1) Price of product at farm

The price of product varies from season, quantity of production, view of middle man, economic state of farmer, etc. As there is no market information network at present, farmers depend on oral information, and the price is not constant at the same season. Therefore, the price at farm of each crop is set based on the data of 1987, 1988 and upto October 1989 by SEA-Constanza Branch, calculating them with consumable price index into monthly mean prices and average them for about 3 years. The price of other vegetables is assumed from the prices of cabbage and chinese cabbage. The price of graminae is set from the price of maize at the other area. The price at farm of each crop is shown below.

Garlic	:	RD$13,800/t
Potato	:	RD$ 2,670/t
Kidney bean	:	RD$ 8,800/t
Onion	:	RD$ 3,890/t
Lettuce	:	RD$ 850/t
Carrot	:	RD$ 1,760/t
Beet	:	RD$ 770/t
Other vegetables	:	RD$ 1,600/t
Graminae	:	RD$ 730/t

2) Price of input

a. Seed

The price is set at the prices in October, 1989.

Garlic	:	RD$32.0/kg
Potato	:	RD$ 3.8/kg
Kidney bean	:	RD$ 5.6/kg

Onion	:	RD$ 2.2/kg
Lettuce	:	RD$ 0.22/g
Carrot	:	RD$86.9/kg
Beet	:	RD$68.8/kg
Vegetables	:	RD$ 0.7/g
Graminae	:	RD$ 2.1/kg

b. Fertilizer and pesticide

Though the kind of fertilizer and pesticide vary for each crop, the kind of pests and diseases, time of spray, etc., average prices of fertilizer, herbicide, insecticide and fungicide are used, which were taken from the investigation on production cost by Banco Agricola.

Fertilizer	:	RD$ 1.6/kg
Herbicide	:	RD$ 89.6/lit.
Insecticide	:	RD$114.7/lit.
Fungicide	:	RD$ 40.4/kg

c. Labor cost

As a labor cost is set RD$20/man-day without regarding to the kind of work by Banco Agricola, the unit labor cost is set at the same level and farmer's labor is set at RD$40/man-day since farmer is considered as skilled labor.

d. Irrigation charge

Though the irrigation charge for a farmer is low at present because of the defrayment by the government, the irrigation charge is set at RD$56/ha for the "Present and "Without" as well as the present charge. The irrigation charge of "With" is defrayed by beneficiaries themselves. RD$446/ha calculated by dividing splinkler equipment, machines and fuel by beneficial cropping area is added to RD$202/ha and the total maintenance cost is calculated by dividing with beneficial cropping area.

The charge will increase more than 10 times, but the maintenance system is intensified since farmer is responsible in maintenance by defraying the necessary cost. The calculation of sprinkler equipment, machines is attached to Annex.

e. Other items

The charge for lease plowing is set at RD$576/ha of the present one. Miscellaneous fee is set at 5% of the above costs.

3) Financial charge

Annual financial rate is 18%, and the financial charge of each crop is given by calculating monthly financial charge by the growing period of each crop.

(2) Gross Profit, Production Cost and Net Profit

The gross profit, production cost and net profit per ha is shown in Table 2.6.1-1 by the "Present", "Without" and "With".

Table 2.6.1-1 Planned Gross Profit, Cost, Net Profit per unit area

Unit:RD$/ha

Crop	Gross profit			Cost			Net profit		
	Present	Without project	With project	Present	Without project	With project	Present	Without project	With project
Garlic	80,040	88,320	111,780	44,156	52,163	54,426	35,884	36,157	57,354
Potato	48,327	53,133	62,745	17,169	19,682	21,511	31,158	33,451	41,234
Kidney bean	9,680	10,560	11,440	4,316	4,933	6,405	5,364	5,627	5,035
Onion	42,401	46,680	50,959	22,248	26,189	27,994	20,153	20,491	22,965
Lettuce	16,660	18,360	19,975	10,137	11,877	13,514	6,523	6,483	6,461
Carrot	28,688	31,504	34,496	11,162	13,526	15,120	17,526	17,978	19,376
Beet	19,558	21,483	23,485	9,299	11,024	12,697	10,259	10,459	10,788
Other vegetables	32,640	35,840	41,920	11,168	21,349	24,504	21,472	14,491	17,416
Export vegetables	-	-	41,920	-	-	24,504	-	-	17,416
Graminae	-	-	5,840	-	-	5,126	-	-	714

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 2.6.1-2. Comparing with the "Present", the gross profit increases by 30% and the net profit 31% after the project implementation.

Table 2.6.1-2 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.

2.7 Procurement Cost of Equipment and Machines of Sprinkler

(1) Required Sets

One set of sprinkler including generator, pump, pipes, head, etc. is to be installed per one irrigated rotation block. The arranged equipments are to be owned and used in common. One irrigated block is 12ha. 126 sets of equipment are to be introduced against 1,510ha of beneficial area.

(2) Equipment Cost

Investment per one set

generator and pump	12,000 RD$
pipes, heads, etc.	47,500 RD$
Total	59,500 RD$

Investment of 126 sets 7,497,000 RD$

Annual depreciation per one set
(endurance year: 5 years, remaining rate: 10%)

$$\frac{59,500 - 5,950}{5} = 10,710$$

Annual depreciation of 126 sets
126 x 10,710 = 1,349,460

(3) Fuel Cost

Annual operating time per one set	1,388 hours
Fuel consumption per one hour	1.9 lit.
Unit price of fuel	0.8 RD$

Annual cost per one set
1,388 x 1.9 x 0.8 = 2,110 RD$
Annual fuel cost of 126 sets
126 x 2,110 = 265,860 RD$

(4) Annual Expense

Per one set	Depreciation	10,710 RD$
	Fuel cost	2,110 RD$
	Total	12,820 RD$
Per 126 sets	Depreciation	1,349,460 RD$
	Fuel cost	265,860 RD$
	Total	1,615,320 RD$

Per 1ha of farm area 1,615,320 ÷ 1,510 = 1,070 RD$
Per 1ha of cropping area 1,070 ÷ 2.4 = 446 RD$

3. Farm Management Plan

3.1 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 3.1.1-1 shows cropping hectarage of each crop by different scales.

Table 3.1.1-1 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.

3.2 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 3.1.1-1, considering the present cropping rate. The planned cropping rate is 283% for small scale, 240% for medium scale and 200% for large scale.

3.3 Cultivation Technique

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

3.4 Agricultural Economy Plan

(1) Agricultural balance

Table 3.4.1-1 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 3.4.1-1 Agricultural Balance

		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

3.5 Farmer's Economic Surplus

Farmer's economic surplus is obtained by substracting living costs from agriculturalnet 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 with project increases by 47 - 230%, comparing with the "Present".

Table 3.5.1-1 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. Marketing Plan of Agricultural Products

4.1 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 in Constanza at present, i.e., garlic, potato, kidney bean and onion are the basic crops necessary for the Dominican recipe. Garlic and onion are the basic seasoning crops, 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 Thrips 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.

4.2 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 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 a booth for direct sale of Constanza vegetables at the big supermarkets in Santo Domingo and Santiago and sells fresh vegetables to consumers.

5. Agricultural Supporting System

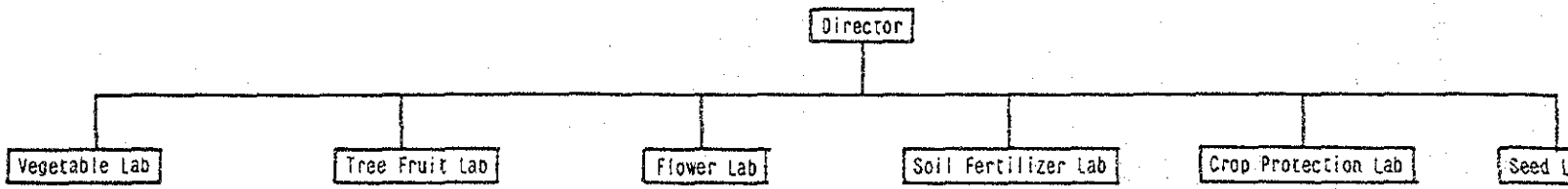
In order to improve the productivity of crops in Constanza, it requires various improvement plans such as improvement of soil fertility, improvement of seed, improvement and extension of cultivation techniques, improvement of pesticide usage, ratification of marketing, effective use of irrigation water, etc. Agriculture supporting system should be also improved to achieve the above improvement plans. Pratically, 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.

5.1 Horticultural Experiment Station

This experiment station is located in Constanza and belongs to CENDA. But this is only the experiment station researching on horticultural crops in the Dominican Republic. Therefore, it may be said that the experiment station is required to function for the whole country. From the above point of view, the experiment station should be improved. Improvement plan is proposed in Fig. 5.1.1-1.

5.2 SEA-Constanza

As described in the present conditions of the study area, the present extension system is that the whole Constanza is divided into two sub-zones, and Constanza Sub-zone is divided into 6 sections and El Rio Sub-zone is devided into 3 sections. The project area belongs to El Valle section and a part of El Convento under Constanza Sub-zone. An extension worker is attached to each section and gives extension services on total farming to farmers.



	Vegetable Lab	Tree Fruit Lab	Flower Lab	Soil Fertilizer Lab	Crop Protection Lab	Seed Lab
	· Cultivation of main vegetables · Nursing of seedling · Irrigation of vegetables · Post harvest · Packing, Transport	· Selection of tree fruit · Propagation, nursing of seedling · Planting · Pruning, thining of fruits · Post harvest	· Adaptability test of flowers · Cultivation · Nursing of seedling · Packing, Transport	· Soil analysis · Soil management · Selection of fertilizer · Application of fertilizer	· Identification of pests, diseases, weed · Ecology of pests, diseases, weed · Control of pests, diseases, weed · Pesticide effectiveness	· Adaptability test of varieties · Selection of varieties · Renewal of seed · Seed production management · Seed disinfection · Storing of seed
Researchers	3-4	1-2	1-2	2-3	3-4	2-3
Assistants	3-4	1-2	1-2	2-3	3-4	2-3

Fig.5.1.1-1 Organization Chart of Horticultural Experiment Station

In the plan, a method of attaching extension worker for crops and specialities is proposed adding to the existing system, and the number of sections under an extension worker varies according to the charge of work. The services of extension worker, number of extension workers for the whole Constanza and specialities are shown below. Nine extension workers will be increased comparing with the present workers.

Table 5.2.1-1 Improvement Plan of SEA-Constanza

Line	No. of Worker	Main services
Crop growing Vegetable, other crops Tree fruit Flower Coffee	 9 1 1 1	Selection of crops, Preparation of seed, Nursing of seedling, Cultivation, Post harvest, Seed production, etc.
Soil & Fertilizer Soil improvement Application	1	Application of organic matters, Plowing, Correction of Alkalinity, Application of fertilizer, etc.
Crop protection Disease Insect	 2 2	Forecasting of pests and diseases, Control method, etc.
Farmer's organization	1	- Organization, Activity, etc.
Machine	1	- Operation, Maintenance, Work method, etc.
Management	2	- Economic statistics, Composition of crops, Cropping pattern, Economic evaluation, etc.
Living	1	- Management of clothing, food and living, etc.

Furthermore, the service of extension should be improved clarifying its content as shown below.

Table 5.2.1-2 Service of Agricultural Extension in SEA-Constanza

Service	Item	Activity
Education	1. Visit	1. To visit farmers peoridically in the section and teach farmers directly in the farm
	2. Demonstration • Practice	2. To demonstrate and teach farmers cultivation, machine operation, etc. in a demonstration farm of a core farmer in the section.
	3. Commnucation	3. To hold workshop, seminar, lecture, etc.
	4. Study tour	4. To tour progress farm, experiment station, market, etc. for study.
Information	1. Distribution of technical information	1. To issue technical news periodically.
	2. Preparation of technical manual	2. To prepare technical manual for each subject.
	3. Production of movie	3. To produce a movie for explaining agricultural skill systematically.
	4. Preparation of panel	4. To prepare photo-panel of damages of pests and disease, growth disorder, cross section of the soil, etc. for examples.
	5. Demonstration meeting	5. To demonstrate machines, equipment, facility materials, etc. and introduce news techniques
Investigation, Information collection	1. Identification problems of production	1. To investigate and diagnose soil, growth, damages of pests and disease, etc.
	2. Analysis of statistics	2. To analyze agricultural statistics on land, house hold, population, labor force, agricultural machines, cropping area, production, cost, living costs, etc. and grasp the real state.
	3. Information collection	3. To collect literatures, reference books, etc. and show them to farmers.