3.3.4 Groundwater

(1) General Hydrogeological Features

The Valley is composed of Quarternary stratum which lies over a depth of about 10 to 40m or more. Quarternary stratum was originated from Cretaceous Andesitic Pyroclastic rocks, Andesitic lave and Tonalite.

Quarternary stratum in the Valley is classified into the upper and the lower aquifer. The depth of upper aquifer ranges from 2 to 16m and it thickness ranges between 3 to 7m. The upper aquifer is composed of sand and gravel in white and bluish green color. The depth of lower aquifer ranges from 23 to 30m or more and its thickness is about 7m or more.

The lower aquifer is composed of sand in yellowish brown colour. The groundwater is found in the bed. The distribution of the bed is mainly in the western area of the Valley.

The existing wells were distributed in the periphery of the valley, especially in northern part of the Valley. The existing wells are 4 to 12 inches in diameter and 25 to 70m in depth. The existing wells in the periphery are mainly 6 to 8 inches in diameter and in central valley their diameter is between 10 to 12 inches. The use of groundwater is about 130 to 1,300m^3/day. The discharge rate at Los Higos of eastern area and Las Auyamas of south-western area is low.

Water levels of existing wells in the periphery of the Valley are 10 to 35m, and the level is near the ground level at the central Valley where a flowing well was confirmed.

(2) Feature of the Aquifer Stratum

On the basis of the pumping test analysis, the permeability coefficient varies from 1.0×10^{-3}cm/sec to 3×10^{-2}cm/sec and the groundwater discharge is estimated to be approximately 0.01m^3/sec.

Judging from this estimated data, the groundwater discharge capacity is insignificant in the Valley.

3.3.5 Soil and Land Classification

(1) Soil Classification

Soil in the study area is classified into two main orders: Mollisols and Inceptisols. Mollisols is divided into two sub-orders called Udolls and Aquolls. Area of each soil order in the study area is shown in Table 3.3.5-1, and the soil map which was prepared based on the above results is shown in Fig. 3.3.5-1.

1) Mollisols

Mollisols, which is rich in organic matter with high cation supply is the representative soil in the study area and is very suitable for crop cultivation.

Mollisols in the study area are mainly classified into two sub-orders called Udolls and Aquolls. Udolls cover an area of 1,121ha and occupy about 88% of Mollisols. This type of soil shows light clay with black to brownish black color. Udolls are widely distributed in the north, south east, northwest and southwest of the Valley. Soil fertility and moisture content of soil are rich.

Aquolls are distributed over an area of 159ha in both sides of the middle and downstream of the Arroyo Constanza and in the southeast of the Valley. Soil shows heavy clay with poor drainage and high groundwater level.

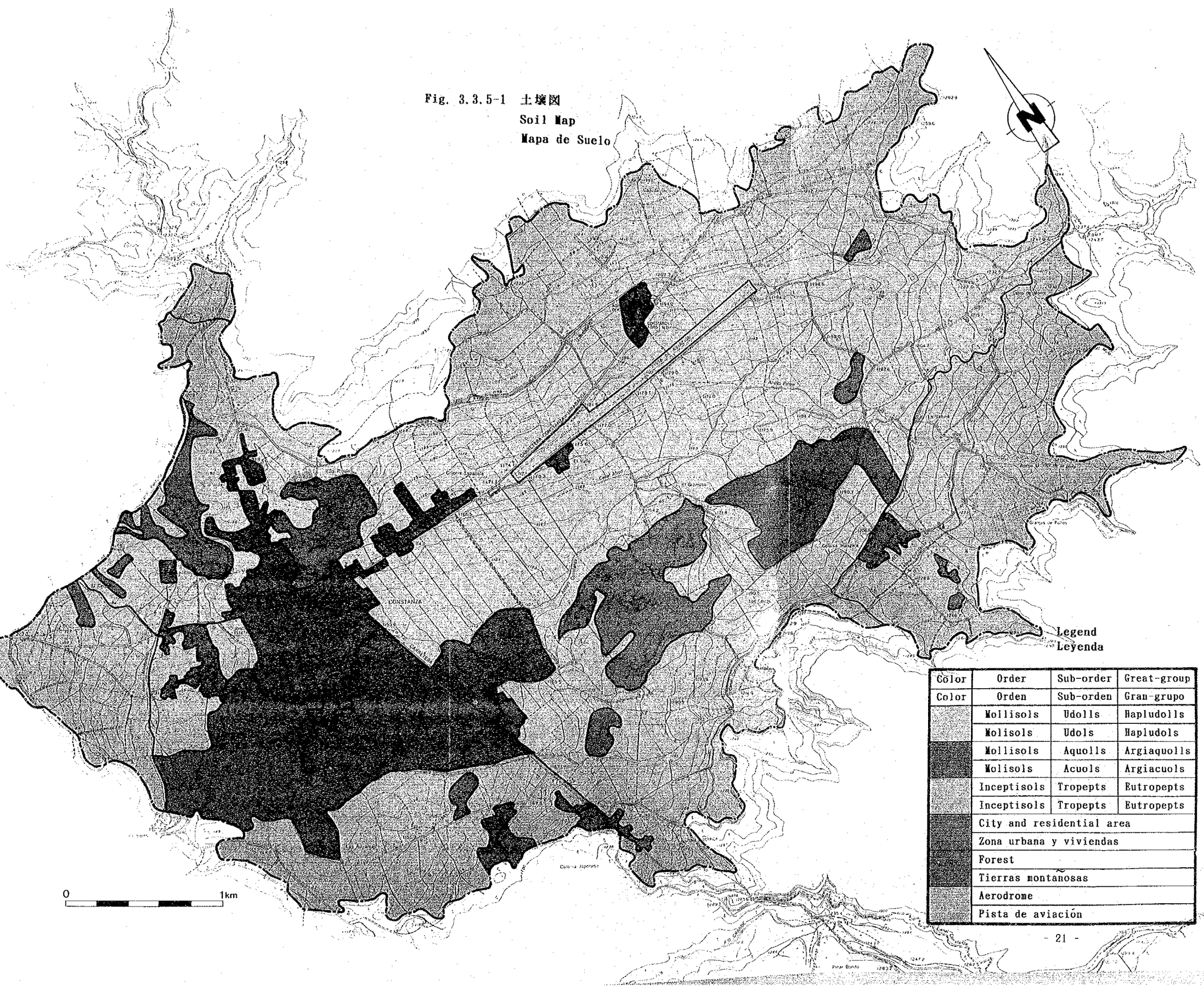
2) Inceptisols

Inceptisols are widely distributed second to Mollisols in the study area and cover an area of 400ha (23.8%). This soil is distributed in La Sabina area in the southeast, the west of the Valley, and the part of the upstream and the alluvion along the Arroyo Pantuflas. The texture of the soil is slightly rough with the existance of gravel. These soil with high fertility and good drainage condition is suitable for crop cultivation.

Fig. 3.3.5-1 土壌図

Soil Map

Mapa de Suelo



Color	Order	Sub-order	Great-group
Color	Orden	Sub-orden	Gran-grupo
	Mollisols	Udolls	Hapludolls
	Molisols	Udols	Hapludols
	Mollisols	Aquolls	Argiaquolls
	Molisols	Acuols	Argiacuols
	Inceptisols	Tropepts	Eutropepts
	Inceptisols	Tropepts	Eutropepts
	City and residential area		
	Zona urbana y viviendas		
	Forest		
	Tierras montañosas		
	Aerodrome		
	Pista de aviación		

Table 3.3.5-1 Area of Arable Lands of Each Soil Order

Order	Sub order	Great group	Area(ha)	Ratio(%)
Mollisols	Udolls	Hapludolls	1,121	66.7
	Aquolls	Argiaquolls	159	9.5
	Sub-total		1,280	76.2
Inceptisols	Tropepts	Eutropepts	400	23.8
Grand-total			1,680	100.0

Mollisols is extensively distributed in the Valley (1,280ha, 76.2%), followed by Inceptisol (400ha, 23.8%).

(2) Land Classification

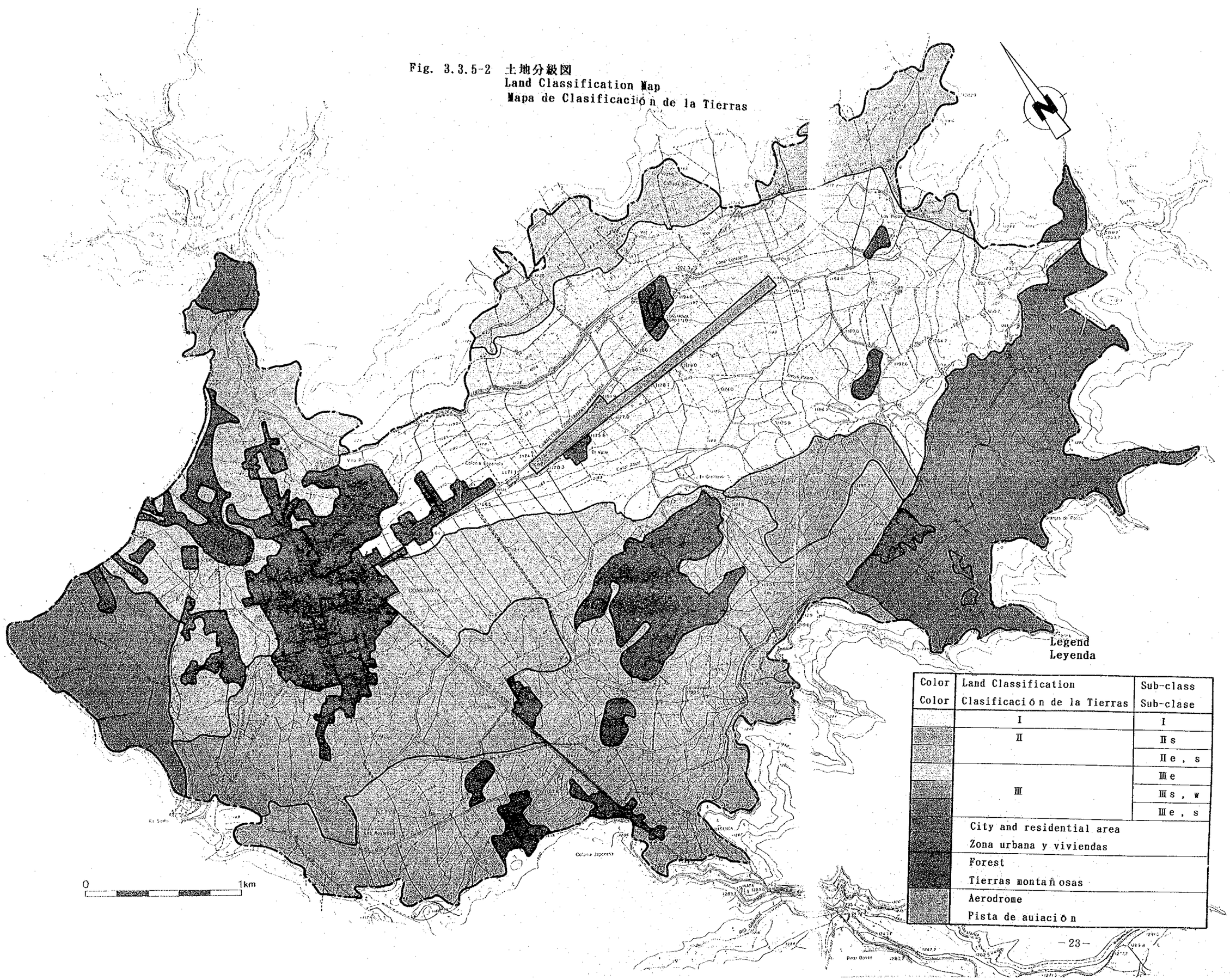
Land classification requires examination and appraisal of the physical and chemical characteristics of the land, which include *soil properties* and *qualities* of the topographic and drainage features. In the Dominican Republic, USDA method has been widely used for land suitability as well as soil classification method. And for this study also USDA method is used for the land classification.

The area of the lands are grouped into three classes as follows:

Table 3.3.5-2 Land Classification

Land class		Area(ha)	Ratio(%)
I		533	31.6
II	IIs	323	19.3
	IIe,s	195	11.6
Sub-total		518	30.9
III	IIIe	111	6.6
	IIIs,w	221	13.2
	IIIe,s	297	17.7
Sub-total		629	37.5
Grand-total		1,680	100.0

Fig. 3.3.5-2 土地分級図
Land Classification Map
Mapa de Clasificación de la Tierras



Legend
Leyenda

Color Color	Land Classification Clasificación de la Tierras	Sub-class Sub-clase
	I	I
	II	IIs
		IIe, s
	III	IIIe
		IIIs, w
		IIIe, s
	City and residential area Zona urbana y viviendas	
	Forest Tierras montañosas	
	Aerodrome Pista de auiación	

The whole of arable lands in the study area belongs to classes I to III. These classes have little limitation but have no problem for crop cultivation. Land classification map in the study area is shown in Fig. 3.3.5-2

3.4 Present Conditions of Agriculture

3.4.1 Land Use and Land Tenure

(1) Land Use

The arable land occupies about 84% of the study area. The horticulture under structure means flowers and ornamental plant, chrysanthemum, rose, carnation, etc. Fruit trees such as apple and grapes are grown in some orchards. The breeding stock farm raises about 52,000 chicks.

The present land use is shown in the following table and Fig. 3.4.1-1.

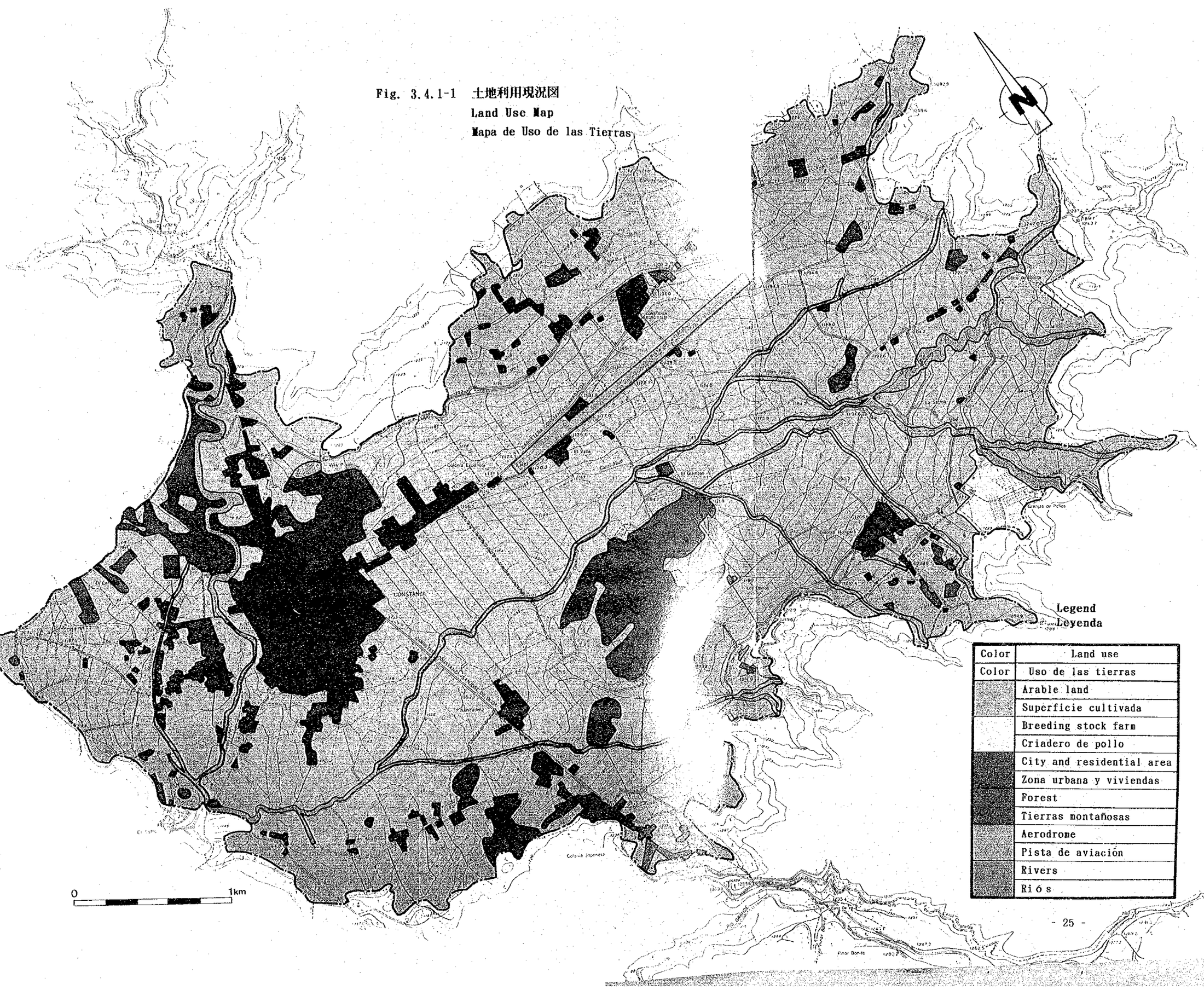
Table 3.4.1-1 Present Land Use

Land Use	Area (ha)	Ratio (%)
Arable land	1,660	78.6
Upland crops	(1,625)	(96.7)
Horticulture under structure	(30)	(1.8)
Orchard	(5)	(0.3)
Breeding stock farm	20	(1.2)
Sub-total	1,680	78.6
Forest	140	6.5
City and residential area	150	7.0
Aerodrome	20	0.9
Other including roads, rivers, etc.	150	7.0
Total	2,140	100.0

Fig. 3.4.1-1 土地利用現況図

Land Use Map

Mapa de Uso de las Tierras



(2) Land Tenure

The number of farmers with the land holding size of less than 1 hectare is about 60% of the total farmers and medium and small scale farmers below 5ha is the exceeding majority occupying 90% of the total farmers in the study area.

The number of farmers of each type in the study area is shown in Table 3.4.1-2.

Table 3.4.1-2 Area of Each Type of Farming

Land holding size (ha)	No. of farmers	Ratio (%)
Less than 1	1,197	60.18
1-5	586	29.46
5-10	131	6.59
10-20	38	1.91
More than 20	37	1.86
Total	1,989	100.00

Source: Estudios Integrados de Recursos Naturales de la Cuenca del Río Grande o del Medio, SEA, Sep. 1988

3.4.2 General Description of Agriculture

In Constanza, the climate is warm with medium rainfall, and farming is practised mainly with vegetables utilizing natural precipitation or irrigation water. The following crops were observed in the Valley during the study.

Vegetables:

Garlic, Potato, Onion, Kidney bean,
Lettuce, Carrot, Beat, Celery, Cabbage
Cauliflower, Broccoli
Radish, Capsicum, Tomato, Parsely,
Garden pea, Zuquini, Pigeon pea,
Squash, coriander, Zayote, Egg plant,
Asparagus

Food Crops:

Cassava, Maize, Sweet potato, Yautía , Rábano

Fruits:

Apple, Grape, Banana, Orange, Avocado, Guava, Loguat, Plum, Strawberry, Zapote, Nut, Persimon

Flowers:

Chrysanthemum, Rose, Carnation, Statis, Strelichea, Margalet

Beans are used here as fully riped seeds instead of young bean with the pod. Most of the crops are grown for commercial purpose, and garlic occupies the major part of cropping in winter season. With the garlic at the center of cropping, potato, onion, carrot, lettuce and/or beet are combined in a crop rotation throughout the year. A farm land is not usually fallowed without particular reason.

Apart from vegetable growing, 7 farms are growing flowers in a big scale. They grow mainly chrysanthemum, rose and carnation almost totally under vinyl houses.

Fruit production is small at present, comparing with vegetable and flower growing, and some people have just started to grow apple and grape as trials.

By the hearing survey of farmers by the study team, it has been revealed that they are more interested in growing garlic, potato, onion and/or lettuce than introducing new crops.

Animal raising in the Valley is also small. Farmers keep chickens and a few pigs around their houses.

Farming in the Valley is intensive with conventional root crops (garlic, potato, onion, beet, etc.) mixed with pulses (kidney bean, pigeon pea, etc.), employing many casual workers and using chemical fertilizers and pesticides.

3.4.3 Agricultural Productivity

Irrigation is done predominantly by sprinklers, followed by surface irrigation. Flower growers use dripping and mist for growing seedlings; water is particularly required in the dry season from January to March, and July when potato needs water at most.

In the Valley pests and diseases cause heavy damages on crops. It is possible that the yield of crops will be reduced if proper countermeasuers are not taken. The conditions such as warm temperature throughout the year, repetition of same cropping patterns, and cropping in succession of the same family crop, have been proliferating pests and diseases more and more. And continuous application of pesticides causes resistence of pest and diseases to the pesticides, and thus the situation becomes worse.

Snow pea pods which earned the most once in the past in the Valley, were banned by U.S.A. because of pesticide residues, and snow pea growing has almost been adandoned. Exposed pesticides were methamidophos, profenofos and monocrotophos.

There are pests and diseases parasiting on various crops and causing heavy damages, such as soil borne diseases, nematode, mites, mosca blanca and thrips palmi. On the other hand, there are pests and diseases parasiting on the particular crop and giving serious damages, such as moho blanco on garlic and onion, and minador on potato.

In the above situation, the proper countermeasures against pests and diseases are thought to be the keys to produce crops in the Valley.

(1) Crops and Production

Principal crops in the Valley are garlic, potato, kidney bean, and onion. In 1987, garlic was grown by 51.4% of farmers, potato by 31.0%, kidney bean by 37.6%, onion by 15.5%, lettuce by 25.4% and carrot by 19.4% . As of the planting area of those crops in 1986/87, 21.5% of gross total area was with potato, 20.3% with garlic,16.6% with kidney bean and 13.4% with onion.

Most of flowers are grown undre vinyl houses in total area of about 27ha run by 7 farmers. As fruit growing, apple and grape are under trials in the Valley, and their production is small.

(2) Cropping Pattern

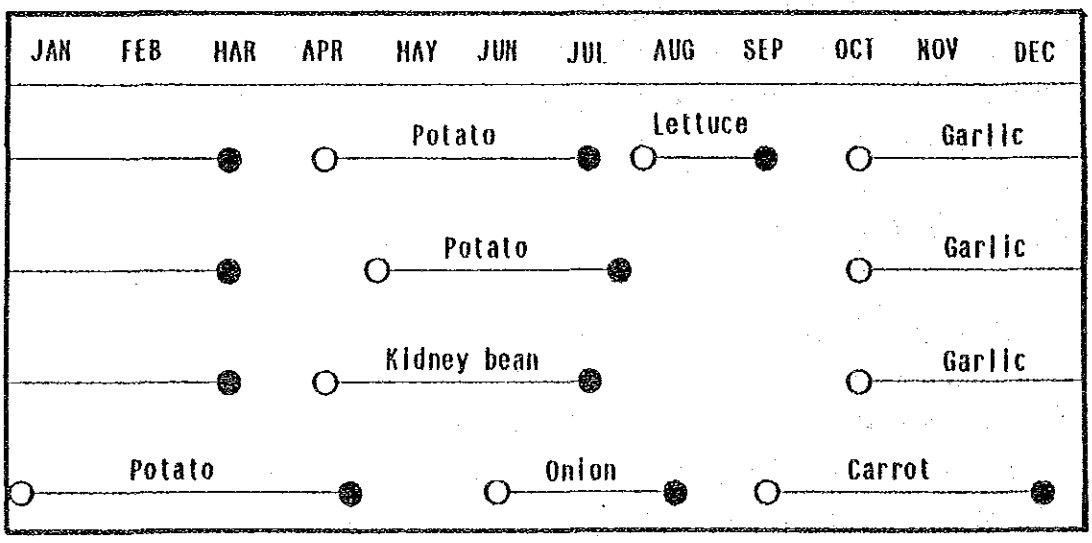
A cropping pattern utilizing low temperatures at the elevation of 1,200m is established centralizing garlic in winter season (Fig. 3.4.3-1).

Some typical cropping patterns in the Valley are shown below.

1. Garlic - Potato - Lettuce
2. Garlic - Potato
3. Garlic - Kidney bean
4. Potato - Onion - Carrot

The cropping patterns including areas are shown in Fig. 3.4.3-2, adding areas to the above mentioned cropping patterns.

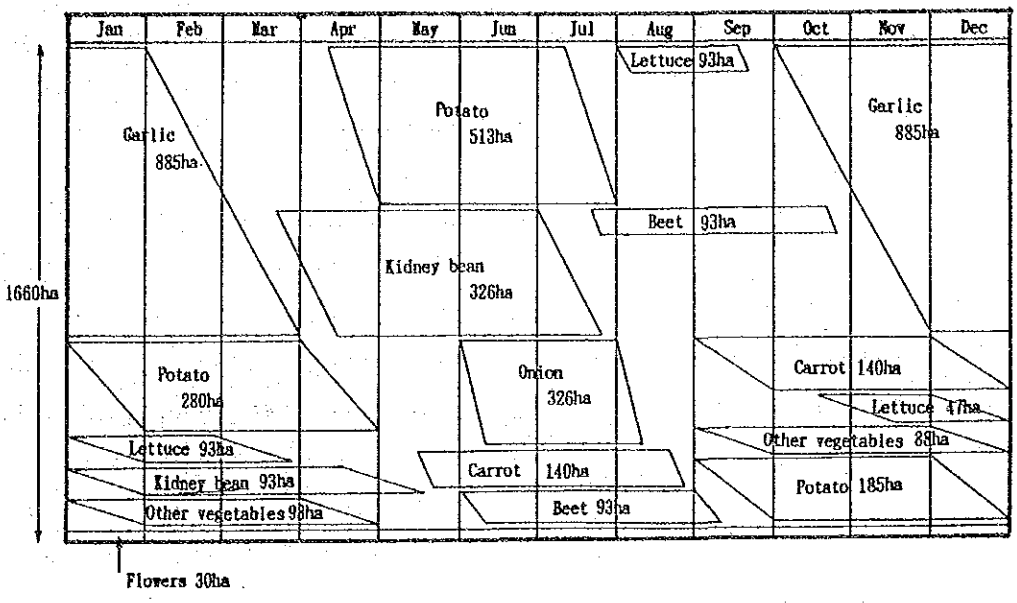
As for the frequency of cropping per annum by an individual, single cropping was followed by 27.4%, double cropping by 36.3%, tripple cropping by 31.5% and more than quadruple cropping by 4.7%. Cropping rate of a farm was estimated as about 214%.



Note: ○ Plantting time
● Harvesting time

From: Investigation by Study Team, Oct. 1989

Fig. 3.4.3-1 Present Cropping Patterns



From: Prepared by Study Team. Nov. 1989.

Fig. 3.4.3-2 Cropping Pattern with Areas

3.4.4 Agricultural Management

The report of SEA in 1986/87 describes that small scale farmers with land holding size of less than 20 tareas (1.25ha) occupy 64.4%, and the "Estudios Integrados de Recursos Naturales de la Cuenca del Río Grande o del Medio" from SEA in 1988 reports that the number of small scale farmers with less than 16 tareas (1ha) are 60.18% of the total farmers. According to the investigation by the study team the average number of members and those engaged in farming in a farmer's family are 6.64 and 2.22 respectively. 71.6% of farmers employ laborers in some way or other, and all the farmers larger than medium scale run their farms with employed labors. Only 3.7% of farmers, however, employ permanent labors. Casual laborers receive RD$20 to 40 per day according to the type of work.

75.2% of farmers use a tractor and 73.4% of them utilize an animal-drawn plow. Though farmers do not hold a tractor, they borrow it from an agricultural association or hire it. It is made clear that the Valley is spread seriously with pests and diseases

by the fact that 92.7% of the farmers use sprayers. In the other inputs, it is striking that users of chemical fertilizers are 91.7% against 15.6% of organic matters. Organic fertilizers utilized in the Valley are rotten baggages, poultry manure, etc.

The investigation was carried out dividing the Valley into 10 sections. And average income of a farmer in each section is shown below, and it reveals that farmers at Arenoso where there are many small scale farmers and water is not enough and the neighboring sections, Las Auyamas and El Cercado earn less than the farmers at other sections except Palero.

Average Individual Income Per Annum In Each Section

Section	Average Income (RD$)	Order
El Cercado	180,801	7
Arenoso	99,944	10
Las Auyamas	101,863	9
El Valle	334,985	4
Sabina	349,293	3
Palero	152,284	8
Canada Seca	440,117	2
Col. Kennedy	550,893	1
Col. Espanola	215,890	6
Arroyo Arriba	309,036	5

Source: Investigation by JICA Study Team, Oct. 1989.

3.4.5 Marketing and Processing of Agricultural Products

Most of the agricultural products are marketed through middle men. There exists farmers' associations in the Valley as mentioned below, but they do not function at all for marketing agricultural products. Santo Domingo and Santiago are the two biggest markets for the Valley products.

Collected agricultural produce by middle men are transported on about one ton pick-ups to a huge whole sale market in Santo Domingo, sold to old whole sellers, then sold to retailers, and

finally sold to consumers. Prices are decided from the amount of the produces, and auction is not practised.

3.4.6 Agricultural Supporting Services

(1) Secretaría de Estado de Agricultura: SEA.

SEA Constanza office belongs to SEA in La Vega Province under Norcentral Región shown at the bottom of the organization chart of the headquarters SEA. The Constanza office is composed of 5 programs and extension work (Fig. 3.4.6-1) Each program has an officer in charge. URPE works for economic planning and statistics, and the others are programs of rural organization, vegetable protection, coffee and natural resources.

(2) Agricultural Extension Work

Extension work in Constanza is divided into two sub-zones, Sub-zona Constanza and Sub-zona El Rio, Sub-zona Constanza is divided into 6 areas and sub-zona El Río into 3 areas (Fig. 3.4.6-1). An extension worker takes care of an area. The study area lies under the whole El Valle and a part of El Convento. Methods of extension are visiting farmers, interviews with farmers, demonstration, crop growing in a demonstration farm, short-term training, etc. Each extension worker is equipped with a motor cycle for his activities.

(3) Agricultural Research Station

Research Station belong to Departamento de Investigaciones Agropecuarias: DIA under Subsecretaría de Investigación, Extension y Capacitación Agropecuaria.
The headquaters of CENDA is located in Santiago, and it has a branch in Constanza, Estación Experimental Hortícola, Constanza, which deals with experiments on vegetables. The branch holds the director, two technicians, an Israelis expert, a Japanese volunteer and several farm workers. The area of experimental farm is 100 tareas (6.3ha). Themes for the experimental tests are picked up from the order by the headquarters, requests from extension workers,

requests from farmers, ideas from researchers, etc., and submitted to the headquaters in Santiago. When an experiment is admitted by the headquaters and budgeted, it is put into practice. The experiments under practices in 1989 are shown below.

1. Varietal test on potato
2. Chemical control of weeds in carrot
3. Chemical control of mosca blanca (Trialenrodes vaporarorium)
4. International program of kidney bean varieties

Experimental programs in the past 5 years are classified as follows:

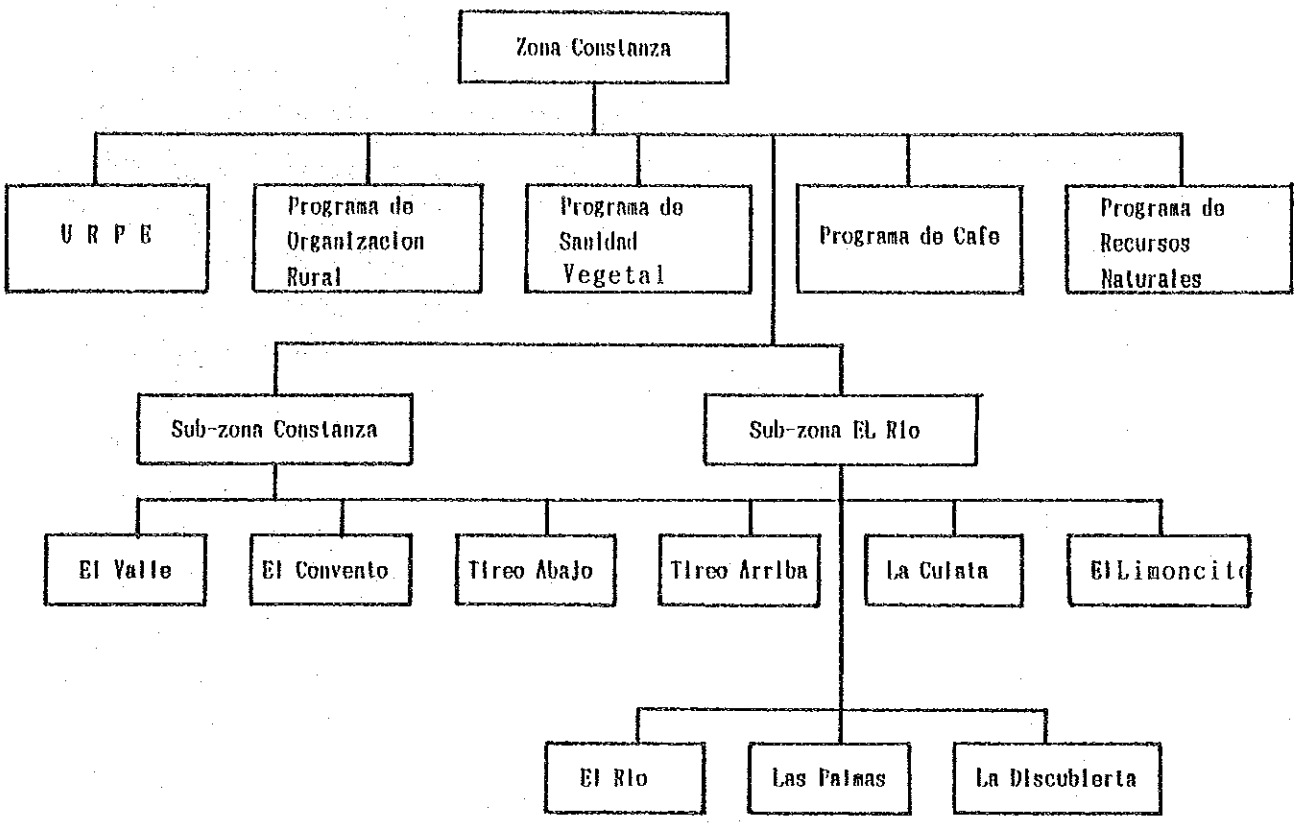
Crop Protection	38	50.0%
Varietal test	20	26.3%
Production of seeds	6	7.9%
Application of fertilizers	5	6.6%
Mixed cropping	4	5.3%
Miscellaneous	3	3.9%
Total	76	100.0%

Source: Investigation by Study Team, Oct., 1989

Experiments on crop protection occupies 50.0% and prominent, 35 out 38 programs were on chemical control of pests and diseases. It also reveals how big the damages from pest and diseases are.

(4) Instituto Agrario Dominicano: IAD

IAD is an official institute to manage the national land. The right to cultivate the national land is admitted, and it can be inherited to the child of the holder, though sale of the right is not permitted. There exists 398 hectares of the national land in the Valley. The land rent is collected at the rate of RD$0.70/crop/tarea through Banco Agricola when the farmer gets credit. IAD has a branch in Constanza.



Note:URPE is abbreviated from United Regional de Planificación y Economía.
From:Investigation by Study Team, Oct. 1989

Fig. 3.4.6-1 Organization Chart of SEA, Zona Constanza

(5) Banco Agricola

Banco Agricola, Constanza was opened in 1987. Banco Agricola finances credits up to 70% of the output of a crop through agricultural association. The financing period is 4 to 8 months according to crops. In case the financed crop yields nothing with some reasons, the term of repayment may be prolonged. Its financial charges are 14%, and are calculated by days. Number of beneficiaries was 386 farmers, number of loans 257 and total amount RD$7,305,209.00 in 1988. Percentage of its utilization was 27.8%. Farmers cultivating the national land and tenant farm may also be financed with the credit.

(6) Instituto Nacional de Recursos Hidráulicos: INDRHI

INDRHI is responsible for planning and management of irrigation to the farms, having a branch in Constanza. This study is carried out under INDRHI.

3.4.7 Farmer's Organization

Farmers' organizations in the Valley are listed below

1. Cooperativa Agropecuaria Productoras del Valle
2. Asociación de Productores Hortícolas del Valle
   95 members
3. Asociación Las Mercedes (Los Cerros)
4. Asociación Amado Peguero (Palero)
   30 members
5. Asociación Juan Pablo Duarte (Las Auyamas)
6. Asociación Corpus Cristi (Las Auyamas)
7. Asociación Unión y Trabajo (Colonia Espanola)
   26 members
8. Asociación Las Mercedes (El Cercado)
9. Asociación Dulce María (El Cercado)
   25 members
10. Asociación La Altagracia (El Cercado)
    25 members

11. Asociación de Pequeños y Medianos Agricultores (El Valle)

Each organization has its own activities. Their activities are commonly facilitation of agricultural credit, common purchase of seeds (especially garlic), lease of agricultural machines bought by an association, improvement of schools, roads, public facilities, etc., and mutual help when a member is sick. At present, there is no associations which collect, transport and sell agricultural products.

3.5 Existing Facilities

3.5.1 Existing Irrigation and Drainage System

(1) Head works in the Rio Grande

The head works is located at upper reach of the Rio Grande and outside of the Constanza Valley. The head works was constructed in 1947. Water collected at the facility is conducted to the Valley through the head race approximately 3.9km in distance and is distributed for irrigation by the Canal Constanza, the Lateral Constanza and their laterals. Its weir is 6m in height, its movable weir is 4.6m in width and its fixed weir is 37m in width.

(2) Irrigation Network by Canals

The Canal Constanza flows through the eastern area of the Valley and reaches the Arroyo Pantuflas. Irrigation water is taken at the head works in the Río Grande and distributed to the Valley through the canal. Ten sub-canals are installed for irrigation in the Valley (Fig. 3.5.1-1).

In accordance with the enlargement of farm lands, the Lateral Constanza which reaches the Arroyo Pantuflas was planned and constructed outside the Canal Constanza twenty years after the initial construction.

However, the Lateral Constanza after El Gajo de la Paila was buried with mud and irrigation water does not flow to the hind place at present.

Irrigation water is taken in at the head works in the Arroyo Pantuflas and distributed to the northern area of the Valley by Canal Pantuflas.

The Canal Palero gets irrigation water at the head works in the Arroyo Palero and distributed to the eastern part of the Valley. On the other hand, the Canal Abud takes water from the Arroyo Constanza and supply it to the middle of the Valley for the purpose of supplementing irrigation water.

(3) Present Conditions of Irrigation

The southern area of the Arroyo Constanza is well irrigated, however water shortage occurs in winter when water supply decreases. In the western area of Las Auyamas which is at the downstream of Lateral 1 irrigation water is not supplied by canals and is irrigated by rainfall and/or pumping up from small rivers. The eastern area of the Valley is divided into two areas. The former is irrigated by the Canal Constanza. The Lateral Constanza and the Canal Palero, and the latter relies on rainfall and small rivers.

Irrigation water is supplied form the Canal Pantuflas in the northern area of Constanza City and the western area of the Arroyo Pantuflas. However, the water is not conveyed to the end of the Canal Pantuflas. It relies on irrigation water by pumping up from the Arroyo Pantuflas in area close to Arroyo Pantuflas. Water by rainfall is only supplied to the area of high elevation.

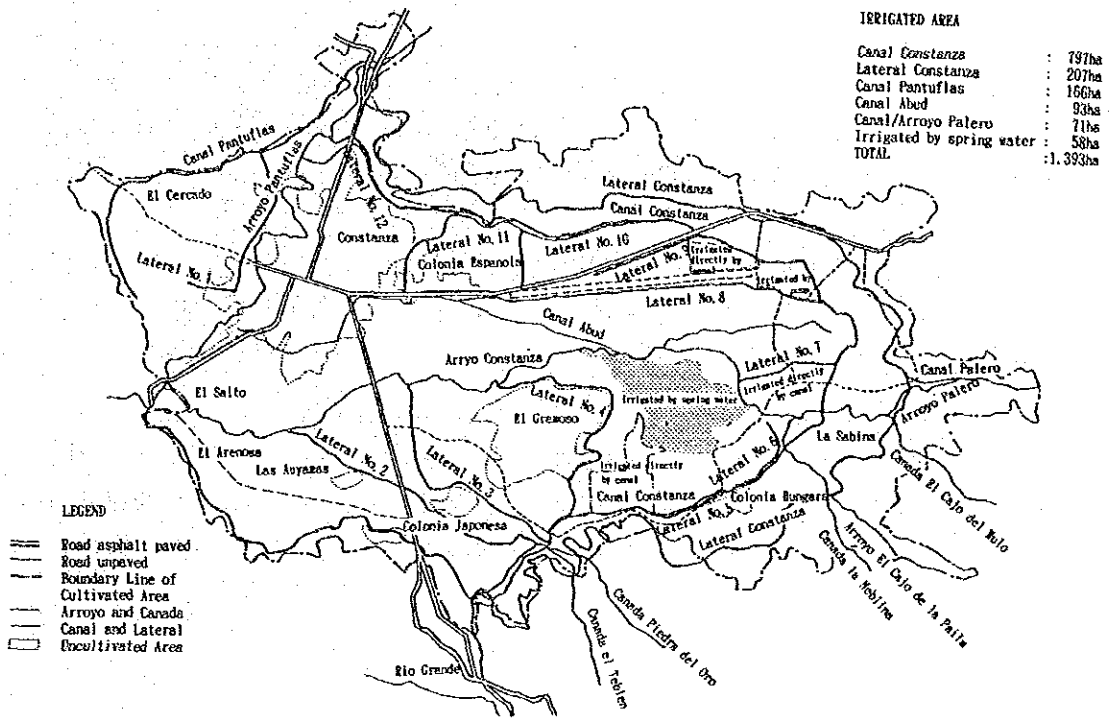


Fig. 3.5.1-1 Irrigation Network by Canals in Constanza Valley

3.5.2 Existing Farm Condition

There are about 1,660 ha of farm land in the Valley. Most of its area is of upland cropping area. The features are as follows;

1. Block reformation is put into practice comparatively well and rectangular blocks are almost established along the land slope
2. Slope of farm land is almost within 0 to 2%
3. Ridges in the field are formed in the same direction of the land slope.

Although the slope of farm land is gentle as mentioned above, errosion of soils is induced on account of the block formation and ridges along the land slope.

3.5.3 Existing Farm Road

Two main roads run in the Valley and connect with the outside regions. Carretera Constanza - Jarabacoa runs from east to west, and Carretera Constanza - San José de Ocoa runs from south to north.

The roads are paved with asphalt and the width is 7 to 11m. Operation and maintenance of the main roads is executed by Ministry of Public Works.

On the other hand, farm roads run throughout the farm land. These farm roads are not paved and their widths are 2.5 to 7.5m. The operation and maintenance of these roads is executed by the INDRHI.

3.6 Actual Use of the Water Resources

The use of the water resources in the study area is classified into 3 types; potable use for Constanza City, irrigation water use for 1,660ha ha of the irrigated area and the water use for the El Salto mini-hydropower station project.

The potable water utilize the water resources of the Arroyo Pinar Bonito. The major parts of the discharge is utilized for the potable water, by the intake work, and distribute to the Constanza City.

The resources of the irrigation water are classified into 3 types; the utilization of the Rio Grande's water by the intake works, the utilization of the small rivers in the study area and the utilization of the groundwater by well.

In addition to these utilization, the use of the Arroyo Constanza discharge will be carried out by the mini-hydropower station which is under construction (Oct. 1989).

The irrigated area of each water resource is shown in the Table 3.6.1-1

Table 3.6.1-1 Irrigated Area of Each Water Resource

Water resource	Canal	Area(ha)	Ratio
Rio Grande	Canal Constanza Canal Lateral Constanza	1,063	64.0%
Arroyo Constanza	Canal Abud	93	5.6%
Arroyo Pantuflas	Canal Pantuflas	166	10.0%
Arroyo Palero	Canal Palero	71	4.2%
Rain fall or Groundwater		267	16.1%
Total		1,660	100.0%

Up to the irrigation system map of the INDRHI, the irrigated area by the each canal is shown as follows;

Table 3.6.1-2 Irrigated Area of Each Canal

Canal Constanza	(Rio Grande's water)	856ha	) 76.3%
Canal Lateral Constanza	(Rio Grande's water)	207ha	
Canal Abud	(Arroyo Constanza's water)	93ha	6.7%
Canal Pantuflas	(Arroyo Pantuflas's water)	166ha	11.9%
Canal Palero	(Arroyo Palero's water)	71ha	5.1%
Total		1,393ha	100 %

As shown above, three quarter (3/4) parts of the irrigated area (A=1,393ha) depends on the water resources of the Rio Grande, the dependence to the small stream of the study area is relatively small.

The utilization of groundwater resources in the Valley is concentrated out of the Canal Constanza and upland places. Especially groundwater is used in the northern part of the Valley i.e. Colonia Espanola. On the other hand, only a few cases of groundwater utilization are observed in the center of the Valley.

3.7 Related Project

The mini-hydropower station is now under construction at El Salto which is at the lowest reach of the stream in the Valley. The outline of the project is as follows.

Table 3.7.1-1 Outline of El Salto mini-hydropower station

Weir Type	:	Movable weir
Height	:	8.0m
Width	:	35.0m
Head race	:	Flume (1.25m x 1.0m) L=1,560m
		Pipeline (Dia. 813mm) L=170m
Generator	:	Maximum generating power 700KVA
Transformer	:	800KVA

The project can be summarized as follows:

1. To construct a weir with the height of 8.0m at El Salto
2. To store water of 11,000m^3
3. To get water of 1.00m^3/sec.
4. To introduce water through the flume head race and drop it through the pipeline
5. To generate electric power by utilizing the potential energy of water drop with capacity of 3.00 GWH in a year.

3.8 Present Problems of the Study Area

The intensive agriculture is carried out by utilizing cultivated land of 1,660ha in the study area.
However, agriculture has problems of soil, pests and diseases due to continuous cultivation for a long time. On the other hand, the irrigation facilities have been superannuated, which causes a problem of effective utilization of water resource. The shortage of irrigation water is a severe problem for small scale farmers who don't have enough funds. The problems in the study area are shown below.

Present facilities

- Superannuation of irrigation facilities
- Ineffective utilization of irrigation water

Agricultural problems

- Shortage of water
- Decline of soil fertility due to intensive cropping and shortage of organic matter
- Promotion of pests and diseases due to simple cropping pattern
- Shortage of healthy seeds and seedlings
- Work efficiency is comparably low since most workers are employed.

Problems of farming

- Farmer's organization for productive activity is not developed
- Organization of marketing by famer's initiative is not arranged
- Shortage of financing fund
- Agricultural development organization is not developed

Social problem

- There are many problems for distribution of irrigation water

CHAPTER 4 PROJECT PLAN

CHAPTER 4 PROJECT PLAN

4.1 Objectives of the Project and Policy of Development

4.1.1 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 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 irrigation water shortage problem is important for the agricultural development of the Valley, since commercialized farming is carried out as a major part of agriculture in 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. And 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 a 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
- Improvement of farming management and increase of farm income
- Increase of agricultural production

- Stable supply of vegetables to urban area
- Increase of employment opportunities, etc.

Fulfilment of the objectives mentioned above will contribute for improving the regional economy, rise the living standard and stabilize the civil administration.

4.1.2 Basic Policy

The basic policy of the project for establishing the project plan is summarized below:

- 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 crop which the farmer can cultivate by their present techniques
- Absorbing excess labor and creating new employment opportunities.
- Priority of economic benefit

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

Economical facilities plan is studied for the planning of facilities.

The dimension of the facilities has been studied on the basis of the 5 years probability 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 minimuze the operation and maintenance cost.

Regarding the farm management plan, the cropping pattern was fixed on the basis of the present prevalent cropping and aimed at the domestic consumption, as a rule. The plan include the soil improvement, the extension of the cropping techniques and establish the rational cropping pattern for the stable agricultural management.

Educating the beneficiaries regarding the operation & maintenance of facilities is considered for 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.

4.1.3 Components of the Project

In accordance with the said policies, the following agricultural and infrastructure development plans are formulated.

- Agricultural development plans
  - Land use plan
  - Farming system plan
  - Agro-products marketing plan
  - Institutional supporting plan
- Infrastructure development plans
  - Irrigation and drainage plan
  - Water resource facility plan

4.2 Basic Development Plan

4.2.1 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 public irrigation facilities. Judging from the land classification, all of the cultivated lands are in the Class-I to III which has no limination for the agriculture.

In the project the new benefit area will also be included in the plan of irrigation system. Some area which is judged as uneconomical will be omitted from the project.

4.2.2 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 flow chart for evaluation of water resources development plans is shown in Fig. 4.2.2-1.

(1) Water Resource Development

Both of Pantuflas and Palero basins have high potentiality for the water resources development in the Valley.

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 Arroyo Hondo and Rio Grande are studied as the water resources outside the Valley.

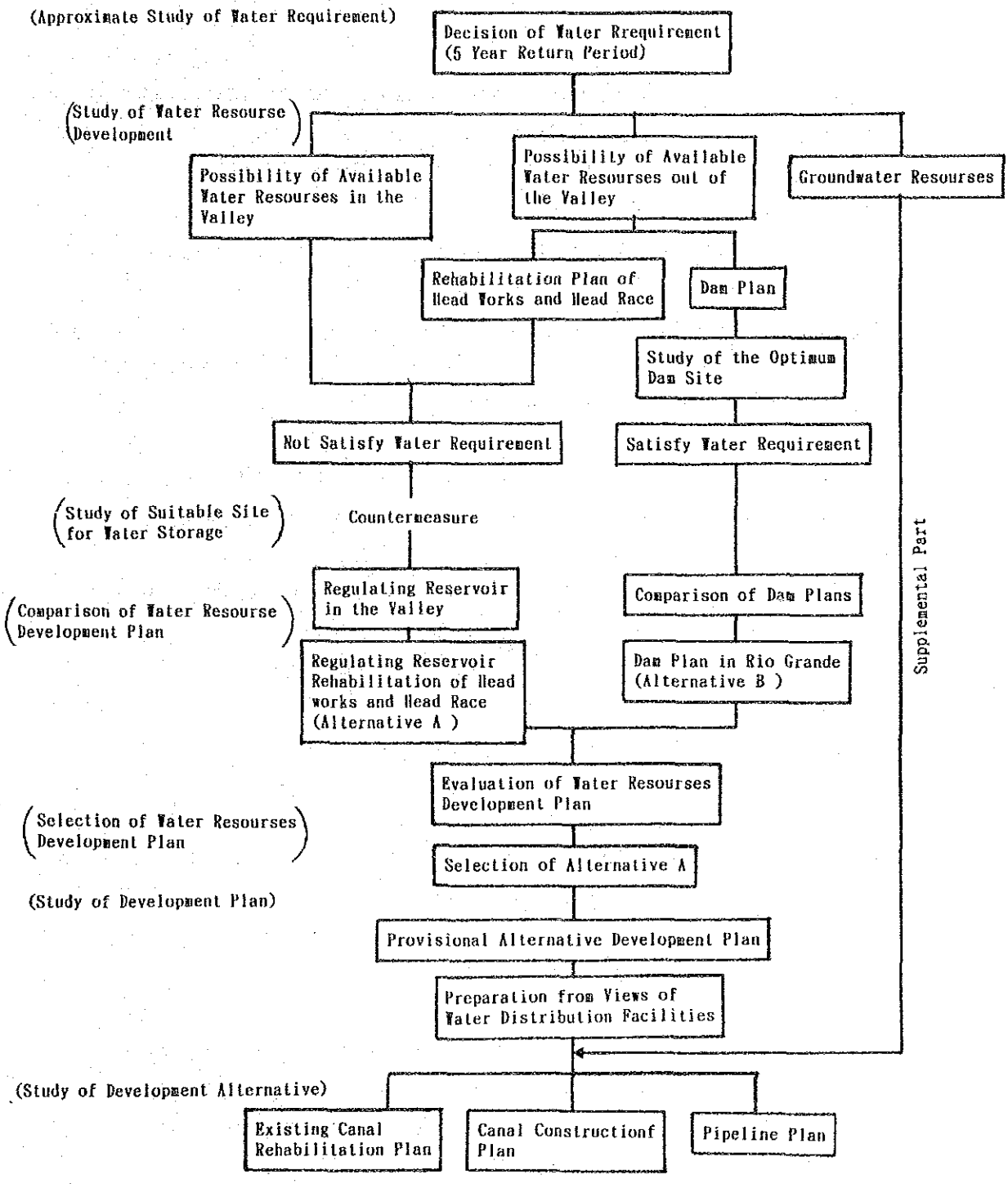


Fig. 4.2.2-1 Flow Chart for Evaluation of Water Resources Development Plan

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

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

a) Dam Construction plan
b) Intake facilities rehabilitation plan

Although 4 dam site alternatives along the Rio Grande are evaluated, it is concluded that Plan D-3 which is located near the confluence with the Arroyo Pinar Bonito.

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

(2) 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 alternative water resources development plans were considered in order to select the appropriate plan.

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

Alternative B: Dam at 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 Arroyo Pantuflas in order to supplement the insufficient water during January to March.

Alternative B is to construct the dam near the confluence with Arroyo Pinar Bonito of the Rio Grande which was selected as the optimum dam site and to irrigate the arable area.

The result of the comparison study is shown in the Table 4.2.2-1.

Table 4.2.2-1 *Comparison of the Water Resource Alternative Plan*

	Alternative - A (Pantuflas Dam)	Alternative - B (Dam at the Rio Grande)
Dimension of the Facility		
Type	Rockfill Dam	Rockfill Dam
Dam Volume	220,000 m^3	380,000 m^3
Height of Dam	30 m	36 m
Length of Dam	162 m	175 m
Available water level	1,236 m	1,253 m
Full water level	1,261 m	1,254 m
Total storage capacity	105 x 10^4 m^3	525 x 10^4 m^3
Available storage capacity	98 x 10^4 m^3	41 x 10^4 m^3
Sediment volume	7 x 10^4 m^3	484 x 10^4 m^3
Accessory facilities	Spillway (A =6.7 km^2)	Canal tunnel ℓ =400m Spillway (A =62 km^2)
Others	Rehabilitation of head works and head race	
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 taken into consideration for the formulation of the development plan.

The irrigation water procurement plan of the Valley is designed as follows.

- Irrigation water is supplied from the Rio Grande water resource in all season.
- The Pantuflas Dam supplements the irrigation water in dry season when the Rio Grande water resource does not satisfy the water requirements.

(3) Water Resources Development Plan

The water resources development plan will be 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 4.2.2-2.

Table 4.2.2-2 Available Water Discharge

Unit : m^3/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 will be considered.

The estimated available discharge to be conveyed into the Valley is shown in Table 4.2.2-3.

Table 4.2.2-3 Available Conveyed Discharge

Unit : m^3/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. It is impossible to satisfy the water demand in the present situation in January, February, March and July.

In the water resources development plan, the excess water will be compensated for the insufficient period, by regulating water in the Pantuflas dam.

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

- To improve the conveyance efficiency from the Rio Grande
- Guarantee of supplemental water resource in dry season
- 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 intake 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 the Fig. 4.2.2-4. The insufficient water volume will be supplemented by the Pantuflas dam.

Table 4.2.2-4 Water Discharge after Improvement of Conveyance Efficiency

Unit : m^3/s

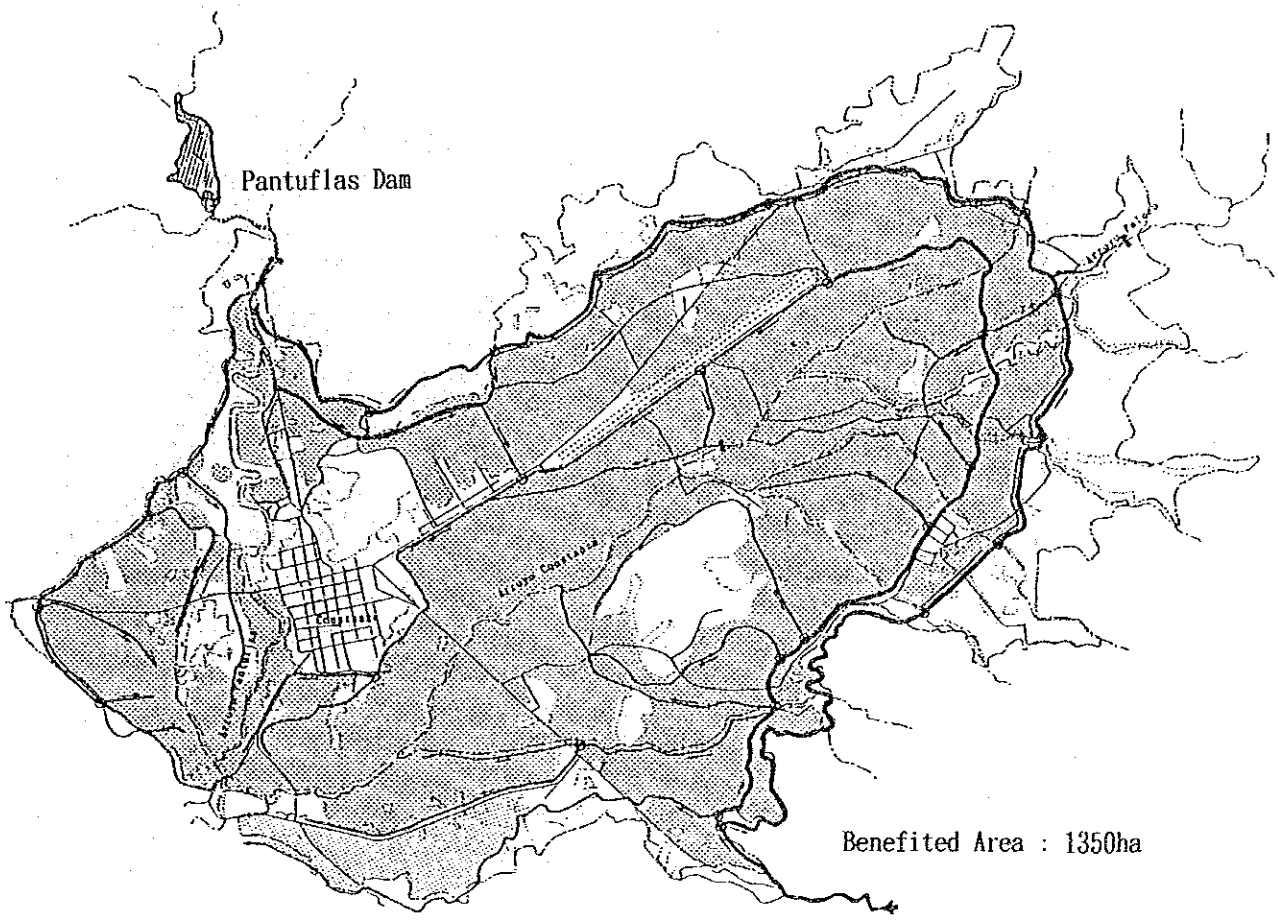
Month	1	2	3	4	5	6	7	8	9	10	11	12
Canal Pantuflas	0.05	0.05	0.05	0.08	0.15	0.10	0.18	0.14	0.13	0.11	0.08	0.05
Canal Palero	0.02	0.03	0.03	0.04	0.08	0.06	0.04	0.07	0.06	0.06	0.04	0.03
Canal Constanza	0.30	0.34	0.34	0.46	0.86	0.57	0.48	0.76	0.69	0.60	0.46	0.40
Total	0.37	0.42	0.42	0.58	1.09	0.73	0.60	0.97	0.88	0.77	0.58	0.48

4.2.3 Selection of the Optimum Development Alternative

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

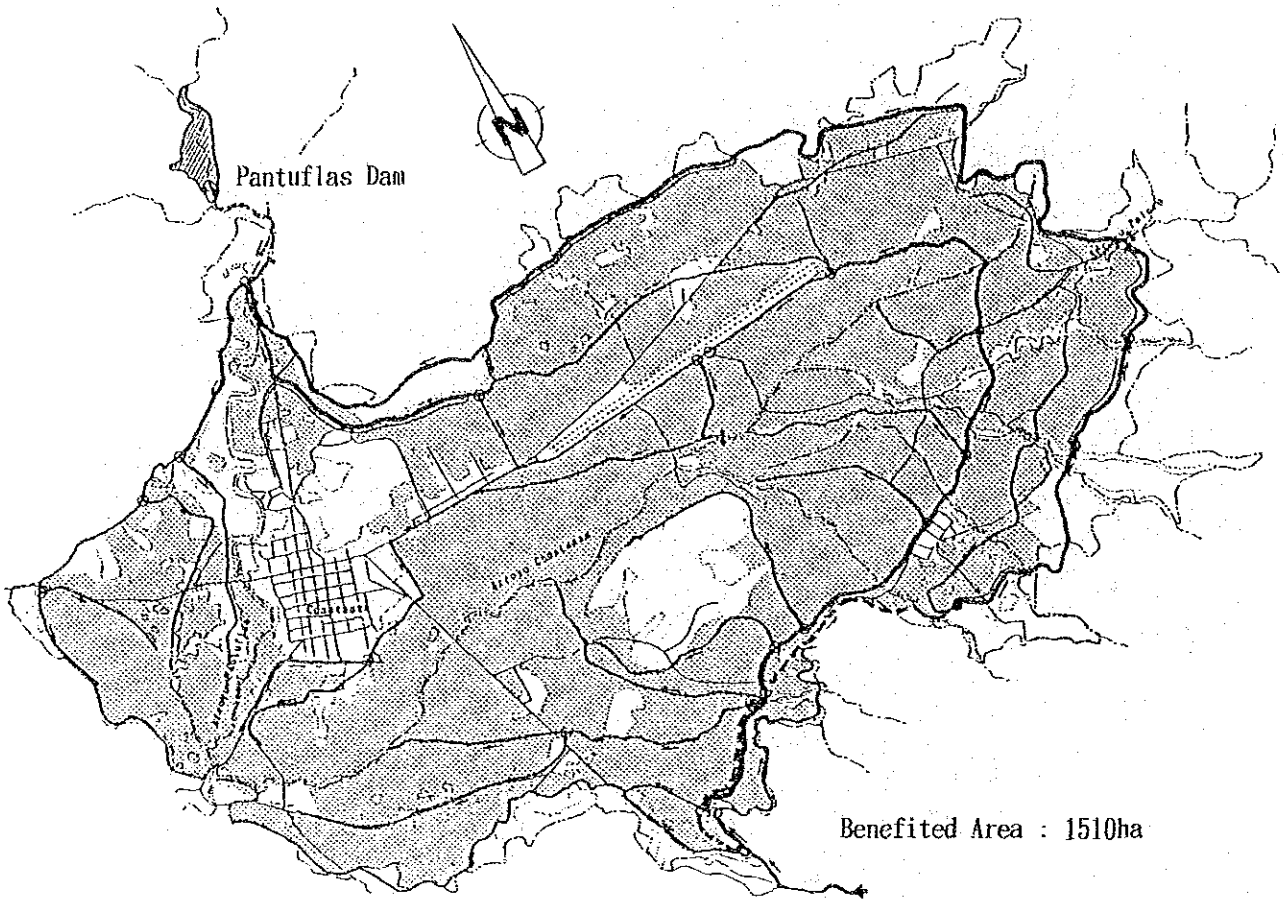
1) Existing canal rehabilitation plan
2) Open canal construction plan
3) Pipeline plan

The existing canal rehabilitation plan proposes rehabilitation of existing canal, the open canal construction plan proposes a new canal near the area of EL 1,240m, and the pipeline plan proposes installation of pipes for the water distribution using the water head energy for the sprinkler irrigation. Summary of each plan is shown in Fig. 4.2.3-1, 2, 3 respectively.



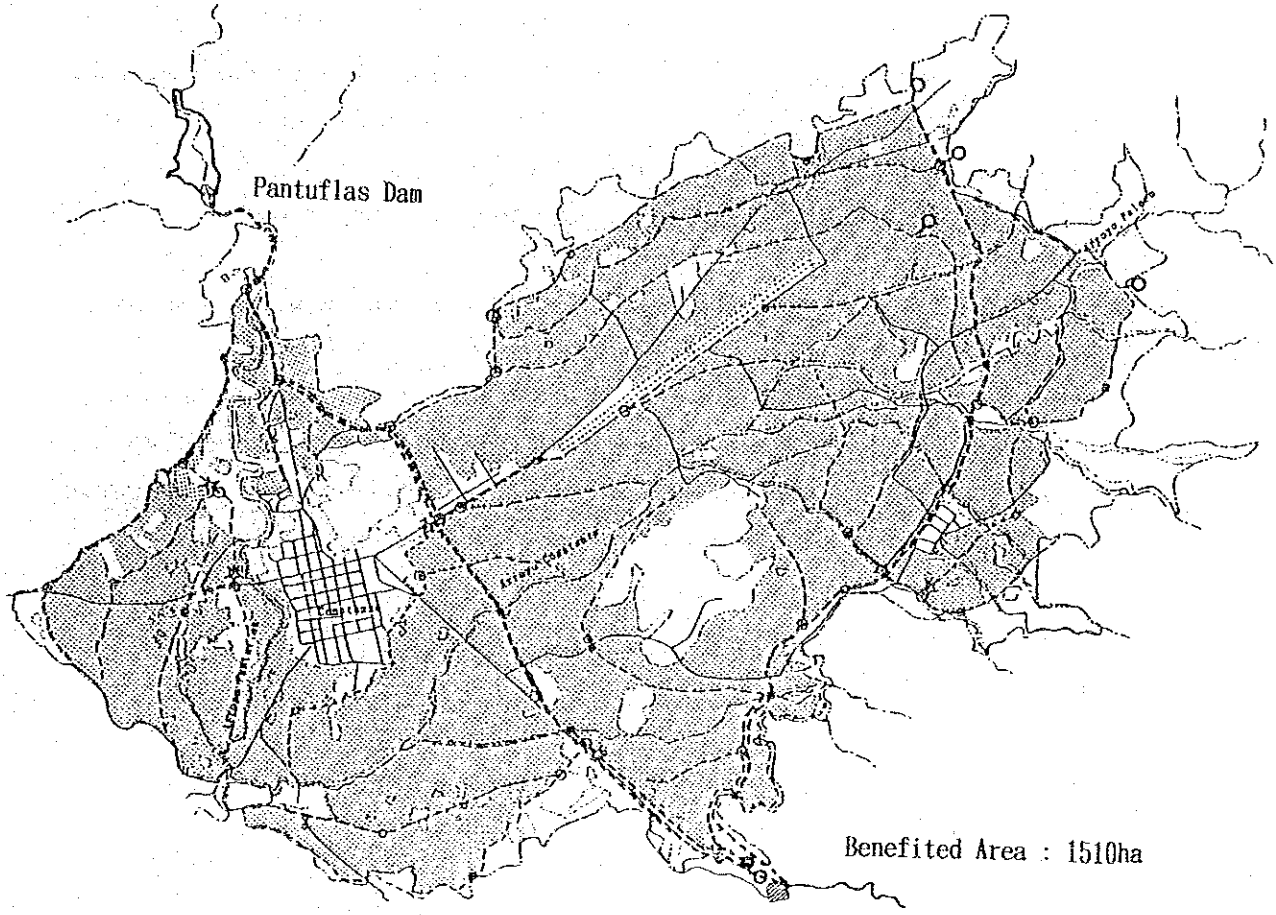
	凡例	Legend	Leyenda
----	境界線	Boundary of Study Area	Limite de Area del Estudio
⊖	ダム	Dam	Embalse
———	幹線用水路	Main Canal	Canal Principal
———	支線用水路	Lateral Canal	Canal Lateral
- - - - -	管路	Pipeline	Tuberia
⊙	分水工	Division works	Derivadora
═══	水路橋	Aquiduct	Canal fluxen
═══	通路横断工	Box culvert	Conduct
●-●	取水工	Intake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

Fig. 4.2.3-1 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 fluuen
—▭—	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	Valvula de deslave
———	河川	River	Rio
———	排水路	Drainage	Canal de drenaje

Fig. 4.2.3-2 Open Canal Construction Plan



	凡例	Legend	Leyenda
———	幹線水路（鋼管）	Main line (steel pipe)	Linea principal (tubo acero)
———	準幹線水路（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 sump	Sumidero
☆	減圧バルブ	Pressure reducing valve	Valvula de control depresion
■	排泥弁	Wash-out valve	Valvula de desleve
□	空気弁	Air valve	Valvula de aire
○	分水工	Division works	Derivador

Fig. 4.2.3-3 Pipeline Plan

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 construct new diversion works as the intake facility in the Rio Grande.
- To rehabilitate the head race in order to improve the conveyance efficiency.

The selection of the appropriate alternative is to be studied considering the construction cost of the facility and operation cost. The process of the comparison study is shown as follows.

(1) Benefit Area

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

Table 4.2.3-1 Benefit Area of Each Plan

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

(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 sprinkler irrigation system.

The crop water requirement and net water requirement calculated by Penman's method are shown in the Table 4.2.3-2. The effective rainfall is estimated by USDA method in 5 years return periods.

Table 4.2.3-2 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
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
Re(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
N.W.R.(mm/month)	42.4	41.0	33.4	0.4	-	25.4	25.6	-	-	-	24.5	26.2

Irrigation efficiencies of the three alternatives are shown below:

Table 4.2.3-3 Irrigation Efficiency

	Alternatine A	Alternatine B	Alternatine C	Present
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

The gross water requirement considering the irrigation efficiency is shown in the Table 4.2.3-4.

Table 4.2.3-4 Gross Water Requirement

Unit: mm/day

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
Open 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) Water Resources Development Plan

The main water resources of this project is the Rio Grande. The conveyance efficiency is to be improved by the rehabilitation of the head race and the construction of the head works at the Rio Grande. Water shortage is supplemented by the Pantuflas dam. In the alternatives A and B, the intake at the Arroyo Pantuflas and Palero is considered for the water resources. However in the alternative C, the discharge of the Arroyo Pantuflas and Palero is excluded.

The shortage volume for each alternative is shown in the Table 4.2.3-5.

Table 4.2.3-5 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										
Open 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 4.2.3-6 Irrigation Plan for Each Alternative

	Existing canal Rehabilitation plan	Open 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
Available storage capacity of 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 total storage capacity of the dam including the dead volume are as follows:

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

The dimension of the dam in each plan is determined by the storage curve of Pantuflas dam which is shown in Fig. 4.2.3-4.

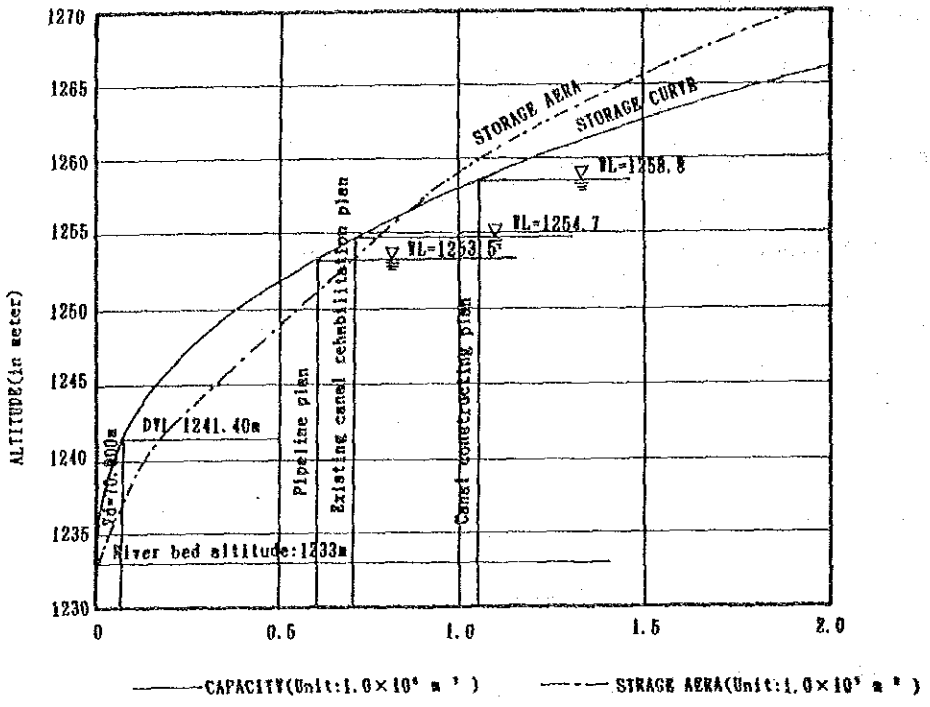


Fig. 4.2.3-4 Storage Curve of Pantuflas Dam

Table 4.2.3-7 Dimensions 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	$V = 140,000m^3$

(4) Summary of Facilities in each plan is shown in Table 4.2.3-8.

Table 4.2.3-8 Summary of Facilities in Each Plan

	Alternatine A	Alternatine B	Alternatine C
(Facilities for water resource)			
Volume content of dam	160,000 m^3	214,000 m^3	140,000 m^3
Head work	1 unit	1 unit	1 unit
Head Race	ℓ =3,000m	ℓ =3,000m	ℓ =3,000m
(Facilities for water distribution)			
Length of open canal	57,600m	67,350m	59,600m
New construction	23,200m	27,650m	59,600m
Rehabilitation	32,800m	35,200m	—
Pipe line	1,600m	4,500m	59,600m
Other facilities	1 set	1 set	1 set

(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

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

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.

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

Table 4.2.3-9 Construction Cost, Farm Equipment Cost and Operation Cost for Each Alternative

	Existing canal rehabilitation plan	Open canal construction plan	Pipeline plan
Benefit area	1,350 ha	1,510 ha	1,510 ha
(1) Construction Cost	RD$62,490,000	RD$77,300,000	RD$109,470,000
(2) Farm equipment cost (yearly)	RD$243,000	RD$272,000	-
(3) Operation cost (yearly)	RD$237,000	RD$266,000	-
(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) Cost per unit area with discount rate 12%	48,911	53,815	72,497

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

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

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

The total cost of alternative B increase by RD$15,230,000 in order to increase 160ha of the benefit area. This increased value 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. This can be easily conpensated since the difference of unit production of garlic is 2.9t/ha between irrigated and non-irrigated area.

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.

(6) Results of the Comparison Study of Development Alternative

The results of the comparison study of development alternative is shown in the following Table. The open canal construction plan is judged as the optimum plan.

Table 4.2.3-10 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 (V = 710,000m3)	Head works at Rio Grande/Pantuflas Dam (V = 1,050,000m3)	Head works at Rio Grande/Pantuflas Dam (V = 610,000m3)
Distribution Facility	Open channel (ℓ = 58km)	Open channel (ℓ = 67km)	Pipeline (ℓ = 60km)
Benefit area	1,350ha	1,510ha	1,510ha
Irrigation method	Sprinkler by pump	Sprinkler by pump	Sprinkler by water head
Total Cost (Discount rate 12%)	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.		

4.3 Agricultural Development Plan

4.3.1 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 develop 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 there is a problem of labor quality.

(2) Improvement Plan

Based on the above problems, an improvement plan is divided 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.

1) Constanza Agricultural Development Organization Improvement Plan

The Constanza Agricultural Development Organization (Fig. 4.3.6-1) will play a central role in carrying out the agricultural development plan. Basically everything does not flow only from the government to farmers. Hence 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

2) 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.

a. Short term plan

i. 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.

ii. 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.

iii. 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.

iv. 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 Annex. 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.

v. 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 not 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 core.

vi. Water management

At present farmers consider water management easy since they think that water is given by the state. They 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."

b. Long term plan

i. Improvement of soil fertility

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

ii. 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. Hopeful export crops are listed in Annex.

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.

iii. 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.

iv. 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 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.

4.3.2 Agicultural Production Plan

(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 proposed 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 loca condtions.

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.

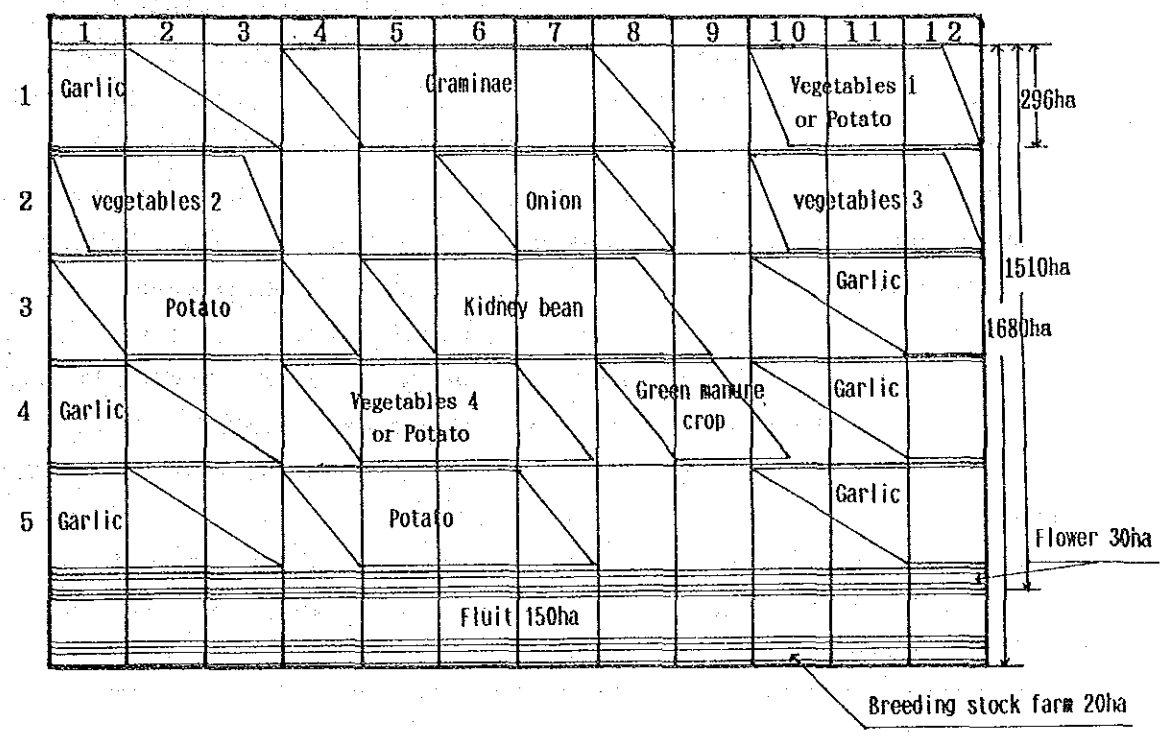
2) Cropping Plan

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. 4.3.2-1 based on the above ideas.

Fig. 4.3.2-1 Planned Cropping Pattern



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

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) 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 benefit 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 4.3.2-1.

Table 4.3.2-1 Planned Cropping Area

Unit: ha

Crop	Present	With Project	Balance
Garlic	885	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 vegetable	181	142	-39
Export vegetable	-	200	200
Graminae	-	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.

(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 4.3.2-2.

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 4.3.2-2 Yield per ha

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 4.3.2-3. 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 4.3.2-3 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

(4) Production Materials

A plan for production materials is briefed below.

Seed : Newly introduced varieties should be tested for adaptability 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).

(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 4.3.2-4. 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 4.3.2-5). 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 4.3.2-5 Required Average Monthly Laborers

Unit : man. day

	10	11	12	1	2	3	4	5	6	7	8	9	total
Present(a)	101.277	128.120	115.481	107.184	117.842	89.189	52.234	34.593	87.286	104.736	60.884	51.376	1.049.724
With pro(b)	113.966	149.547	136.606	98.411	152.556	140.688	69.484	39.328	92.714	118.083	85.966	19.984	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	117.587

Table 4.3.2-4 Investment Plan of Production Material and Laborers

per ha

	Unit	Garlic			Potato			Kidney been			Onion			Lettuce			Carrot			Beet			Other vegetables			Graminae		
		Present	Without	With	Present	Without	With	Present	Without	With	Present	Without	With	Present	Without	With	Present	Without	With	Present	Without	With	Present	Without	With	Present	Without	With
Production materials																												
Seed and seedling	Kg	846	846	846	1.758	1.758	1.758	105	105	105	5.288	5.288	5.288	0.605	0.805	0.605		6.54	6.54	17.41	17.41	17.41	0.990	0.990	0.990	–	–	172
Fertilizer																												
Organic matter	t	–	–	5	–	–	5	–	–	5	–	–	5	–	–	5	–	–	5	–	–	5	–	–	5	–	–	5
Chemical fertilizer	Kg	1.452	1.580	1.654	1.089	1.230	1.230	383	399	416.3	1.089	1.228	1.248	726	797	635	757	822	871	914	1.006	1.051	1.512	1.662	1.729	–	–	232
Pesticide																												
Herbicide	ℓ	2.4	2.4	2.4	–	–	–	–	–	–	2	2.4	2	–	–	–	2.9	2.9	2.9	2.1	2.1	2.1	–	–	–	–	–	2.2
Insecticide	ℓ	16.3	16.3	16.3	24.6	24.6	24.6	1.7	1.7	1.7	6.6	6.6	6.6	3.1	3.1	3.1	7.2	7.2	7.2	0.4	0.4	0.4	19.2	19.2	19.2	–	–	8.7
Fungicide	Kg	20.6	20.6	20.6	22.6	22.6	22.6	6.8	6.8	6.8	17.8	17.8	17.8	5.3	5.3	5.3	27.5	27.5	27.5	12.1	12.1	12.1	12.3	12.3	12.3	–	–	–
Labor																												
Rearingofseedling	man-day	20	20	20	5	5	5	–	–	–	4	4	4	20	20	20	–	–	–	–	–	–	80	80	80	–	–	–
Plowing Ridging	"	5	5	5	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	4	4	4	3	3	3	–	–	–
Sowing Planting	"	104	104	104	16	16	16	9	9	9	56	56	56	52	52	52	5	5	5	1	1	1	24	24	24	–	–	4
Apl.of fertilizer																												
Organic	"	–	–	10	–	–	10	–	–	10	–	–	10	–	–	10	–	–	10	–	–	10	–	–	10	–	–	10
Chemical	"	5	5	6	3	3	3	2	2	2	3	3	4	2	2	2	4	4	4	2	2	2	4	5	5	–	–	2
Splaying																												
Herbicide	"	5	5	5	–	–	–	–	–	–	4	4	4	–	–	–	5	5	5	–	–	–	–	–	–	–	–	2
Pesticide	"	32	32	32	28	28	28	4	4	4	32	32	32	6	6	6	44	44	44	28	28	28	28	28	32	–	–	3
Intertillage	"	105	105	105	31	31	31	24	24	24	52	52	52	37	37	37	42	42	42	48	48	48	28	28	28	–	–	24
Harvest,Plop	"	128	142	181	80	88	104	24	28	28	114	125	137	128	132	144	116	121	132	120	132	144	284	312	341	–	–	23
Irrigation	"	91	91	72	23	23	27	23	23	19	32	32	27	37	37	30	46	46	37	36	36	29	40	40	32	–	–	11
Total		502	515	547	290	308	325	90	92	101	301	312	330	259	351	358	302	313	325	257	269	284	501	530	561	–	–	79

(6) Crop Profit

1) Price of Product and Input

a. 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

b. Price of input

i. 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$68.8/kg
Other Vegetables	:	RD$ 0.7/g
Graminae	:	RD$ 2.1/kg

ii. 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

iii. 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 level and farmer's labor is set at RD$40/man-day since farmer is considered as skilled labor.

iv. 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.

v. 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 total of the above costs.

c. Financial charge

Annual financial rate is 18%, and the financial charge of each crop is given 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 4.3.2-6 by the "Present", "Without" and "With".

Table 4.3.2-6 Planned Gross Profit, Cost, Net Profit per ha

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