

DESARROLLO AGRICOLA Y MANEJO DE AGUAS DEL AREA METROPOLITANA (JICA - CNR)

Fig. 1.2.4 AGRICULTURAL PRODUCTION INFRASTRUCTURE DEVELOPMENT PLAN (POPETA, YALI, ALHUE)

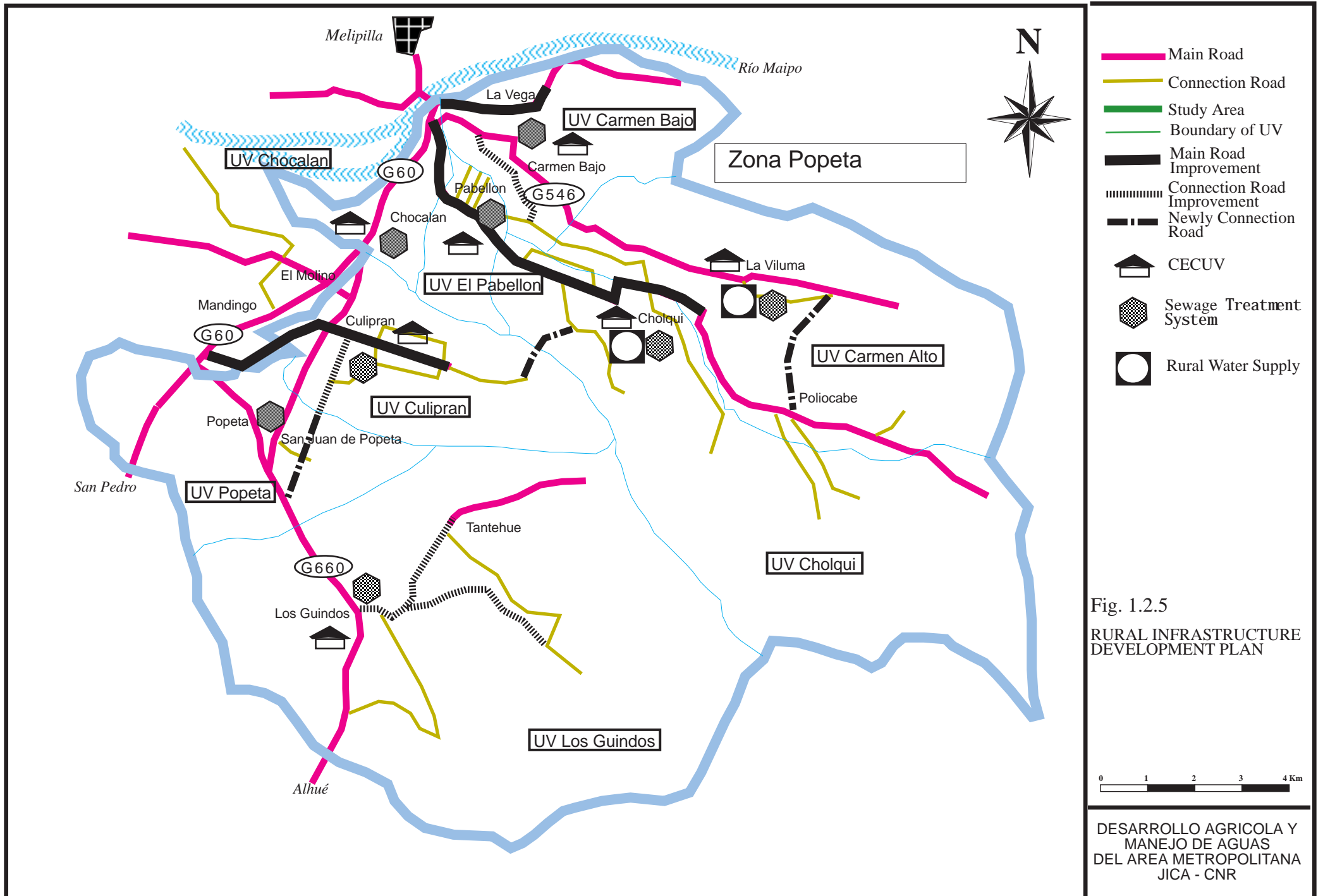
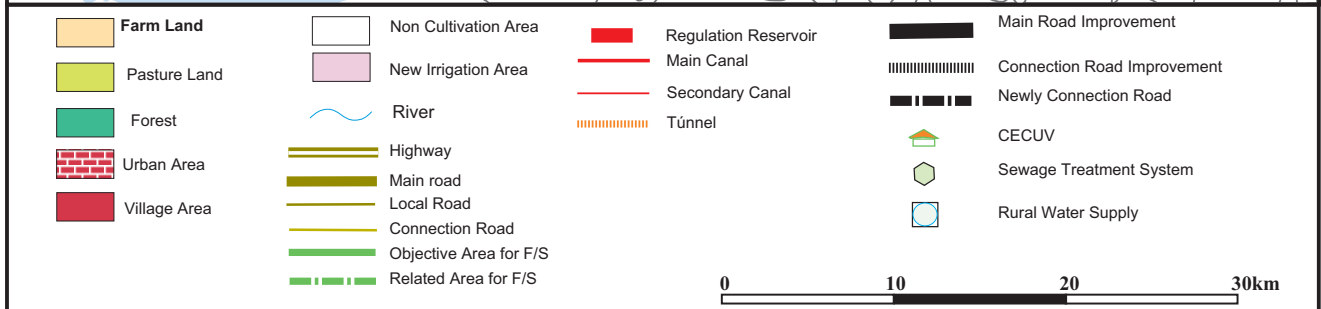
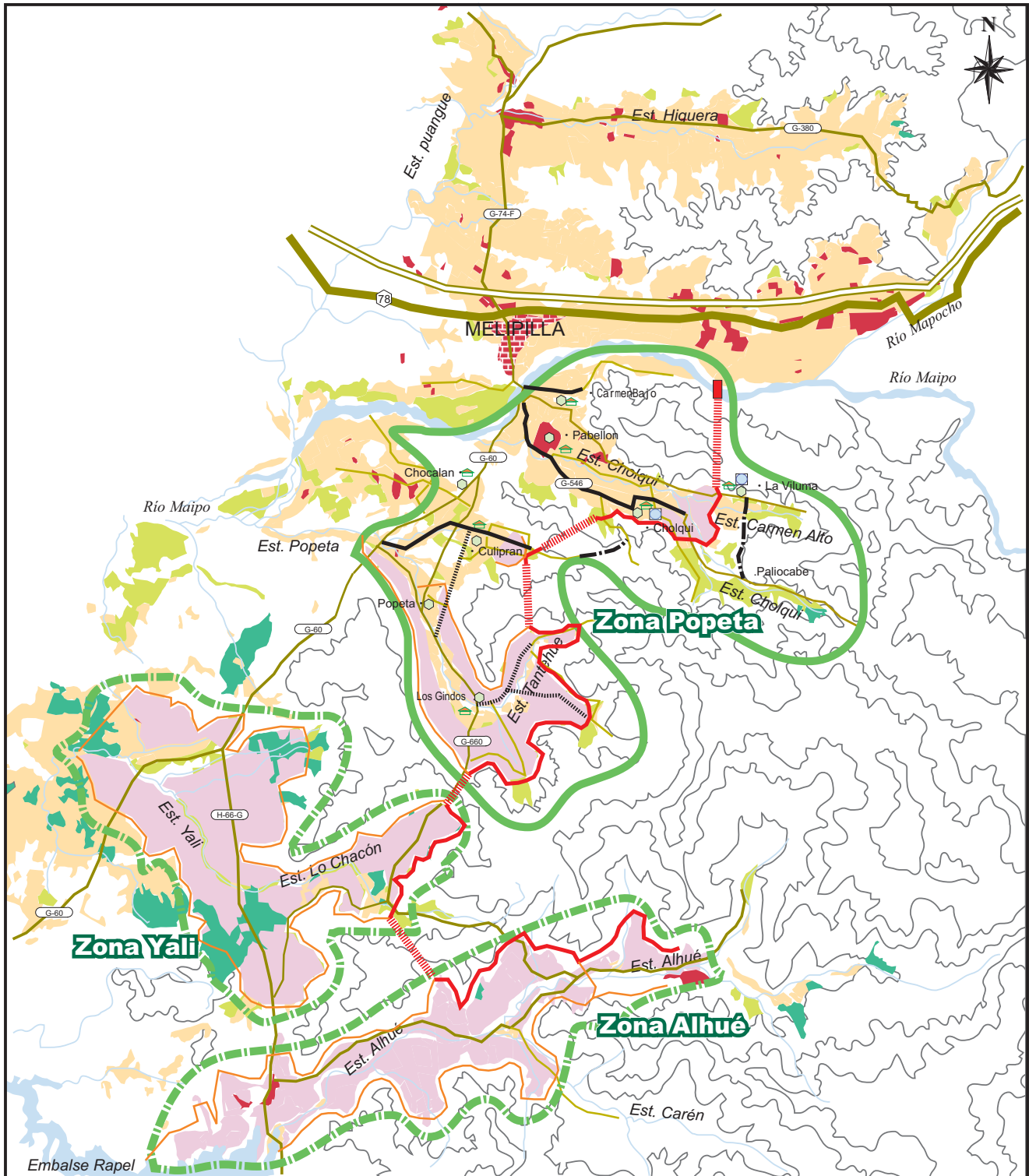


Fig. 1.2.5
RURAL INFRASTRUCTURE
DEVELOPMENT PLAN





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Fig. 1.2.6 Overall Development Plan (Popeta Area)

CHAPTER 2

*AGRICULTURAL DEVELOPMENT PROJECT
IN MALLARAUCO AREA*

2 AGRICULTURAL DEVELOPMENT PROJECT IN MALLARAUCO AREA

2.1 Present Situation of Mallarauco Area

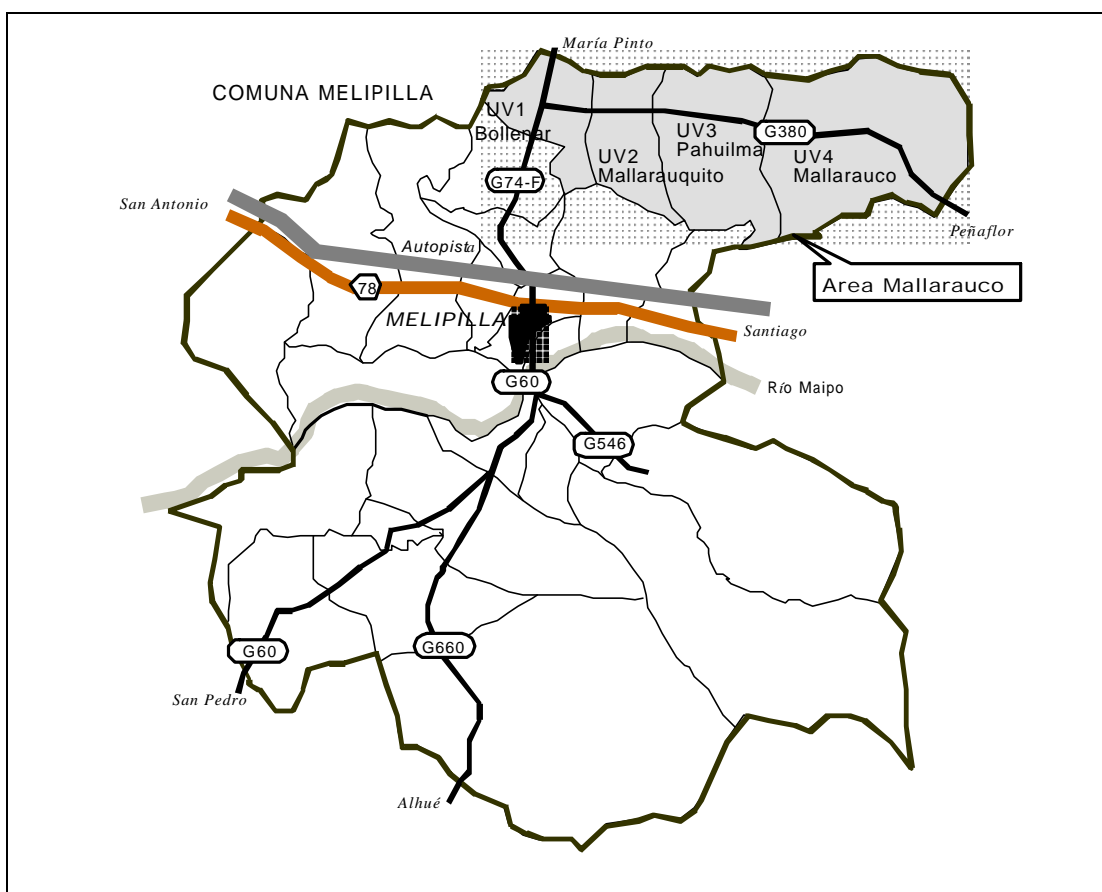
2.1.1 Present Social Situation

(1) Administrative Organization

Mallarauco area that belongs to *Comuna* Melipilla consists of 4 *Unidad Vecinal* (hereinafter referred to as the UV). Constitutions of UV in Mallarauco area are as follows.

Area	No.	<i>Unidad Vecinal</i>	No. of Council of Community
Mallarauco	UV1	Bollenar	3
	UV2	Mallarauquito	2
	UV3	Pahuilma	2
	UV4	Mallarauco	3

Allocation of UV in the study area is as follows.



(2) Population

Population of Mallarauco area is 8,145 heads according to the Census '92. Population of each UV are as follows;

Area	UV	No. of Households	Total population	Male	Female
Mallarauco	UV1 Bollenar	689	2,790	1,445	1,345
	UV2 Mallarauquito	250	986	523	463
	UV3 Pahuilma	480	1,871	1,008	863
	UV4 Mallarauco	688	2,498	1,335	1,163
	Total	2,107	8,145	4,311	3,834

Age composition of population in each UV is as follows.

		Population constitution					Unit: %
Area	UV	0-15	16-30	31-50	51-60	61<	
Mallarauco	UV1 Bollenar	31.7	27.8	24.1	5.7	10.8	
	UV2 Mallarauquito	32.0	26.6	25.8	5.4	10.2	
	UV3 Pahuilma	33.2	25.1	26.6	5.8	9.3	
	UV4 Mallarauco	35.4	25.5	24.3	7.3	7.5	
	Total	33.2	26.3	24.9	6.2	9.4	
<i>Comuna</i> level		32.8	26.8	24.3	6.7	9.6	
Nation level		29.0	25.1	27.9	8.1	9.8	

Source: Melipilla-SECPLAC

(3) Rural society

About 77% of constituents of rural society in Mallarauco area are farmers. Among them, small scale farmers occupy about 90%. Breakdown of constituents is as follows.

Area	UV	No. of household	Total population	Men	Women
Mallarauco	UV1 Bollenar	689	2,790	1,445	1,345
	UV2 Mallarauquito	250	986	523	463
	UV3 Pahuilma	480	1,871	1,008	863
	UV4 Mallarauco	688	2,498	1,335	1,163
	Total	2,107	8,145	4,311	3,834

Source: REA-CIREN 95

Among the constituents of UV mentioned above, most of medium and large scale farmers carry out enterprise type of farm management. They do not live in the area and has become absentee landowners. Therefore, management of UV is undertaken by small scale farmers who settle down in the area.

As well as Popeta area, this area is divided administratively by UV, which is an integrated unit of *Junta de Vecino* (hereinafter referred to as JJVV). UV forms regional society and is recognized as a main body of local self-governance.

Minimum unit of the area as a group is JJVV. Communities in the area are extended into both sides of main roads, and shape so-called "row community." In case of row community, it is difficult to form the center of a community. The place where public facilities such as churches and schools are located is the center of a community at present.

(4) Rural organizations

UV is a core of rural society. As the other associations that form the rural society, there are JJVV, Center of Mother (*Centro de Madres*), Sports club (*Clubes Deportivos*), Aid committee (*Comités Allegados*), Young man's association (*Grupos Juveniles*), Culture club (*Centros Culturales*), and so on. Through activities of these associations, inhabitants of the area promote the activities of self-governance in the area with deepening solidarity by enhancing mutual friendship and help.

Distribution of various inhabitants' organizations in the area is as follows;

Area	UV		<i>Juntas de Vecinos</i>	Mothers' Center	Sports Club	Aid Committee	Young Man's Association	Culture Club
Mallarauco	UV1	Bollenar	3	2	3	1	-	1
	UV2	Mallarauquito	2	1	3	1	-	-
	UV3	Pahuilma	2	1	2	1	-	-
	UV4	Mallarauco	3	2	3	1	-	1
	Total		10	6	11	4	0	2
<i>Comuna Melipilla</i>			100	50	84	42	2	21

(5) Gender

According to the data of MIDEPLAN-CASEN 96 (Socio-economic Characterization Survey), the ratio of the extremely poor in *Comuna Melipilla* is high, compared to that in whole the Metropolitan Region. Yet, the ratio is 3.4% and is about 60% of the national average. That of the poor is also low, 17.5% and 76% of the national average. The other indicators also tend to be more improved, compared with the national average. Nevertheless, illiteracy rate is 1.5 times as much as the national average and 2.7 times as much as the Metropolitan Region's one, or 7.2%. The improvement of educational environment can be said the problem.

Indicators in *Comuna Melipilla* are summarized as follows;

Index			<i>Comuna</i>	Metropolitan	Nation wide
Illiteracy rate	Total	%	7.2	2.7	4.9
Poverty line	The extremely poor	%	3.4	2.7	5.7
	Non extremely poor	%	13.3	12.1	17.5
	Not extremely poor	%	83.3	85.2	76.8

Source; Casen96, MIDEPLAN

In many cases, the women's share of works in Mallarauco areas is also limited to housework and bringing up children as well as other rural areas. The concept that men work outside and women protect houses takes root. Therefore, women are isolated from the activities of JJVV and economic activities. The reason of this situation is that there are not enough training and education of skills for economic independence and of organized activities for women.

In Mallarauco area, there is not an organization which utilizes the program which supports independence of rural women (PRODEMU) by INDAP. Nevertheless, producers' organizations by rural women supported by PRODEMU are working in EL Bajo and San José areas around the area. Both of them produce and sell flowers. The organization in El Bajo area is managed by 15 housewives of farm households, and the other one in San José area is managed by 15 women.

Accordingly, the activities for improving rural women's status are taking root, gradually. So as to establish this tendency more effectively, forming organizations of women in community level is needed. For this, improvement and construction of the base facilities for interchange among rural women and the support system for forming organization are indispensable. Moreover, deepening interchange between the existing organizations by women and women in Mallarauco area has great meaning to promote forming organizations of rural women. Thus, it is important to establish this kind of interchange system.

2.1.2 Natural Resources

(1) Geology

Mallarauco area consists of a plain where old riverbed deposit and terrace

deposit of Quaternary age cover the valley formed by impervious base rock. However, the surface layer is a tableland composed by Alluvial pumice volcanic ash. The rivers flow and erode the tableland at present. Diluvium aquifers is overlain by the volcanic ash deposit, and development of alluvial deposit along the existing river is poor.

(2) Climate

Mallarauco area, selected as the priority development area through the Master Plan study of the project, is located in the south-west of the objective study area. Melipilla meteorological station represents the climatic factors in the south-west of the study area. The station is located in the coastal mountainous areas and being observed the items to estimate the crop evapo-transpiration. Study on the meteorological items concerning the priority development areas will be made using the observed value at the Melipilla station. General climatic features on the Melipilla station are as follows;

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature (°C)													
Max.	32.2	32.4	31.1	29.0	25.2	21.8	21.9	23.8	26.8	28.4	31.1	32.5	28.0
Min.	7.4	7.2	5.3	2.9	1.2	0.4	0.0	0.2	1.4	2.7	4.4	6.3	3.3
Mean	19.1	18.9	17.7	15.1	12.6	10.7	10.1	11.0	12.6	14.5	16.5	18.4	14.8
Precipitation (mm)													
	0.1	0.2	3.0	17.8	76.1	94.7	107.4	57.6	25.4	10.9	6.0	1.3	400.6
Evaporation (mm)													
	206.3	165.9	124.9	70.7	34.9	20.1	21.8	36.2	62.2	112.5	154.8	202.0	1212.4
Relative Humidity (%)													
	60.1	62.5	66.3	70.9	77.5	80.7	80.1	77.1	72.9	67.2	62.5	58.7	69.7
Sunshine Hours (Hr)													
	10.5	9.6	7.7	6.1	4.2	3.4	3.6	5.0	5.8	8.0	8.9	9.9	6.9
Wind Velocity (km/month)													
	1599.5	1158.1	877.9	508.1	526.5	693.6	845.6	751.2	900.3	1158.6	1381.8	1641.8	1003.6

(3) Soils and land use

According to Agricultural Landholding Survey (REA : *Rol Extracto Agrícola*) in 1995, area of the study area is summarized in the table below. The present land use of Mallarauco area is shown in Figure. 2.1.1.

Area	UV	Total area	Unit: ha	
			Farmland	Others
Mallarauco	UV1 Bollenar	2,369.9	1,777.4	592.5
	UV2 Mallarauquito	2,952.6	1,535.4	1,417.2
	UV3 Pahuilma	5,379.4	1,882.8	3,496.7
	UV4 Mallarauco	9,622.4	4,041.4	5,581.0
Total		20,324.4	9,237.0	11,087.4

For soil and land classification of the study area, the data of REA and the orthophoto which obtained from CIREN are used. Land productivity classification of the area is summarized as follows.

Land productivity classification	Area by REA (ha)
(No limitation for cultivation)	0.0
(A little limitation)	134.2
(Necessary to select crops)	593.3
(Serious limitation for cultivation)	315.0
(Difficult for farmland)	0.0
(Impossible excluding pasture land)	0.0
(Impossible for farmland)	0.0
(Impossible for whole land use)	0.0
Total	1,042.5

Total benefited area by the project is to be 1,042.5ha. The area is existing irrigated land which belongs to between Class II and Class IV of the land productivity classification. 70% of total benefited area belongs to between Class II and Class III where is no limitation for agricultural use. Another 30% belongs to Class IV because of drainage aspects, and it is concentrated in farmland of Reforma area.

(4) Water resources

1) Surface water

Irrigation water for the farming plot in the Mallarauco area is conducted through the Canal Mallarauco. Intake facilities of the Canal Mallarauco is installed at the right bank of the Mapocho river. Monthly basis intake amount of the Canal Mallarauco is as follows;

Bocatoma Mallarauco												Unidad : m ³ /s
Año	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC
1988	-	-	-	-	-	-	-	1.40	4.59	7.75	7.69	7.54
1989	7.49	7.54	6.90	-	-	-	-	-	3.84	7.54	7.54	7.54
1990	7.54	7.60	7.32	7.54	-	-	-	3.02	6.00	6.63	7.02	7.70
1991	7.26	6.54	6.58	5.88	4.45	1.47	-	-	3.77	7.52	7.75	7.70
1992	7.89	8.06	7.45	6.35	3.10	-	-	-	4.54	7.42	7.75	7.80
1993	8.06	8.06	7.79	5.61	2.38	-	-	3.37	5.80	7.73	8.06	-
1994	7.80	8.06	7.09	6.63	4.37	2.32	-	1.20	6.04	7.30	8.06	8.06
1995	8.36	8.08	5.81	5.30	2.69	3.34	-	-	5.21	7.33	8.06	8.08
1996	7.67	6.62	7.53	6.22	5.12	3.73	-	2.79	3.98	3.84	3.68	7.80
1997	4.91	4.28	4.88	4.44	3.70	-	-	-	2.48	4.61	6.72	4.19
1998	8.00	8.06	6.98	5.75	4.79	2.88	-	4.70	4.97	5.50	6.84	7.99
Promedio	7.50	7.29	6.83	5.97	3.83	2.75	-	2.75	4.66	6.65	7.20	7.44

Water rights in the Mallarauco irrigation system are settled on 920 *Accións* at intake point. Available irrigation water of 1 *Acción* varies from 4.5 lit./s to 8.0 lit./s. Based on the maximum available irrigation water of 8.0 lit./s and water rights, total water requirement amount at headrace of canal counts at 7.36 m³/s. Water requirement amount for peak demand of irrigation can be assured in comparison with the actual intake water amount shown in the above table.

Design discharge for the areas to be improved the water quality of irrigation will be settled multiplying total water rights by 8 lit./s of maximum available irrigation water per *Acción* because priority development areas locates in the Mallarauco irrigation system.

2) Groundwater

Mallarauco area is a whole basin of *Estero La Higuera* which is a branch of *Estero Puangue*.

a) Distribution and number of wells

According to the survey of DGA, distribution of wells in Mallarauco area is as follows.

Area	<i>Estero</i>	Number	For agriculture use	For domestic water supply	others
Mallarauco	Higuera	14	2	7	5 (5)

() was dig for irrigation use but is not utilized at present.

Compared the number of wells in 1984 with that surveyed by the study in 1999, it has increased from 8 to 14.

b) Number of wells for agriculture and irrigation area

According to the well register of DGA, 2 wells for agriculture are registered. The irrigation area by using groundwater is estimated 60ha from the average irrigation area (30ha/well).

c) Fluctuation of groundwater

Long term observation of groundwater fluctuation has been undertaken in Mallarauco area. The results of survey whose data is relatively good are shown below.

Basin	No.	Coordinate (South - North)	Coordinate (East - West)	No. of well	Use	Bore of well (inch)	Depth (m)	Date of digging	Natural water level (m)	Pumping volume (l/sec)	Pumping head (m)
Mallarauco	M-1	33 30	71 00	D1	RSU	10	82.5	1959.9	4.6	33	23,2
	M-2	33 30	71 00	B1	P	8	61.0	1967.2	6.2	10	40.2

Both M-1 (confined groundwater) and M-2 (free groundwater) in Mallarauco basin show a tendency to lower the water level. Therefore, change of water quantity caused by lowering the water level is worried.

2.1.3 Agriculture

(1) General feature

In Mallarauco area, under the extremely mild climate with highly productive soil, profitable fruits growing (mainly avocados and lemons) is carried out and occupies a half of the present irrigated farmland. The area is a pioneer of fruits plantation on the sloped land (*plantación en laderas*), and fruits are cultivated in 2,000ha of the sloped land.

One of the significant features of the area is dairy products. There are three large farms which produce and process milk in the area. They produce milk under the direct management and also purchase and process the raw milk which is produced in and around the area. These farms hold 1,000ha of land as a whole but purchase feed and raw milk from small scale farmers as well. The Pahulmo farm among them is famous for cheese production.

Some kinds of vegetables and cereals are cultivated by small scale farmers. Many kinds of vegetable have been produced in the past, and especially large quantity of melons for export, watermelons, pumpkins, onions and garlic were produced. The other vegetable such as lettuces, cabbages and cauliflower were also produced but small quantity. Production of export melons was drastically decreased by mosaic virus infection. Vegetables are not major cultivation crops any more in the area due to prohibition of their cultivation by using contaminated water after outbreak of cholera in 1990.

(1) Scale of farming

The farmers in the project area for water quality improvement are confirmed by the REA report and the Ortho-photography and are classified by farming scale. The results of this is shown in the table below.

Farming Size (ha)	No. of Farmers	Holding Area (ha)	Irrigation Area (ha)	Average Farming Area (ha)	Average Irrigation Area (ha)	Non-Irrigation Area (ha)
0.1 – 15	84	782.9	782.9	9.3	9.3	0
15.1 – 100	7	166.9	104.4	23.8	14.9	62.9
Over 100.1	3	791.1	155.2	263.8	50.9	638.3
Total	94	1740.9	1,042.5			701.2

Average scale of farmers' landholding in the project area is 9.4 ha for small scale farmers and 25.3 ha for large and medium scale farmers. Among beneficiaries of the project, 89% of the beneficiaries is small scale farmers and 11% of them is a large and medium scale farmer. The beneficiaries who hold land outside the projected area are only large and medium scale farmers. Most of their land is unirrigated area.

Small scale farmers in Mallarauco area have very wide farming experience and agricultural technology, compared with small scale farmers in the other areas. When export melons were produced in the area in the past, small scale farmers also cultivated them. Small scale farmers started to engage in milk production after quitting melon cultivation by the virus infection and the regulation on vegetable cultivation by contaminated irrigation water. Some of them produce quite high quality milk. Because the milk price decreased, small farmers had to quit milk production. Farming alternative for them is fruits growing but most of them cannot invest enough and remain small scale and low productivity farming.

(2) Present situation of cultivation crops

According to the information from Mallarauco canal association and the results of the survey on 25 farms in the study area, the present situation of cultivation crops is described in the table below

Crop	Grains			Vegetable *	Forage Crops	Fruit Trees			Sub total	Forage & Others	Total
	Maize	Wheat	Total			Avocado	Lemon	Total			
Area (ha)	164.7	22	186.7	99.1	225.2	31.3	20.9	52.2	563.2	479.8	1043
%	15.8	2.1	17.9	9.5	21.6	3.0	2.0	5.0	54.0	46.0	100

Note *: Basically indicate Pumpkin, Melon, Watermelon, zucchini and potato

Cultivation crops by scale of farming such as small scale farmers, and medium and large scale farmers are shown in the table below.

Crops	Grain Crops			Vegetables			Forage Crops	Fruits Trees			Sub total	Pasture & Others	Total
	Wheat	Maize	Sub total	Pumpkin	Watermelon	Sub total		Alfalfa	Avocado	Lemon			
Small scale (9.4 ha)	0.28	1.2	1.48	0.4	0.41	0.81	1.83	0.06	0.12	0.18	4.3	5.1	9.4
(%)	2.7	13.0	15.7	4.2	4.4	8.6	19.5	0.67	1.16	1.9	45.7	54.3	100.0
Total Area (ha)	22	102.4	124.4	33.6	34.5	68.1	154.2	5.3	9.2	14.5	361.2	428.8	790.0

Crops	Grain Crops		Vegetables	Forage Crops	Fruits Trees			Subtotal	Pasture & Others	Total
	Maize	Melons			Alfalfa	Avocado	Lemon			
Large / Medium Scale (25.3ha)	6.2	3.1	7.1	2.6	1.2	3.8	20.2	5.1	25.3	
(%)	24.5	12.3	28.1	10.3	4.6	14.9	79.8	20.2	100.0	
Total Area (ha)	62.3	31.0	71.0	26.0	11.7	37.7	202.0	51.0	253.0	

Crop cultivation of an average small scale farmer occupies over 54% of his landholding area with pasture or low profit crops. This cropping pattern reflects the history of crop cultivation in the area as mentioned before. Most of fruit growing is

undertaken in small scale orchards, and only one exception is a commercial plantation of 5ha.

In case of large and medium scale farmers, pasture and low profit crops share 20.2% of total crop cultivation. The most important crop is forage crops and it shares 28.1 % of total crop cultivation.

(3) Farm income

Gross income of a typical farmer is shown in the table below.

Small Scale Farmer			Large / Medium Scale Farmer		
Crop	Farmland Area (ha)	Farm Income (\$1,000)	Crop	Farmland Area (ha)	Farm Income (\$1,000)
Wheat	0.28	70	Maize	6.2	2,480
Maize	1.2	360	Melons	3.1	4,650
Pumpkins	0.4	320	Alfalfa	7.1	4,970
Watermelons	0.41	533	Avocado	2.6	3,380
Alfalfa	1.83	732	Lemon	1.2	960
Avocado	0.06	48	Pasture	5.1	510
Lemon	0.12	48			
Pasture	5.1	510			
Total	9.4	2,621	Total	25.3	16,930

(4) Agro-processing

The table below shows agro-processing factories operating near the study area, María Pinto and Peñaflo. Melipilla, Talagante and Culacaví are located within 10km, 30km and 25 km from the study area, respectively. Buin, Paine, Linderos and Santiago are located within 60 km from the study area. Accordingly, it is possible for the study area to access easily all kinds of agro-processing facilities.

Type of Processing Facilities	No. of Facilities	Capacity
Nuts Processing Facility	1	45,000 kg/ day
Fruits Dehydration Facility	2	10,000 kg/day
Raw Milk Processing	3	N/A
Vegetable Freezing Facility	5	29,500 m ³
Packing Facility	16	135,500 kg/ day
Sterilizing Facility	3	31,000 kg/ day

2.1.4 Agricultural Support Services and Farmers' Organizations

All of agricultural support services in the study area are provided through INDAP-Melipilla. As farmers' organizations in the study area, there are three types of organizations; canal association, milk collecting cooperative and citrus group.

As water users' association, there is only one, Mallarauco canal association. This association distributes irrigation water fairly, and maintains canals in the area as a whole. The association can utilize INDAP service systems for improvement and construction of facilities, and also applies for and materializes the project. So that, the canal associations employ full-time advisers, and intend to promote their business and implement effective operation and maintenance of facilities.

Milk collecting cooperative and citrus group are producers' organizations and both of them are organized by INDAP services.

The milk collecting cooperative was established in 1987 and managed by 15 dairy farms. Its base is a milk collection center, which equipped with a fixed

temperature storage by INDAP services. Based on the centers, the cooperative intends to control milk quality for maintaining the selling price through controlling animal raising, feed and milking of each farm. The selling destination is a large milk processor (SOPROLE). SOPROLE gives technical guidance for quality control. The quality is strictly controlled at the cooperative as well as among the members because the price is largely fluctuated by quality. The cooperative aims at construction of dairy processing facilities of original brand in the future. It receives financial support not only from public loan of FOSIS but also from OCAC (Farmers Support Association), NGO. It combines various financial sources effectively and utilize them.

Citrus group (*Grupo Citricola*) is organized by 17 small scale farmers through utilizing SAL program of INDAP. The group intends to increase productivity and control quality of lemons and oranges. This results in establishment of the productions' status in a market and maintenance of quality.

Although there are a few producers' organizations in the area as mentioned above, they have been achieved steadily the results and contribute largely to improvement of small scale farmers' status and stability of regional society. The ratio of forming organization is still very low. This is a big constraint on self-independence of small scale farmers.

The constraints on organizing small scale farmers are vigorous feeling for self-independence of themselves and mutual distrusts among them. On the other hand, there are lack of public relation on the support system, of basic motivation to form organizations. There is also lack of support organizations for them. In addition, it is also a big constraint that there are not enough places for reaching agreement through discussion of farmers themselves and for enlightening about and extending the support system. Therefore, solving these constraints and the way to establish the class of socio-economically independent small scale farmers are to be future subjects.

2.1.5 Agricultural Economy and Marketing

(1) Marketing of agricultural products

1) Production and distribution

Marketing of farm products in the study area can be (a) individual, in which the producer sells his/her products to an intermediary without a contract, generally obtaining low prices, but leaving the option open for good prices when market conditions turn favorable, and (b) group marketing, or through a trade association of the producers themselves, which not only improves marketing by replacing intermediaries, but permits access to credit and technical assistance.

As marketing channel, small producers in the priority study area mention intermediaries in the first place. Intermediaries bridge the gap between producers and wholesale markets in Santiago. Apparently there are two types of intermediaries: (a) those who pay before taking the products, and (b) those who combine transportation and sale services, paying the producer after selling the products, thereby making them more akin to consignees. Wholesale markets in Santiago are the main destination of most agricultural products, and serve as suppliers to regional consumption centers.

Concerning direct sale from producers to consumers, farmers who own land along a trunk road have the option of selling their produce in makeshift stands, which allow them to obtain better prices. Another marketing option is contract production, generally involving agroindustry or packing plants. To ensure the quality of agricultural products, these firms set a number of requirements, which are not always accessible or economically justifiable for the small producer.

Collective milk marketing is becoming a required step for small producers, due to the refrigeration requirement set by the milk buyers. The price differential between non-refrigerated and refrigerated milk can be as much as 50% (\$40 against \$60 per liter some time ago). A center for collective milk marketing can be set up by a group of dairy farmers who finance the necessary investments, but when there is surplus capacity it is usually open to non-members as well, paying a lower price than to members or charging around \$2/liter as refrigeration service.

The purpose of quality control upon milk reception at the collective milk marketing center is to detect acidity and to prevent milk dilution with water. The milk price paid to producers is the same in some places, regardless of quality differences. However, better-organized collective milk marketing centers have all producers identified by individual codes, and their milk samples are analyzed in the laboratories of the final buyer who sets prices according to the milk quality. Milk quality requirements are defined by buyers, usually major dairy firms or local cheese factories, but small milk producers generally do not know what these requirements are.

Small collective milk marketing centers in the study area include Viña El Campesino, Santa Elena and Los Carrera.

2) Marketing facilities

Within the priority study area, there are facilities for the marketing of perishable products. These facilities consist of packing plants and cold storage, which permit value added to the produce, either through processing or through an improved inter-temporal distribution of the product.

(2) Price and quality of agricultural products

Agricultural products identified in the study area by the questionnaire survey were fruit like orange, avocado and lemon, melon, pumpkin, cucumber, water melon, corn, potato, alfalfa and natural pasture for cattle.

1) Farm gate price

The farm gate price received by the small producers appears to be influenced more strongly by the harvest time, rather than by the quality of the product. Farmers receive price information through 2 or 3 radio stations, and they are aware of the existence of such service. However, they argue that these radio stations broadcast price information during the morning when they need to be working in the field. The prestigious daily *El Mercurio* publishes an agricultural supplement on Mondays, with extensive information on prices of inputs and outputs. The Office of Studies and Agricultural Policy (ODEPA) of the Ministry of Agriculture provides price information by fax to interested farmers, and sends regional price information to the relevant local government office.

2) Wholesale price

The price recorded by ODEPA in wholesale markets specify the area where the product originates, three levels of prices (low, high, and common) by variety and quality of products, and the transaction volume per day. Price information is also available as weekly averages by variety and quality of products, and the transaction volume per week. Finally, price information is available as the monthly average between 1975 and 1998.

Wholesale price differentiation by quality of products indicates that some kinds of classification take place between the farm and the wholesale market. The tables

below show examples of wholesale prices in two wholesale markets of Santiago, Lo Valledor and Mapocho, choosing the products originating in the Central Zone or in Santiago. Price differences can be noticed between the wholesale markets, prices being higher in the Mapocho market as a reflection of its convenient location in downtown Santiago, while Lo Valledor is located in the outskirts of the city.

3) Quality standards

The National Standards Institute (INN) defines quality standards for a variety of products, including some agricultural products. Quality standards for grapes, apples, pears, avocados and lemons are set for both the domestic market and export markets. In the case of Thompson Seedless variety of grapes, and taking the bunch weight as the criterion, standards for the domestic market and the export markets differ as follows:

Class	Domestic Standard (gram/bunch)	Export Standard (gram/bunch)	
		Thompson Seedless, Cardinal, Perlette	Other Varieties
1	225	250	300
2	180	200	250
3	115		
4	115		

Source: NCh1818.Of80, NCh1925.Of82

The quality standards set by INN are used by Agriculture and Livestock Service (SAG) to control the quality of agricultural products for export, through its regional offices located in Melipilla and Talagante within the priority area. On the other hand, in the case of domestic market, no control seems to exist for the enforcement of quality standards set by INN.

4) Marketing improvement

There are favorable factors that can enable producers in the study area to improve the marketing of their products. The favorable factors are the proximity to the main consumption centers of the country, and the relative abundance of information on prices and quality of agricultural products.

The long-term price trend can give an indication on promising products. The quality standards for the promising products will indicate market requirements, and therefore, the technology that will be required in the production of such products. Once the selected products are produced, recent or short-term price information will give the pattern to decide in which market to sell.

Small producers should set up their own trade associations in order to take over the role of intermediaries. Trade associations will give their members additional advantages, such as access to technical assistance and credit offered by government institutions. A trade association can rent a sale and exhibit module in the new Santiago Wholesale Market (MERSAN), to make it possible to sell directly to consumers. If the rental fee of a sale and exhibit module in MERSAN is out of reach of a trade association, a group of trade associations can share the same space. In this case, each trade association can directly sell to consumers a specific product, which should ideally be produced successively during the year, so as to permit an efficient rotation in the use of the sale and exhibit module.

(3) Farm income

Results from the questionnaire survey were analyzed with reference to small farms of less than 15ha. In the Mallarauco area, the survey included small farms and one medium size farm, but no large farm. The economic results from these farms in

the Mallarauco area, as indicated by the questionnaire survey, are presented below.

Small scale farmer				Medium scale farmer				
Item	Area (ha)	Income (\$)	Expenses (\$)	Result (\$)	Area (ha)	Income (\$)	Expenses (\$)	Result (\$)
Farm Area	8.14				18.5			
Used Area	4.39				17.0			
Gross Farm Income		3,164,032				12,133,456		
General Expenses			412,458				1,003,200	
Net Farm Income				2,751,574				11,130,256
Family Labor		75,000						
Off-farm Income		156,000						
Family Expenses			988,625				760,000	
Household Income				1,993,949				10,370,256

The economic results presented above indicate that the small farm is in a difficult situation, requiring off-farm income to make the farm viable.

2.1.6 Agricultural Infrastructure

(1) Infrastructure on irrigation

Mallarauco area extends over 7,000ha of farmland and is irrigated by contaminated river flow of the Mapocho river by urban sewerage. Irrigation water taken from the Mapocho river passes through Pervin and tunnel, then irrigation water is divided into seven irrigation systems (irrigation areas) in *Comuna Mallarauco*. The details on volume of water rights (*Acción*) and users (*Acciónistas*) are as follows.

Irrigation System	User	Water-Right	Discharge (m ³ /sec)
1. Pervin	35	140,000	1.120 – 0.630
2. Norte	53	261,160	2.089 – 1.175
3. Sur	91	167,924	1.343 – 0.755
4. Higuierillas	95	193,890	1.551 – 0.872
5. Santa Ana	60	98,916	0.791 – 0.445
6. Italiano	61	107,364	0.858 – 0.483
7. Reforma	78	76,971	0.615 – 0.346
8. Retamo	21	8,000	0.064 – 0.036
Total	494	1,054,225	8.433 – 4.744

Note: Discharge is calculated from water right's discharge (1 *Acción*: 8~4.5 l/sec/ water right)

In Pervin area, 670ha or the section of about 6km ranged between intake facilities and a tunnel is irrigated by four diversion facilities. The Downstream Pervin, (after a tunnel of about 3km) is divided into three major systems (Norte, Sur and Higuierillas) and again divided into five systems (irrigation section). Number of water right (No. of *Acción*) at the intake facilities is 920 in the area as a whole. There is also *Acción* at the water source which uses return flow in the downstream basin. Sum of them is 1,054,225. Intake water volume is varied by season, the volume per *Acción* is changed between 8.0 and 4.5lit./sec, and distributed. Irrigation method in the area is mostly a furrow irrigation in the flat land including orchard. A drip irrigation method by pumping up is applied in the orchard of the sloped land.

(2) Drainage facilities

There are mountains in the north and the south and the Higuierillas river flows from the east to the west in the low flat of the center in the area. This river plays a role of a drain that collects rain and excess water of irrigation. However, the flow of river is dammed up at the downstream basin and utilized for irrigation. The river has a

function as both irrigation and drainage canal.

There are poor drainage areas in the central lowland of the downstream basin. In the areas, although there are drainage canals per a branch irrigation canal, there is no organized drainage canal networks in the area as a whole. Moreover, the drainage canals are dammed up and become irrigation canal. This means that drainage and irrigation canals are mixed, there.

(3) Contamination of irrigation water

Irrigation water of Mallarauco area is taken from the Mapocho river. Water of the Mapocho river is already contaminated by the urban sewage at the intake point of the Mallarauco canal. Thus, the farmers must use contaminated water as irrigation water in the entire area. Accordingly, the problem of contaminated irrigation water is not solved in the area, otherwise sewage is treated in the Santiago city.

(4) Facilities and water management

Mallarauco canal association manages irrigation facilities from intake facilities to the secondary canals. Maintenance cost is paid according to number of water right (*Acción*) by a holder. The holders of water right are 494 and the maintenance cost per *Acción* is \$63,000 annually. Main work of maintenance is canal repair, and the repair schedule is prepared every year. The management cost of the main canal is paid by users of the entire area. After the secondary, the management cost is paid by users concerned. The burden of canal repair cost is large in the canal system which passes through the slope of mountains.

Mallarauco canal association manages water and distributes *Acción* flow fairly at each diversion point according to intake water volume.

2.1.7 Rural Infrastructure

(1) Installation of basic infrastructure

The present situation of basic infrastructure in the Mallarauco area is shown in the table below.

Area		UV	Electricity	Water Supply	Sewage System
Unit: %					
Mallarauco	UV1	Bollenar	84.9	89.6	10.9
	UV2	Mallarauquito	87.2	90.0	9.2
	UV3	Pahuilma	85.8	90.4	26.7
	UV4	Mallarauco	78.5	82.5	14.4
Total			83.3	87.6	15.4

On the basic infrastructure in the study area, installation of electricity and water supply is almost completed. Electricity is supplied by the electric supply company and will be supplied to all households, soon. All drinking water is taken from groundwater. The water supply system is renewing in the entire area by the support of EMOS at present. All households will be able to obtain tap water by the water supply system. Accordingly, installation of electricity and water supply does not have problems at all.

On the other hand, installation of sewage systems has almost not proceeded, and there are no sewerage treatment facilities even in the communities where water supply facilities have already installed. Excreta is treated in the septic tank of individual houses and domestic sewage is directly discharged into drain canals.

Therefore, contamination of agricultural water and river flows by domestic sewage is getting noticeable in some places. Communities of Mallarauco area extend into the valley and the structure of communities is relatively gathered. Therefore, there are a few constraints on installation of a rural sewage system. It is necessary to promote installation of a rural sewerage system from the aspect of living and production environmental conservation for inhabitants.

(2) Road / Traffic facility

The road network in the area is formed by MOP managed road, Route G380 which runs from the East to the West in the central part of the area, and Municipality managed lateral roads which crosses Route G380 orthogonally. The area connects with Melipilla and Peñaflor by Route G380. Route G380 has been completely paved except the part of road to Peñaflor. Although lateral roads are not paved at all, they have already widen enough for passage of vehicle. Connection between lateral roads are very poor because most of lateral roads are arranged as comb-shape against trunk roads. According to the road situation mentioned above, connection between lateral roads should be promoted.

On the other hand, regarding public transportation facilities, there is a route bus service mainly on the trunk roads and connects with Melipilla city, the Peñaflo city and the Santiago city.

(3) Other facilities

As educational facilities, primary schools (*Básica*) are in Santa Elisa (Esc. Patricio Larrain, 10 teachers, 271 pupils) and Santa Victoria (Esc. Lidia Matte, 10 teachers, 273 pupils) and kindergarten is attached to each school. Normally they are going to high school and schools for professions in the Melipilla city.

As medical facilities, a health center (*Posta Bollenar*) is located in Bollenar community, the western end of the area. A nurse is always stationed. A medical doctor and a dentist make their rounds once a week. The Municipal hospital and the Red Cross hospital (*Policlinicos Cruz Roja*) in Melipilla city are used when high level treatment is needed or in case of emergency.

As a communication facilities, coin type public telephone of CTC which utilize cellular telephone networks is arranged in each community and it is possible to contact with outside by dialing. As telephone companies, NTEL and CTC provide various telecommunication services in Melipilla city.

2.1.8 Environment

(1) Designated area such as natural parks

There is no designated area in Mallarauco.

(2) Present condition of water contamination

Mallarauco area is irrigated by Canal Mallarauco taking water mainly from the Mapocho river. The table below shows the results of the water quality analysis in Mallarauco.

Date	22/7	11/8	8/12	11/12	Chilian standard	Chilian standard	Standard for growing	EMOS
Item	Unit	St.20	St.20	St.20	C11	for Irrigation	for Recreation	specified Vegetables
Temperature		11.0	12.8	23.4	21.5			
pH	-	7.4	7.1	7.7	7.4	5.5-9.0	6.5-8.3	
BOD	mg/l	96.0	59.0	38.0	110.0			
No. of Coliform Group	MPN/100ml	9.2E+06	1.1E+08	1.7E+05	9.2E+08			
No. of Fecal Coliform Group	MPN/100ml	1.7E+06	2.4E+07	3.5E+03	1.1E+07		1000	1000
Cu ²⁺	mg/l	0.003	0.044	0.020	0.069	0.20		
SO ₄ ²⁻	mg/l	405.0	381.0	324.0	326.0	250.00		
Cl ⁻	mg/l	257.0	275.1	204.4	224.2	200		

St.20:the Mapocho river at Canal Mallarauco C11:Canal Mallarauco(at outlet of tunnel)

The analyses were made three times at the intake point on Canal Mallarauco of the Mapocho river and once on the outlet point of the tunnel of Canal Mallarauco. Compared to the standard value shown in the table above, both points in all seasons meet the standard requirement of water for agricultural use as to pH and Cu²⁺, while both points in all seasons exceed the standard as to SO₄²⁻ and Cl⁻. Concerning fecal coliform, both points in all seasons exceed the standard value of water for recreation use and water for growing the specified vegetables. The analysis of well water in Mallarauco is shown in the table below.

Date	22/7	12/8	9/12	Chilian standard	Chilian standard	Standard for growing
Item	Unit	#6	#6	#6	for Drinking	for Irrigation
Temperature		16.0	14.3	23.2		
pH	-	6.7	7.2	7.2		5.5-9.0
BOD	mg/l	<10.0	<10.0	14.0		
No. of Coliform Group	MPN/100ml	7.9E+01	1.7E+01	2.4E+02		
No. of Fecal Coliform Group	MPN/100ml	1.1E+01	2.0E+00	4.9E+01		1000
Cu ²⁺	mg/l	0.003	0.002	0.002	1.0	0.20
SO ₄ ²⁻	mg/l	127.0	176.0	147.0	250	250.00
Cl ⁻	mg/l	119.0	137.6	121.4	250	200

#6:Well Bollenar (Hosteria Las Lilas)

The analyses were made three times at the main well in Bollenar. Compared to the standard value shown in the table above, three analyses meet the standard requirement of drinking water as to Mg²⁺, Cu²⁺, SO₄²⁻, and Cl⁻, and meet the standard of water for agricultural use as to pH, Cu²⁺, SO₄²⁻, and Cl⁻. Further, concerning fecal coliform, these analyses meet the standard value of water for growing the specified vegetables.

The table below shows the water analysis made in March 1995 on the Pervin Bridge on the Mapocho river and the Corta Bridge on the same downstream river.

Date	1/3	3/3	3/3	7/3
Item	Unit	P.Pervin	P.Pervin	P.Corta
p H	-	7.10	7.30	7.21
SS	mg/l	16	20	9
BOD5	mg/l	18	12	8
Total coliforms	MNP/100ml	4.9E+06	3.5E+06	1.1E+06
Fecal coliforms	MNP/100ml	4.9E+05	3.9E+05	1.1E+05
T-N	mg/l	7.3	11.2	5.5
(Kjeldahl)				
NH ₄ -N	mg/l	5.4	6	3.3
Nitrate	mg/l	0.05	0.08	0.09

Source: Asociación de Canalistas Mallarauco (Programa de Monitoreo de Calidad de aguas sistema río Maipo. Campaña monitoreo inicial)
(CONAMA-CADE IDEPE)

The conclusion is that the contaminated water of the Mapocho river (including a part of Canal Esperanza Alto) is supplied in Mallarauco as irrigation water by way of Canal Mallarauco. Water contamination in the area including Mallarauco is a serious problem.

2.1.9 Problems and Development Approach

Present problems on agriculture is confirmed in the Master Plan of “Agricultural Development and Water Management in Metropolitan Area, Chile.” They are involved in agricultural sector and are disparity caused by landholding scale regarded as a problem on the agricultural production structure, tightness and competition of water use as an agricultural condition, contamination of agricultural water, and decrease of farmland.

Mallarauco area is selected as the F/S area according to the standard that agricultural promotion from inside of the sector as the countermeasures to solve these problems, effective use of resources as an improving condition for its support, treatment of contaminated water and improvement of the existing irrigation facilities in accordance with contents of environmental conservation plans.

Following points can be listed by reviewing the present situation, according to the background of Mallarauco area.

- Contamination of irrigation water

Using contaminated water limits kinds of cultivation crops under the regulation of vegetable cultivation and gives negative impact on farmers' health and sanitation. The reasons why water quality is not improved by farmers' side are that original cause of contamination is urban inhabitants, cost of improvement is high, and there are some crops which contaminated water use does not directly effect on farming income.

- Superannuation of irrigation facilities

Existing irrigation system has been superannuated. Particularly, the main canals which run mountainsides have problems such as collapse with canals. Thus, cost of O & M has increased. In the terminal part of irrigation area, shortage of water is caused by leakage during dry season. There is about 7,000ha irrigated farmland, and cost of improvement should be paid by the beneficiaries. Thus, rehabilitation of the entire system is difficult.

- Unstable management bases of small scale farmers

In case of small scale farmers in Mallarauco area, they can use irrigation water and farming technology reaches a certain level except a problem of landholding scale. The change of small scale farmers' cultivation crops in the past were melons, vegetables, dairy products and fruits in turn. It is recognized that the reasons of the change were disease and insect pest, contaminated irrigation water, decline of milk price and uneconomic farming scale. On the contrary, it can be said that the change is accumulation of experience of various crop cultivation or actual results of bearing difficulties on management. The problems of small scale farmers in Mallarauco area are different from hardware problems that are the problems of the small scale farmers who do not have farming infrastructure, but software problems that relates to farm management.

Based on the present problems in Mallarauco area, the measurements to solve these problems and to enjoy its advantage as a food supply base near the metropolitan area are recognized that improvement of production and living environment by improving quality of irrigation water, decrease of O & M cost and alleviation of water shortage at the terminal point of the irrigation system by rehabilitation of the existing

irrigation facilities. Crop diversification which is resulted from water quality improvement brings about stabilization of farming base by more intensive agriculture and at the same time, the quality improvement of water contributes largely to maintaining favorable health and sanitary condition of farmers.

2.2 Agricultural Development Plan in Malla-rauco Area

2.2.1 Basic Concept of Development

(1) General

The Master Plan on “Agricultural Development and Water Management in Metropolitan Area” targeted on the year 2010 was established with the frames of effective use of land and water, environmental conservation and agricultural promotion as countermeasures to solve the problems (disparity caused by landholding scale, decrease of farmland, contamination of irrigation water and tightness of water use) on agriculture in the Metropolitan area. Based on the Master Plan, Malla-rauco area was selected as the priority area for carrying out the Feasibility Study where water quality improvement and rehabilitation of the existing irrigation facilities are to be undertaken.

Malla-rauco area was formed by the Higuera river which is a branch of the Puangue river and flows in Melipilla Province. Irrigation water in the area is taken from the Mapocho river after the Zanjón de la Aguada canal, which sewage of Santiago city is concentrated in the Talagante province, joined the Mapocho river. The water reaches the top of the Higuera river after passing through Co. Los Erizos by tunnel canal. Afterward, it is conveyed by the three main canals in the right, left and central banks of the Higuera river to be used in approximately 7,000ha of farmland.

Contamination level of irrigation water taken from the Mapocho river shows extremely high, over 10^5 MPN/100ml of coliform groups. However, water of the Mapocho river contaminated by urban wastes must be used continuously as irrigation water under the present situation of Malla-rauco area where is no alternative water sources in and out of the area. Farming in the area is mainly cultivation of crops whose harvested products are not affected by contaminated water use. Main crops are perennial crops such as fruit trees in the upstream basin, and annual crops such as cereals, pasture and livestock in the middle and downstream basins. Recently, fruit growing on hillside of mountains has increased.

(2) Development approach

Contamination of water quality is to be reduced by step-by-step improvement of sewage treatment plants of EMOS, gradually. Nevertheless, it will take about 25 years until good irrigation water can be taken from the rivers by completing the plants. Positive measures for water quality improvement from agricultural section are required to establish sound agricultural production environment and recover the function as the base of perishable food supply which utilizes the characteristics of suburban agricultural area. These measures will also contribute to establishment of agricultural production environment which satisfies the demand of markets and achievement of sound health and sanitary environment for farmers who engage in agricultural production.

On the other hand, irrigation facilities in Malla-rauco are well managed by canal associations, however the majority of facilities was constructed in 1800s. They have been repaired, repeatedly and used until now. The decrepit facilities has increased the maintenance cost and work. It is time to rehabilitate the entire irrigation system.

The plan for water quality improvement and rehabilitation of the existing irrigation facilities intends to have applicable contents to the other areas as a model

project on improvement of deteriorated agriculture environment which metropolitan agriculture is facing at present.

On water quality improvement, either center type or block type is selected as the sewage treatment method according to sewage treatment capacity and capability. In case of Mallarauco, a block type treatment system is selected because a certain level of water quality is to be secured by operating EMOS's treatment facilities in the future, and large scale and high cost facilities are not favorable for model project. Treatment method is planned for each project area based on the conventional activated sludge method, considering treatment capacity and capability. The volume of sewage treatment corresponds to the amount of water determined by water right (Acción) in each area. On the canals in each project area, the existing canals are to be rehabilitated and used principally.

(3) Improvement area of irrigation water quality

Improvement area of irrigation water quality that F/S is to be implemented is selected according to the following standards which focus on appearing improvement effect, considering characteristics of water quality improvement project as a model.

- 1) Areas are independent on their irrigation and drainage systems
- 2) Easy diversification of crops by water quality improvement
- 3) Large number of beneficiaries including small scale farmers

From the point 1), proposed sites of water quality improvement areas are Pervin irrigation area where farmland extends from an intake point up to a tunnel, parts of Sur, Norte, Santa Ana and Higuierillas irrigation areas where irrigation areas extend on the place where canals pass through small valley and farm ditch, and Reforma irrigation area where surrounded by streams (Estero). Perennial crop cultivation such as fruits trees is mainly in the upstream Sur and Norte. From the point 2), irrigation areas which extend in the lower basin than middle basin can be selected. From the point 3), El Quillay irrigation area in the upstream Norte irrigation area, Los Carrera in Sur irrigation area, Reforma irrigation area and Santa Ana irrigation area can be proposed.

Five areas are selected according to criteria that areas are independent on their irrigation and drainage systems among the proposed water quality improvement areas mentioned above. Major indicators relevant to agriculture in each area are as follow.

Area	Irrigation Area	Area (ha)	No. of Farm household			Total	Crop
			Large Scale	Medium Scale	Small Scale		
Pervin	Pervin	676	4	5	26	35	Annual
El Quillay	Norte	248	-	-	18	18	Perennial
Los Carrera	Sur	196	-	-	24	24	Annual
Reforma	Reforma	716	-	17	53	70	Annual
Santa Ana	Mansano	531	3	10	25	38	Annual

Pervin and El Quillay areas are excluded from F/S areas because Pervin area is mostly occupied by farmland of large scale farmers, and in El Quillay area, although there are many small scale farmers, main cultivation crop is fruit tree at present. Accordingly, F/S on agricultural water improvement project in Mallarauco canal system is to be undertaken in Las Carrea, Reforma, and Santa Ana.

2.2.2 Agricultural Production Plan

(1) Cropping system

From agricultural view point, main purpose of water quality improvement plan in Mallarauco area is that producers, especially small scale producers can gain higher income from their farming through making intensive cropping system and crop diversification possible. The second important point in the plan is influence derived from the construction of sewage treatment plants. That is to say, as a result of sewage treatment plants' construction, introduction of technical irrigation systems such as drip irrigation and sprinkler irrigation can realize because water distribution is made by pressure conveyance method using pump facilities.

Crop diversification, in reality, boosts vegetable cultivation of prohibited kinds by using contaminated water mainly from the Mapocho river. Introduction of mechanized irrigation system is predominantly reflected in increase of orchards. This result enables small scale farmers to introduce high level intensive cultivation and highly profitable crops (vegetables which are prohibited to grow at present) as well as medium and large scale producers.

Considering distribution of water improvement areas and the purpose of the plan, expected effects of the plan must be important for small scale farmers, and proposed crop cultivation mainly focuses on expansion and diversification of vegetable cultivation. This is because vegetable would be the most profitable crop for small scale producers if water quality improvement is possible. Fruit tree growing requires capital and production scale which small scale farmers cannot afford. Actual prices of milk products cannot make high profit under management scale and technical level of small scale farmers. Based on the consideration above, a proposed cropping system for small scale farmers is shown in the table below.

Crop	Cereal		Vegetable					Forage	Fruits Tree			Subtotal	Pasture & Others	Total
	Wheat	Traditional Potato	Swiss chard	Onion	Cabbage Melon	Broccoli Cauliflower	Total		Alfalfa	Avocado	Lemon			
Small Scale Farmer (ha)	0.5	0.5	1	1	1	1	4 (6)	2	0.2	0.2	0.4	7.4	2.0	9.4 (11.4)
%	5.3 (4.6)	5.3 (4.4)	10.6	10.6	10.6	10.6	42.4 (52.6)	21.2 (17.5)	2.2	2.2	4.3 (3.5)	78.6	21.4	100

In case of two vegetable cultivation, for example, combinations of cabbage and melon, broccoli and cauliflower, double cropping is possible. This has same meanings with that new farmland area for one cropping is added to the present farmland. If there is this additional effect, it is shown in () in the table above. In the present cropping system of small scale farmers, the ratio of vegetable cultivation increases from 8.6 % at present to 52.6 %. Potato is usually classified as *Chacra* or "the traditional crop," however in areas such as Mallarauco, it is an intensive cultivation crop as well as vegetable. Water quality improvement is required to reach this intensive level. Among proposed vegetables, three of them, Swiss chard, cabbage and cauliflower, are prohibited to cultivate under the present situation but have high marketability. The other three vegetables and potato are indirectly affected by water quality. On vegetable selection for Reforma area, there is a constraint against vegetable cultivation that drainage is relatively poor, compared with the other areas. Alfalfa is important in the meaning of that it can be included in land rotation and is a rational and highly profitable crop. Cereal crops which are represented in wheat is also important crop for completing the crop rotation and self-consumption for small scale farmers. In case of small scale farmers, fruit growing has an effect mainly as a kitchen orchard. For average small scale farmers, the area of pasture and the other relatively low profitable crops is to be reduced in the plan.

In case of average medium and large scale farmers in irrigation areas, orchards are given priority on water use, considering advantage of improved water quality. The proposed cropping system for medium and large scale farmers is described in the table below.

Crop	Cereal	Vegetable	Fruits tree			Seed production	Sub total	Pasture & Other	Total
	Maize	Melon	Avocado	Lemon	Total				
Large/ Medium Scale Farmers (ha)	2.0	3.0	9.0	7.0	16.0	2.3	23.3	2.0	25.3
%	7.9	11.9	35.5	27.7	63.2	9.0	92.1	7.9	100

Fruit growing in the cropping system is planned to occupy 63.2% of total farmland. In detail, avocado and lemon occupy 35.5% and 27.7%, respectively. Melon is cultivated in 3ha, and seed production occupies 2.3ha. On seed production, F1 hybrid vegetable seed which can be expected high profit is planned. Pasture and other relatively low profitable crops are planned to reduce from 20% to less than 8%.

(2) Farm income

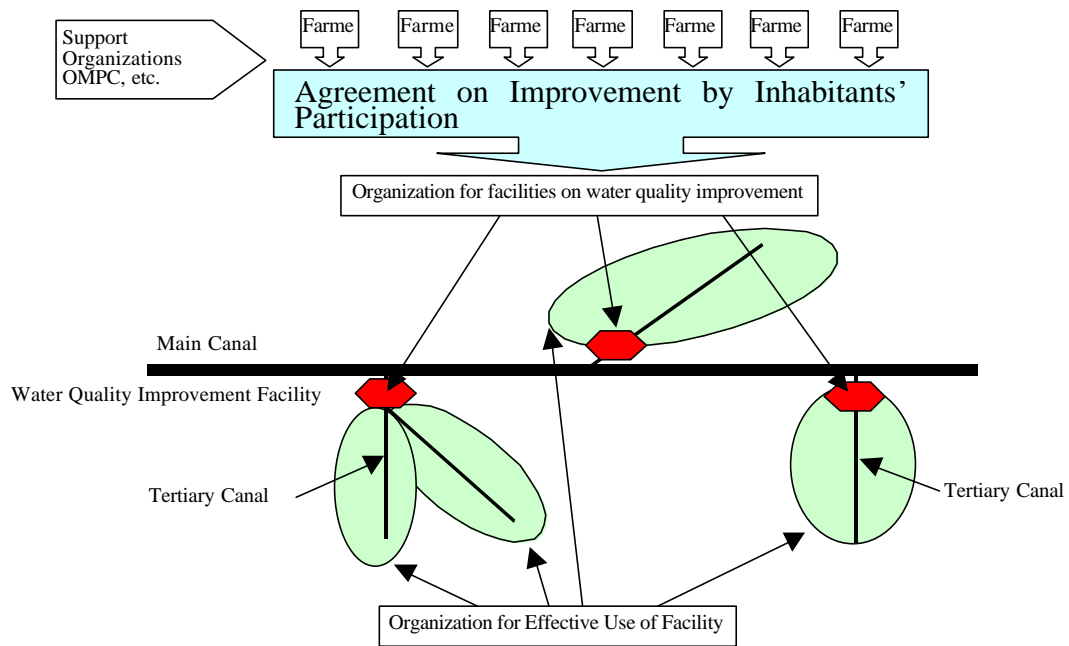
Farm income on the proposed cultivation crops for average small, medium and large scale farmers is shown in the table below.

Small Scale Farmers			Large/Medium Scale Farmers		
Crop	Farmland Area (ha)	Farm Income (\$ 000)	Crop	Farmland Area (ha)	Farm Income (\$ 000)
Wheat	0.5	150	Maize	2.0	1,000
Potato	0.5	400	Melon	3.0	5,100
Swiss Chard	1.0	1,300	Avocado	9.0	11,700
Onion	1.0	2,000	Lemon	7.0	7,000
Cabbage-Melon	1.0	1,200	Seed production	2.3	4,600
Broccoli-Cauliflower	1.0	1,500	Forage	2.0	200
Alfalfa	2.0	1,000	Total	25.3	29,600
Avocado	0.2	200			
Lemon	0.2	160			
Forage	2.0	200			
Total	9.4	9,710			

2.2.3 Agricultural Supporting Plan

In order to promote socio-economic self-independence of the area, establishment of organizations of farmers, who are beneficiaries, is indispensable. The base for regional agricultural development is established by realizing diversification of agricultural production through improvement of water quality for irrigation. Establishment of beneficiaries' organization is indispensable as a nucleus body to promote the materialization of project in the objective area and to use improved irrigation water effective and accelerative. For this, the consensus on improving the present situation should be achieved by inhabitant's participation.

Based on the consensus for improvement, following two organizations are required to be established as principal nucleus body of beneficiaries; 1) an organization for facilities on water quality improvement and 2) an organization for effective use of facilities (promotion of agricultural development by INDAP services and so on) A flow of the project promotion system is summarized as the figure below.



(1) Setting of mutual consensus

The beneficiaries of the project in the study area are mostly small scale farmers according to the structure of regional society. Participation of inhabitants as democratic procedure is indispensable at every stage of the project because the contents of the project directly connect with the interest of objective farmers. Participation of farmers is to be implemented in accordance with the purpose of each stage by following activities such as a conference with experts (INIA, universities, private consultants and so on), discussion among representatives of farmers, and a workshop among farmers and experts. Participation of farmers in these activities leads to deepening farmers' understanding against the project and promoting the establishment of identity as the regional inhabitants. Moreover, this also creates derived effects such as growing regional leaders and providing accurate information for farmers.

In case of Mallerauco, improvement of the present situation will be accomplished through securing the sound irrigation water in quality and the release from the regulation of vegetable cultivation. Therefore, construction of facilities on water quality improvement and rehabilitation of irrigation facilities are set up as the principle projects. Accordingly, consensus on the project implementation of farmers are indispensable to promote these projects. The process on setting of mutual consensus is proceeded as follows;

- 1) Motivating: regarded the necessity of the project, the implementation system of the project, right and duty of beneficiaries based on the present situation
- 2) Problem finding: finding the problems to be changed, setting the purpose of the project, and then clarifying the subjects to be struggled for solving the problems
- 3) Analysis of the plan: analysis and appraisal of the project including alternatives to solve the problem or achieve the purpose
- 4) Determination of the plan: based on the comparative analysis of the alternatives, corresponding with the projects which are other projects such as water use plan at the terminal system, water management plan, and farming plan, determining the final plan, and then, setting of mutual

consensus of beneficiaries on the project

In the procedure on setting of mutual consensus among the beneficiaries, the most important part is the first part, “motivating.” Because this part has been lacking in the agricultural support plan so far, sufficient consensus has not been formed and the plan has broken down.

The agricultural support plan in the project strengthens this part stated above. OMPC is regarded as the go-between organization between beneficiaries and the project plan. Based on the cooperation of external supporters (INIA, universities, private consultants and so on) employed by OMPC, the workshop for “motivating” will be held through JJVV and UV.

After 2) of the procedure on setting of mutual consensus is mainly carried out by beneficiaries and external support agencies concerned. Consulting fee is supported by OMPC and the beneficiaries will pay about 10% of it. The burden of the beneficiaries is clarified at the stage of “Motivating.”

Based on the procedure of setting of mutual consensus mentioned above, two types of organization are to be established. One is for facilities on water quality improvement and another is for effective use of facilities.

(2) Organization for facilities on water quality improvement

In Mallarauco area, because whole irrigated area is managed by *Asc. Canalista Mallarauco*, it does not need to form new organization to promote the project. This canal association is utilized as the organization to promote the project. Nevertheless, as for operation and maintenance of facilities on water quality improvement, an independent section in the existing organization structure of canal association is established for smooth operation of facilities.

Concerned Project	Organization	Promotion Body
Water Quality Improvement for Irrigation	Section of O & M of Facility	Mallarauco Canal association

(3) Organization for effective use of facilities

Service system provided by the INDAP will be applied for technical and financial support services to the producers’ groups for improvement of farming and for utilization of improved irrigation water at the field level. Various producers’ groups are expected to be organized due to diversification of cultivation crops by water quality improvement. An advisor is to be employed through OMPC’s arrangement for organizing producer’s groups.

To accelerate the project implementation of INDAP, SAL, SAP or SAE is to be applied for elevation of function on production cooperatives.

Existing producers’ groups and newly organized groups are as follow.

Groups	Name of Group
Existing Producers’ Groups	Citrus Group
	Milk Collecting Organization
New Producers’ Groups	Water Users’ Association
	Grapevine Group
	Horticulture Group
	Avocado Group
	Cereals Group
	Multiple Production Group
	Rural Women Production Group

(4) Installation of base facility for agricultural support

Many of *UV* in Mallarauco area do not have base facilities for meeting and training. Thus, it is impossible to communicate smoothly among inhabitants, and this leads to difficult environment for establishment of fundamental organizations aiming at improvement of present agricultural situation. Thus, it is indispensable to construct the base facilities for vitalization of *UV* activities and smooth communication among regional inhabitants. This base facility is named as Communication Center for *Unidad Vecinal* (CECUV) and is constructed in each *UV*. Based on these facilities, beside promoting the activities for unity by small scale farmers, promotion of regional self-government, improvement of living environment, training and lectures on living and producing skills, and training of rural women for self-independence will be taken place. Through these activities, self-independence of *UV* will be promoted.

Functions of CECUV are promotion of communication, of support activities for farmers, and of self-independence of rural farmers. They are as follows;

- Promotion of regional communication
 - 1) Improvement of rural living environment
 - 2) Activation of communication among regional inhabitant
 - 3) Operate and maintenance of regional social infrastructure
 - 4) Participation of inhabitants in the plan for living environment improvement
 - 5) Providing the place for medical and health service
 - 6) Promotion of cultural activities for regional inhabitants and young generation
 - 7) Cooperation with OMPC

- Promotion of support activities for farmers
 - 1) Extension and enlightenment about agricultural and livestock farming's technology
 - 2) Extension and enlightenment about irrigation technology
 - 3) Promotion of uniting activities by small scale producers
 - 4) Providing the place for a training course of farming improvement
 - 5) Enlightenment about self-independence and promotion of rural women
 - 6) Providing an office for a producers' organization
 - 7) Interchange with producers' organizations in the other areas and exchange of information

Among agricultural support activities, promotion of uniting, enlightenment and technical guidance of agricultural support activities are undertaken by advisors organized by SECPLAC through cooperation with external support organizations (INIA, universities, private consultants and NGOs). These advisors make their rounds and give guidance in each CECUV, *Communa*. The contents of uniting promotion, enlightenment and technical guidance provided by SECPLAC are summarized as follow.

Agricultural Production	Economic Activity and Management	Living Improvement
- Guidance for organization	- Guidance of farm management	- Guidance & training on house works
- Guidance of cropping season	- Guidance of income generation	- Guidance of health control
- Guidance on problem of crops	- Guidance of group activity	- Guidance of group activity
- Guidance of irrigation	- Guidance on example of advanced area	
- Guidance of fertilization	- Guidance of business and finance	
- Guidance of marketing	- Guidance of merchandize	

Facilities of CECUV are planned as the table below.

Facility	Size (m ²)
Training room	48.6
Meeting Room	48.6
Administration office	12.2
Producers' Organization Office	72.9
Storage	12.2
Toilet	12.2
Total	206.7

Because Bollenar and Mallarauco UV in Mallarauco area have already had the Resident Center, agricultural support and living improvement are to be facilitated by using this center. Therefore, CECUVs which should be newly constructed are as follows.

UV	Population	Household	CECUV
Bollenar	689	2,790	-
Mallarauquito	250	986	1
Pahuilma	480	1,871	1
Mallarauco	688	2,498	-

2.2.4 Agricultural Infrastructure Development

(1) Proposed areas

Three areas, Los Carrera, Reforma and Santa Ana, are selected as the agriculture promotion areas by water quality improvement, and the improvement of existing irrigation facilities is also planned bringing about water quality improvement in the areas. Irrigation area, duty of water and irrigation methods of the proposed areas are as follow.

Area	Irrigation Area (ha)	Water-Right		Irrigation Method
		No. of <i>Acción</i>	Water requirement (l/sec)	
Los Carrera	135.2	15.6488	125.19	Furrow
Reforma	488.5	67.932	543.46	Furrow
Santa Ana	418.7	53.7163	429.73	Furrow
Total	1,042.5	137.2971	1,098.38	

Note: Irrigation Area is measured from 1/10,000, Water requirement is based on 8 l/sec/Right

Reforma area takes water by dam-up the Higuerrillas canal, which is the drain of Mallarauco irrigation area and distributed irrigation water to three canals, Norte, Centro and Sur. Among these, a confluent section of the Sur canal is not included in the proposed area for water quality improvement because it joins with the other water system in the downstream reach. Irrigation area by canal system and number of water right (*Acción*) of the Reforma area are as follows, and their locations are shown in Figure 2.2.1.

Area	Irrigation Area (ha)	Water-Right	
		No. of <i>Acción</i>	Water requirement (l/sec)
Reforma	Reforma Norte	172.8	24,816
	Reforma Centro	246.1	33,016
	Reforma Sur	69.8	10,010
Total	488.7		543.46

(2) Sites of water quality improvement facilities

Water treatment plants are basically to be constructed around the present intake facilities. Because the canals in Los Carrera and Santa Ana are located in higher elevation than the proposed irrigation area, the plant sites are selected according to the plan of treated water distribution by gravity method. In both Reforma and Santa Ana areas, because the canals are located in the lower elevation and irrigation areas are flat land, treated water needs to be conveyed to the existing canals by pumping up. The sites of water treatment plants in each area are planned as follow.

Area	Location		Planned Plant Size (ha)	Summary of Site
	Longitude (W)	Latitude (S)		
Los Carrera	30 ° 52 00	62 ° 79 50	4.00	Right bank of Sur canal, High location in East of the area
Reforma	30 ° 26 00	62 ° 83 40	7.00	Reforma diversion, Right bank of Higuierillas canal
Santa Ana	30 ° 24 00	62 ° 85 00	7.00	Upstream of the target area, Left bank of Santa Ana canal

Geologically, treated water can be distribute by gravity method since the proposed site of treatment plant in Los Carrera area is located in the higher position of the irrigation area. Because treated water of Reforma and Santa Ana have the lower discharge level than the existing canals, it needs to be pumped up for irrigation use.

(3) Irrigation facility improvement

1) Treatment capacity and duty of water

Treatment capacity of the water treatment plant is determined by treatment capability. Thus, the treatment capacity is set by the discharge of water right mentioned above. Up to the degree of load on inflow discharge, it is adjustable to a certain level of discharge change by selecting number of treatment tanks.

Unit water requirement is calculated in accordance with the cropping pattern by farming scale proposed in the production plan of Mallarauco area. Preconditions of calculation are as follows;

Effective rainfall : estimated by SCS method using rainfall on 85% exceedance probability

Irrigation efficiency : field level; furrow irrigation 50 %, california type 60%, drip irrigation 90 %, canal level 80 %

According to the conditions mentioned above, the summary of unit water requirement by farm sizes at the intake point is as follows. Details are shown in Table 2.2.1

Type	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9 ha	mm	107.69	79.06	52.10	32.60	3.41	0.02	0.00	25.30	91.88	170.57	208.08	192.10	962.80
50 ha	mm	136.30	98.61	70.70	45.89	4.11	0.00	0.00	21.02	75.85	142.37	171.24	165.17	931.27

2) Intake facilities and other related facilities

Intake facilities of the existing main canals are planned to be rehabilitated in connection with the construction of water treatment plants. The works include increase of intake capability. The detailed plan of major facilities is as follows.

Irrigation Area	Intake facilities Improvement		Pump Facility		
	Intake water volume (m ³ /sec)	Diversion Gate Height x Width (m)	Pump Head (m)	Dia. of Pump (mm)	No. of Pump (unit)
Los Carrera	0.125	0.8 x 1.0	-	-	-
Reforma	0.543	1.2 x 1.5	7.0	300	2
Santa Ana	0.430	1.2 x 1.5	7.0	300	2
Total	1.098				4

Treated water at the water treatment plant is distributed through a regulation pond of canals for adjustment the time of treatment and irrigation. The capacity of a regulation pond is determined at 6 hours considering management of plant operation and irrigation.

Irrigation Area	Treatment Capacity (l/sec)	Pond Size		
		Reservation Capacity (m ³)	Area (m ²)	Depth (m)
Los Carrera	0.125	3,000	1,000	3.0
Reforma	0.543	12,000	4,000	3.0
Santa Ana	0.430	10,000	3,500	3.0
Total	1.098	25,000	11,500	

3) Canal plan

Treated water can be conveyed to the field through existing canals. However, because the existing canals are earth canals, the main canal to the field is planned to be rehabilitated by a pipeline in order to reduce conveyance losses and to simplify the O & M of canals. The duty of irrigation water and the length of proposed pipeline in each irrigation area are summarized below.

Irrigation Area	Pipeline Extension by discharge (km)			
	0.05–0.1 (l/sec)	0.1–0.2 (l/sec)	0.2–0.3 (l/sec)	0.3–0.5 (l/sec)
Los Carrera	9.65	1.01	-	-
Reforma	11.05	3.65	2.15	0.96
Santa Ana	5.35	3.70	2.14	4.16
Total	26.37	8.36	4.29	5.06

The diameters of pipe are planned under the condition of 1.0kg/cm² of water head at the diversion points, considering conveyance losses to the irrigation areas. The required diameters of pipe are shown in the table below.

Irrigation Area	Pipe Diameter by Flow Scales (mm)			
	0.05–0.1 (l/sec)	0.1–0.2 (l/sec)	0.2–0.3 (l/sec)	0.3–0.5 (l/sec)
Los Carrera	ø150	ø250	-	-
Reforma	ø150	ø250	ø400	ø700
Santa Ana	ø150	ø250	ø400	ø600

4) Rehabilitation of existing irrigation facilities

Among the proposed areas for water quality improvement, the intake weir of Reforma area is required to be rehabilitated. Irrigation water for Reforma area is taken by dammed up the Higuerrillas drain (the natural river). The weir of Reforma is planned to rehabilitate.

- Flood discharge of the Higuerrillas river

The Higuerrillas river runs in the low flat plain of Mallarauco area, and rainwater in the basin flows into the Higuerrillas river. Flood discharge at the weir site is estimated at 142m³/sec with 2% probability of exceedance.

- Structural design of the weir

The Higuerrillas river flowing in the low flat land is usually dammed up by wooden fixed gates, but when the flood is occurred, the gate is removed for release of excess water. The wooden gates is planned to be changed to the steel sluice gate in order to simplify O & M. The size of gate width (closing width), gate height and intake gate width is shown in the table below.

	Discharge (m ³ /sec)	Gate Width (m)	Gate Height (m)	No. of Gate	Gate Structure
Higuerillas-Main: Gate-1	81.0	2.5	2.8	2	Steel Gate
Higuerillas-Main: Gate-2	67.5	3.0	2.6	1	Steel Gate
Intake Gate	0.55	1.0	1.5	1	Steel Gate
Intake Gate	0.30	0.6	1.0	1	Steel Gate

5) Plan for field irrigation

Treated water is to be conveyed by pipelines considering the high cost of treated water. Changing canal structure to pipeline is important because it can prevent inflows of contaminated water into canals at flood time. Drip and micro-sprinkler can be used in the field since 1.0 kg/m² of water head can be obtained from tap of the pipeline.

Agricultural infrastructure development plan is shown in Figure 2.2.1.

2.2.5 Rural Infrastructure Development Plan

In the rural infrastructure development plan is promoted through promoting regional agriculture and increasing comfort and safety of inhabitants in the area from the point of settlement. Accordingly, the parts of rural infrastructure where are not well proceeded will be mainly improved based on the analysis of present situation.

On road improvement, plan is put stress on the establishment of road networks in the area. Trunk roads are to be paved up to the center of each community. On lateral roads, new connection roads between lateral roads are to be constructed and improvement level is targeted for vehicle traffics. Community sewage treatment facilities are to be constructed mainly in the center of each UV for living and production environment conservation. As for the treatment facilities, high operation technique and special chemical treatment should be avoided because O & M of treatment facilities are to be handled by community members. Treated water is to be able to reuse for agriculture. The target of treatment level is less than 30 mg/lit. on BOD and less than 1,000 MPN on coliform groups.

CECUV is established for technical support on agriculture in the area, and providing the place for fostering agricultural successors, meeting of inhabitants, various subjects of lectures and rural women's activities and so on. Obtaining the space of each producers' group for technical support in the center expects to result in effective support services and technology transfer.

Based on the survey of the present situation and the improvement plan of irrigation facility, required items and quantity for improvement of rural living environmental are shown in the table below. General plan of rural infrastructure improvement is shown in Fig. 2.2.2.

Improvement Item		Mallrauco Area		
Road	Trunk road pavement	4 routes	L= 10.2 km	W= 6.0
	Lateral road improvement	1 route	L= 6.6 km	W= 5.0
	Construction of new lateral road	1 route	L= 9.4 km	W= 5.0
Rural sewage treatment facility		4 sites		
	Bollenar		2,790 persons	Ø150 L= 34 km
	Mallarauquito		986 persons	Ø150 L= 27 km
	Pahuilma		1,871 persons	Ø150 L= 35 km
Community center (CECUV)				
		2 sites		
		210 m ² / site		
		Mallarauquito, Pahuilma		

2.2.6 Environmental Conservation Plan

(1) Water quality improvement plan

According to the construction plan of the sewage treatment plants in Santiago city by EMOS, three plants will be completed along the Mapocho river in 2024 and then the treated water of approximately 25 m³/sec will be discharged into the Mapocho river. Consequently, water quality of the Maipo river joining the Mapocho river will be greatly improved. However, according to the predicted quality of water for irrigation in the priority project area in the target year of the project (2010), water quality of the Mapocho river will be more improved than the present, the BOD value predicted by EMOS will exceed 20mg/l in 2010 with the exception of the time at minimum discharge, despite the fact that a part of the construction of the EMOS treatment plants will be completed at that time.

The purpose of the water quality improvement project in Mallarauco is to improve the contaminated water for irrigation by means of the sewage treatment plants and to create the model area for agricultural development by improvement of the rural environment and diversification of crops. It is preferable to ameliorate water in the BOD and SS values, both of which are the index of water contamination, up to the lowest value as possible, and to discharge the water. The present project, however, the object values of BOD and SS are set as 20mg/l and 30mg/l respectively, both of which are the same as the planned values in the sewage treatment plant over the Metropolitan Region. The object group number of fecal coliform is set at 1000MPN/100ml as the domestic standard, though in this project, it is set at 23MPN/100ml which is the standard number for crops for export.

1) The sewage treatment plant

The supposed quality of water discharged into the treatment plant is set at 300mg/l of BOD and 300mg/l of SS. The planned quantity of water to be treated is supposed to the maximum volume of water rights in the proposed area. The treatment method is planned the conventional activated sludge method in the case where the quantity of water to be treated corresponds to 0.2m³/sec or more, or the sequencing batch reactor process which is suitable for the middle- or small-sized plant in the case where water volume is less than 0.2m³/sec. The disinfection method by chlorine or by ultraviolet rays is known as the method to disinfect coliform bacilli. In this project, adopted is the method by ultraviolet rays by which no chlorine is remained because the treated water is directly used for irrigation water. On the basis of the methods above, the sequence of sewage treatment and list of facilities are as follows:

Flow of Treatment Process

Conventional Activated Sludge Method:	Inflow- Sand Basin- Pump Well- Primary Settling Tank- Reaction Chamber- Final Settling Tank- Disinfection Chamber- Outflow
Sequencing Batch Reactor Process:	Inflow- Sand Basin- Pump Well- Batch Reactor - Disinfection Chamber- Outflow
Design inflow quality:	BOD 300 mg/l SS 300 mg/l (1.1E+07 MPN/100 ml of fecal coliforms)
Amount of sewage treated:	0.15 m ³ /sec in Los Carrera (140 ha irrigated) 0.45 m ³ /sec in Santa Ana (420 ha irrigated) 0.55 m ³ /sec in Reforma (490 ha irrigated)
Design treated water:	BOD 20 mg/l SS 30 mg/l (23 MPN/100 ml of fecal coliforms)
Processing method:	Conventional activated sludge method in Santa Ana and Reforma Sequencing batch reactor process in Los Carrera
Disinfection method:	Method using ultraviolet rays
Site area	Los Carreras 1.5 ha Santa Ana 2.5 ha Reforma 5.0 ha

2) O & M of the plant

O & M of the sewage water plant is to be carried out by the Mallarauco canal association. Main works of O & M are as follows:

- Collecting screenings and transportation
- Grit, sludge removal and transportation
- Water quality survey
- Maintenance of facilities including garden trees and weeding.

(2) Environmental management plan

1) Promotion of environmental education in a basin

After implementation of the project, facilities related to the project will be managed by the canal association. However, at the points where canals pass through communities, it may be considered that the canals will be damaged and irrigation water contaminated by wastes, domestic sewage, and stock-farming wastes.

UV, the smallest unit of the organization for administrative support in *Comuna*, has a role of promoting to obey the hygiene regulation, carrying out the activities for the environmental hygiene, promoting the environmental conservation, and keeping the balance of ecosystem. In this project, a campaign for enlightenment and public relations are planned on the-community-basis with respect to the environmental conservation to keep high quality of water. The promotion campaign of environmental education is also planned by recommending a member of the youth group of *UV* or other groups, and farmer's groups to have a qualification to be engaged in the environmental conservation.

2) Promotion of agriculture with environmental consideration

In order to prevent environmental pollution by agriculture due to expansion of fertilizer and pesticide use and to promote the sustainable farming, skill guidance and technology transfer to farmers concerning the reduction of fertilizer and pesticide use are executed by the public organizations such as INIA. These activities are carried out on the farmers' organizations formed to obtain the agricultural support services from INDAP.

(3) Environmental Impact Assessment (EIA)

EIA System in Chile, No. 35,731, established in April 1997 provides the projects to be assessed from the environmental view. The related items in the system to the EIA System selected as the priority project for development in Mallarauco is "in case of the sewage treatment plant construction."

Environmental assessment with regard to the EIA System is conducted by the Chile side when the implementation of this project is determined definitely as a project. In the process of the assessment, the environmental factors as to the conduction of the project are investigated and predicted based on the contents of the project including the alternative plan. The predicted results and designated goal for the environmental conservation are assessed, and then the goal is achieved by preparing the measures for the goal. If the goal is not achieved, the alternative plan is predicted and assessed instead, and the goal is achieved by making measures for the goal.

With respect to the environmental influence by the construction of the sewage plant, the following items are considered by the result of scooping as to the environmental factors to be the objects to be assessed.

Air pollution	: Generation of dust from vehicles during construction stage.
Contaminated water	: Water contamination of surrounding rivers and canals during construction stage.
Noise and Vibration	: Generation of noise and vibration from plants and pumping stations during construction and operation stage.
Offensive odor	: Generation of offensive odor by sewage treatment plant operation
Wastes	: Generation of construction wastes and generation of wastes, grit and sludge after construction.

As the evaluation standard, the influence of qualitative objects is set the minimum, while water quality and noise are set as follows:

Water quality	Turbidity 50-Silica, Color 100, Temperature 30 , Transparency 1.2m, pH 6.5-8.3, Fecal Coliforms 1000MPN/100ml
Noise	45-55dB

2.2.7 Summary of Agricultural Development Plan in Mallarauco Area

Structural improvement in Mallarauco area relevant to the priority project proposed in the Master Plan of the Study is formed as following contents.

Project	Project component				
Water quality improvement project	Target area	Los Carrera	Reforma	Santa Ana	Total
	Treatment water volume (m ³ /s)	0.13	0.54	0.43	1.10
	Treatment method	Sequencing batch reactor process	Conventional activated sludge method	Conventional activated sludge method	
	Inflow quality	BOD 20 mg/l, SS 30 mg/l, 23 MPN/100ml of fecal coliforms			
	Facility area (ha)	2	6	6	14
Agricultural infrastructure development project	Irrigation area (ha)	135	488	418	1.043
	1. Improvement of irrigation canals (pipeline) (km)	10.98	17.75	15.35	44.02
	2. Improvement of intake facility (No..)	1	1	1	3
	3. Diversion facility (Nos.)	38	14	25	77
	4. Regulation pond (Nos.) (Volume m ³)	1 (3.000)	1 (12.000)	1 (10.000)	3 (25.000)
5. Pump facility (unit)	-	300 x 2	300 x 2	300 x 4	
Rural infrastructure development project	1 Road				
	Pavement of main road (km)	4 routes 10.2			10.2
	Improvement of lateral road (km)	1 route 6.6			6.6
	Construction of lateral road (km)	1 route 9.4			9.4
2 Rural sewage treatment facility (Nos.)	4			4	
3 Community center (Nos.)	2			2	

General development plan in Mallarauco area is shown in Figure 2.2.3.

2.3 Project Cost

2.3.1 Basic Conditions of Cost Estimation

Project costs are estimated at the price level as of December 1998 based on the results of field survey regarding the costs of labor, construction materials and equipment. Basic conditions of cost estimation are as follows.

(1) Construction cost

Construction works is executed by the contractor with contract basis. Since contractor prepares construction materials and equipment, which are necessary to execute the works, costs of construction materials and equipment are estimated by depreciation cost. Referenced materials for construction costs are as follows.

- Cost of Corrales project which were executed by DOH (December/'98)
- Commodity price book published by ONDAC (December/'98)
- Prevailing costs in Chile is used on working ratio and depreciation cost of construction equipment, depreciation cost for temporary works.
- Cost for equipment of sewage treatment facilities is employed based on estimation results of manufacturers in Japan.

(2) Component of project cost and ratio applied for estimation

Component and ratio of indirect costs of the project against direct construction cost are assumed as follows.

- Project cost consists of preparation cost, direct construction cost, engineering and administration cost as well as physical contingency.
- Direct construction cost includes overhead and profits.
- Engineering and administration cost is assumed as 10% of direct construction cost.
- Each cost is divided into local and foreign currency portions. Labor costs and materials such as sand, aggregate, are assumed as local currency portion and others are foreign currency portion. Physical contingency is 10% of total costs from direct construction cost to engineering and administration costs.
- Price escalation is assumed as 5% of inflation index.
- Land acquisition and compensation costs are applied 600 to 1000 thousand pesos per ha based on kind of land.
- Operation and maintenance cost is estimated separately as the Operation and maintenance cost of canal association for water management.

2.3.2 Project cost

Project component consists of water quality improvement, rehabilitation of existing irrigation facilities, rural infrastructure improvement and installation of facilities for agricultural support. Entire project cost is estimated at 264 billion pesos as shown in the table below. Details of the construction cost is shown in Table 2.3.1. While, disbursement schedule of the project is shown in Table 2.3.2.

Component	Unit: Thousand Pesos.		
	F.C	L.C	Total
1. Preparation cost	590,845	360,008	950,853
2. Water quality improvement / Irrigation facility improvement cost			
Sewage treatment plant facilities	11,114,356	7,123,208	18,237,564
Irrigation facility improvement	692,540	276,956	969,496
3. Rural infrastructure and Agricultural support facility development cost	624,530	838,323	1,462,853
4. Land acquisition and compensation cost		15,442	15,442
5. Engineering and administration cost	861,169	1,416,907	2,278,047
6. O&M equipment cost	121,577	45,000	166,577
7. Physical contingency (10%)	1,391,470	1,007,279	2,398,743
8. Total	15,306,167	11,080,070	26,386,171

2.4 Implementation Schedule of the Project

2.4.1 Executive Agencies

Agricultural development project in Mallarauco area is defined as the project which farmers apply for. The project is executed within the government subsidy regulation system for irrigation project. Therefore, the executive agencies of the project are divided into two based on the project scale. Water quality improvement project is executed by DOH in accordance with Government ordinance No.1123 and the rehabilitation project of irrigation facilities is executed by CNR in accordance with Law No.18450. Regarding construction of sewage treatment plants, proposed standard of water quality and structure, and water quality examination after completing the construction works are managed and implemented under the guidance of CONAMA.

2.4.2 Burden of the Project Cost (Source of Funds)

Among these projects, in case of water quality improvement, maximum 70% of the project cost is paid by national government subsidy under Government ordinance No. 1123 and the rest of it is paid by beneficiaries. However, the burden of Santiago City, which is the cause of pollution and also the nation, should be examined. On the other hand, in case of rehabilitation project of existing irrigation facilities, maximum 75% of the project cost is paid by the national government subsidy under the Law No. 18450. Beneficiaries pay the rest of it.

2.4.3 Process of the Project Implementation

(1) Agreement on the project of beneficiaries

DOH examines the project implementation after *Consejo de Riego* approved the project. DOH carries out questionnaire survey on approval or disapproval of the project for expected beneficiaries, and then confirms if more than 50% of the benefiting farmland area agrees with the project (consensus on the repayment of the project cost). DOH usually explains and collects agreement sheets directly.

(2) Implementation schedule

DOH employs consultants to execute the detailed design (D/D) with cooperation of CONAMA after confirmation of beneficiaries' agreement on participation of the project. Then, DOH promotes the project from the contract by competitive bidding among contractors to commencement of construction works. In case of tertiary canals (terminal facilities), Mallarauco canal association employs a consultant company and submit the implementation program to CNR. After approval of the project, they procure fund and implement the project.

1) Works to be carried out by consultant

DOH will entrust topographic survey, geological survey, survey for structural design and the survey relevant to the construction planning for detailed design to a consultant company. The consultant company restudy and examine the general issues on the project implementation such as the project plan and sewage treatment plants, the detail design of canals, the cost estimation, the bidding, the contract documents, and quality control of the construction. The inspection of design and execution methods of sewage treatment plants is guided by CONAMA.

2) Preparation works

Preparation works consist of the topographical survey for the detailed design, the geological survey for regulation reservoirs, and acquisition of land for facilities.

Topographical survey

- Longitudinal section, cross section and plan of site for proposed sewage treatment facilities in Los Carrera, Reforma, and Santa Ana areas (Scale: 1/500)
- Longitudinal section, cross section and plan of proposed rehabilitation canal route in Los Carrera, Reforma, and Santa Ana areas (Scale: 1/1,000)

Geological survey

- Geological survey of site for proposed sewage treatment facilities
- Drilling at 2 places of each proposed plant site
- Drilling at 3 proposed regulation reservoirs (each depth is 30m, total 90 m) and soil analysis

Required facilities for the supervision of the project implementation are prepared by the consultant and the constructor before commencement of construction works.

3) Land acquisition

The land for construction of the sewage treatment facilities, canals, regulation reservoirs and so on is acquired by the consultant through the procedure of land acquisition under the consignment of DOH. Estimated land area is as follows.

Components	Area of land acquisition (ha)
Sewage treatment facility	11.0(3 places)
Canals	4.0
Los Carrera	1.2
Reforma	1.9
Santa Ana	1.6
Regulation reservoir	3.0(3 places)
Total	18.0

(3) Construction planning

Implementation schedule of the project is planned to meet the effects of sewage treatment facility construction and canals rehabilitation at the same time.

Construction works of sewage treatment facility

In the plan, 3 sewage treatment facilities in Los Carrera, Reforma, and Santa Ana are constructed. Construction works of three sites are not executed at the same time. Construction works commence from Los Carrera whose treatment volume is small, and then Reforma and Santa

Ana. It is possible to construct the sewage treatment plants all the year round. Rehabilitation of canals is executed during winter season which requirement of irrigation is low.

- Civil works

Civil works are treatment tank of the sewage treatment plant, headrace from canals, and buildings. Main civil works are foundation excavation and concrete placing. No specified problems can be considered for execution of the works. Required equipment are mainly backhoe for foundation excavation, dump truck for conveyance of sediment, batching plant and truck crane for concrete placing.

- Installation of the sewage treatment plant

As most of materials and equipment for the sewage treatment plant is foreign made, therefore, training of equipment method, operation of equipment, and operation technique should be considered.

Canal works

The pipes are set up on a flank wall of canals at the parts where canals are utilized at present and the existing canals which are remained as a drainage canal. Concrete placing for concrete structure such as diversion facilities and so on are executed by manpower directly from the agitating truck.

Regulation pond works

Regulation ponds are constructed next to the sewage treatment facilities. A dam body is constructed by concrete wall. Concrete placing is executed by concrete mixer and truck crane.

(4) Implementation schedule of the project

Commencement of the project is scheduled at 2003 taking into account arrangement of the funds, confirmation of beneficiaries' agreement on project participation, establishment of the O & M system of Mallarauco canal association. Total implementation period is 4 years up to 2006. In the period, project evaluation and preparation for budget by the government of Chile, the enhancement of management section in the canal association, farmers' agreement on the burden of the project cost, the detailed design and the construction works will be carried out. The implementation schedule of the project is shown in Table 2.4.1.

2.4.4 Operation and Maintenance Plan

(1) O & M of water improvement facilities

1) Items of O & M

Mallarauco canal association is carried out the O & M of the projected sewage treatment plants. Main works of O & M are as follows:

- Management of operation & maintenance of plants
- Collecting screenings and transportation
- Water quality survey
- Clerical work
- Grit, sludge removal and transportation
- Maintenance of facilities including garden trees and weeding.

2) Personnel

The organization for O & M of the plants is divided into four sections, operation, maintenance, water quality and clerical work. Among them, one full-time staff who is in charge of operation and one full-time staff who is in charge of water quality are stationed at each facility. Regarding staffs being in charge of maintenance, and clerical work, two for each section are stationed and cover three plants in shift. Private companies are entrusted to dump waste and sludge. The contents of service are as follows:

Items of Management	Descriptions	Los Carrera (0.15m ³ /s) No. of persons	Mallarauco (0.45m ³ /s) No. of persons	Santa Ana (0.55m ³ /s) No. of persons	Total (No. of persons)
Operation	Inspection, monitoring, operation and recording work in water and sludge treatment facilities.	1	1	1	3
Maintenance	Repairing work and environmental control of machines, electric facilities and buildings.	1*	2*	2*	4
Water quality	Periodic analyses of sewage and sludge and instruction of change of operation of treatment processes.	1*	1*	1*	2
Clerical work	Budget, supply of materials, machine parts, vehicles, general affairs, etc.	1*	1*	1*	2

Note : Asterisk (*) means the persons who hold the position concurrently.

3) Management of sludge

The amount of sludge generated from three plants is estimated at 133 tons of sludge cake (the dry solid sludge about 26.7t/day) whose maximum water content rate is 80% per day. The sludge cake is dumped to landfill by the external private companies entrusted.

4) Analysis of water quality

Analysis of water quality is executed on water discharged into the plant, water in process of treatment, and the treated water to be discharged in order to manage water quality. The data is used for the best operation of the plants and achievement of the best quality of water for irrigation, and submitted to the related organizations.

5) Electric power for operation and management

The electric consumption for operation and maintenance of the plants is estimated for each plant based on sewage treatment capacity as follows:

Contents	Los Carrera (0.15m ³ /s)	Mallarauco (0.45m ³ /s)	Santa Ana (0.55m ³ /s)
	Electric consumption (MWH/d)	Electric consumption (MWH/d)	Electric consumption (MWH/d)
Aerator, Pumps and Disinfection facilities by ultra violet.	3.2	5.5	6.7

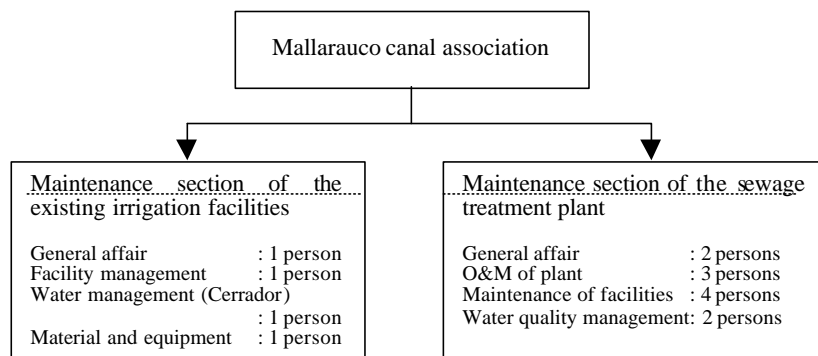
(2) O & M of rehabilitation canal

Because the canal is pipeline, water is distributed by pumping irrigation system. Therefore, those who hold water right have to submit annual planting schedule to canal associations as O & M of pump operation, and water distribution is planned based on the farming scale. O & M of canals and a pump are carried out by Mallarauco canal association. Water management will be carried out by the present Cerrador as it is. O

& M of irrigation pump is included in the O & M works of sewage treatment plant.

(3) O & M organizations

O & M of canals and water management are carried out by Mallarauco canal association. The present works and roles of Mallarauco canal association are management of canal structures and diversion, but O & M of the plant facilities and water quality management mentioned above are added. Therefore, the organization of canal association will be expanded as follows.



(4) O & M cost and it's burden

O & M of the existing irrigation facilities and water management in Mallarauco area are carried out by Mallarauco canal association. Its O & M cost is collected based on unit of *Acción*, and 1 *Acción* is 63,000 pesos. O & M cost of the sewage treatment plant facilities is summarized as follows.

Items of expense	Items of O&M	Expense (pesos)
Personnel expense	11 persons : permanent	70,380,000
Electric charge for operation	15.4MWH/hr. (Full operation for 6 months, Half operation for 3 months)	174,636,000
Maintenance cost of facilities	Repair of machine etc.	103,000,000
Sewage treatment cost	Maximum daily treatment volume 26 ton	12,150,000
Total		360,166,000

Number of water right or *Acción* of Mallarauco area is 137. Total O&M cost is estimated at 360,166,000 pesos and per 1 *Acción* as 2,628,000 pesos.

2.5 Development Impact and Evaluation

2.5.1 Project Evaluation

(1) Basic assumption

- 1) The economic life of the facilities is 30 years after completing them. Replacement costs for gates and machinery will be appropriated after 20 years from when the project works are completed.
- 2) All prices are shown in 1998 prices in Chilean pesos.
- 3) Evaluation is made on financial and economic aspects. Market prices and economic prices are used for financial evaluation and economic evaluation, respectively.
- 4) Economic evaluation of the project requires conversion of market prices to economic prices. For this purpose, adjustment factors provided by the Chilean Planning Ministry consisted of the following:

Foreign currency	1.06	Skilled labor	1.00
Semi-skilled labor	0.65	Unskilled labor	0.85
Social Discount Rate	12%		

In addition, tariff of 11% and value added tax of 18% are excluded as transfer expenditure.

(2) Benefits

- 1) Quantified benefits in the Mallaauco project area include increase of agricultural production and environmental benefits, the latter consisting of BOD reduction.
- 2) Agricultural benefits in the Mallaauco project area is the incremental benefits of \$692,777/ha stemming from changes in cultivation crops.
- 3) Transformation of agricultural benefits to economic prices is made by applying the standard coefficient of transformation. Production cost is classified into foreign and local currency portions. Coefficient of transportation for foreign currency applies to foreign currency portion after excluding tariff and value added tax. On the other hand, in case of local currency portion, coefficient of transportation applies to personnel expenses excluding value added tax, and ratio of personnel expenses is 25% of local currency portion. The rest of local currency portion, 75% is cost of input material and equipment, and coefficient of transportation applies to it after excluding value added tax.
- 4) Benefits from BOD reduction are estimated as follows:
 - The sewage treatment plants in Mallaauco area are planned to reduce BOD for irrigation water of 1.15m³/sec from 300mg/l to 20mg/l. This means that present BOD concentration is to become 1/15.
 - In other words, 15 times water for dilution requires against the present Mallaauco irrigation water.
 - Because water required for irrigation is estimated at 1liter/sec/ha, the water required for dilution (15m³/sec) has the potential to irrigate 15,000 ha.
 - The present benefit of agricultural production in Mallaauco is estimated at \$373,407/ha. If it multiplies by 15,000 ha, the potential agricultural benefit of water for dilution is \$5,601.1 Million. If the treatment plants were assumed to operate at 80% annually, the potential agricultural benefit is \$4,480.9 Million.
- 5) In case of transforming the items which cannot be classified into foreign or local currency portion into economic prices, standard coefficient of transformation, 0.96 which is used in Chilean foreign trade data is applied.

Accordingly, the benefits in market prices and economic prices are shown in the table below.

Benefits	Market Prices	Economic Prices
Agriculture	\$692,777/ha	\$1,112,724/ha
Environment	\$4,481 million	\$4,302 million

(3) Costs

Project cost in market prices is the cost which was estimated in the previous chapter, "Project Cost." For transformation of the project cost into economic prices,

the project cost is divided into foreign currency portion and local currency portion. The project cost is classified into foreign and local currency portions. Coefficient of transportation for foreign currency applies to foreign currency portion after excluding import tariff and value added tax. In case of local currency portion, coefficient of transportation applies to personnel expenses excluding value added tax. The ratio of personnel expenses is 20% of local currency portion. The rest of local currency portion, 80% is cost of input material and equipment, and coefficient of transportation applies to it after excluding value added tax. Land acquisition cost is excluded from economic prices.

Accordingly, the project cost in market prices and economic prices are shown in the table below.

	Market Prices (\$ Million)	Social Price (\$ Million)
Project cost	25,318	19,777

(4) Evaluation

The results of evaluation indicates net present value(NPV), benefit cost ratio (B/C), internal rate of return (IRR) at social discount rate of 12% are shown below.

Evaluation	IRR (%)	NPV (12%) \$ Million	B/C (12%)
Financial	15.2	3,629.4	1.2
Economic	20.5	8,030.6	1.7

(5) Sensitivity Analysis

Sensitivity analysis is made about the case that cost increases by 10% and the benefits decreases by 10%, simultaneously. As shown in the table below, even in case that increase of cost and decrease of benefit are occurred at the same time, internal rate of return (IRR) of the project exceeds 12% of social discount rate.

Sensitivity Analysis	Internal Rate of Return (IRR)	
	Economic	Financial
1. Base Case	20.5%	15.2%
2. Cost Increase: + 10%	18.8%	13.8%
3. Benefit decrease: -10%	18.6%	13.6%
4. 2 + 3	17.0%	12.2%

2.5.2 Financial Analysis

The effects of the project are examined from improvement of farms' income and expenditure brought about agricultural development, and repayment and O&M cost of the project cost relevant to each farm based on farm income and expenditure of typical farmers, seeing the table below. The repayment of the project cost by farmers is estimated in cases of that they did not receive subsidy for the project, that they received 75% subsidy, and that they received 90% subsidy. Repayment condition is set up that repayment term is 20 years and interest rate is 12%. Annual O&M cost does not depend on subsidy.

Item	9ha	25ha
Mallarauco area		
Landholding area (ha)	9.4	25.3
Number of farms	84	10
Project cost	\$19,021,665,452	\$6,094,834,548
O&M cost	\$344,967,197	\$110,532,803
Project cost/farm	\$226,448,398	\$609,483,455
O&M cost/farm	\$4,106,752	\$11,053,280

to be continued

Item	9ha	25ha
Farm income and expenditure		
Gross income	\$22,410,773	\$52,767,116
Production cost	\$12,700,773	\$23,167,116
Net income	\$9,710,000	\$29,600,000
Living expenses	\$1,800,000	\$2,400,000
Agricultural revenue	\$7,910,000	\$27,200,000
Without subsidy		
1. Repayment of project cost /year/farm	\$30,316,635	\$81,596,901
2. O&M cost/year/farm	\$4,106,752	\$11,053,280
3. 1+2/year/farm	\$34,423,387	\$92,650,181
4. Agricultural revenue/year/farm	\$7,910,000	\$27,200,000
5. Surplus/year/farm	(\$26,513,387)	(\$65,450,181)
With 75% Subsidy		
1. Repayment of project cost /year/farm	\$7,579,159	\$20,399,225
2. O&M cost/year/farm	\$4,106,752	\$11,053,280
3. 1+2/year/farm	\$11,685,911	\$31,452,505
4. Agricultural revenue/year/farm	\$7,910,000	\$27,200,000
5. Surplus/year/farm	(\$3,775,911)	(\$4,252,505)
With 90% Subsidy		
1. Repayment of project cost /year/farm	\$3,031,664	\$8,159,690
2. O&M cost/year/farm	\$4,106,752	\$11,053,280
3. 1+2/year/farm	\$7,138,416	\$19,212,970
4. Agricultural revenue/year/farm	\$7,910,000	\$27,200,000
5. Surplus/year/farm	\$771,584	\$7,987,030

In case of Mallarauco area, it is impossible to repay if subsidy for the project cost is 75%. Annual deficiency of 9ha holding farmers and 25ha holding farmers are \$3,775,911 and \$4,252,505, respectively. If subsidy for the project cost is 90%, annual surplus of 9ha holding farmers and 25ha holding farmers are \$771,584 and \$7,987,030, respectively. Accordingly, in case of Mallarauco area, if farmers receive 90% subsidy for the project cost, farmers who hold any scales of farmland would have the ability to repay the burden of the project cost and pay for O&M cost.

2.5.3 Other Development Impact

By the project implementation, following socio-economical impacts is expected in addition to the benefit estimated by financial and economical evaluation. The effect of the project implementation will be borne by following condition;

- Inhabitants' will to improve the present situation
- Promotion of the project by participation of inhabitants
- Support organization system for realizing the will of improvement
- Improvement of irrigation water quality and advancement of land use
- Activation of agriculture by improvement of irrigation water, advancement of land use and improvement of farming technique
- Advancement of product marketability and promotion of diversification
- Activation of the area based on the community center (CECUV)
- Establishment of sustainable operation of the area and agricultural system considering environment.

Main expected socio-economical impact by the project implementation is as follows;

(1) Creation of the solidarity among inhabitants

In the process of the project, the beneficiaries themselves are to participate the plan for improvement of the present situation, and consensus on the goal of better improvement is formed. As a result, solidarity of inhabitants is created. Based on the solidarity of inhabitants, it is expected that mutual confidence of farmers, who are easy to be isolated, is created and then motivation of creating various organizations such as producers' cooperation is formed.

(2) Diversification of agricultural products

Water quality improvement of irrigation water is expected to bring about diversification of agricultural products such as fruits and vegetables and that small scale farmers can carry out high profitable intensive cultivation, and then to contribute to economic independence of small scale farmers. In addition, implementing water quality improvement of irrigation water is expected to result in that improvement of recognition against safety of agricultural products brings about increasing marketability and quality of agricultural products. Furthermore, diversification of agricultural products is expected to bring about promotion of forming production organizations against the diversification and growth of motivation to organize among small scale farmers.

(3) Effects of water quality improvement

Water quality improvement of irrigation water by farmers themselves promotes diversification of agricultural products and contributes greatly to agricultural improvement in the area. Furthermore, efforts for water quality improvement is to be appreciated domestically and internationally, and then marketability of agricultural products is to become high. Moreover, safety, healthy and comfortable agricultural and rural environment is created and the basic condition for the promotion of regional socio-economic independence is established.

(4) Increase of job opportunity

During the construction period of the project, job opportunity is created because most of construction workers are to be recruited from farmers in and around the project area. The technique which the employed farmers achieve through the construction works is expected to be useful for operation, management and maintenance of the constructed irrigation system and roads.

After implementation of the project, activated agricultural production activities in the area create job opportunities. Creation of job opportunity for non-farm houses can be also expected because increased farm work by irrigation and intensive land boosts the demand of labor force in and around the project area.

These created job opportunity alleviates out flow of rural population to cities such as Santiago, and contributes to well balanced development of the country.

(5) Increase of intention for working

Compared to the limited agricultural production under water contamination at present, improvement of farm economy by diversification of agricultural products and its result, improvement of living standard after the project implementation give the farmers satisfaction and sufficiency in the area. This raise farmers' intention to increase the productivity, and accelerates development of the area.

(6) Activation of socio-economic activities

The activities of the community center (CECUV) promote integrated interchange in the area as a whole. The integrated interchange results in the motive power of activating and developing the area. Moreover, quality improvement of irrigation water and construction of rural sewage treatment plants makes an appeal for safety of agricultural products to outside of the area beside environmental conservation in the area. It is also expected that the effort of environmental conservation arouses public response everywhere and contributes to improving socio-economic status of the area.

(7) Development of regional economy

It is expected that increase of agricultural products brings about increase of farmers' income after the project implementation. Increases of farmers' purchase power can contribute largely to development of regional economy and also stable national economy of Chile

(8) Fostering of human resource

Establishment of the community center (CECUV) is expected to be a base of manpower development by conducting social education and technical training such as living improvement, irrigation method, agriculture technique, operation and maintenance of various machinery, environment and so on. The center is expected to contribute to the future development in rural areas as well as the nation. The activities of the center are expected to promote women's participation in the project and to improve their social status.

(9) Effect on environment

Quality improvement of irrigation water by farmers themselves contributes largely to alleviating the burden of environment and conserving natural environment. The effort against environmental improvement by farmer themselves is to be a model for the other areas where have same problems, and a stimulus for improvement of present situation. The construction of rural sewage treatment facility is expected to contribute largely to not only living environment but also environmental conservation of the area as a whole. Moreover, environmental education at the community center (CECUV) clarifies the relation between agriculture and environment, and between human activities and environment. This creates motive power of promoting practical activities for environmental conservation.

2.5.4 Justification of the Project

The objectives of the project implementation are providing the support for farmers' will to improve the present situation and realizing safe and comfortable rural areas. On the other hand, as the precondition of the project, development for accomplishment of the objective has to be carried out under participation of inhabitants.

In the development plan, agricultural production increases through promoting diversification of agricultural products by amelioration of quality of irrigation water and of agricultural infrastructure based on the purpose and precondition of the project. As a result, income growth of farmers is reflected not only household expenditure but also improvement of farmers' quality of life as a whole with development of rural infrastructure and improvement of knowledge and technique. Then, breakaway from the present situation is promoted for the farmers living in the area.

As living environment in rural area, improvement of the basic living condition

satisfies the condition of settlement. At the same time, through the activities of farmers in the community and of production, lively socio-economic interchange such as human communication among inhabitants in the area activates the area as a whole.

In view of economic aspects, implementation of the proposed development plan can be evaluated at 20.5% with the index of economic internal rate of return (EIRR).

With these stand points, the implementation of the project is justified.

2.6 Conclusion and Recommendation

2.6.1 Conclusion

To formulate the agricultural development plan in Mallarauco area, study and examination on the present situation, facing problems and development potentials has been carried out. Following is obtained as a conclusion.

(1) The source of irrigation water in the proposed project area is the Mapocho river, but contamination level of water taken from the Mapocho river shows extremely high, over 10^5 MPN/100ml of coliform groups. However, water of the Mapocho river contaminated by urban wastes must be used continuously as irrigation water under the present situation of Mallarauco area where is no alternative water sources in and around area. On the other hand, major irrigation facilities in Mallarauco were constructed in 1800s. The decrepit facilities have increased the maintenance cost and work. Farming in the area is mainly cultivation of crops whose harvested products are not affected by contaminated water use. Main crops are perennial crops such as fruit trees in the upstream basin, and annual crops such as cereals, pasture and livestock in the middle and downstream basins. Recently, fruit growing on hillside of mountains has increased.

As the development plan in the Mallarauco area, the quality improvement of irrigation water by construction of sewage treatment plants and rehabilitation of existing irrigation facilities are proposed at the three irrigation blocks of about 1,000ha among the Mallarauco irrigation system of about 7,000ha. Implementation of these development measures will attain improvement of production and living environment, reduction of O & M cost and alleviation of water shortage at the terminal point of irrigation system. As for the water quality improvement project, ameriolation of deteriorated environment on water which agriculture in metropolitan area faces at present is undertaken by agricultural sector itself. Implementation of the project, therefore, has the meaning of the pilot project.

(2) From the point of views above, the structural improvement plan, which consists of following contents, is proposed as structures to be improved in the Proposed Project.

Contents	Unit	Quantities
Water quality improvement		
Project area	site	3
Treatment volume	m ³ /sec	1.10
Irrigation facilities improvement project		
Irrigation area	ha	1,043
Improvement of canals	km	44.02
Improvement of intake facilities	site	3
Diversion facilities	site	77
Regulation pond	site	3
Pumping facilities	site	4

To be continued

Contents	Unit	Quantities
Rural infrastructure development project		
Road improvement		
Pavement of main road	km	10.2
Improvement of lateral road	km	6.6
Construction of lateral road	km	9.4
Rural sewage treatment facilities	site	4
Community Center	site	2

(3) Total investment for implementing the project above is estimated at 26,386 million pesos (local currency portion: 11,080 million pesos, foreign currency portion: 15,306 million pesos). Required period of works is proposed at 7 years including the period of the detailed design.

(4) The economic internal rate of return of the project is 20.5% according to the required costs and expected benefits. Socio-economic effects of the project implementation are to be expected intensive utilization of land and water, diversification of crop cultivation, improvement of consciousness on environmental conservation, improvement of health and sanitary environment for the farmers, creation of job opportunity and so on.

2.6.2 Recommendation

(1) The project implementation benefits directly to the improvement on farming and farming condition of the farmers in the projected area. Because the sanitary environment surrounding production of perishable food has become international interest, infrastructure improvement for agricultural production is an urgent problem in order to expand agricultural export. The water quality improvement project is recommended as a pilot project based on the understanding stated above. On the other hand, required cost of water quality improvement is large and it is hard to be established as the project in the range of direct benefit which usually can be measured. From the results of financial analysis of farmers, subsidy of 90% on investment costs is required to promote the project execution. Taking these condition into account, the burden of Santiago City, which is the cause of pollution and also the nation, should also be examined. Accordingly, it is recommended for early implementation of the project that subsidy methods for initial investment should be established in the frame of existing or new subsidy system of government, considering the project advantage.

(2) As Government ordinance No.1123 is applied to the project under the frame of the present subsidy system, close cooperation between CNR and DOH is necessary at each stage such as adoption of the project by DOH, approval of the project and execution of the project. Guidance of CONAMA is required at the stage of the project promotion because the project includes water quality improvement relevant to environmental issues. Therefore, it is recommended that a project promotion committee which consists of CNR, DOH, and CONAMA should be established.

(3) The main body of the beneficiary of the project is the Mallarauco canal association. As operation and O & M of sewage water facilities handed by the association, it is proposed that the section of O & M for sewage treatment facilities should be established in the present Mallarauco canal association.

Table 2.2.1 Irrigation Water Requirement (Mallarauco)

Item	Area (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
9 ha													
Wheat	0.110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	148.78	217.31	159.68	44.25
Potato	0.110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	142.24	250.74	291.18	247.80
Pumpkin(1)	0.055	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.90	111.40	191.04	169.45	86.45
Pumpkin(2)	0.055	90.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.12	176.71	244.22	191.58
Onion	0.110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.18	110.32	189.05	229.61	221.25
Broccoli-Melon	0.055	0.00	0.00	0.00	43.74	20.53	0.22	0.00	0.00	0.00	0.00	0.00	0.00
	0.055	117.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.74	133.33	221.78	250.75
Cabbage-Cauliflower	0.055	0.00	0.00	0.00	0.00	0.00	0.00	0.01	15.20	14.31	0.00	0.00	0.00
	0.055	193.37	144.56	37.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.22	128.50
Alfalfa	0.230	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
Unused Land	0.110												
Total	1.000	86.15	63.24	41.68	26.08	2.73	0.01	0.00	20.24	73.50	136.46	166.46	153.68
50 ha													
Wheat	0.100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.98	148.78	217.31	159.68	44.25
Melon	0.100	117.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.74	133.33	221.78	250.75
Alfalfa	0.100	278.54	240.41	172.35	102.92	6.95	0.00	0.01	18.81	75.37	159.20	234.83	265.50
Avocado	0.280	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
Lemon	0.280	113.48	97.94	70.22	47.17	4.63	0.00	0.00	15.16	45.78	79.60	95.67	108.17
Seed Production (Hybrid)	0.080	73.53	0.00	0.00	0.00	0.00	0.00	0.00	19.34	119.47	229.25	272.40	193.92
Unused Land	0.060												
Total	1.000	109.04	78.89	56.56	36.71	3.29	0.00	0.00	16.82	60.68	113.90	137.00	132.14

Table 2.3.1 Agricultural Development Project Total Construction Cost in Mallarauco Area
(Unit : Thousand Pesos)

Description	F.C	L.C	Total
1 Preparation Cost			
(1) Water Quality Improvement and Irrigation Facilities Rural Infrastructure	590,845	360,008	950,853
(2) Sub-total	31,226	41,916	73,142
	622,071	401,924	1,023,995
2 Water Quality Improvement and Irrigation Facilities Improvement Cost			
(1) Water Quality Improvement Facilities Construction Cost			
1) Civil Facilities	2,704,208	7,113,566	9,817,774
2) Plant Facilities	8,410,148	9,642	8,419,790
Sub-total	11,114,356	7,123,208	18,237,564
(2) Irrigation Facilities Improvement Cost			
1) Pipe Lines	596,461	226,178	822,639
2) Related Facilities	96,079	50,778	146,857
Sub-total	692,540	276,956	969,496
Total	11,806,896	7,400,164	19,207,060
3 Rural Infrastructure Construction Cost			
(1) Rural Sewage Treatment Facilit	481,763	268,887	750,649
(2) Rural Road	115,784	481,492	597,276
(3) Community Centers (CECUV)	26,983	87,945	114,928
Sub-total	624,530	838,323	1,462,853
4 Land Acquisition and Compensation Cost			
(1) Water Quality Improvement and Irrigation Facilities Rural Infrastructure	0	14,616	14,616
(2) Sub-total	0	826	826
	0	15442	15442
5 Engineering and Administration Cost			
(1) Water Quality Improvement and Irrigation Facilities Rural Infrastructure	798,716	1,333,075	2,131,762
(2) Sub-total	62,453	83,832	146,285
	861,169	1,416,907	2,278,047
6 O & M Equipment	121,577	45,000	166,577
7 Total (1-5)	13,914,697	10,072,791	23,987,428
8 Physical Contingencies (10%)	1,391,470	1,007,279	2,398,743
9 Total (6+7)	15,306,167	11,080,070	26,386,171
10 Price Contingencies	2,813,288	4,100,753	6,914,041
11 Grand Total	17,306,414	11,675,715	28,982,129

Table 2.3.2 Disbursement Schedule (Total Construction Cost in Mallarauco Area)

Year	(Unit : Million Pesos)		
	F.C	L.C	Total
2000	0.0	0.0	0.0
2001	319.5	473.9	793.4
2002	609.8	692.9	1,302.7
2003	1,259.3	1,568.8	2,828.1
2004	3,795.3	2,319.1	6,114.4
2005	8,318.9	4,764.3	13,083.2
2006	2,893.8	1,966.4	4,860.2
Total	17,196.6	11,785.4	28,982.0

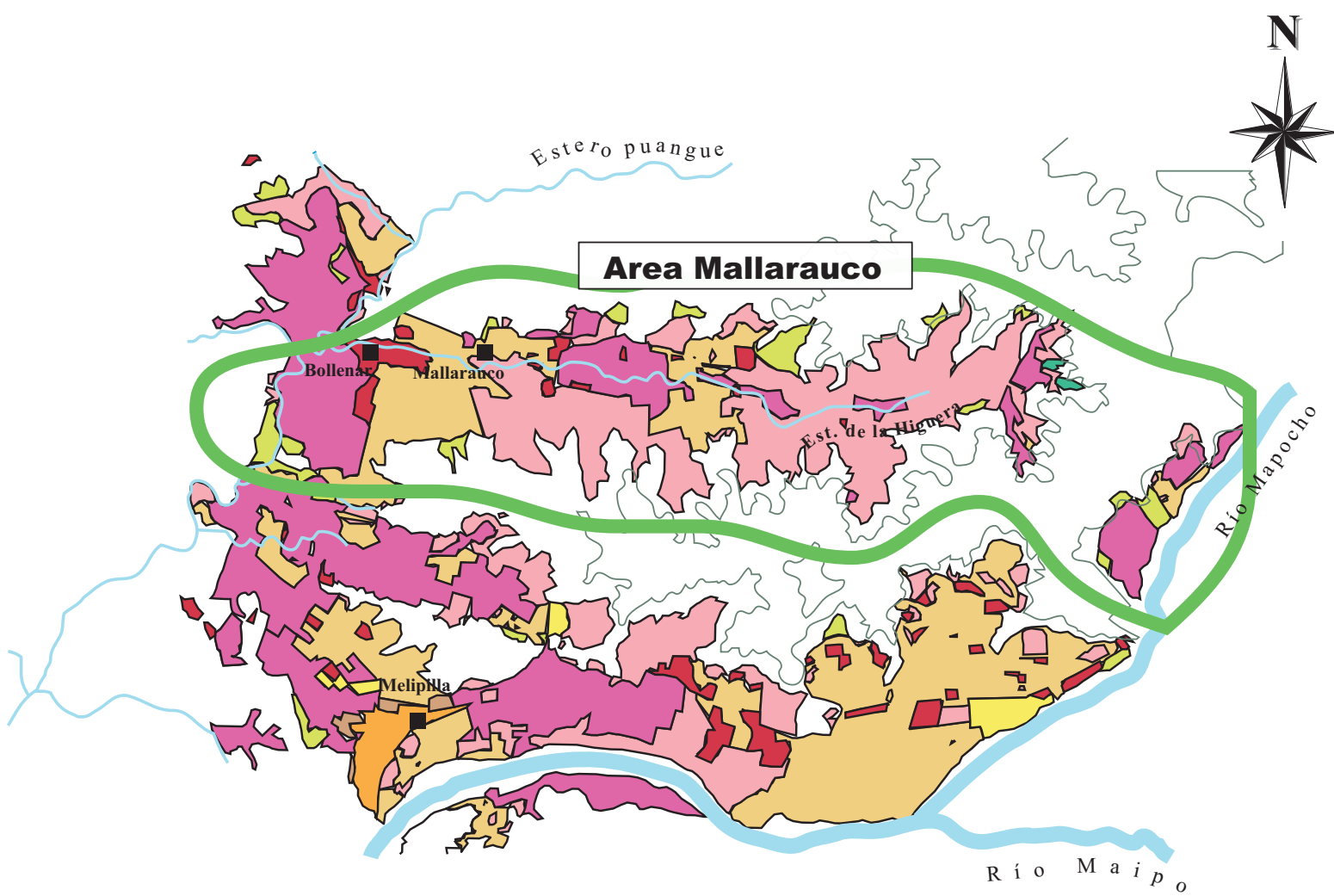
Table 2.4.1 Project Implementation Schedule in Mallarauco Area

Development Items	Quantities	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008
1. Project Evaluation by the Government of Chile			■								
2. Provision of Fund by the Government of Chile			■								
3. Agricultural Development Project in Mallarauco Area											
(1) Preparation Works for the Implementation of the Project											
Contract with Consultant Company	1.0	unit		■							
Detail Design Study	1.0	unit		■	■						
Land Acquisition and Compensation	1.0	unit			■						
Selection and Contract of Construction C	1.0	unit			■						
(2) Water Quality Improvement Project	12.0	Places									
Las Carrera	0.13	(m ³ /sec)									
Civil Works	1.0	unit				■					
Construction of Plant Facilities	1.0	unit				■					
Reforma	0.54	(m ³ /sec)									
Civil Works	1.0	unit						■			
Construction of Plant Facilities	1.0	unit						■			
Manzano	0.43	(m ³ /sec)									
Civil Works	1.0	unit						■			
Construction of Plant Facilities	1.0	unit						■			
(3) Agricultural Production Development Project											
Rehabilitation Work of Canals											
Las Carrera	14.1	km					■				
Reforma	17.2	km					■				
Manzano	16.5	km					■				
(4) Rural Infrastructure Development Project											
Construction of Road	26.2	km							■		
Construction of Rural Water Supply Faci	4.0	Places							■		
Construction of Rural Sewage Treatment	2.0	Places							■		

Table 2.5.1 Project Evaluation (Mallarauco Area)

< Financial Evaluation of the Project : Mallarauco >											
Year	Costs			Benefits			Cash Flow	Cost [+10%]	Benefit [-10%]	Cost + 10% Benefit-10%	
	Investment	O & M	Total	Agriculture	Environment	Total					
2000			0.0			0.0	0.0	0.0	0.0	0.0	
2001	793.4		793.4			0.0	-793.4	-872.7	-793.4	-872.7	
2002	1239.8		1239.8			0.0	-1239.8	-1363.8	-1239.8	-1363.8	
2003	2571.2		2571.2			0.0	-2571.2	-2828.3	-2571.2	-2828.3	
2004	5245.3	45.6	5290.9		0.0	0.0	-5290.9	-5820.0	-5290.9	-5820.0	
2005	10864.9	136.7	11001.6	144.5	896.2	1040.7	-9960.9	-11061.1	-10065.0	-11165.1	
2006	3611.3	318.9	3930.2	216.8	1344.3	1561.1	-2369.2	-2762.2	-2525.3	-2918.3	
2007		455.5	455.5	505.8	3136.6	3642.5	3187.0	3141.4	2822.7	2777.2	
2008		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2009		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2010		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2011		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2012		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2013		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2014		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2015		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2016		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2017		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2018		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2019		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2020		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2021		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2022		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2023		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2024		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2025		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2026	992.1	455.5	1447.6	722.6	4480.9	5203.5	3755.9	3611.1	3235.6	3090.8	
2027		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2028		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
2029		455.5	455.5	722.6	4480.9	5203.5	4748.0	4702.5	4227.7	4182.1	
			\$15,139.6				\$18,770.6				
							IRR=	15.21%	13.75%	13.60%	12.20%
							NPV(12%)=	\$3,630.9	\$2,116.9	\$1,753.9	\$239.9
							B/C=	1.24			

< Social Evaluation of the Project : Mallarauco >											
Year	Social Cost			Social Benefits			Cash Flow	Cost [+10%]	Benefit [-10%]	Cost+10% Benefit-10%	
	Foreign	Local	Total	Agriculture	Environment	Total					
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2001	247.2	358.9	606.1	0.0	0.0	0.0	-606.1	-666.7	-606.1	-666.7	
2002	449.3	501.3	950.6	0.0	0.0	0.0	-950.6	-1045.6	-950.6	-1045.6	
2003	885.8	1097.0	1982.7	0.0	0.0	0.0	-1982.7	-2181.0	-1982.7	-2181.0	
2004	2538.9	1545.2	4084.1	0.0	0.0	0.0	-4084.1	-4492.5	-4084.1	-4492.5	
2005	5451.4	3041.8	8493.2	232.1	860.3	1092.4	-7400.7	-8250.1	-7510.0	-8359.3	
2006	1804.4	1228.9	3033.3	348.2	1290.5	1638.7	-1394.6	-1697.9	-1558.5	-1861.8	
2007	95.9	255.0	350.9	812.4	3011.2	3823.6	3472.7	3437.6	3090.3	3055.2	
2008	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2009	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2010	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2011	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2012	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2013	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2014	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2015	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2016	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2017	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2018	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2019	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2020	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2021	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2022	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2023	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2024	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2025	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2026	863.4	255.0	1118.4	1160.6	4301.6	5462.2	4343.9	4232.0	3797.6	3685.8	
2027	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2028	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
2029	95.9	255.0	350.9	1160.6	4301.6	5462.2	5111.3	5076.3	4565.1	4530.0	
			\$11,673.4				\$19,703.9	\$8,030.6	\$6,863.2	\$6,060.2	\$4,892.8
							IRR =	20.47%	18.76%	18.58%	16.96%
							NPV =	\$8,030.6	\$6,863.2	\$6,060.2	\$4,892.8
							B/C =	1.7			



LEGEND

- Vegetable
- Fruits
- Cereales
- Pasture Land
- Forest
- Urban Area
- Residential Land
- New Residential Land
- Non Cultivation Area
- River

Fig. 2.1.1
Present Land use
in Mollarauco



DESARROLLO AGRICOLA Y
MANEJO DE AGUAS
DEL AREA METROPOLITANA
JICA - CNR