CHAPTER 4

BASIC CONCEPT OF THE DEVELOPMENT PLAN

4 BASIC CONCEPT OF THE DEVELOPMENT PLAN

4.1 Basic Concept

The objective area for the development covers the Metropolitan Region that includes the capital city of Santiago, and part of the V and VI Regions. The population of the capital city is one third of national population (14.2 million) or 5 million. The objective area plays important role historically and presently as the main agricultural production area in Chile, especially for horticultural products (fruits and vegetables) and other agricultural products consumed in the Metropolitan area and for exportation.

The current problems of agriculture in the area are expansion of Santiago city by population growth, disappearance or decrease of farmland, contaminated irrigation water, tightness of available water and difficulties of farming management on small scale farmers.

Based on the above recognition, the development plan is to promote socio-economically well-balanced agriculture for the harmonized progress by effective use of limited sources of water and land considering environmental conservation, on agriculture affected by sprawled expansion and contaminated irrigation water due to sewage by population growth.

4.2 Approach on the Development Plan

4.2.1 Justification with the National and Provincial Policies

Agriculture policy of Chile is described in "Strategic Agenda 1998 – 2000, Target of Agricultural Development" prepared by the Ministry of Agriculture. Provincial agriculture policy is also formed an action plan within the frameworks of the national policy.

The "Strategic Agenda" intents an urgent agriculture modernization by promote export of agricultural products to international market, and is raised, as basic components for the productivity improvement, infrastructure development for production by irrigation improvement and innovation and improvement on both technology and management. Agriculture in Chile is, at the same time, required sloughs away from conventional profit-seeking commercial agriculture and alters to agriculture with new vision capable to respond demand of new age, and stressing a fostering and strengthening of middle and small-scale farmers for their promotion.

In line with the concept of "Strategic Agenda" , the development plans to be formulated intend to play a role of food production center for the Metropolitan area and to improve productivity in order to maintain its important position in the national agriculture by effective use of land and water resources, development of environmental conservation, establishment of infrastructure for production (including development to make possible to supply clean water for irrigation), and development and strengthen agricultural support system for small scale farmers.

4.2.2 Intention on the Development Plan

(1) Economic Development

The objective area is located in the Mediterranean Agriculture Zone in Agro-ecological classification of Chile and is the most developed irrigation area with fertile soil and favorable climate conditions in the country. The area is also an important position on economy as major food supply center for the Metropolitan area and agricultural production area for export products recently.

Progress and stability of the economics are one of the major elements on the national policy. It is needless to say that agriculture in the Metropolitan area is taking a leading role on the history and the traditions. Just as mentioned in "Strategic Agenda", modernization of agriculture is the major subject for achieving the target and the economical progress is to be realized as the result. In the other hand as "Agenda" pointed out, the development intention intended to avoid to concentrate only to a profit-seeking commercialism of efficiency oriented. Along the above intention, agriculture in the Metropolitan area in the plan is intended to maintain a role on economic development considering various aspects as farmers types in the aspect of manpower resource and effective use of land and water in the aspect of the natural resource.

(2) Balanced Society

Population inflow into urban area and surroundings is common phenomena in the world. These phenomena involve the risk as the cause of social and environmental problems arising in both urban and rural areas. Depopulation and devastation of rural area due to population outflow cause decline of economic activity in the agricultural production and the distortion of rural society. Moreover, Depopulation in the rural area affects seriously to the natural environment, because natural environment in the rural area is maintained through the living activities of rural habitants. In case of recent Chile, population increase is tend to occur in the capital city of Santiago as well as surrounding urban cities, on the other hand, rural population has been constant in general or no significant in case of decrease. It is considered that rural condition in Chile is still remain without significant problem even though the fact of decrease labor population is exist.

The significant difference in living condition and income level between urban and rural areas is observed. Although farmers are not giving up farming, many are selling farmland as subdivided housing lots and it is serious situation from the point of agriculture development. It is required to reform as the past situation to maintain the relation of neighboring of urban and rural and fulfill food supply for urban residents, and to reduce the gap with urban on condition of rural living, production and economics in order to play a role of food supply center of the Metropolitan area. It is the condition to maintain steadily rural area of Chile in which is still remain without serious problem. Approach in the plan will be made from three aspects of infrastructures on living and production, and agricultural support for certifying the conditions above.

4.2.3 Target Year of the Development Plan

Target year is to be 2010 in the plan.

4.2.4 Framework of the Development Plan

The framework of the development plan is recognized as follow by the basic concept of the development.

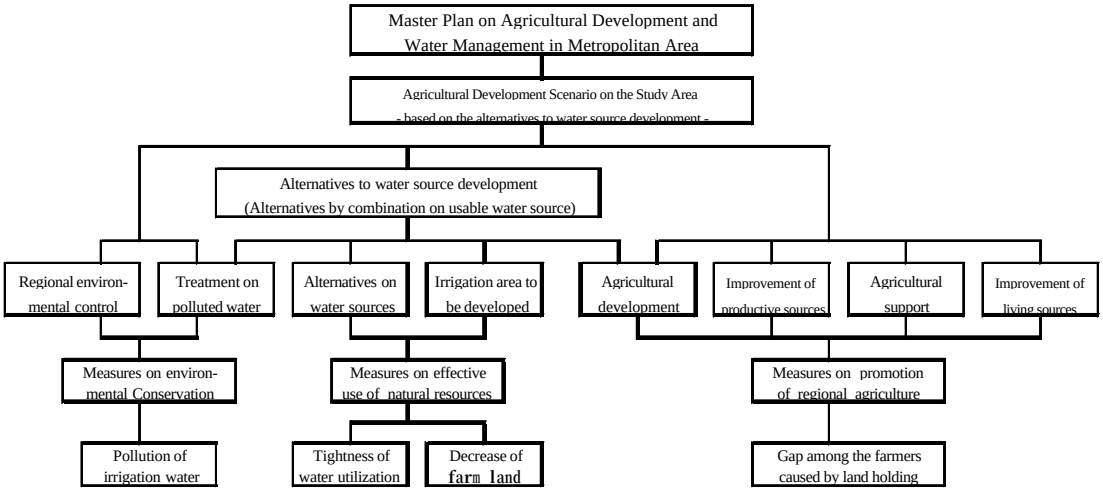
1) Effective use of water and land resources in the Project area
2) Environmental conservation in entire basin.
3) Agricultural promotion in the Metropolitan area

CHAPTER 5

PLAN OF THE AGRICULTURAL DEVELOPMENT AND WATER MANAGEMENT IN METROPOLITAN AREA

5 PLAN OF THE AGRICULTURAL DEVELOPMENT AND WATER MANAGEMENT IN METROPOLITAN AREA

Study procedures of the master plan on "Agricultural Development and Water Management in Metropolitan Area" is summarized in the flow chart below based on the present condition of the study area and the basic concepts of the development plan.



5.1 Water Resources Development Plan

5.1.1 Basic Concept on the Water Resources Development Plan

The present water utilization in the study area mostly depends on the discharge from the upstream reach of the Maipo river. Available surface runoff in the basin is 4,100 MCM in average year and 2,500 MCM in 85% exceedance probability, however, demands on irrigation, water works and other industrial uses accounts 3,370 MCM in average year and 3,150 MCM in 85% exceedance probability. Present water utilization of surface runoff in the Maipo basin reaches its upper limits of available amount.

Forecasted demands of water in 2010 are about 730 MCM for domestic water supply and about 490MCM for mining and other industries. The amount of domestic water supply depending on the surface runoff of the Maipo river is estimated to increase about 40 MCM from about 450MCM at present to 490 MCM. The countermeasures to increase of water demands are to obtain by buying existing water right, rehabilitation of the Yeso dam located in the upstream reach of the Maipo river, utilization of Laguna Negra, and storage of runoff by construction of a dam in the Maipo river. On the other hand, newly required irrigation area is estimated as about 112,000 ha. Available surface runoff, except the Maipo river downstream, has reached to its limit. Thus, most of the water source for new irrigation is to be from groundwater. However, groundwater has also become harder to obtain new water right annually because water use has been increasing. Accordingly, groundwater use can be judged also to reach to its limit in the future.

The countermeasures to the shortage of available surface runoff and groundwater to satisfy increasing demand are to decrease ineffective discharge by constructing reservoirs, save at existing irrigation area and effective use of unused water rights for reasonable water use of existing water resources. These are realistic methods for developing new water sources and expanding water use in the study area.

5.1.2 Water Resources Development

(1) Reservoir

Possibility of dam construction in 6 rivers and 14 sites are examined on the basis of topography, geology, and scale of basins. Average annual discharge, probable discharge, and available water amount in these sites are shown in the table below. Whole available water is eventual discharge (surplus discharge with 85% exceedance probability over 85 % exceedance probable runoff). Table 5.1.1 shows the runoff resume at each dam site.

Rivers	No.	Area of basin (km^2)	River bed elevation (m)	Dam height (**m**)	Dam crest-length (**m**)	Available water storage (MCM)	Average annual runoff (MCM)	85%year runoff (MCM)	Available water amount (MCM)
Maipo	M-1-1	1,378	1,510	200	850	570	855.7	348.9	145.5
	M-1-2	1,378	1,510	150	735	290	855.7	348.9	145.5
	M-2-1	1,488	1,363	165	422	780	924.0	376.8	157.1
	M-2-2	1,488	1,363	147	356	620	924.0	376.8	157.1
	M-2-3	1,488	1,363	128	296	460	924.0	376.8	157.1
	M-3	1,518	1,335	175	568	729	942.6	384.4	160.2
	M-4-1	2,785	1,159	200	895	800	2,666.7	1,705.0	431.3
	M-4-2	2,785	1,159	161	800	440	2,666.7	1,705.0	431.3
Mapocho	1	584	1,070	130	470	97	221.4	80.4	29.82
Colina	C-1	208	970	150	630	110	26.9	12.7	4.63
	C-2	235	804	150	940	150	30.4	14.3	5.24
Rosario	1	184	120	55	350	81	67.4	38.1	29.3
Yali	1	555	113	37	260	108	253.2	146.7	106.6
Curacavi	1	244	331	125	250	115	40.5	4.8	4.7

As examining each dam site from the view of water quality and natural environmental conservation, the site of Mapocho has drainage from mines in the upstream and submergence of power station, and the site of Yali has the natural environmental conservation area. Thus, both sites are eliminated from the objective site for reservoir construction. As the potential site for dam construction in the upstream of the Maipo river, the site of M-4 is to be selected, in which reaches maximum capacity of reservoir by the available water and possible storage capacity. Yet, the dam height is limited at the site. Estimated available capacity including sediment volume is shown below. In this case, sediment volume is estimated to be 560 m^3/km^2/year for 50 years.

Point		Available capacity (MCM)	Available runoff (MCM)	Amount of sediment (MCM)	Capacity of dam (MCM)		Dam scale (m)	
					Total capacity	Effective capacity	Dam height	Dam crest-length
M-4	El Ingenio	440	431	80	440	360	161	800

In the case of the dam site of Colina, the C-1 (El Cepo) site is selected for dam construction site because the C-2 site is developed for a park. Accordingly, available supply of the new water source is estimated 398.6 MCM as follows;

River	Site	Area of basin (km^2)	River bed elevation (m)	Dam height (**m**)	Dam crest-length (**m**)	Storage capacity (MCM)
Maipo	El Ingenio	2,785	1,159	161	800	360
Colina	El Cepo	208	970	45	630	4.6
Rosario	Patagua Chica	184	120	37	350	29.3
Curacavi	El Flamenco	244	331	27	250	4.7

It is also possible to construct small reservoirs in minor streams in the area beside the dams above. The small reservoirs can be used as storage of surplus water

from irrigation canals and discharge of its basin by rainfall, and as supplementary water source during irrigation period.

(2) Water saving for irrigation water

Changing irrigation method of furrow irrigation to Californian method (Californiano) and drip irrigation, and lining of existing main canals and rehabilitation of division structures are effective for water saving at the fields and canals. Those saving water amount can be expressed with irrigation efficiency and conveyance loss in a calculation for irrigation water. Changing furrow irrigation to Californian method increases irrigation efficiency from 10 to 15% at the field level. Changing unlined canals to lining canals increase canal conveyance efficiency from about 5 to 10 %.

When furrow irrigation changes into Californian method and unlined canals changes into lining ones in the study area, total irrigation efficiency would improve 15 %, in detail, from 0.45 X 0.8=0.36 to 0.6 X 0.85=0.51. Annual average irrigation water in the whole basin is 2,460 MCM and among it, 29% or 720 MCM can be saved theoretically. However, water losses such as seepage water from the earth canals and at fields are utilized as the return flow at the downstream areas and fostering source of groundwater. In INIA, overall irrigation efficiency in the Maipo basin is estimated at 80% and it can be said that the most of calculated water amount of 720 MCM is made circulatory utilization at present.

From the point of actual irrigation use, it is hard to implement the projects which aim at water saving as irrigation system because of following reasons. They are that the rehabilitation of irrigation facilities is basically beneficial principal, water is divided proportionally, water use fully depends on users after receiving water from division inlet decided by water right, and aquifer charging effects with unlined canals' percolation and irrigation. On the other hand, in the recent years, introduction of Californian method and drip irrigation has been progressed rapidly for effective use of irrigation water at the levels after division inlet.

Under the present water right system and its water use, if available supply increases because of water saving at the levels of after division inlet, intake amount would not decrease at division inlet. Increased water amount is distributed to those who have water right at the levels after division inlet. Thus, increased water amount by water saving of irrigation use contributes to stability and expansion of water use at the field level. This also will result in alleviating the present shortage of water. Accordingly, the development plan do not expect newly developed water amount by water-saving.

(3) Effective utilization of unused water right

Unused water rights occur due to suspension of water source development program and farm retirement because prevailing water utilization is being carried out under the water right system. These unused water rights make objects for buying and selling in the market. Due to difficulties of utilization on its location and volume, however, no transition of right is occurred and leaves as unused water right as it was. Recently, some movement is occurred to take measures by law for activation of such unused water right.

DOH has an undistributed but available water right of 25.0m^3/s (Decreto No.1039) for the irrigation project in the second section. In the development plan, the irrigation utilization plan is formulated through utilization of these water rights held by DOH from the view of effective utilization of unused water right.

(4) The other measures for water source

- Treated sewerage

  EMOS has the plan of using treated water of 3.5m^3/s as irrigation water because an urban sewerage–treatment plant, the first period, in South Santiago will start to work from 2001. Utilization of the treated water has some problems to be solved in near future, such as decreasing return flow in the downstream basin and water right on the treated water. The development plan assumes the problems would be solved. Thus, the those treated water includes the development plan mentioned above.

- Groundwater

  Groundwater use for water supply, industries, and irrigation have been increasing annually since 1950. Groundwater level has been lowered noticeably in the northern part of Santiago city, Lampa and Casablanca in the V region. Thus, development of groundwater is limited at present. It should be careful in the other areas beside two areas mentioned above in the study area because groundwater use for irrigation by farmers has been increasing there. In the development plan, groundwater use recognizes as small supplementary water source, thus, the water resources development does not deal with a large scaled groundwater development.

5.1.3 Distribution of Water Resources

As for the distribution of newly developed water amount by dams, in the case of a large-scale dam, water will be distributed optimally based on the development costs of irrigation and domestic water uses. Conditional formula is settled by cost and benefit of irrigation and domestic water use. As analyzing a target function, which maximizes B/C by optimizing method, the result is when all newly developed water amounts is used for irrigation, B/C is maximized. However, concerning the competition between expanding domestic water use in Santiago area and agricultural use, 40 MCM among 360 MCM of newly developed water amount, which is expected water demand growth in Santiago City, 2010 is allocated for domestic water use. Thus, the rest of it, 320 MCM is new irrigation water source. The irrigation area is expected to be about 18,500ha.

On the other hand, available supply of middle and small-scaled dams, 39 MCM is regarded as new irrigation or supplementary water sources around reservoir sites. Their available irrigation area is estimated to be about 2,300ha.

The water with unused water right in the downstream basin of the Maipo river is distributed only for irrigation use. As available discharge with the water right is 25.0m^3/s in the second section, new irrigation area will be 21,000ha on the base of peak water requirement for irrigation. Moreover, as available supply by disposed waste water is 3.5m^3/s, it can irrigate about 3,000ha.

New irrigation areas in the study area are distributed in the northern and southern, and the downstream basin of the Maipo river. In the case of new water source utilization, the southern part and the downstream basin of the Maipo river will be irrigated by unused water right. The developed water by large reservoirs will be distributed for irrigation of the northern part.

5.1.4 Alternatives to Water Resources Development

The water distribution mentioned above, the alternatives to newly developed water amount are summarized as follows;

Item	The alternatives of water source development plan			
	Without dams	With dams		
	A－1	A－2 (middle and small scale dams)	A－3 (Large scale dam)	A－4 (A-2+A-3)
Large dam	—	—	360 MCM	360 MCM
Middle and small dam	—	39MCM	—	39MCM
Water right of the 2nd section	25.0 m^3/s	25.0 m^3/s	25.0 m^3/s	25.0 m^3/s
Treated sewerage use	(3.5 m^3/s)	(3.5 m^3/s)	(3.5 m^3/s)	(3.5 m^3/s)
Water supply	—	—	40 MCM	40 MCM
Irrigation development (With existing water right)	21,000 ha	21,000 ha	21,000 ha	21,000 ha
Treated sewerage use	(3,000 ha)	(3,000 ha)	(3,000 ha)	(3,000 ha)
Total (1)	21,000 ha	23,300 ha	39,500 ha	41,800 ha
Total (2)	(24,000 ha)	(26,300 ha)	(42,500 ha)	(44,800 ha)

5.2 Land Resources Development Plan

5.2.1 Basic Concept of the Land Resources Development Plan

The Metropolitan Region of Santiago has been expanding by the sprawl of farmland. In the recent years, once expansion toward the southern area has reached to its limit, that toward the northern area has started and proceeded rapidly. At the result, Chacabuko Province must be included into the Metropolitan Region of Santiago, now.

In order to control such disordered expansion of urban area, " Plan Regulador Metropolitano de Santiago" was established by SEREMI-MINVU in 1994. On the other hand, Low No. 3516 admits to sell a farmland with sub-division up to 0.5 ha. This system encourages the sprawl in surroundings of metropolitan area. A trend on expansion of metropolitan area and decrease of farmland will be continued for the time being.

While the farmland around the metropolitan area has been decreasing drastically, in the rural areas which are located within about 40 km from the center of the metropolitan area, reclamation of large arboricultural land has been progressed in grassland and hilly area. The form of land use within farmland has been changing. Moreover, there are natural parks, conservation areas, protection areas, and sanctuaries in the study area. These areas must remain as what to be.

Based on the observation above, land resources development plans in the study area aims at land use plan in the study area and selection of newly irrigated farmland. Following is the basic approach for planning and selection.

1) Maintaining the sustainable regional society,

2) Clarifying promotion areas for urbanization, agricultural promotion area, and natural environmental conservation area, and

3) Effective land use of available land is aimed in each district/ area.

5.2.2 Land Use Plan

(1) Land use

Based on the concept stated in the previous chapter, urbanization promotion area is established through the urban planning by SEREMI-MINVU.(Fig. 5.2.1) The whole present land use remains except the urbanization promotion area. The land use plan in the target year is established as follows;

Land use	1998 (1,000ha)	2010 (1,000ha)	Change (1,000ha)
Urbanization promotion area	49	62	13
Land for agricultural use	1,465	1,452	-17
Forest	325	325	0
Others	112	116	4
Total	1,951	1,951	0

(2) New irrigation area

New available irrigation area is selected among present farmland based on land productivity classification. The classification is led by the condition of soil, and agricultural climate. As have mentioned in "3.2.3 Soils and Land Use," based on the land productivity potential classification which summarized in the study through using land productivity potential classification by REA and data by CIREN, if the subjects of this plan are areas from **I** to **IV** in the potential classification, the new available irrigation area is estimated about 112,000ha. The areas from **I** to **IV** have high possibility of irrigation development.

Division of basin	Land productivity potential I – IV	
Est. Yali	26,002	*
Est. Casablanca	25,779	**
Est. Alhué	19,184	*
Est. Lampa	20,688	**
Est. Puangue (Curacaví, Maria Pinto)	9,634	*
Cue. Melipilla	10,383	*
	111,670	

*Source : * CIREN , **REA*

5.3 Agricultural Promotion Plan

5.3.1 Principles of Agricultural Promotion Plan

The agricultural problems of the project area are recognized disparity caused by landholding scale, decreasing farmland in farming environment, contamination of irrigation water, and tightness of water use.

Agricultural policy given by Ministry of Agriculture aim at more stable agricultural export through improving farming infrastructure and at the same time support and strengthening of small scale farmers who operate sustainable agriculture. Direct aims of support and strengthening of small scale farmers are improving farm household economy and intending stable supply of agricultural products. This can also contribute to maintaining local vitality and natural ecology through restraining migration to urban areas that will be led by the settlement of small farmers who dominate a large part of rural population in rural areas.

Based on the present situation of the problems which regional agriculture structurally contains and the development target on the overall goal, a measure for agricultural promotion in the project area aim mainly at agricultural development by

development of agriculture that makes most use of regional characteristics. The measure consists of infrastructure's improvement including improvement of irrigation facilities, and applying to the established agricultural support program through forming farmers' organizations aimed at educating and strengthening small farmers. This will be supported and reinforced through improvement of living infrastructure as the basic condition for small scale farmers' permanent settlement.

5.3.2 Agricultural Production Plan

Agricultural production plan is proposed mainly in the new irrigation area. Study on crop production plan is also made on both rehabilitation area of existing irrigation facilities and the area of water quality improvement.

(1) New Irrigation Area

The agricultural production plan established in the study is backed up basically by the condition of new irrigation areas selected in the study. The production plan which is implemented at present is conditioned by economically successful export. Nevertheless, the basic approaches of the plan are supplementing insufficiency of small scale farmers' production opportunities and increasing their productivity because their productivity is low in agricultural production structure and modernization of agriculture burdens them. So as to promote agriculture in the metropolitan area, which is the target of the Study Plan, selection of new irrigation areas is required to deal with decreasing farmland. In the Master Plan, 6 areas (Popeta, Yali, Alhué, Puangue, Casablanca, and Lampa) will be new irrigation areas. These areas are selected based on examination of land and water resources from the view point of agricultural development.

1) Distribution of new water right

Based on the regulation of new water right created by a large dam construction from the legal point of view, the owners of farmland benefited by irrigation have the priority of this water right. So as to achieve the permission of constructing facilities by MOP, it is required to be satisfied with the demand of DL No.1123 that regulates implementing a large project. According to the law, there must be demanders for at least more than 50% of new water right, and the sum of unirrigated farmland's price and total project cost should not exceed the price of irrigated farmland. In case of this, the project cost needs to be estimated with the standard of DOH. Moreover, according to DL No.1123, the President of Chile can approve the project in the case that implementation of the project is desirable from the point of public benefit even if the project is not satisfied with the conditions above.

The water right which the landowners do not want to obtain is sold by DOH at market price and the formalities for this is regulated by the law.

- Distribution of water right to small scale farmers

  From the point of landholding, most of new irrigation areas are occupied by large and middle scale farmers. The number of small scale farmers who can be beneficiaries of irrigation is estimated by the new irrigation area as follows; 117 households in Alhué (504ha), 324 households in Yali (1,322ha), 261 households in Curacaví (1,266ha), 314 households in María Pinto (1,523ha), 400 households in Melipilla (1,940ha), and 500 households in Lampa(2,500ha). In this estimation, all small scale farmers in each Comuna are the subjects of the estimation, and it is assumed that half of total households could be distributed irrigation water in all areas except Melipilla. This percentage is very high as the assumption but it is led by the fact that

most farmland of small scale farmers is located in unirrigated areas and its use of irrigation water is limited (cf. Echenique J. Rolando N, "Small Scale Agriculture"). In Alhué and Casablanca where the percentage of unirrigated areas is very high, 100% and 70% of present small scale farmers are regarded as small scale farmers in new irrigation areas respectively. In case of Melipilla, available irrigation area is limited by area. This is about 6,000ha located between Popeta and Ibacache.
There are two alternatives to distribute more irrigation water to small scale farmers. One is that assuming that whole less than 15ha land be available unirrigated farmland, and the land is tried to be included the Plan as large as possible. Then, the necessary cost for constructing diversion facilities up to fields is estimated. However, it is almost impossible for small scale farmers to pay this kind of expense, and the subsidy from the government is necessary. The other one is that the government of Chile buys the land for irrigation and distributes irrigation water to small scale farmers. Nevertheless, this is out of the present political framework and it is difficult to alter it in the Plan.

- Distribution of water right to large and middle scale farmers

  The rest of distributed irrigation water to small scale farmers as mentioned above will distribute to large and small scale farmers based on the system which regulated in DL 1123.

2) Planting program of new irrigation areas

The crop cultivation plan by new irrigation area shown in this chapter is established based on following advantages ;

- Warm climate and the possibility of various highly commercial valued fruits and flowers. Advantage in international markets due to the inverse season of the Northern Hemisphere.

- Fertile soil which is available for intensive cultivation of various crops.

- Under the isolated condition from disease and insect pest of animals and plants in this area due to natural barriers such as the Andes mountains in East, Pacific Ocean in West, Patagonia and the Southern edge of the ocean in South, and desert in North.

- Location of the area closed to the markets which supply perishable and other foods to cities such as Santiago and Valparaíso.

- Geographical condition, which suits for shipment by land, sea, and air, promotes cultivation of agricultural export products more.

- Road network which consists of main and branch roads that sustain the access of regional agriculture to market.

- Close to the most important technical center that is built by universities of Santiago and Valparaíso and agricultural research center.

- Existence of agricultural products processing industries. This can be basic measures for agricultural promotion such as securing markets, and technical support, innovation, and promotion, and simultaneously promote the credit for production.

- Possibility of developing established industries of agricultural products processing. Most of present agricultural export products (tomato paste, concentrated juice and so on) are commercial products, but there is the possibility of transferring from this stage to production of final consumption goods such as wine.

- It is possible for middle and small scale farmers to specify crops because this area is close by Santiago market which consists of sections by kind of each agricultural product. In addition, there are many alternatives for farming improvement such as the cropping relevant to agricultural product processing.

Moreover, the present crop cultivation is the base of establishing the framework of farming in the Study mentioned above.

Based on the framework above and following view points, the crop cultivation plan is established for small scale farmers and large and middle scale farmers by new irrigation area. Table 5.3.1 shows the crop cultivation plan.

The preconditions of the established crop cultivation plan are as follows;

- The farmland which plans to be newly irrigated is unirrigated land at present.

- The crop cultivation plan includes estimation of unused land area for production such as follow land, staircase land and meadow on both small scale farmers and large and middle scale farmers. Under the present condition, the area is estimated at from 27 to 69% with small scale farmers' and from 15 to 20% with large and middle scale farmers. In the Plan, it is estimated at from 22 to 33% with small scale farmers and from 9 to 20% with large and middle scale farmers. The average percentage in the new irrigation areas is 12.7%.

- On the other hand, from the point of land use in the crop cultivation plan, one of the standards is not beyond largely the portion of intensive cultivation (fruits, vegetables, grapes for wine and table grapes, seed production, and seed) in Lampa, Mapocho Bajo, and Angostura where intensive cultivation has been already operated. In case of subjecting average regions, the degree of intensity in these three basins is realistic, feasible and best level for reaching under the present market condition and the framework of economic policy.

- In crop selection, available crops in basins of the Maipo river and crops whose planting and cultivation area is large in the project area and its suburb are selected.

In addition, the possibility of introducing mainly following crops is taken into account for deciding land use in the project area.

- Total area of fruits cultivation in the new irrigation areas, Popeta, Yali and Alhué where located in Melipilla province, has increased 12.4% from 1994 to 1998. While in the metropolitan area, it has decreased 9.7%. The main cultivation area of fruits has been transferring from the suburb of Santiago city, where the competition with real estate business is very severe, to the neighboring areas of the new irrigation areas where have advantages on climate, soil, transportation infrastructure, agricultural product processing industries, and geographical condition for domestic market and

export port. New cultivation crops are mainly avocado, oranges, stone fruits, and table grapes. The newly developed area has exceeded 3,000ha during these four years in Melipilla province. It is planned to expand the cultivated area 5,500ha in these three new irrigation areas.

- Through making use of commerce on grapes for wine and established facilities of agro-industry, cultivation of grapes for wine is plans to be expanded. Beside the varieties which are produced domestically at present, new varieties which is suitable for the characteristics of the climate in this area will be planted. In these areas, fruits are matured slowly because of climatic characteristics which relates to superior quality of wine. Many large vineyards consider that the areas of Popeta, Yali, and Alhué are the best places for producing grapes for wine. They have already started cultivation of them with irrigation by groundwater in these areas. Investors also have started to cultivate grapes for wine largely in these areas. Main varieties of cultivation are Cabernet, Sauvignon, Merlot, and Chardonnay. Moreover, according to Santa Lita vineyard, it has the opinion that these areas is under very appropriate condition for organic cultivation of new grapes. It also expects the possibility of developing a new market on the field in the future. Total newly cultivated area has already exceeded 2,000ha, but the Plan proposes 3,300ha.

- Cultivation of vegetables (if water quality is improved) and flowers plans to be expanded to the new planning area because the location is close to Santiago and health resorts and easy to access export market. Nevertheless, according to the report on small scale farmers in Melipilla province (agricultural survey based on ENA 86), vegetable cultivation is occupied 24% of the area but the percentage is too big in case that subjective areas were Popeta, Yali and Alhué. Thus, in the Plan, the percentage assumes about 10%.

- Crop cultivation for seed production is going to be expanded to the areas, where are few problems of insect pest, located near a seed control plant, and the producers who knows the system of seed production a lot live closed by. According to Agricultural and Livestock Farming Survey '97, the crop cultivation area for seed production is more than 1,000ha and 700ha in Melipilla area and San Pedro area respectively. In the Plan, it is proposed to expand the crop cultivation area for seed production 500ha in the new irrigation areas.

- So as to maintain the area for grains, potatoes and beans (*Chacra*), and forage crop cultivation, crop rotation plans to be adopted. Cultivation of these crops is realistic selection when they start to produce in new irrigation areas because small scale farmers know at least basic production skill of them. Therefore, these crops will occupy more than 30% in new cultivation plan, and higher percentage is shown in Yali, Alhué, and Casablanca.

3) Crop cultivation by the areas

Following is the relation between present cultivated crops and proposed crop cultivation plan in view of the geo-graphical location in the study area.

- Popeta area

The cultivation plan is mainly relevant to the present crop cultivation in present irrigated areas, Melipilla and Popeta. In irrigated areas in Popeta

(including Cholqui, Carmen Alto, Culiprán, Tantehue, and Los Guindos), a lot of grapes, vegetables and fruits are cultivated due to its climatic condition. Many private investors promote cultivation by groundwater and rainfall in unirrigated area here.

- Alhué area

It is planed that the present level of Alhué area, where large unirrigated land exists even it is blessed with fertile soil and fine climatic condition, alters to the level of Melipilla basin and irrigated areas in Cabras where a lot of fruits and grapes for wine are cultivated. This area is provided very appropriate climatic condition for grape cultivation as well as Casablanca area. High potentials of this area is supported by keen interest of many vineyards and investors on the expanding cultivation plan in this area. On the other hand, there is possibility of cultivation crop diversification on vegetables, flowers, crop cultivation for seed production because of advantage on the aspect from producing environment, which is isolated condition due to natural condition, the neighboring of markets, and blessed climatic condition.

- Yali area

San Pedro area where much fruits, grapes, and crop cultivation for seed production have been cultivated in these years is provided with blessed climatic condition. Nevertheless, there is large area of unirrigated land. Because of this, the crop cultivation plan for fruits, grapes, seed production is planned.

- Puangue area (Curacaví, Maria Pinto, and Ibacache)

The idea of the crop cultivation plan in this area mainly connects with the crop cultivation system of present irrigated area in Puangue and Melipilla basin. In the plan, mainly fruits cultivation and secondly grape cultivation for wine will be major cultivation crops. Besides them, vegetable and flower cultivation will occupy some potion because this area is the suburb of Santiago.

- Casablanca area

The idea of crop cultivation plan mainly connects with present irrigated area in Casablanca basin and rapid growth of grapes for wine cultivation in these years. Therefore, grapes and fruits cultivation is planned as main crops in this area. The portion of forage crop cultivation will decrease compared to the present level, but it will remain an important crop especially in the area where irrigation water is not distributed. Furthermore, vegetable cultivation also has a certain level of possibility because main road to the central coast is passed through in this area.

- Lampa area (Colina and Polpaico)

Crop cultivation relates to crop cultivation system of present irrigated area in Lampara basin where a lot of vegetables, fruits, and crop cultivation for seed production are cultivated. At present, cultivation of vegetables, fruits, and crops for seed production occupy 69% of farmland. Yet, cultivation of vegetables and crops for seed production which need small investment will be stressed.

A new crop cultivation plan usually does not include forestry because forestry

with foreign varieties does not exist in present irrigated area. In case of the project area, if exceptional forestry is implemented, its area would be limited. Livestock farming is not included in the farming plan as well. This is because it is hard for large and middle scale farmers to expand livestock farming sector in proper land for intensive agriculture. While for small scale farmers, there is the possibility of introducing livestock farming for domestic consumption rather than commercial purpose. On the contrary, forage crop cultivation is mainly included in crop cultivation plan.

In the new crop cultivation plan, fruits and grapes for wine cultivation, and then crop cultivation for seed production by small scale farmers will increase considerably. Cultivation of these crops will become an important factor for boosting small scale farmers' income. However, this depends on forming producers' organizations and establishing and implementing a contract farming system. This will be explained in the agricultural support plan in detail.

4) Rentability of new irrigation areas

Whole farmland in new irrigation areas is unirrigated land. Available producing activities are severely limited by average annual rainfall in these areas. Seeing the example of the area where is close to the coast and suitable for livestock farming, production of meat is usually 100kg/ha at annual average. It is not beyond $50,000/ha at current price. Annual production value of fire wood is less than $30,000/ha. Nevertheless, if irrigation is introduced and nice climate and soil conditions are considered, it would become possible to do production activities with high returns such as fruits, grapes for wine, crops for seed production, and vegetables cultivation. Regarding any crops, it is estimated that gross margin per hectare reaches no less than from $700,000/ha to $1,000,000/ha. Some of these crops' gross margin exceeds $2,000,000/ha. Some varieties of crops for seed production of it reach $5,000,000/ha. In the unirrigated areas where are the subjects of the plan, the profit is extremely low when the project is not implemented, if it is compared with the profit when the project is implemented.

In the agricultural development plan for the plan area, classification by landholding scale is implemented. Farming pattern of small scale farmers is set up based on average farm area in the basin which the most relates to the plan area. That of large and middle scale farmers is set by landholding scale. It is 100ha which is the landholding scale used for estimation of the present profit. The crop cultivation plan is established based on the framework of cultivation crops mentioned above by farmers' landholding scale. The profits by landholding scale when the projects are implemented are shown in Table 5.3.2.

According to the Table, average profit of small scale farmers by landholding scale in the plan area is expected to increase 72%, from $1,921,000 at present to $3,304,000 in the future. Production activities are not planned for from 22% to 33% of farmland, but fruits and vegetable cultivation in the crop cultivation plan support this increase basically. So as to achieve this estimation, cooperation agencies have to provide the necessary support for small scale farmers. This is explained in the section of the agricultural support.

In case of large and middle scale farmers, compared with the present average profit, the future one will increase by 20% over, from $109,000,000 to $130,000,000. This is due to the availability of large investment by farmers who enter newly without exception as mentioned above. So as to estimate gross benefit, all of development cost and farming cost are subtracted. All of mechanization cost is also subtracted as rental, and capital cost is included as loan. Basic data of each cost is obtained from institutions such as Catolica University, Department of Agriculture in Chile University, INA and Foundation of Chile (*Fundación de Chile*). Benefit of each cultivation crop is

estimated through considering the present condition of the Study Area. Estimation of benefit does not include investment for irrigation project.

Calculated gross benefit per unit area by the plan area is shown in Table 5.3.3. The Table shows small difference among gross benefit per unit area in these areas.

(2) Area for rehabilitation of existing irrigation facilities

The northern part of Lampa, the left bank area of Clarillo, areas of Angostura, Puangue and Melipilla are mentioned as the areas where water resource is scarce and the level of structural condition is low on the irrigation facilities. Improvement of existing irrigation facilities is planned in these areas. The farming on these areas will maintain the present farming type but fruits growing will increase at hilly and sloping areas.

However, following small changes of cultivation area are planned through stabilizing water use resulted from rehabilitation of irrigation facilities and enabling investment in production resulted from reduction of O & M cost. Basically, small scale farmers aim at transformation of cereal cultivation and fallow land into fruits growing and forage crop cultivation, and medium and large scale farmers aims at transformation of cereal cultivation and forestation into fruits growing and forage crop cultivation.

Although stability of water use increases by improving irrigation facilities, farmers, who are holders of water right, have to take responsibility for their ways of developing agriculture balanced with its stability. Therefore, providing farming support for improvement of irrigation technique especially to small scale farmers gives important meaning on effective use of water resource and improvement of farming.

Accordingly, based on the present cultivation, main cultivation crops by the area are summarized in the table below. Details are shown in Table 5.3.4 and 5.3.5.

Farmers' scale	Small scale farmers				Medium and large scale farmers			
Farming area	24,562.9 ha				105,165.7 ha			
Sub-basin	Decreased crops		Increased crops		Decreased crops		Increased crops	
Clarillo	Cereals	17.1ha	Fruit tree	24.2ha	Cereals	120.7ha	Fruit tree	63.3ha
	Fallow land	21.4ha	Forage crop	14.3ha	Forestation	65.5ha	Forage crop	60.5ha
							Seed	62.4ha
Lampa	Cereals	65.2ha	Fruit tree	65.2ha	Forestation	155.2ha	Fruit tree	155.2ha
	Fallow land	97.9ha	Forage crop	97.9ha				
Angostura	Cereals	69.2ha	Fruit tree	34.6ha	Cereals	442.1ha	Fruit tree	443.7ha
			Vegetable / Flower	34.6ha	Forestation	492.2ha	Forage crop	490.6ha
Melipilla	Cereals	82.2ha	Fruit tree	106.8ha	Cereals	259.4ha	Fruit tree	257.8ha
	Fallow land	106.8ha	Forage crop	82.2ha	Forestation	265.2ha	Vegetable	266.8ha
Puange	Cereals	49.4ha	Fruit tree	64.2ha	Cereals	105.9ha	Fruit tree	88.8ha
	Fallow land	64.2ha	Forage crop	49.4ha	Traditional crops	102.4ha	Forage crop	119.5ha
Total		573.4ha		573.4ha		2,008.6ha		2,008.6ha
Crop transformation ratio	2.3 %				1.9 %			

(3) Area on water quality improvement

Cultivation of dedicated vegetables by the Bureau of Environmental Health in the Capital City is prohibited in 85% of the areas where utilize water of Maipo and Mapocho water systems due to contamination of water quality. Although the Study area is under the benefited production and marketing conditions, the cultivation is limited. Therefore, water quality improvement is indispensable in order to improve farming condition. Vegetable cultivation is highly beneficial, and small scale farmers can get its merits. Frozen and perishable vegetables can be sold to the neighboring countries and markets of the Northern Hemisphere.

Crop production plan in the improvement area of quality on irrigation water, cropping ratio of vegetables will be increased in case of small scale farmers introducing the chard, cabbage, cauliflower, etc. which prohibited the cultivation at present. Even the quality of irrigation water is improved, utilization of irrigation water will be made mainly on prevailing fruits cultivation in case of large and medium scale farmers. Quality of Fruits cultivated by the improved irrigation water has high marketability. With these, present cultivation of fruits will be followed on the crop production plan of the large and medium scale farmers.

5.3.3 Agricultural Support Plan

Stable development of rural areas where dominate land area and population is necessary for balanced and sustainable development of Chilean socio-economy. Exhaustion and devastation of rural areas can be the main constraints of balanced regional development because that causes loss of their land conservation function, urban concentration of population, and deterioration of natural, social and economic environment. Moreover, more than 80% of small scale farmers among those who engage in agriculture live in rural areas, and they are in charge of main role in rural and regional society in fact. Therefore, it is important for vital and stable development of rural areas to make the small scale farmers vital and settled down.

So as to make small scale farmers vital, it is required for small scale farmers, who will deal with activation, to liven them up by themselves eagerly before solving financial and economic problems. For this,

1) uniting small scale farmers
2) support for change of the present situation
3) policy for realization of the plan

are needed. In case of this area, regarding 2) and 3), supporting institutions such as SECPLAC, INDAP, and FOSIS and programs for implementation are already prepared. So, the guidance system for realizing unity of small scale farmers is wanted. Moreover, cooperation between the services of SECPLAC and INDAP which are the sector of implementing social policy are not close enough as a precondition of connecting small scale farmers with these support services. Improvement of organization of SECPLAC is required in view of the support services for small scale farmers.

Thus, SECPLAC that grasps regional condition is as an adviser, OMPC (Oficina Municipal de Planificación para Campecina) is established in Comuna. And it needs to support unorganized small scale farmers for establishing producers' organizations for enlightenment and extension of the support system, independence of small scale farmers, stabilization of their farming, and rural permanent settlement. Through this, it is significant to establish the system that those organizations can receive financial and technical support from INDAP, FOSIS and so on.

Based on the points mentioned above, the plan for agricultural support in the Study Area is to be established.

(1) Promotion of forming fundamental organization

Forming fundamental organization here means the preparatory stage of forming a producers' organization for isolated unorganized small scale farmers. In short, through

1) Analyzing characteristics and intention of each farm household,
2) Classifying them into basic groups roughly,

3) And enlightening each group about the support system and deepening their recognition of its utilization,
4) Agreement on the activities for changing their present condition is to be formed.
5) Based on this agreement, activities for forming producers' organization starts.

As the lack of these parts in the support systems so far, it was not possible to unite farmers widely. This support system intends to strengthen and systemize these parts. In this plan, OMPC is in charge of following roles as a core of the system.

- Grasp of local inhabitants' farming condition
- Grasp of farmers' intention
- Enlightenment of the support system
- Organizing the fundamental groups based on farmers' information
- Advising on obtaining agreement among a fundamental group
- Advising on forming producers' organizations based on the agreement and introducing consultants
- Support newly formed producers' organizations for attending INDAP projects
- Utilization and application of social policy subsidy to promote forming fundamental organizations
- Advising and supporting established producers' organizations for highly-advanced ones

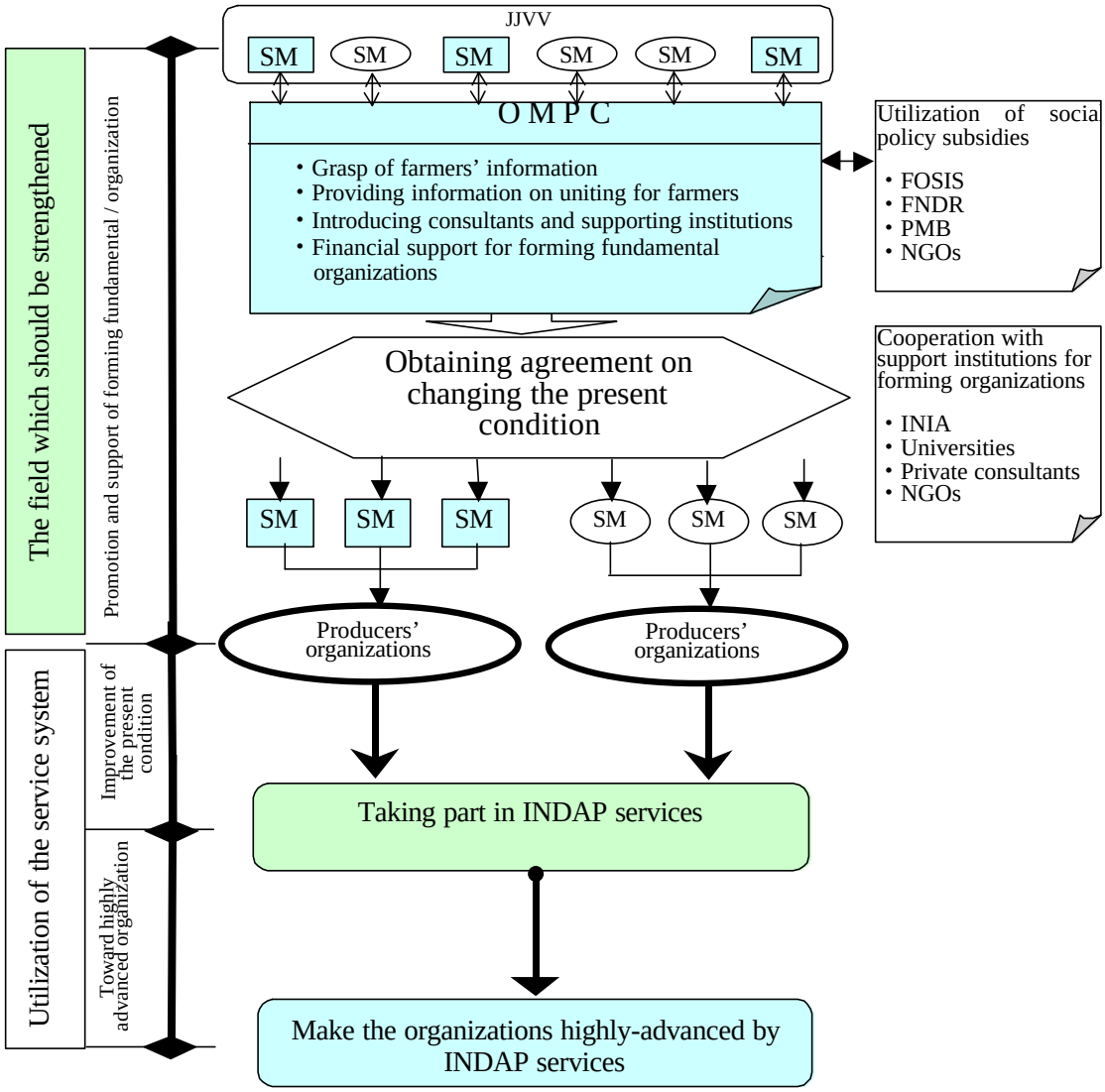
So as to organize information for implementing the roles mentioned above, following activities are also important.

- Listing up and registration of supporting institutions such as consultants
- Cooperation with and utilization of external supporting institutions (INIA, universities, consultants, and NGO)

It is also required to make most use of subsidies (FOSIS, FNDA, PMB, and NGOs) for social policy provided by the government for that OMPC implements the support services on forming organization.

Public budget provided by *Comuna* is also needed. OMPC should be set up as the special sector to promote forming small scale farmers' organizations. Then, the system for establishing required project plans should be built up through effective combination of various sources of fund. So as to implement this system efficiently and promote mutual understanding of farmers, the base facility of activities is to be constructed in *Unidad Vcinal* (UV).

The flow chart for strengthening and promoting agricultural support is presented on the next page.



In the flow, the point which should be particularly strengthened in this plan is "promotion and support of forming fundamental organizations" as mentioned above. One of the reasons why independence of small scale farmers has not been promoted well so far is the lack of this part in the public organizations. The purpose on "promotion and support of forming fundamental organizations" of small scale farmers which planned here is to establish the initial and basic part of the process to realize forming unity which is the condition of participating "the programs for independence" or the support services of government. In other words, the first step lead to forming a "producers' organization" which is the group for receiving the support services implemented by INDAP and FOSIS should be harden. In order to do this, small scale farmers should utilize the power of organization and experience which belong to *Comuna*. OMPC does not organize fundamental organizations by itself but it is just a promoter of fundamental organizations. The activities for forming organizations should be carried out by small scale farmers.

The first stage is the stage of encouraging small scale farmers to participate the activities for changing of the present situation by OMPC. Based on the cooperation with external support institutions such as INIA, universities, private consultants and NGOs, OMPC enlightens small scale farmers and carries out public relations about contents of support programs and services, and examples of the existing producers'

organizations by unit of JJVV. Then, it intends to make them recognize what kind of activities should be done for changing the present situation. Afterward, it classifies small scale farmers into some groups by product, and make them clarified what is required for changing the present situation on each group and what kind of support programs can be used for this. The process up to this is the promotion stage by OMPC.

The second stage is the stage for the study of the present situation, finding problems and making a basic plan for change. Under the guidance of the external support institutions, the basic plan for the change of each group is established by farmers' participation, and obtain agreement on implementation among farmers. In this stage, introducing Regional Support Service (SAL) of INDAP should be examined.

The third stage is application to INDAP after establishing the implementation plan for application for the support programs under the agreement among farmers in the groups. After the second stages, the external support institutions and producers' group are to be cooperated.

The fourth stage is the stage for making formed producers' organizations highly-advanced, giving and boosting value added against products, and improving production skill and ability of business enterprise type farming. Project Support Service (SAP) and Specialization Support Service (SAE) are to be introduced.

As mentioned above, agricultural support system can function on the base of close cooperation among OMPC, external support institutions and small scale farmers. If any of them lacks, sound development of agricultural support could not be achieved.

Sites and numbers that required establishing the support system for small scale farmers through founding OMPC in *Comuna* are as follows;

Basin	Site	Basin	Site
1.Río Maipo	2	8.Melipilla	1
2.Río Clarillo	1	9.Río Puangue	2
3.Río Mapocho	6	10.Est. Yali	3
4.Est. Lampa	3	11.San Antonio	3
5.Río Mapocho	6	12.Est.	4
6.Río Angostura	6		
7.Río Rapel	2	Total	39

(2) Making producers' organizations highly-advanced

The support at the next stage, for instance, the support for cooperative sale, agricultural processing, and the activities to obtain sale's right of agricultural products in central market, is necessary for the producers' organization which has already formed and started their activities. The services for this are SAP and SAE which provided by INDAP. Thus, it is possible to aim at more highly-advanced organizations, corresponding with reached stages by each producers' organization.

Finally, quality of unit producers' organization will be improved through taking part in the services by INDAP leading to a highly-advanced organization. Then, the organizations is to be grown as the industry which supports regional economy.

Regular shipment, fixed quantity, and standardization are demanded to promote making organizations highly-advanced. Nevertheless, it is very hard for an unit organization to satisfy the demand. Thus, the demand should be satisfied with alliance of homogeneous unit organizations.

(3) Installation of facilities for the base of activities

Unit producers' organizations are often formed as fundamental bases through the activities of *Unidad Vecinal* (UV). It is reasonable to form organizations through UV, basically. Yet, many of UVs do not have the base facilities for meeting and training courses, and it is impossible to communicate among inhabitants smoothly. This may lead to low rate of organizations in UV and difficult environment for forming fundamental organizations aiming at improvement of the present agriculture.

So as to break this situation, it is indispensable to construct the activity base facilities for vitalization of UV's activities and smooth communication among regional inhabitants. 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 skill will be taken place. Through these activities, self-independence of UV is to be promoted.

The base facilities name Regional Communication Center (CECUV: *Centro de Communicación para UV*) and is built in each UV, each *Comuna*. The number of required CECUV by each basin is as follows;

Basin	Number	Basin	Number
1.Río Maipo Alto	13	8.Melipilla	25
2.Río Clarillo	3	9.Río Puangue	8
3.Río Mapocho Alto	36	10.Est. Yali	8
4.Est. Lampa	15	11.San Antonio	8
5.Río Mapocho Bajo	26	12.Est. Casablanca	18
6.Río Angostura	24		
7.Río Rapel	13	Total	197

Functions of CECUV are promotion of communication and of support activities for farmers. They are as follows;

- Promotion of communication
    1) Improvement of rural living environment
    2) Vitalization of communication among regional inhabitant
    3) Operation and maintenance of regional and 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) Providing an office for a producers' organization

CECUV should be operated with consensus of inhabitants in UV and based on discussion for obtaining the consensus among inhabitants. Therefore, if the plan is not made by inhabitants' participation on what kind of CECUV is needed for their UV and the types of operation, the CECUV would not be a necessary facility for the area truly. So as to establish the truly needed facility, it should be started from the activities to make the CECUV building plan clear through using present meeting places (for example, schools, churches, constructed producers' facilities) with the support from

SECPLAC. Therefore, in the Master Plan, the main purposes are to confirm the necessity of CECUV and pull the motivation for construction out from the inhabitants.

(4) Fund for small scale farmers' support and its utilization methods

As the funds to support public finance of each *Comuna*, there are local tax and subsidy from Municipal Community Foundation. Nevertheless, the subsidy from Municipal Community Foundation supports the public finance in local rural areas where strong manufacturers and enterprises are not located in. Most of *Comunas* in rural areas such as the Study Area are financially vulnerable. Because of this, it is extremely hard to raise fund for the support of small scale farmers from general account of *Comuna*.

Accordingly, the required project for *Comuna* should be planned by mixing various foundations with subsidies provided by governmental authorities for the projects. Making the most of these subsidies and foundations is the important role of *Comuna* and OMPC in *Comuna* is to take in charge of this role. Main foundation sources are as follows.

Main Foundation Source	Components of Foundation
Municipal Community Foundation (FCM : Fondo Común Municipal)	The subsidy consists of funds contributed from all cities of the country and subsidies from the national budget and alcohol tax and etc. and redistributed corresponding to financial situation
Solidarity and Social Investment Foundation (FOSIS : Fondo de Solidaridad e Inversión Social)	Foundation established within MIDEPLAN in 1990 for financial and technological support on social policy promotion
National Regional Development Foundation (FNDR : Fondo Nacional de Desarrollo Regional)	Foundation consists of the national budget and loans from Inter-American Development Bank and redistributed through Regional government
Environment of City District Program (PMB : Programa de Mejoramiento de Barrios)	Foundation for improvement of residential district by Ministry of interior

In order to utilize the funds of FOSIS, FNDR, and PMB, the clear implementation plan should be made by farmers. Among them, while fund of FNDR and PMB is public work type's fund, fund of FOSIS is so flexible that it is possible to promote software projects by concluding agreement between *Comuna* and FOSIS. For example, cultural events for young generation were undertaken and "Youth Hall" was built by the agreement on "Young generation development plan" between FOSIS and the city. The hall is utilized multiply as the place for vocational education and sports recreation activities, and succeeds in promoting permanent settlement of young generation.

Like this example, under concluding the agreement on "small scale farmers development plan" between OMPC in *Comuna* and FOSIS, the receiver of INDAP service can be formed through support for forming organizations and promotion of constructing CECUV by utilizing private consultants in this area, too.

The basic purpose of "small scale farmers development plan" is forming organizations of small scale farmers. OMPC in *Comuna* undertakes intention survey on small scale farmers and survey on farming condition to collect basic information by utilizing the funds as mentioned above and private consultants. Moreover, under cooperation with INDAP or consultants, OMPC makes small scale farmers recognize necessity and importance of changing the present situation through enlightenment about, public relations and extension of the service system.

Number of required consultants per *Comuna* is set as follows.

Required items	No. of Consultants
• Basic information such as intention survey	2 personnel
• Enlightenment about materializing the project	1 personnel
• Guidance for forming organizations	2 personnel
• Guidance for farm management	2 personnel
• Guidance for irrigation	2 personnel

When consultant fee is average $800,000/month, annual necessary expense is estimated at $86.4 million. If the subsidy for the project is 70% of the annual necessary expense under the agreement, expense of *Comuna* would be about $2.6 million (about ¥8.7 million).

Because the cooperation with NGOs is possible on the field of basic information collection and guidance on farming and irrigation, contact with NGOs is promoted. Moreover, a woman of Japan Overseas Cooperation Volunteers is posted as a village development extension worker in Provincia Melipilla, the Study Area, and takes in charge of San Pedro area. In April, 1999, another four volunteers will dispatch to Alhué area. Accordingly, under cooperation with international institutions, the support program for independence of small scale farmers is to be established.

5.3.4 Rural Infrastructure Improvement Plan

(1) Improvement of basic infrastructure

Improvement of basic infrastructure in rural areas is promoted from the view point of rural permanent settlement's promotion and agricultural production environment's improvement. As shown in analysis of the present condition, installation rate of basic infrastructure which is relevant to living is relatively high in rural areas, the Study Area. Yet, installation of water supply service and road construction fall behind mainly in mountainous areas. So, improvement of basic infrastructure will start mainly from installation of these facilities. Because waste water is not treated at all in local middle and small cities, it damages production and living environment. Countermeasures are needed for forming safe and comfortable rural environment.

Based on the points of view above, in living basic infrastructure improvement, installation of rural water supply facilities, construction of waste water treatment plan and wide ranged local road network are mainly promoted.

Amount of installation is as follows;

Basin	Installation of rural water supply	Waste water treatment plants	Local road installation
	Unit	Unit	Km
1.Río Maipo Alto	-	2	-
2.Río Clarillo	4	1	-
3.Río Mapocho	-	6	-
4.Est. Lampa	3	3	-
5.Río Mapocho	-	6	-
6.Río Angostura	4	6	15
7.Est. Alhué	8	2	35
8.Melipilla	5	1	20
9.Est. Puangue	9	2	12
10.Est. Yali	8	3	55
11.San Antonio	3	3	28
12.Est. Casablanca	8	4	26
Total	52	39	191

So as to promote the projects, following project systems will be utilized.

Projects	Development Projects	Ministry
Agua Potable	Programa de Agua Potable Rural	MOP
Tratamiento de agua negura	Fondo Nacional de Desarrollo Regional : Subsector Alcan-tarillado Sanitario	MI
Camino	Fondo Nacional de Desarrollo Regional : Subsector Caminos Rulales	MI
	Programa de Conservacion de Caminos Secundarios	MOP

(2) Community center for *Unidad Vecinal* (CECUV: Centro de Communicación para *Unidad Vecinal*)

CECUV will be constructed as the place for promoting communication and supporting activities for farmers as mentioned in the section of farmers' support organizations. The facility composition is proposed as follows;

Facilities	Scale (㎡)
Study room	48.6
Conference room	24.3
Supervision room	12.2
Producers' organizations room	48.6
Warehouse	12.2
Bath room	12.2

(3) Construction and improvement of other facilities

It is also important to construct or improve educational facilities and medical and health institutions for promoting rural permanent settlement and growing agricultural successors. However, they are not the facilities or institutions which should be constructed or improved in the field of agricultural development but should be constructed or improved as fundamental right of inhabitants. Therefore, they will not be constructed or improved within this plan but following facilities and institutions need to be constructed for guaranteeing fundamental right of inhabitants and regional stable development.

Basin	Construction and improvement of basic educational facilities	Construction and improvement of medical and health facilities
	Unit	Unit
1.Río Maipo Alto	-	-
2.Río Clarillo	-	-
3.Río Mapocho Alto	-	-
4.Est. Lampa	4	2
5.Río Mapocho Bajo	-	-
6.Río Angostura	6	4
7.Est. Alhué	5	3
8.Melipilla	6	3
9.Est. Puangue	4	2
10.Est. Yali	5	3
11.San Antonio	2	2
12.Est. Casablanca	4	2
Total	36	21

5.3.5 Agricultural Infrastructure Improvement Plan

The agricultural infrastructure improvement plan in the objective area is an irrigation facility improvement. The irrigation facility improvement is divided into a two targets. One is the existing irrigated areas and the another is construction of facilities in new irrigation areas.

(1) Structural improvement in the existing irrigation areas

Based on the survey results of existing irrigation facilities, the plan try to reduce O & M cost of canals and water shortage at the field level by improvement of diversion weirs and main canals.

At the present, sub-basin of Clarillo, Angostura, Puangue, Lampa and Melipilla in which indicated significant shortage of irrigation water with existing irrigation facilities by the results of water balance study are to be selected. Integration of intake structure at the second and third sections of the Maipo river is to be implemented to establish an order of water use by improvement of the facility. Summary of the development plan is as follows;

Sub-basin	Area	Main improvement structures		
	(ha)	Intake structures (unit)	Diversion works (unit)	Canals (km)
Río Clarillo	2,500	-	12	16
Río Angostura	45,105	22	47	235
Est. Puangue	13,412	6	17	98
Est. Lampa	13,381	-	14	63
Melipilla	28,690	5	34	211
Total	103,088	33	127	623

Preconditions to establish the structural improvement plan are as follows;

- Improvement plan of weirs such as integration of intake structures does not exceed the river section, which formulated by water use system.

- Increase of intake amount by transferring or buying water right is not considered.

- For the project implementation, application of the Irrigation Law No.1123 and No.18450 are considered. The scale of the plan should not exceed that of support projects.

- The plan does not include a construction or improvement plan of water saving irrigation facilities at field level because the facilities must be improved by farm households.

(2) New irrigation plan

- Irrigation plan by utilization of unused water right in the downstream reach of the Maipo river

  Using DOH's water right of 25 m^3/s, newly irrigated areas of total area of 21,000ha is planned at Yali (10,000ha), Alhué (6,000ha), and Popeta (5,000ha). The areas of Yali, Alhué, and Popeta are to be integrated to one irrigation system since they are holding same intake structures and main canals. Construction of four power generations is planned by utilization the fall on the way of a main canal. The purpose is the decrease of O & M cost by selling the generated power.

- Irrigation plan by a large scale dam

  Expected available supply of 320 MCM by construction of a large scale dam distributes to total area of 18,500ha to sub-areas of Lampa (Colina 2,000ha, Porpaico 3,000ha), Curacavi (6,500ha) and Casablanca (7,000ha). Construction of four power generations is planned by utilization the fall on

the way of a conduction canal from the dam.

- Irrigation plans by middle and small scale dams

  Expected available water of 39 MCM by construction of middle and small dams is new irrigation for around the dam sites and supplementary water source for areas of Colina and Curacavi by 270 ha and 280 ha respectively. Rosario area is no new irrigation area and is reserved as a future water source.

The irrigation plans mentioned above are summarized by alternative plan of water source development as follows;

Item	Alternatives to water source development			
	Without dams	With dams		Combination
	A－1	A－2 (Middle and small scale dams)	A－3 (A large scale dam)	A－4 (A-2+A-3)
Available developing area	—	2,300 ha	18,500 ha	20,800 ha
(With existing water right)	21,000 ha	21,000 ha	21,000 ha	21,000 ha
Total	21,000 ha	23,300 ha	39,500 ha	41,800 ha
Development plan	—	550 ha	18,500ha	19,050ha
(With existing water right)	21,000ha	21,000ha	21,000ha	21,000ha
Total	21,000ha	21,250ha	39,500ha	40,050ha

(3) Utilization of treated sewerage

The treated sewerage is to be used as irrigation water in Curacavi. Irrigation area comes 3,000ha.

(4) O & M plan for existing irrigation system

O & M organizations are formed with all irrigation systems in the study area and is implemented by canal organizations. As have mentioned so far, the Mapocho river and the Maipo main river course are divided into 5 sections and 3 sections respectively in the Maipo river basin. Although the arrangement of water use should be carried out based on these sections, *Junta de Vigilanccia*s has not established in the 2nd and the 3rd sections in the Maipo river, yet. However, the water users prepare to establish *Junta de Vigilanccia* in two sectors, too. This is because the requirement of water use arrangement by *Junta de Vigilanccia* has been recognized through increasing water use and frequent shortage of water in recent years. According to the present situation, in the study, the plan concerned with O & M of the existing irrigation system will not be established.

In the areas where irrigation will be newly introduced by the study, irrigation beneficiaries need to establish a new water users' association. The water users' association is established according to the Law of Water Users' Association, and will be approved by DGA. Water management and O & M of newly constructed irrigation structures are implemented by the newly organized water users' association.

5.4 Environmental Conservation Plan

5.4.1 Basic Concept of the Environmental Conservation Plan

Based on the study results of present environmental situation, problems regarding the objective areas are recognized as the contamination of irrigation water, deterioration of social environment and environmental impact by development. Summaries are as follows;

- In the construction plan of the sewage treatment plants in Santiago by EMOS, three plants will be completely constructed along the Mapocho River in 2024 to ameliorate water quality. However, it will have taken about 25 years to obtain the excellent water for irrigation from the river since the completion of the plants. Therefore, the progressive measures to ameliorate water quality by the agricultural side in order to obtain the desirable environment for agriculture in the whole period including the process period.

- The establishment of CONAMA in 1994 became in the areas a start of the local environmental preservation. It is promoted to make the countermeasure against air pollution, illegal dumping of waste, and discharging factory effluent without being treated and to preserve the local environment in cooperation with residents. The activity for environmental preservation in accordance with the CONAMA's plan is needed for preservation of the future regional environment.

- Only the control system of air pollution over the metropolitan region is working as the present environmental monitoring system. In order to preserve the local environment, it is necessary to observe continuously the environmental factors such as forest, current, water quality, use of land or the like. Therefore, it is also necessary to establish the system to investigate continuously and periodically the influence by agricultural development on the area or by the local environment on the new development section.

According to the above-mentioned problems on the regional environment and the method to solve them in future, it is a step of amelioration of agricultural environment in the area in this project to improve water quality from the agricultural side, preserve the regional environment in accordance with the CONAMA's plan, and establish the monitoring system. The method to solve them needs to be approached in diversity and general ways including the systematic supports from the resident group.

5.4.2 Irrigation Water Conservation Plan

According to the plan by EMOS, water contamination is decreasing gradually by the development plan, however, it takes about 25 years to obtain adequate irrigation water from the rivers after completing of the plants. Therefore, the countermeasures for water quality improvement from agriculture side are needed in order to recover the function of the suburban agricultural area as a perishable food supply center by establish preferable environment for agricultural production.

The measures can be considered as follows;

a. Avoiding contamination source: Conveying adequate irrigation water through bypasses to avoid contamination sources
b. Changing water sources: Obtaining irrigation water from uncontaminated areas or groundwater
c. Improving water quality: Obtaining irrigation water by treatment of contaminated water

The areas are not to be included where contaminated irrigation water is to be improved until the target year of 2010 by the sewerage-treatment plants of EMOS in order to corresponds with the sewerage treatment plan of EMOS. The countermeasures of each intake source are summarized as follows;

Area / Measures	Appearance of treatment's effect by EMOS	Avoiding contamination source	Changing water source	Improving water quality
The midstream basin of the Mapocho river (up to the confluence of Z. de la Aguada)	The end	San Carlos with canals	Impossible	Not needed
The downstream basin of the Mapocho river (from the confluence of Z. de la Aguada to confluence of the Maipo river)	From the middle to the end	Impossible	The area with groundwater regulation	Possible
The midstream of the Maipo river	The beginning	—	—	—
After the confluence of the Maipo river and the Mapocho river	The end	Impossible	Groundwater (possibly)	Possible

The measures for improvement of water quality with canals are summarized as follows;

Measures for improving water quality	The objective canals	Intake amount (m^3/sec)
Avoiding contamination sources (through bypass)	Canal La Polvora	0.5
	Canal La Punta	5.8
	Canal Casas de Pudahuel	0.8
	Total	7.1 m^3/sec (3 canals)
Improving water quality	Canal Las Mercedes	10.5
	Canal Esperanza Alto	0.7
	Canal Esperanza Bajo	1.7
	Canal Romero	1.0
	Canal Castillo	2.0
	Canal Domingano	0.8
	Canal Mallarauco	8.5
	Canal El Paico	2.5
	Canal San Miguel	4.2
	Canal Lo Aguirre	3.6
	Canal Lo Chacon	3.6
	Canal La Manresa	1.2
	Total	40.3 m^3/sec (12 canals)

Among the measures of water quality improvement, the targets on water quality improvement is shown in the table below. The targets concerns forbidden vegetable cultivation caused by contaminated irrigation water and quality of products as agricultural exporting products (mainly toward the United States). These are the problems which agriculture in the metropolitan faces.

Subject	Crops	Criteria
Bureau of Environment and Health in Chile	Vegetables	Less than 1,000 groups of colitis germ/100ml
For agricultural export	Grapes	For sprinkler irrigation, primary treatment water is not permitted.
(toward the United States)	Forage and seed crops	For irrigation, primary treatment water is permitted.
	Food crops	For surface irrigation, primary treatment water is permitted.
		For sprinkler irrigation, water should be disinfected and groups of colitis germ should be less than 23/100ml.
	Table crops	For surface irrigation, groups of colitis germ should be less than 2.2/100ml.

Prevailing irrigation methods are furrow and drip irrigation methods. In the case of improving water quality, groups of colitis germ should be less than 23/100ml. If chlorine disinfection is planned, a domestic criteria and the criteria for exporting food crops can be cleared. Accordingly, the targets of water quality improvement are less than 23/100ml groups of colitis germ and chlorinated. In the case of cultivation of fruits, because sprinkler irrigation is the objective of criteria, a plan on improvement of water quality which focused on vegetable cultivation is established. The method of

sewerage treatment is planned in accordance with the method of Standard Activated Sludge as well as the treatment method planned by EMOS based on treatment scale and capacity.

Vegetable cultivation by canals was set by crop cultivation in '97 Census as follows and volume of improvement is estimated from required irrigation water to the cultivation area.

Objective canal	Vegetable cultivation area (ha)	Treated (irrigation) water m^3/s
Canal Las Mercedes	1,500	1.50
Canal Esperanza Alto	150	0.15
Canal Esperanza Bajo	240	0.24
Canal Romero	100	0.10
Canal Castillo	30	0.03
Canal Domingao	200	0.20
Canal Mallarauco	1,500	1.50
Canal El Paico	200	0.20
Canal San Miguel	300	0.30
Canal Lo Aguirre	200	0.20
Canal Lo Chacon	300	0.30
Canal La Manresa	20	0.02
Total	4,740	4.74

The canal associations are to execute the water quality improvement, however, the project has an effect for conservation on natural, social and economic environments and required to promote by introduction of the government finance as the public project. In case of discharging domestic sewage into the canals that cause contamination of water for irrigation, such case is related to the construction of the sewage treatment plant in the local city so that it is solved in the arrangement of the living environments within the study area.

5.4.3 Environmental Management Plan

(1) Promotion of environmental education in basins

Urban areas have the problems of illegal disposal of wastes and non-treated discharge of contaminated water by industries while rural areas have the problems of the canal contamination by domestic wastes, miscellaneous sewerage and waste of animals. An areal approach is to play an important role based on the national environmental conservation policy in order to solve these problems. At the present, CONAMA is implementing "The countermeasures against contamination campaign." This is a fourteen years plan. Activity area limits only to the Centro area and Las Condes area at present but the plans to extend to rural area.

Volunteers are organized from youth groups, various organizations and farmers' organizations under the cooperation with SECPLAC of *Comuna*. The volunteers obtained CONAMA certificate of the environmental conservation's extension workers carry out environmental education and enlightenment activities in each Community.

(2) Promotion of agriculture concerned environment

The plan is to avoid environmental contamination caused by increment of fertilizer and agricultural chemicals use in the agricultural development. The measures for decreasing inputs of pesticide and fertilizer by the cooperation of INIA and public research institute such as Chile University in order to promote sustainable agriculture based on utilization of available resources in area are to be planned. Technology transfer or technological instruction to farmers is implemented by the cooperation of INDAP

and private agricultural consultants.

When carrying out the promotion, SECPLAC will become the core of the promotion to which the Ministry of Agriculture is to give instruction on the planning.

(3) Establishment of an environmental monitoring system

Chile has a management system for air pollution in the metropolitan area at present. Thus, an environmental management system will be established by utilizing the system and expanding its function the management. The environmental management subject in the development plan covers wide range of fields such as natural resources (i.e. forestry), condition of rivers, water quality, land use, agricultural development, irrigation, cropping, plant growth and so on. Accordingly, compulsory environmental monitoring by Landsat and Spot satellite pictures is needed to monitor environment periodically for global supervision of the subjects. Organization related to Ministry of Agriculture by cooperation with the environment center is to establish the system.

The core organization of the promotion is set CONAMA. The national environment center is in charge of measuring and analyzing each environmental factor.

5.5 Selection of the Agricultural Development Scenario

5.5.1 Development Components of Each Scenario

Based on the alternatives of water resource development in the study area described in the water source development plan, following four agricultural development scenarios is proposed in the study area. Each agricultural development scenario formulates agricultural promotion and environmental conservation plans. Agricultural promotion plan consists of following sub-development plans described in the agricultural promotion plan.

- Construction of the irrigation system including water source facilities for the new irrigation development,
- Rehabilitation of existing irrigation system,
- Improvement of water quality for the existing irrigation system using the contaminated irrigation water, and
- Improvement of rural infrastructure to facilitate the settling condition of in the rural area.

Environmental conservation plan consists of promotion of environmental education, sustainable agriculture taking the regional environment and establishment of environmental monitoring system to control the regional environment.

The structural components of each agricultural development scenario are as follows;

Item	Component	S - 1	S - 2	S - 3	S - 4
1 Agricultural infrastructure Development					
Irrigation development					
Colina-Casablanca	Irrigation area (Colina, Porpaico, Curacavi, Casablanca)	-	-	18,500 ha	18,500 ha
	Water source facilities (Maipo Dam)	-	-	1 site	1 site
	V=360 MCM, H=161 m, L=800 m				
	Main canal	-	-	296.5 km	296.5 km
	Related structures (tunnels、siphons)	-	-	21.7 km	21.7 km
	Power station	-	-	4 sites	4 sites
Colina	Irrigation area (Colina)	-	270 ha	-	270 ha
	Water source facilities (Colina Dam)	-	1 site	-	1 site
	V= 4.6 MCM, H= 45 m, L=230 m				
	Main canal	-	4 km	-	4 km
Curacavi	Irrigation area (Curacavi)	-	280 ha	-	280 ha
	Water source facilities(Cracavi Dam)	-	1 site	-	1 site
	V= 4.7 MCM, H= 27 m, L=150 m				
	Main canal	-	30 km	-	30 km
Yali -Popeta	Irrigation area (Yali, Alhué, Popeta)	21,000 ha	21,000 ha	21,000 ha	21,000 ha
	Headworks (Integration)	1 site	1 site	1 site	1 site
	Main canal	140.5 km	140.5 km	140.5 km	140.5 km
	Related structures (tunnels、siphons)	13.6 km	13.6 km	13.6 km	13.6 km
	Power station	4 sites	4 sites	4 sites	4 sites
Improvement of existing irrigation system	Objective sites (Clarillo, Angostura, Lampa, Puangue, Melipilla)	5 sites	5 sites	5 sites	5 sites
	Objective area	103,088 ha	103,088 ha	103,088 ha	103,088 ha
	Objectives for improvement				
	rehabilitation of intake structures	33 sites	33 sites	33 sites	33 sites
	:rehabilitation of main canal	623 km	623 km	623 km	623 km
2 Rural Living infrastructure Development	Rural water supply	52 sites	52 sites	52 sites	52 sites
	Rural sewerage system	39 sites	39 sites	39 sites	39 sites
	Local roads improvement	191 km	191 km	191 km	191 km
3 Environmental conservation	Improvement of water quality				
	Bypass canal	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s	3 sites Q= 7.1 m^3/s
	Treatment of water quality	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s	12sites Q=4.74m^3/s

Summaries of each agricultural development scenario are shown in Fig. 5.5.1 to Fig. 5.5.4.

5.5.2 Evaluation of Agricultural Development Scenarios

Even though this is an agricultural development project, some of the four scenarios included water uses other than irrigation, namely, electricity generation and drinking water supply. Benefits from hydroelectric generation along irrigation canals were estimated in term of the value of the generated electricity. Likewise, benefits from drinking water were estimated in terms of the lower cost of the Maipo river as water source, compared with groundwater as the alternative water source.

Benefits from agriculture were estimated on the basis of three components: annual crops, fruits species, and seed production. Fruit species were assumed to take fifteen years to reach full production stage. On the other hand, grapes for wine were assumed to take nine years to reach full production stage. The evaluation of agricultural development scenarios was conducted using current market prices, without adjustments for price distortions.

(1) Project cost estimation

The unit price used for estimation is formulated by the data obtained from DOH.

a) As for unit price of dam, unit price per m^3 is calculated by dam construction costs which were constructed from 1930 to 1995 by DOH.
b) Unit cost for earth work and for related structures is referred to unit price of implemented projects by DOH.

(2) Basic assumption of the evaluation

a) Useful life of the project: 30 years, with implementation period between the year 2000 and 2010
b) Price level of August 1998
c) Benefits from drinking water : $35/m^3 (difference in production cost between surface water and groundwater), 30% water loss, 85% bill collection rate
d) Benefits from hydroelectric generation : $25/kwh, 10% loss, 95% bill collection rate
e) Benefits from agriculture : gross margin per ha, which varies depending on the location of the irrigation area, and type of crops. Annual crops were assumed to start in 2005, while fruits and grapes for wine in 2004. Fruit species were assumed to reach full production in 15 years, while grapes for wine in 9 years.

Irrigation Development Area		Benefits
Section	Area (ha)	(1,000$/ha)
Alhué	6,000	1,143.2
Popeta	5,000	981.1
Yali	10,000	1,073.5
Curacavi	280	1,073.7
Colina-Casablanca	18,500	1,025.6
Colina	270	1,027.6

(3) Results of evaluation

The evaluation results of four agricultural development scenarios are shown as IRR in the table below. IRR of agricultural development scenario 1 and 2 exceeds social discount rate of 12% set by MIDEPLAN. On the contrary, IRR of agricultural development scenario 3 and 4 are less than 12%.

Development scenario	IRR(%)	NPV (12%, Million)	B/C (12%)
S-1	14.95	22,043.3	1.37
S-2	14.19	15,076.8	1.22
S-3	2.52	-172,863.6	0.48
S-4	2.56	-179,830.2	0.48

Project cost and benefit of each agricultural development scenario are as follows;

(Mil $)

Scenario	Item	Project Cost	O&M Cost	Project Benefit	IRR (%)
S-1	Popeta-Yali				
	Bocatoma	7,840.1	40.7		
	Canales	76,540.5	178.6		
	Obras de Arte	31,783.8	24.5		
	Total	116,164.4	243.8	38,696	16.69
S-2	Popeta-Yali				
	Sub-Total	116,164.4	243.8		
	Colina				
	Embalse	6,750.0	18.6		
	Canales	362.5	0.0		
	Obras de Arte	1,443.5	0.0		
	Sub-Total	8,556.0	18.6		
	Curacavi				
	Embalse	2,680.0	12.3		
	Canales	1,346.0	0.0		
	Obras de Arte	949.0	0.0		
	Sub-Total	4,975.0	12.3		
	Total	129,695.4	274.7	40,234	14.77

To be continued

Scenario	Item	Project Cost	O&M Cost	Project Benefit	IRR (%)
S-3	Popeta-Yali				
	Sub-Total	116,164.4	243.8		
	Colina-Casablanca				
	Embalse	202,397.0	404.8		
	Canales	173,442.6	351.4		
	Obras de Arte	126,389.3	0.0		
	Central Hidroelect.	45,941.2	229.7		
	Sub-Total	535,251.3	985.9		
	Total	651,415.7	1,229.7	40,234	14.77
				To be continued	
S-4	Popeta-Yali				
	Sub-Total	116,164.4	243.8		
	Colina				
	Sub-Total	8,556.0	18.6		
	Curacavi				
	Sub-Total	4,975.0	12.3		
	Colina-Casablanca				
	Sub-Total	535,251.3	985.9		
	Total	664,946.7	1,260.6	65.928	3.55

(4) Social and environmental impacts

In case of large scale dam related to the scenarios S-3 and S-4, social impact is estimated around 200 households including one school, and each 6.5 km of roads and pipelines as compensation of removal. As for the natural environmental impact, each development scenario has the protection area which locates the mouth of the Yali river in the downstream of the development area, though protection area locates out of proposed development area. Also, sanctuary is located at the downstream reach of the proposed site of large scale dam.

Social and environmental impacts of each agricultural development scenario are summarized as follows;

Item	S-1	S-2	S-3	S-4
Social impact				
Change of basins	+	+	+	+
Removal of inhabitants			++	++
Compensation except land				
Roads			+	+
Pipelines			++	++
Environmental impact				
Designated environmental conservation area				
Protection area	++	++	++	++
Sanctuary			++	++
Lowering river bed			+	+
Sight			+	+
Change of land category and topography	+	+	+	+

(5) Selection of the agricultural development scenario

As considering the results of economic evaluation and the degree of social and environmental impacts of each agricultural development scenario, S-1 and S-2 have same degree of social and economic impact. Taking effective utilization of water resources, S-2 is prior to S-1 because S-2 has the plan of constructing new water source facilities. Accordingly, S-2 is selected as the agricultural development plan aimed at 2010 (the target year).

5.6 Salient Features of Development Projects Proposed in the Master Plan

Based on the study results described above, the following projects is proposed to contribute utilization of water and land resources, environmental conservation of basins, and agricultural promotion in the study area.

Projects		Description	Quantities
Agricultural promotion measures	1 Irrigation development Colina	Irrigation area (Colina) Major crops : Vegetables and seeds, Fruits Water source facilities (Colina Dam) V= 4.6 MCM, H= 45 m, L=230 m Main canal	270 ha 1 site 4 km
	Curacavi	Irrigation area (Curacavi) Major crops : Fruits, Grapes for wine, Vegetables and flowers Water source facilities (Curacavi Dam) V= 4.7 MCM, H= 27 m, L=150 m Main canal	280 ha 1 site 30 km
	Popeta - Alhué	Irrigation area (Popeta, Yali, Alhué) Major crops : Fruits, Grapes for wine, Vegetables and seeds Headworks (Integrated weir) Main canal Related structures (Tunnel, Syphon) Power station	21,000 ha 1 site 140.5 km 13.6 km 4 sites
	2 Agricultural infrastructure	Improvement of existing irrigation system Objective sites (Clarillo, Angostura, Lampa, Puangue, Melipilla) Objective area Objectives for improvement rehabilitation of intake structures rehabilitation of main canal	 5 sites 103,088 ha 33 sites 623 km
	3 Agricultural support	Promotion of organization on small-scale farmers Advancement of function on existing producers group Provision of base facility for agricultural activity	L. S. L. S. L. S.
	4 Rural infrastructure	Rural water supply Rural sewerage system Local roads improvement	52 sites 39 sites 191 km
Environmental conservation measures	1 Improvement of water quality	Bypass canal Treatment of water quality	3 sites Q= 7.1 m^3/s 12sites Q=4.74m^3/s
	2 Environmental control	Promotion of environmental education in the basin Promotion of sustainable agriculture Establishment of environmental monitoring system	L. S. L. S. L. S.
Contents of the alternative study on development plans in the master plan			
Measures on practical use of natural resources	1 Alternatives on water source development	Utilization of reservoir water Total 369 MCM Maipo dam (360 MCM, irrigation 320 MCM, drinking water 40 MCM) Colina dam (4.6 MCM), Curacavi dam (4.7 MCM) Utilization of unused water right Total 25 m^3/sec (Utilization of treated sewerage water Total 3.5 m^3/sec)	
	2 Irrigation area	Available irrigation area Total 40,050 ha (based on the alternatives on water source development) Colina - Casablanca 18,500 ha, Popeta – Alhué 21,000 ha Colina 270 ha, Curacavi 280 ha	

Total cost to implement the proposed projects is estimated at 280,363 million peso (equivalent to US$ 623 million as of August 1998) and details are as follows;

Name of project	Scale	Unit	Project cost Mill. Peso ($)	O&M cost Mill. Peso ($)/ann.
1. New irrigation development				
1) YALI – ALHUE - POPETA	21,000	ha	116,164.4	243.8
2) COLINA (dam)	270	ha	8,556.0	18.6
3) CURACAVI (dam)	280	ha	4,975.0	12.3
Sub-total	28,250	ha	129,695.4	274.7
2. Improvement of existing irrigation system				
1) Río Clarillo	2,500	ha	393.9	3.9
2) Estero Lampa	13,381	ha	845.6	8.5
3) Río Angostura	21,105	ha	6,160.4	61.6
4) Melipilla	28,691	ha	8,687.9	86.9
5) Estero Puango	13,412	ha	4.693.7	46.9
Sub-total	79,089	ha	20,781.5	207.8
3. Improvement of water quality				
1) Treatment of water quality	4,740	ha	85,831.0	10,852.0
2) Bypass canal	2,300	ha	5,044.0	50.4
Sub-total	7,040	ha	90,875.0	10,902.4
4. Rural water supply	52	unit	3,195.0	383.4
5. Rural sewerage system	39	unit	20,344.8	1,973.0
6. Local roads improvement	191	km	15,471.0	30.9

To be continued

Name of project	Scale	Unit	Project cost Mill. Peso ($)	O&M cost Mill. Peso ($)/ann.
7.Environmental conservation				
1) Promotion of environmental education	1	unit	—	432.6
2) Promotion of the agriculture concerned environment	1	unit	—	160.0
3) Establishment of the environmental monitoring system	1	unit	—	185.0
Sub-total	3	unit	—	777.6
Total			280,362.7	14,549.8

5.7 Priority Projects

5.7.1 General

For the priority projects and/or areas, model or pilot project components for the agricultural promotion in the objective area will be selected among the projects proposed in the master plan study.

In the existing irrigated farmlands, agricultural infrastructure improvement concerned environmental conservation consisting water quality improvement for irrigation and rehabilitation of existing irrigation system will be proposed as the priority project at the area that improvement of water quality for irrigation is required. This priority project is settled as the pilot scheme related to the water quality improvement. Also, in the existing non-irrigated farmland, agricultural development with effective use of present water resources is proposed as the priority project. As for living environment improvement, the plan that concerned living environment improvement is established in the areas where priority projects will be implemented.

5.7.2 Selection of the Priority Projects

(1) Selection of the area for agricultural infrastructure improvement concerned environmental conservation

Required area of the rehabilitation on the existing irrigation system composes 5 areas, Clarillo, Puangue, Lampa, Melipilla and Angostura. Both Puangue and Melipilla areas are entirely being used contaminated river water for irrigation, however, contaminated water utilization for irrigation is limited partly in the remaining three areas.

Required area for rehabilitation of irrigation system	Clarillo	Puange	Lampa	Melipilla	Angosutura
Area utilized contaminated water for irrigation	-	○	-	○	-

Out of three areas, bypasses method to avoid contamination sources is applied for the Lampa area. Cralillo and Angostura areas are eliminated for the objective area of improvement because water quality of both areas will be improved by the plan of EMOS up to target year of 2010. Contaminated water of the Mapocho river is used for irrigation water through Canal Las Mercedes, and Canal Mallarauco in the area of Puangue and Melipilla, respectively. EMOS has the plan to use the disposed sewerage water for irrigation in the Puangue area. So, in the study, the agricultural infrastructure improvement concerned with environmental conservation is planned in the existing irrigation area with Canal Mallarauco. 1,500ha is selected as the areas to be ameliorated in its farming and farm management due to improvement of water quality.. The development outline under the plan is as follows;

Objective site	Objective area	Details of improvement	
Mallarauco	1 ,5 00ha	Treatment capacity	: 1.5 m^3/sec
		Improvement of main canal	: 12.0km
		Lateral canals	: 24.0km

(2) Selection of the area for agricultural development with water resource utilization

The areas for agricultural development with water resource utilization are the new irrigation areas by utilizing unused water right such as Yali-Alhué-Popeta. Areas to be irrigated by construction of small scale dams are Colina and Curacavi. Total area of irrigation is 21,550ha. Results of comparison by IRR on each area are as follows;

Section	IRR	NPV	B/C
Yali-Alhué-Popeta	16.69	$22,043.4	1.37
Colina	-2.90	$ -4,729.0	0.17
Curacavi	-1.63	$ -2,237.6	0.37

According to the economic viability, Yali-Alhué-Popeta irrigation areas are selected as the priority project areas.

The total area of the Yali-Alhué-Popeta irrigation system is 21,000ha. It consists of three irrigation areas, Yali, Alhué, and Popeta. Intake structure and a main canal will be used as the joint operation. As estimating the burden ration of construction cost in each irrigation block, cost per household and per ha are as follows;

Index	Yali	Alhué	Popeta
1 Projected irrigation area (ha)	10,000	6,000	5,000
2 Number of farm households	1,873	765	1,020
3 Number of farm households who hold less than 15ha of farmland	1,095	440	724
4 3/2= (%)	58.5	57.6	71.0
5 Burden ratio on construction cost	0.52	0.36	0.12
Distance ratio	0.37	0.45	0.18
Area ratio	0.49	0.28	0.23
6 Cost per irrigation block (million peso)	60,405	42,052	13,707
7 Cost per household (million peso)	32.3	55.0	13.4
8 Cost per ha (million peso)	6.04	7.01	2.74
9 IRR (%)	16.27	13.07	27.69

The summary of comprehensive evaluation based on the standard of project evaluation method by PROMM-World Bank is as follows;

Index		Yali	Alhué	Popeta
1 Impact on environment		2	5	5
2 Project economy	IRR	0	0	10
	Cost/ha	6	3	6
3 Number of beneficiaries		10	10	10
4 Ratio of small farmers		10	10	10
5 Actual results of former development survey		0	0	0
6 Impact on other facilities		0	0	0
7 Existence of water right		3	3	3
8 Adjustment with the national development policy		10	10	10
9 Spread effects		10	10	10
Total		51	51	64

According to the table above, irrigation area of Popeta is selected as the priority area for agricultural development through utilizing water resource. Following is the summary of proposed facilities in the Popeta area;

Objective site	Objective area	Details of improvement
Popeta	5,0 00ha	Intake Structure : 1 unit (unified weir)
		Main canal : 25.3 km (140.5 km)
		Related structures : 6.0 km (Tunnel, Syphon)

Tabla 5.1.1 Runoff Resume at Dam Sites

(Unit: mm)

			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Maipo	Average	m3/sec	74.050	46.019	24.645	9.278	4.813	4.984	3.929	4.124	5.351	17.728	46.489	84.666	
(1-1,2)		MCM	198.335	111.330	66.009	24.048	12.890	12.920	10.524	11.045	13.869	47.484	120.499	226.771	855.723
	85%	m3/sec	27.380	19.910	7.637	2.495	0.957	0.592	0.741	0.877	1.230	6.544	26.339	38.482	
		MCM	73.336	48.166	20.456	6.467	2.562	1.534	1.984	2.349	3.188	17.527	68.272	103.071	348.909
	Eventual	m3/sec	13.325	6.763	4.839	1.875	1.087	1.186	0.894	0.917	1.122	3.272	5.769	13.274	
		MCM	35.690	18.113	12.959	5.023	2.911	3.176	2.395	2.457	3.006	8.763	15.451	35.552	145.496
Station : RIO MAIPO EN LAS MELOSAS															
Maipo	Average	m3/sec	79.9607	49.6929	26.6121	10.0186	5.19679	5.38229	4.24293	4.45293	5.77786	19.1436	50.2	91.425	
(2-1,2,3)		MCM	214.167	120.217	71.278	25.9681	13.9191	13.9509	11.3643	11.9267	14.9762	51.2741	130.118	244.873	924.032244
	85%	m3/sec	29.566	21.499	8.247	2.694	1.033	0.639	0.8	0.947	1.328	7.066	28.442	41.554	
		MCM	79.1896	52.0104	22.0888	6.98285	2.76679	1.65629	2.14272	2.53644	3.44218	18.9256	73.7217	111.298	376.761456
	Eventual	m3/sec	14.3888	7.30254	5.22474	2.02496	1.17344	1.28026	0.96569	0.99041	1.21191	3.533	6.22936	14.3331	
		MCM	38.5389	19.5591	13.994	5.42365	3.14293	3.42904	2.5865	2.65273	3.24599	9.4628	16.6847	38.3897	157.11
Maipo	Average	m3/sec	81.573	50.695	27.149	10.221	5.302	5.491	4.328	4.543	5.894	19.530	51.212	93.268	
(3)		MCM	218.485	122.641	72.715	26.492	14.200	14.232	11.593	12.167	15.278	52.308	132.742	249.810	942.662
	85%	m3/sec	30.162	21.932	8.413	2.748	1.054	0.652	0.816	0.966	1.355	7.208	29.015	42.392	
		MCM	80.786	53.059	22.534	7.124	2.823	1.690	2.186	2.588	3.512	19.307	75.208	113.542	384.357
	Eventual	m3/sec	14.679	7.450	5.330	2.066	1.197	1.306	0.985	1.010	1.236	3.604	6.355	14.622	
		MCM	39.316	19.953	14.276	5.533	3.206	3.498	2.639	2.706	3.311	9.654	17.021	39.164	160.278
Station : RIO MAIPO EN SAN ALFONSO															
Alfonso	Average	m3/sec	166.569	120.647	79.739	56.156	53.867	50.189	45.661	44.306	51.989	75.422	125.172	169.978	
		MCM	446.138	291.869	213.573	145.555	144.276	130.09	122.299	118.668	134.755	202.011	324.446	455.268	2728.949
	85%	m3/sec	90.707	75.168	55.751	42.463	32.495	29.936	29.711	31.549	37.118	57.133	88.506	94.566	
		MCM	242.95	181.846	149.323	110.064	87.0346	77.5941	79.5779	84.5008	96.2099	153.025	229.408	253.286	1744.819
	Eventual	m3/sec	30.918	17.726	10.981	6.076	9.681	8.964	7.405	5.880	6.644	8.659	16.967	34.873	
		MCM	82.812	47.476	29.412	16.275	25.929	24.009	19.833	15.748	17.796	23.191	45.444	93.405	441.330
Maipo	Average	m3/sec	162.770	117.895	77.920	54.875	52.638	49.044	44.620	43.295	50.803	73.702	122.317	166.101	
(4-1,2)		MCM	435.963	285.213	208.702	142.236	140.986	127.123	119.509	115.962	131.682	197.404	317.047	444.885	2666.710
	85%	m3/sec	88.638	73.454	54.479	41.495	31.754	29.253	29.033	30.829	36.271	55.830	86.487	92.409	
		MCM	237.409	177.699	145.918	107.554	85.050	75.824	77.763	82.574	94.016	149.535	224.175	247.509	1705.025
	Eventual	m3/sec	30.213	17.321	10.731	5.938	9.460	8.760	7.236	5.745	6.493	8.461	16.580	34.078	
		MCM	80.923	46.394	28.742	15.903	25.338	23.462	19.380	15.389	17.390	22.662	44.407	91.274	431.265
Station : RIO MAPOCHO EN LOS ALMENDROS															
Mapocho	Average	m3/sec	10.046	5.642	3.426	2.667	3.448	4.363	7.034	5.869	7.654	11.666	14.140	13.261	
		MCM	26.908	13.648	9.177	6.912	9.235	11.308	18.839	15.721	19.838	31.247	36.651	35.519	235.003
	85%	m3/sec	3.449	2.551	1.785	1.406	1.357	1.521	1.767	2.086	3.017	4.241	5.103	4.200	
		MCM	9.238	6.171	4.781	3.644	3.635	3.942	4.733	5.587	7.820	11.359	13.227	11.249	85.387
	Eventual	m3/sec	1.099	0.544	0.316	0.250	0.412	0.550	0.852	0.935	1.093	1.741	2.286	1.930	
		MCM	2.945	1.316	0.845	0.647	1.102	1.424	2.283	2.505	2.834	4.664	5.924	5.170	31.660
Mapocho	Average	m3/sec	9.463	5.314	3.227	2.512	3.248	4.109	6.625	5.529	7.209	10.989	13.319	12.491	
(1)		MCM	25.345	12.856	8.644	6.511	8.699	10.651	17.745	14.808	18.686	29.433	34.523	33.456	221.358
	85%	m3/sec	3.249	2.403	1.681	1.324	1.278	1.433	1.664	1.965	2.842	3.995	4.807	3.956	
		MCM	8.701	5.813	4.503	3.433	3.424	3.714	4.458	5.263	7.366	10.700	12.459	10.596	80.429
	Eventual	m3/sec	1.036	0.512	0.297	0.235	0.388	0.518	0.803	0.881	1.030	1.640	2.153	1.818	
		MCM	2.774	1.239	0.796	0.610	1.038	1.342	2.150	2.359	2.669	4.393	5.580	4.870	29.822
Colina	Average	m3/sec	0.857	0.518	0.458	0.435	0.514	0.555	0.582	0.739	0.883	1.290	1.892	1.508	
(C-1)		MCM	2.295	1.252	1.228	1.127	1.376	1.437	1.559	1.980	2.289	3.456	4.903	4.038	26.941
	85%	m3/sec	0.326	0.235	0.231	0.230	0.267	0.295	0.352	0.360	0.473	0.659	0.804	0.580	
		MCM	0.872	0.570	0.619	0.596	0.716	0.764	0.944	0.965	1.225	1.766	2.083	1.553	12.673
	Eventual	m3/sec	0.169	0.080	0.073	0.067	0.083	0.081	0.077	0.123	0.131	0.211	0.337	0.299	
		MCM	0.453	0.216	0.196	0.178	0.222	0.217	0.206	0.329	0.352	0.566	0.903	0.800	4.638
Colina	Average	m3/sec	0.968	0.585	0.518	0.491	0.580	0.627	0.658	0.835	0.998	1.458	2.137	1.703	
(C-2)		MCM	2.592	1.415	1.387	1.273	1.554	1.624	1.762	2.237	2.586	3.905	5.540	4.562	30.438
	85%	m3/sec	0.368	0.266	0.261	0.260	0.302	0.333	0.398	0.407	0.534	0.745	0.908	0.655	
		MCM	0.986	0.644	0.699	0.674	0.809	0.863	1.066	1.090	1.384	1.995	2.354	1.754	14.318
	Eventual	m3/sec	0.191	0.091	0.083	0.075	0.093	0.092	0.087	0.139	0.148	0.239	0.381	0.338	
		MCM	0.512	0.243	0.221	0.201	0.250	0.245	0.232	0.372	0.397	0.640	1.020	0.904	5.240
Rosario	Average	m3/sec	0.000	0.000	0.275	1.079	4.458	6.226	5.111	5.214	1.704	1.106	0.092	0.179	
		MCM	0.000	0.000	0.736	2.797	11.942	16.137	13.690	13.966	4.416	2.962	0.239	0.478	67.362
	85%	m3/sec	0.000	0.000	0.155	0.610	2.518	3.517	2.887	2.945	0.962	0.625	0.052	0.101	
		MCM	0.000	0.000	0.416	1.580	6.745	9.115	7.733	7.889	2.494	1.673	0.135	0.270	38.051
	Eventual	m3/sec	0.000	0.000	0.120	0.470	1.940	2.709	2.224	2.269	0.741	0.481	0.040	0.078	
		MCM	0.000	0.000	0.320	1.217	5.196	7.022	5.957	6.077	1.922	1.289	0.104	0.208	29.311
Yali	Average	m3/sec	0.011	0.016	1.080	5.386	16.022	26.204	19.740	14.931	6.747	3.663	1.094	0.913	
		MCM	0.029	0.038	2.892	13.961	42.914	67.922	52.872	39.992	17.489	9.810	2.835	2.445	253.199
	85%	m3/sec	0.006	0.008	0.633	3.142	9.236	15.244	11.309	8.676	3.920	2.145	0.625	0.542	
		MCM	0.015	0.020	1.696	8.145	24.739	39.512	30.290	23.239	10.160	5.745	1.620	1.451	146.633
	Eventual	m3/sec	0.005	0.007	0.446	2.244	6.786	10.961	8.431	6.255	2.827	1.518	0.469	0.371	
		MCM	0.014	0.018	1.196	5.817	18.175	28.410	22.581	16.753	7.329	4.065	1.214	0.994	106.566
Station : ESTERO PUANGUE EN BOQUERON															
	Average	m3/sec	0.060	0.042	0.038	0.046	0.181	1.345	2.442	2.036	1.521	0.553	0.233	0.097	
		MCM	0.162	0.102	0.103	0.120	0.484	3.486	6.541	5.453	3.942	1.480	0.603	0.259	22.734
	85%	m3/sec	0.020	0.015	0.010	0.009	0.010	0.034	0.242	0.289	0.171	0.098	0.072	0.041	
		MCM	0.054	0.036	0.027	0.023	0.027	0.088	0.648	0.774	0.443	0.262	0.187	0.110	2.679
	Eventual	m3/sec	0.005	0.004	0.004	0.005	0.022	0.171	0.290	0.230	0.177	0.060	0.021	0.007	
		MCM	0.014	0.009	0.010	0.013	0.060	0.443	0.776	0.615	0.458	0.161	0.055	0.020	2.632
Curacavi	Average	m3/sec	0.108	0.075	0.068	0.082	0.322	2.396	4.349	3.626	2.709	0.984	0.414	0.172	
		MCM	0.288	0.181	0.183	0.214	0.862	6.209	11.649	9.712	7.021	2.636	1.074	0.461	40.490
	85%	m3/sec	0.036	0.027	0.018	0.016	0.018	0.061	0.431	0.515	0.305	0.175	0.128	0.073	
		MCM	0.095	0.065	0.048	0.042	0.048	0.157	1.154	1.379	0.789	0.467	0.332	0.196	4.772
	Eventual	m3/sec	0.010	0.006	0.007	0.009	0.040	0.304	0.516	0.409	0.315	0.107	0.038	0.013	
		MCM	0.026	0.015	0.018	0.022	0.106	0.788	1.381	1.096	0.815	0.286	0.098	0.035	4.688

Table 5.3.1 Crop Cultivation Plan

New Irrigation Area	Total Area (ha)	Farming Type	Area by Scale (ha)	Cereal Crops		Traditional Crops*		Vegetables		Flowers		Forage Crops		Fruits		Grape Vines		Seedlings Production		Seed Production**		Sub-Total		Others	
				Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
1.-Alhué	6,000	Medium & Large Scale Farmers	5,527	829	15	553	10	332	6	55	1	663	12	1,382	25	995	18	0	0	166	3	4,975	90	552	10
		Small Scale Farmers	473	99	21	47	10	14	3	0	0	71	15	71	15	33	7	0	0	0	0	335	71	138	29
2.- Popeta	5,000	Medium & Large Scale Farmers	3,496	524	15	0	0	350	10	35	1	524	15	1014	29	385	11	70	2	280	8	3,182	91	314	9
		Small Scale Farmers	1,504	226	15	75	5	165	11	0	0	241	16	301	20	60	4	0	0	45	3	1,113	74	391	26
3.- Yali	10,000	Medium & Large Scale Farmers	7,400	1,110	15	296	4	740	10	74	1	1,332	18	1,850	25	1,036	14	0	0	222	3	6,660	90	740	10
		Small Scale Farmers	2,600	442	17	260	10	130	5	0	0	364	14	364	14	260	10	0	0	0	0	1,820	70	780	30
4.-Puangue (Curacavi M. Pinto, Ibacache)	6,500	Medium & Large Scale Farmers	3,900	507	13	0	0	390	10	78	2	546	14	1,170	30	468	12	0	0	312	8	3,471	89	429	11
		Small Scale Farmers	2,600	390	15	130	5	520	20	26	1	416	16	260	10	182	7	0	0	78	3	2,002	77	598	23
5.- Casablanca	7,000	Medium & Large Scale Farmers	6,046	605	10	0	0	484	8	0	0	1,209	20	1,209	20	1,512	25	60	1	121	2	5,200	86	846	14
		Small Scale Farmers	954	153	16	76	8	38	4	0	0	153	16	153	16	114	12	0	0	0	0	687	72	267	28
6.- Lampa	5,000	Medium & Large Scale Farmers	2,500	125	5	0	0	625	25	50	2	450	18	750	30	0	0	25	1	250	10	2,275	91	225	9
		Small Scale Farmers	2,500	0	0	125	5	750	30	25	1	500	20	375	15	0	0	0	0	50	2	1,825	73	675	27
TOTAL	39,500		39,500	5,010	13	1,563	4	4,538	11	343	1	6,469	16	8,899	23	5,045	13	155	0	1,524	4	33,545	84	5,955	26

Source: Censo Nacional Agropecuario 1997

* Chacras (Traditional Crop) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.).

** Seed Production: Seed for export and domestic consumption (Vegetable, Maize, Wheat and etc.).

Table 5.3.2 Benefit of "with-Project" Condition by Land Holding Scale

Small Scale Farmers

New Irrigation Area	Cultivation Area of Each Farming Type		Cereal Crops	Traditional Crops*	Vegetables	Flowers	Forage Crops	Fruits	Grapes (wine & Table)	Seedlings Production	Seed Production**			Gross Income or Net Income of Farming Type ($000)
			Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Subtotal	Others	
			300	480	1,206	1,600	500	1,800	1,800	1,400	1,100			
1.-Alhué	4 ha	Ha/Crop	0.84	0.40	0.12	0.00	0.60	0.60	0.30	0.00	0.00	2.86	1.14	
		Benefit/Crop	252	192	145	-	300	1,080	540					2,509
2.- Popeta	5 ha	Ha/Crop	0.75	0.25	1.00	0.00	0.75	0.70	0.00	0.00	0.10	3.55	1.45	
		Benefit/Crop	225	120	1,206	-	375	1,260	-	-	110			3,296
3.- Yali	5,5 ha	Ha/Crop	0.94	0.55	0.28	0.00	0.77	0.77	0.55	0.00	0.00	4.00	1.50	
		Benefit/Crop	282	264	337.68	-	385	1,386	990	-	-			3,645
4.-Puangue (Curacavi M. Pinto,Ibacache)	4,5 ha	Ha/Crop	0.68	0.23	0.90	0.05	0.72	0.45	0.32	0.00	0.14	3.49	1.01	
		Benefit/Crop	204	110	1,085	80	360	810	576	-	154			3,380
5.- Casablanca	4,5 ha	Ha/Crop	0.72	0.36	0.18	0.00	0.72	0.72	0.54	0.00	0.00	3.24	1.26	
		Benefit/Crop	216	173	217	-	360	1,296	972	-	-			3,234
6.- Lampa	5 ha	Ha/Crop	0.0	0.25	1.50	0.10	1.00	0.75	0.00	0.00	0.20	3.80	1.200	
		Benefit/Crop	-	120	1,809	160	500	1,350	-	-	220			4,159

Medium and Large Scale Farmers

New Irrigation Area	Cultivation Area of Each Farming Type		Cereal Crops	Traditional Crops*	Vegetables	Flowers	Forage Crops	Fruits	Grapes (wine & Table)	Seedlings Production	Seed Production**			Gross Income or Net Income of Farming Type ($000)
			Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Subtotal	Others	
			356.70	605.46	1,206.90	2,000.00	637.00	2,330.00	2,400.00	2,000.00	1,597.00			
1.-Alhué	100 ha	Ha/Crop	15	10	6	1	12	25	18	0	3	90	10	
		Benefit/Crop	5,351	6,055	7,241	2,000	7,644	58,250	43,200	-	4,791			134,532
2.- Popeta	100 ha	Ha/Crop	20	0	10	1	15	29	6	2	8	91	9	
		Benefit/Crop	7,134	-	12,069	2,000	9,555	67,570	14,400	4,000	12,776			129,504
3.- Yali	100 ha	Ha/Crop	15	4	10	1	18	25	14	0	3	90	10	
		Benefit/Crop	5,351	2,422	12,069	2,000	11,466	58,250	33,600	-	4,791			129,948
4.-Puangue (Curacavi M. Pinto,Ibacache)	100 ha	Ha/Crop	13	0	10	1.5	14	30	12	0	8	89	11	
		Benefit/Crop	4,637	-	12,069	3,000	8,918	69,900	28,800	-	12,776			140,100
5.- Casablanca	100 ha	Ha/Crop	10	0	8	0	20	20	25	1	2	86	14	
		Benefit/Crop	3,567	-	9,655	-	12,740	46,600	60,000	2,000	3,194			137756
6.- Lampa	100 ha	Ha/Crop	5	0	25	2	18	30	0	1	10	91	9	
		Benefit/Crop	1,784	-	30,173	4,000	11,466	69,900	-	2,000	15,970			135,292

Source: Censo Nacional Agropecuario 1997

* Chacras (Traditional Crop) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.).

** Seed Production: Seed for export and domestic consumption (Vegetable, Maize, Wheat and etc.).

Table 5.3.3 Gross Income per Unit Area in Project Area-wise

New Irrigation Area	Total Area (ha)	Farming Type		Area by Scale (ha)	Cereal Crops		Traditional Crops+		Vegetables		Flowers		Forage Crops		Fruits		Grapes		Seedlings Production		Seed Production++				Annual Income by Farming Scale	Project Area Total	
					Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Subtotal %	Others %		Annual Income	Yield
					$000		$000		$000		$000		$000		$000		$000		$000		$000						
			Medium & Large		356.7		605.5		1,206.0		2,000.0		637.0		2,074.0		1,600.0		2,000.0		1,597.0						
			Small Scale		300.0		480.0		1,206.0		1,600.0		500.0		1,400.0		1,200.0		1,400.0		1,100.0						
1. Alhué	6,000																										
		Medium & Large Scale Farmers	Land Holding Area	5,527	829.0	15	553.0	10	331.6	6	55.0	1	663.0	12	1,382.0	25	995.0	18	0.0	0	165.8	3	90	10			
			Total Benefit		295,704.3		334,841.5		399,933.7		110,000.0		422,331.0		2,866,268.0		1,592,000.0		0.0		264,798.6				6,285,877.09		
		Small Scale Farmers	Land Holding Area	473	99.0	21	47.0	10	14.2	3	0.0	0	71.0	15	71.0	15	33.0	7	0.0	0	0.0	0	71	29			
			Total Benefit		29,700.0		22,560.0		17,113.1		0.0		35,500.0		99,400.0		39,600.0		0.0		0.0				243,873.14	6,529,750.23	1,088.29
2. Popeta	5,000																										
		Medium & Large Scale Farmers	Land Holding Area	3,496	524.0	15	0.0	0	350.0	10	35.0	1	524.0	15	1,014.0	29	385.0	11	70.0	2	280.0	8	91	9			
			Total Benefit		186,910.8		0.0		422,100.0		70,000.0		333,788.0		2,103,036.0		616,000.0		140,000.0		447,160.0				4,318,994.80		
		Small Scale Farmers	Land Holding Area	1,504	226.0	15	75.0	5	165.0	11	0.0	0	241.0	16	301.0	20	60.0	4	0.0	0	45.0	3	74	26			
			Total Benefit		67,800.0		36,000.0		198,990.0		0.0		120,500.0		421,400.0		72,000.0		0.0		49,500.0				966,190.00	5,285,184.80	1,057.04
3. Yali	10,000																										
		Medium & Large Scale Farmers	Land Holding Area	7,400	1,110.0	15	296.0	4	740.0	10	74.0	1	1,332.0	18	1,850.0	25	1,036.0	14	0.0	0	222.0	3	90	10			
			Total Benefit		395,937.0		179,228.0		892,440.0		148,000.0		848,484.0		3,836,900.0		1,657,600.0		0.0		354,534.0				8,313,123.00		
		Small Scale Farmers	Land Holding Area	2,600	442.0	17	260.0	10	130.0	5	0.0	0	364.0	14	364.0	14	260.0	10	0.0	0	0.0	0	70	30			
			Total Benefit		132,600.0		124,800.0		156,780.0		0.0		182,000.0		509,600.0		312,000.0		0.0		0.0				1,417,780.00	9,730,903.00	973.09
4. Puangue (Curacaví, M. Pinto, Ibacache)	6,500																										
		Medium & Large Scale Farmers	Land Holding Area	3,900	507.0	13	0.0	0	390.0	10	78.0	2	546.0	14	1,170.0	30	468.0	12	0.0	0	312.0	8	89	11			
			Total Benefit		180,846.9		0.0		470,340.0		156,000.0		347,802.0		2,426,580.0		748,800.0		0.0		498,264.0				4,828,632.90		
		Small Scale Farmers	Land Holding Area	2,600	390.0	15	130.0	5	520.0	20	26.0	1	416.0	16	260.0	10	182.0	7	0.0	0	78.0	3	77	23			
			Total Benefit		117,000.0		62,400.0		627,120.0		41,600.0		208,000.0		364,000.0		218,400.0		0.0		85,800.0				1,724,320.00	6,552,952.90	1,008.15
5. Casablanca	7,000																										
		Medium & Large Scale Farmers	Land Holding Area	6,046	605.0	10	0.0	0	484.0	8	0.0	0	1,209.0	20	1,209.0	20	1,512.0	25	60.0	1	121.0	2	86	14			
			Total Benefit		215,803.5		0.0		583,704.0		0.0		770,133.0		2,507,466.0		2,419,200.0		120,000.0		193,237.0				6,809,543.50		
		Small Scale Farmers	Land Holding Area	954	153.0	16	76.0	8	38.0	4	0.0	0	153.0	16	153.0	16	114.0	12	0.0	0	0.0	0	72	28			
			Total Benefit		45,900.0		36,480.0		45,828.0		0.0		76,500.0		214,200.0		136,800.0		0.0		0.0				555,708.00	7,365,251.50	1,052.18
6. Lampa	5,000																										
		Medium & Large Scale Farmers	Land Holding Area	2,500	125.0	5	0.0	0	625.0	25	50.0	2	450.0	18	750.0	30	0.0	0	25.0	1	250.0	10	91	9			
			Total Benefit		44,587.5		0.0		753,750.0		100,000.0		286,650.0		1,555,500.0		0.0		50,000.0		399,250.0				3,189,737.50		
		Small Scale Farmers	Land Holding Area	2,500	0.0	0	125.0	5	750.0	30	25.0	1	500.0	20	375.0	15	0.0	0	0.0	0	50.0	2	73	27			
			Total Benefit		0.0		60,000.0		904,500.0		40,000.0		250,000.0		525,000.0		0.0		0.0		55,000.0				1,834,500.00	5,024,237.50	1,004.85
Total				39,500	1,717,800.0	13	857,871.5	4	5,477,136.7	11	665,943.0	1	3,888,157.0	16	17,438,249.0	22	7,817,445.0	13	310,155.0	0	2,349,067.4	4	84	26			

Source: Censo Nacional Agropecuario 1997

\+ Chacras (Traditional Crop) : Main crops which farmers cultivated in the land where was provided instead of salary during the plantation era (Potato, Maize, Beans, Melon and etc.).

++ Seed Production: Seed for export and domestic consumption (Vegetable, Maize, Wheat and etc.).

Table 5.3.4 Small Scale Farmers' Farming Plan in Rehabilitation Area

crop \ Sub-basin		2. Río Clarillo		4. Est. Lampa		6. Río Angostura (Cachapoal)		8. Cue. Melipilla		9. Est. Puangue		Total	
		present	plan	present	plan	present	plan	present	plan	present	plan	present	plan
1. Fruits	ha	145.2	169.4	117.4	215.3	394.6	429.2	591.7	698.5	355.4	419.5	1,604.3	1,932.0
	%	10.2	12.5	1.8	3.3	11.4	12.4	7.2	8.5	7.2	8.5	6.5	7.9
2. Grapes for Wine Production	ha	21.4	21.4	-	-	-		-	-	-	-	21.4	21.4
	%	1.5	1.5	-	-	-		-	-	-	-	0.1	0.1
3. Vegetables and Flowers	ha	226.4	226.4	3,262.2	3,262.2	394.6	429.2	1,955.9	1,955.9	1,174.7	1,174.7	7,013.7	7,048.3
	%	15.9	15.9	50.0	50.0	11.4	12.4	23.8	23.8	23.8	23.8	28.6	28.7
4. Cereals	ha	435.7	418.6	1,122.2	1,056.9	1,145.6	1,076.4	1,331.4	1,249.2	799.6	750.2	4,834.4	4,551.3
	%	30.6	29.4	17.2	16.2	33.1	31.1	16.2	15.2	16.2	15.2	19.7	18.5
5. Field Crops	ha	54.1	54.1	163.1	163.1	138.4	138.4	427.4	427.4	256.7	256.7	1,039.7	1,039.7
	%	3.8	3.8	2.5	2.5	4.0	4.0	5.2	5.2	5.2	5.2	4.2	4.2
6. Industrial Crops	ha	27.1	27.1	-	-	100.4	100.4	-	-	-	-	127.4	127.4
	%	1.9	1.9	-	-	2.9	2.9	-	-	-	-	0.5	0.5
7. Forage Crops	ha	165.2	179.4	117.4	182.7	100.4	100.4	394.5	476.7	236.9	286.3	1,014.4	1,225.4
	%	11.6	12.6	1.8	2.8	2.9	2.9	4.8	5.8	4.8	5.8	4.1	5.0
8. Forage	ha	225.0	225.0	815.5	815.5	1,086.8	1,086.8	2,342.2	2,342.2	1,406.7	1,406.7	5,876.1	5,876.1
	%	15.8	15.8	12.5	12.5	31.4	31.4	28.5	28.5	28.5	28.5	23.9	23.9
9 .Fallow	ha	123.9	102.5	926.5	828.6	100.4	100.4	1,175.2	1,068.4	705.8	641.6	3,031.7	2,741.5
	%	8.7	7.2	14.2	12.7	2.9	2.9	14.3	13.0	14.3	13.0	12.3	11.2
Total	ha	1,423.8	1,423.8	6,524.3	6,524.3	3,461.0	3,461.0	8,218.2	8,218.2	4,935.6	4,935.6	24,562.9	24,562.9
No. of Small Farmers	No.	341		1,331		901		2,184		1,018		5,775	
Farming Area	ha	1423.8		6,524.3		3,461.0		8,218.2		4,935.6		24,562.9	
Average Farming Area	ha	4.18		4.90		3.84		3.76		4.85		4.25	

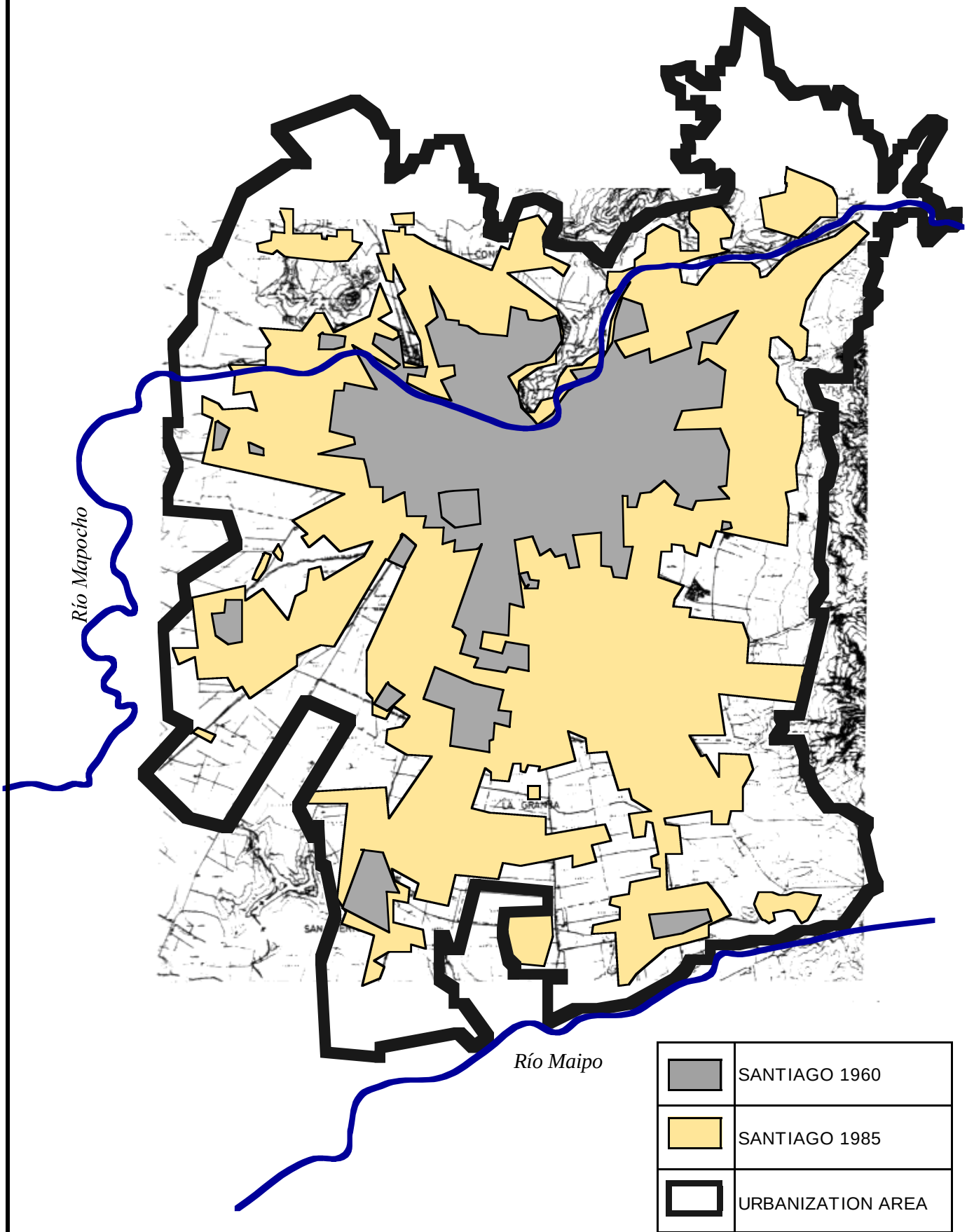
Table 5.3.5 Medium and Large Scale Farmers' Faming Plan in Rehabilitation Area

Crop \ Sub-basin / Region		2. Río Clarillo Cordillera		4. Est. Lampa Chacabuco		6. Río Angostura Talagante, Maipo Cachapoal		8. Cue. Melipilla Melipilla		9. Est. Puangue Melipilla		Total	
		present	plan	present	plan	present	plan	present	plan	present	plan	present	plan
Fruits	(ha)	1,573.2	1,636.5	5,601.9	5,757.1	20,647.8	21,091.5	6,245.4	6,503.2	1,619.0	1,707.8	35,687.3	36,696.1
	%	25.7	26.7	37.7	38.7	43.0	44.0	24.3	25.3	15.5	16.5	33.9	35
Grapes	(ha)	563.4	563.4	93.5	93.5	3,951.1	3,951.1	410.7	410.7	314.6	314.6	5,333.3	5,333.3
	%	9.2	9.2	0.6	0.6	8.2	8.2	1.6	1.6	3.0	3.0	5.1	5.1
Vegetables	(ha)	0.0	0.0	3,520.9	3,520.9	3,045.0	3,045.0	1,872.2	2,139.0	1,034.5	1,034.5	9,472.6	9,739.4
	%	0.0	0.0	23.7	23.7	6.3	6.3	7.3	8.3	9.9	9.9	9.0	9.00728954
Flowers	(ha)	22.3	22.3	11.4	11.4	48.5	48.5	6.7	6.7	1.6	1.6	90.5	90.5
	%	0.4	0.4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1
Cereals	(ha)	267.7	147.0	0.0	0.0	7,545.4	7,103.3	6,032.2	5,772.8	1,834.3	1,728.4	15,679.6	14,751.5
	%	4.4	2.4	0.0	0.0	15.8	14.8	23.4	22.4	17.6	16.6	14.9	14
Field Crops	(ha)	0.0	0.0	0.0	0.0	871.0	871.0	612.2	612.2	1,216.5	1,114.1	2,699.7	2,597.3
	%	0.0	0.0	0.0	0.0	1.8	1.8	2.4	2.4	11.7	10.7	2.6	2.5
Industrial Crops	(ha)	0.0	0.0	24.0	24.0	0.0	0.0	1.7	1.7	1.0	1.0	26.7	26.7
	%	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Forage Crops	(ha)	1,453.5	1,514.0	3,773.2	3,773.2	3,541.0	4,031.6	8,426.9	8,426.9	3,326.9	3,446.4	20,521.5	21,192.1
	%	23.7	24.7	25.4	25.4	7.4	8.4	32.7	32.7	32.1	33.1	19.5	20.2
Seedling	(ha)	5.1	5.1	20.4	20.4	332.7	332.7	35.9	35.9	0.5	0.5	394.6	394.6
	%	0.1	0.1	0.1	0.1	0.7	0.7	0.1	0.1	0.0	0.0	0.4	0.4
Seeds	(ha)	90.7	153.1	1,081.1	1,081.1	3,489.0	3,489.0	1,037.8	1,037.8	851.4	851.4	6,550.0	6,612.4
	%	1.5	2.5	7.3	7.3	7.3	7.3	4.0	4.0	8.2	8.2	6.2	6.3
Forest Products	(ha)	2,149.7	2,084.2	734.8	579.6	4,523.8	4,031.6	1,089.9	824.7	211.7	211.7	8,709.9	7,731.8
	%	35.0	34.0	4.9	3.9	9.4	8.4	4.2	3.2	2.0	2.0	8.3	7.4
Total	ha	6,125.6	6,125.6	14,861.2	14,861.2	47,995.3	47,995.3	25,771.6	25,771.6	10,412.0	10,412.0	105,165.7	105,165.7

Source; Agriculture and Forestry Census 1997

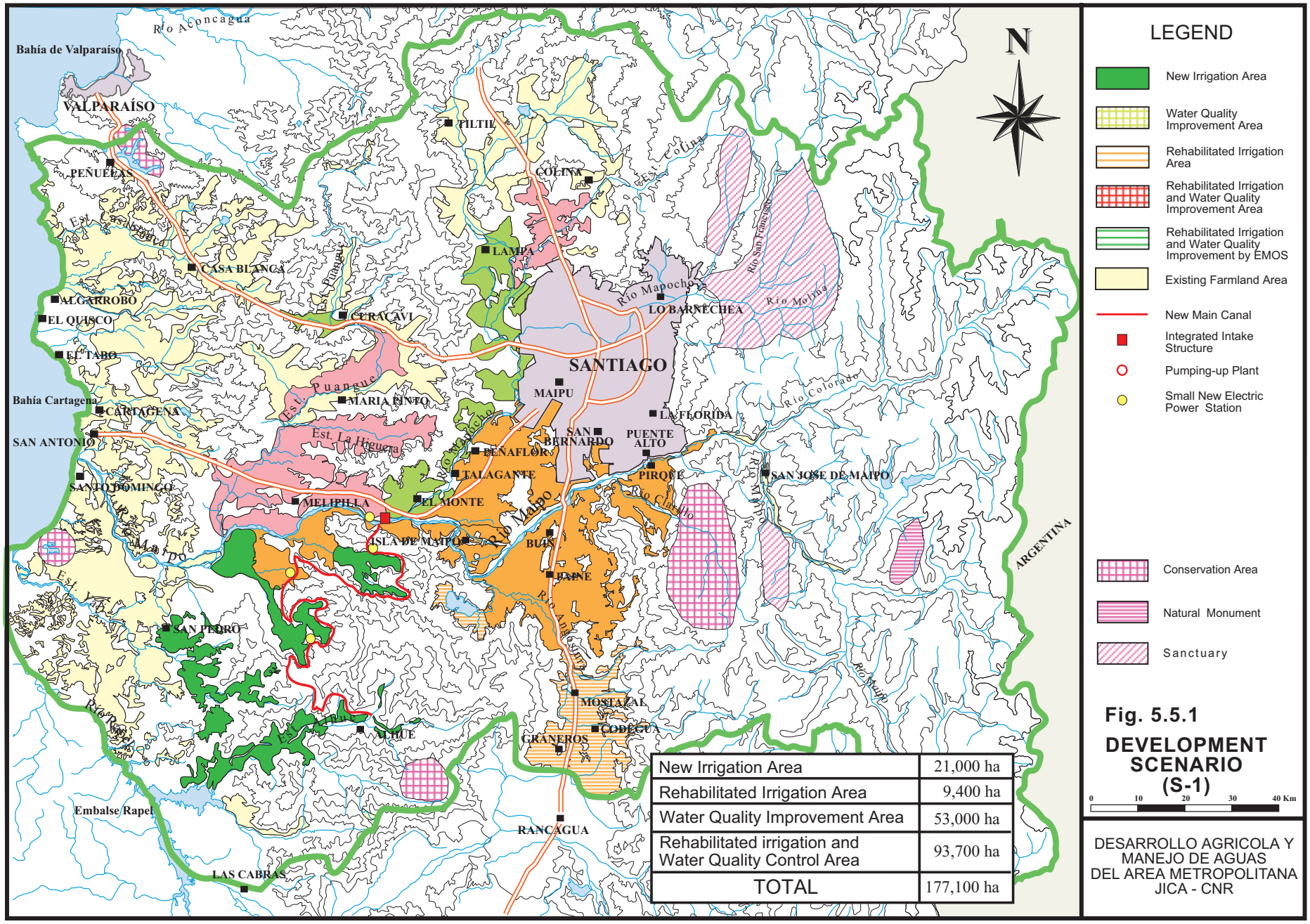
Table 5.6.1 Project Implementation Schedule

Development Items	Main Component	Quantities	Unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1. Agricultural Production Development Project														
Provision of Fund		1.0	Unit											
Survey and Design		1.0	Unit											
(1) New Irrigation Development Project														
Construction of Middle Scale Dams	Dams	2.0	Places											
Construction of Canals	Canals	12.0	km											
Construction of Field ditches	Field Ditches	550.0	ha											
Construction of Integrated Diversion Weir	Diversion Weir	600.0	m											
Construction of Canals	Canals	154.0	km											
Construction of Field ditches	Field Ditches	21,000.0	ha											
(2) Irrigation Facilities Rehabilitation Project														
Rio Clarillo	Irrigation Facilities	15.0	km											
Est. Lampa	Irrigation Facilities	62.5	km											
Rio Angostura	Irrigation Facilities	235.0	km											
Est. Melipilla	Irrigation Facilities	211.0	km											
Est. Puange	Irrigation Facilities	98.0	km											
2. Water Quantity Improvement Project														
Provision of Fund		1.0	Unit											
Survey and Design		1.0	Unit											
(1) Sewage Treatment Facilities	Treatment Facilities	12.0	Places											
(2) Detour	Canals	5.0	km											
3. Rural Infrastructure Development Project														
Provision of Fund		1.0	Unit											
Survey and Design		1.0	Unit											
(1) Rural Water Supply Facilities	Water Supply Facilities	52.0	Places											
(2) Rural Sewage Treatment Facilities	Sewage Treatment Faci	39.0	Places											
(3) Rural road	Low Cost Pavement	191.0	km											
4. Environmental Management Project														
Preparation and Plan		1.0	Unit											
(1) Educational Promotion Project	Promotion Project	2.0	Peoples											
(2) Agricultural Environment Promotion Project	Promotion Project	2.0	Peoples											
(3) Environmental Monitoring Project	Monitoring Project	3.0	Peoples											



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

Fig. 5.2.1 Urban Planning Area

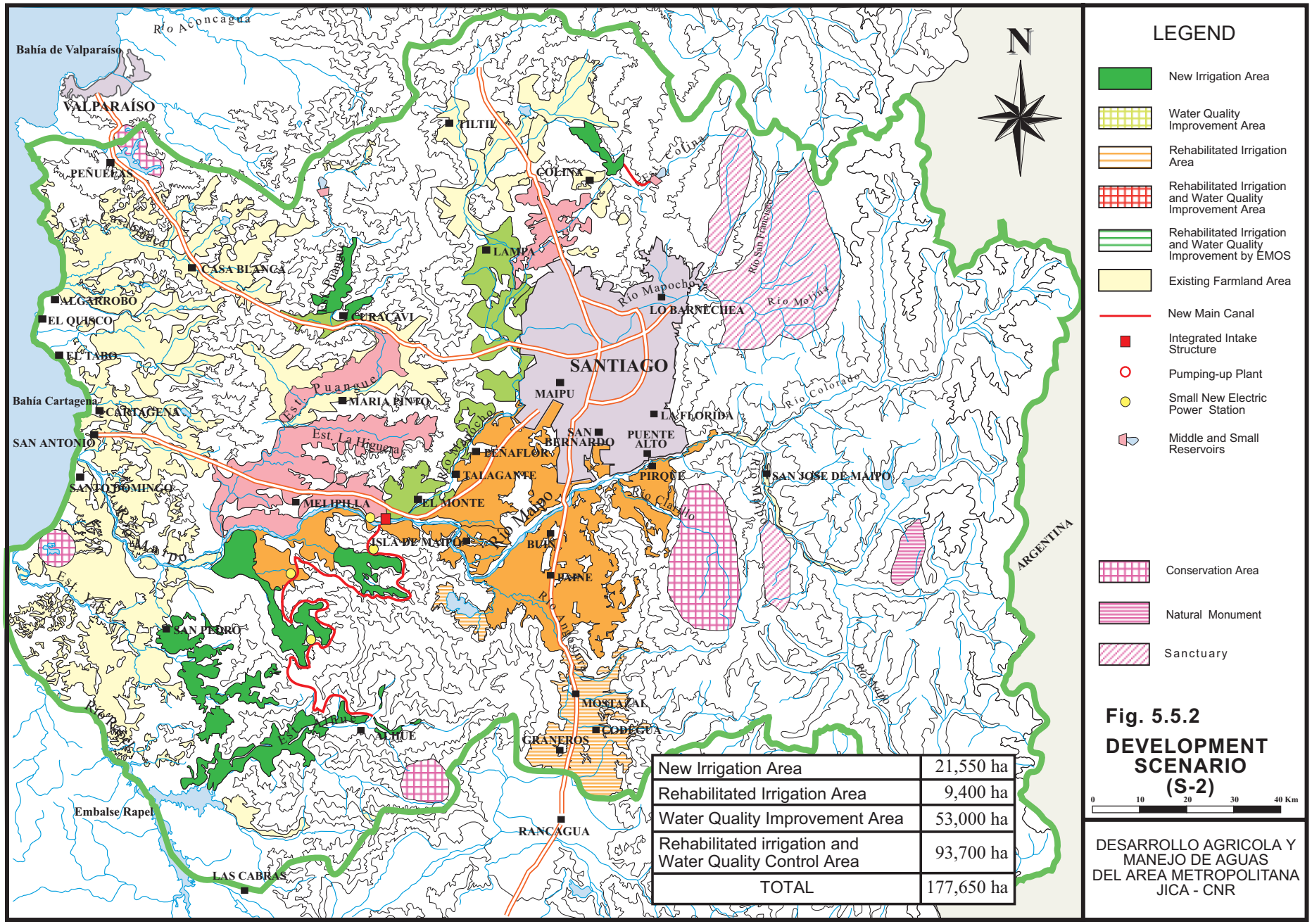


New Irrigation Area	21,000 ha
Rehabilitated Irrigation Area	9,400 ha
Water Quality Improvement Area	53,000 ha
Rehabilitated irrigation and Water Quality Control Area	93,700 ha
TOTAL	177,100 ha

Fig. 5.5.1

DEVELOPMENT SCENARIO (S-1)

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



New Irrigation Area	21,550 ha
Rehabilitated Irrigation Area	9,400 ha
Water Quality Improvement Area	53,000 ha
Rehabilitated irrigation and Water Quality Control Area	93,700 ha
TOTAL	177,650 ha

Fig. 5.5.2

DEVELOPMENT SCENARIO (S-2)

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