Some part of the Project Area has little access to the irrigation due to the lack of absolute amount of water that can be used for this purpose. Therefore, it is desirable that the farmers there adopt farming centered on cotton and sugarcane and other crops which have drought resistance.

4.3.3 Proposed Cropping Area and Pattern

The proposed cropping areas will be established on the following considerations and basic concepts of the agricultural production plan.

- Taking into consideration the present farm household condition, the farming scale and cropping pattern to suit family labor are proposed.
- Rate of cultivation, not a mere expansion of land area, should be increased for vegetables and fruit, provided that irrigation water is available.
- Soil fertility should be maintained and labor reduced by making use of the fallow land.

Crop	Without Project		With Project		
	Cropping Area(ha)	%	Cropping Area(ha)	%	Increase Rate(%)
1. Cotton	820	32.4	825	27.7	6.0
2. Sugarcane	255	10.1	500	17.5	96.0
3. Miscellaneous crops	1,090	43.2	1,056	38.2	- 3.0
4. Vegetables	180*	7.1	400**	14.0	122.2
5. Fruit	182	7.2	200	7.0	9.9
Total	2,527	100.0	2,981	100.0	18.0

Note: * 1-5-year rotation system in the 120 ha.
** Twice-year rotation system in the 200 ha.

The proposed cropping area is anticipated to 2,981 ha, increased in the 18% more than the present condition. Cropping area of vegetables, in particular, will be substantially increased as they will be able to be grown year-round by the irrigation. The cropping pattern according to the proposed cropping area is shown in Fig. 4.1.

4.3.4 Expected Yield, Production and Production Cost

In accordance with the implementation of the project, the farmers will experience introduction of crop rotation systems, more effective use of production materials and improved cultivation techniques. These

changes will result in improvement of crop-growing environment and increased yield. Expected yield and costs to realize it will be calculated based on the results of the experimental and investigation by IAN and the actual yield of the high productivity areas and the involved costs.

The expected production based on the expected yield and the cropping area is shown as follows. The total production will be twice as much as the present figure. In particular, production of vegetables will be increased by 3.8 times as much. The producer's price used in the plan is set at the same level as the present figure. Expected production volume and production value are shown in Table 4.1.

Crop	Cropping Area(ha)	Yield (t/ha)	Production Cost(1,000G/ha)	Production Volume (t)
1. Cotton	825	1.5	229.2	1,238
2. Sugarcane	500	75.0	383.1	37,500
3. Miscelloneous				
- Maize	481	1.2	130.9	577
- Poroto	275	0.8		220
- Mandioca*	300	18.0	261.0	5,400
4. Vegitables				
- Onion	125	15.0	505.4	1,800
- Tomato	60	30.0	2,446.0	1,800
- Watermelon	30	25.0	1,060.2	750
- Melon	10	17.0	982.5	170
- Green Pepper	30	15.0	1,725.0	450
- Others	150	25.0	757.2	3,750
5. Fruit				
- Grape	75	22.0	1,129.2	1,650
- Plum	75	7.0	796.3	525
- Citrous	40	8.0	609.0	320
- Others	10	8.0	957.2	80
Total	2,981	-	-	56,622

* Harvesting Area

4.4 Agricultural Supporting Plan for Small-Scale Farmers

4.4.1 Objective Farmers

The number of small-scale farmers owing less than 20 ha, accounting for 64% of the total farm household in the Project Area. Among these small-scale farmers, however, some are making more income than

others due to the differences in the area of land they own and farming types. In particular, annual income levels of the 119 farm households with less than 10 ha and 5 ha of own land are below the minimum national income average. Worse yet, more than 50% (61 families) of these farmers are not eligible for bank loans as they do not posses land holding title, compounding their difficulties of obtaining enough funds for effective agriculture.

The farmers other than those above possess land holding title, making them eligible for loans. For these farmers, it is easier to predict expansion of farming according to the Project. For these reasons, farming types 1 and 2 and the farmers with less than 5 ha are designated as model farmers.

4.4.2 Improvement of Farming Pattern and Establishment of Farmers' Institution

Conversion of prevailing cropping paterns which cotton and sugarcane are mainly cultivated is required to elevate the income level of small-scale farmers. Diversification to more profitable crops is proposed taking the improvement plans of the project on irrigation facilities and road networks into account.

A part of cultivation on cotton or self-consumption will be planned to change fruit growing when irrigation water is available. Also, cotton cultivation will be changed to sugarcane growing due to easy shipping of agricultural products with implementation of the road improvements. Cultivation of sugarcane is preferable not only demands and profits but in view of soil conservation.

The existence of the agricultural cooperative gives valuable effects to the agricultural management in the Area. These are proved with the activities of the existing agricultural cooperative. At present, Habilitation Agricultural Credit (CAH) plays one of the major financial institutes for the small-scale farmers. CAH is the effectual institute for the small-scale farmers who posses the land holding title. The Agricultural Credit Users Association (AUCA) should be established urgently to apply the institute. The committee is organized in each administrative district in the Area. Establishment of new agricultural cooperative is desirable on the basis of existing committees taking a change of farming patterns through the execution of the project into account because a change of cropping and farming patterns with the project is a proper opprtunity to improve the prevailing marketing system. Furthermore, it is proposed that the cooperative makes

development successively to manage the selling and purchasing.

To establish the new cooperative, independency of farmers' themselves is essential. In addition these, efforts to be realized will be required such as guidance of the concerned officials and advertisement of activities made by the existing cooperative.

4.4.3 Farm Income Improvement Plan

Following table shows estimated result of farm income levels of the small-scale farmers on the premise that the agricultural management in the Area was reformed with the improvement plan of the project. To accomplish the plan, governmental guidance and assistance will require intensely to promote the improvement of agricultural management and reignforcement of farmers' organization though farmers' independency is indispensable.

Unit: ha

Farm Household	Project Condition	Cropping Area					Total	Fallow Land/ Others	Land Holding Area
		Cotton	Sugar-cane	Vegetable	Fruit	Others			
Less than 5 ha	Without	1.0	-	-	-	0.5	1.5	3.5	5.0
	With	-	1.0	0.5(1.0)	-	0.5(1.0)	2.0(3.0)	3.0	5.0
Farming Type 1	Without	2.0	-	-	-	2.0	4.0	6.0	10.0
	With	1.5	-	0.5(2.0)	-	2.0	4.0(5.5)	6.0	10.0
Farming Type 2	Without	-	1.5	-	-	2.5	4.0	6.0	10.0
	With	-	2.0	0.5(1.0)	-	1.5	4.0(4.5)	6.0	10.0

Unit: G

Farm Household	Project Condition	Agricultural Gross Income	Agricultural Net Income
Less than 5 ha	Without	375,000	406,000*
	With	3,255,000	2,112,227
Farming Type 1	Without	1,400,000	1,194,600
	With	5,007,500	2,845,125
Farming Type 2	Without	1,200,000	1,124,100
	With	4,080,000	2,769,174

* Included the non-agricultural income.
\- Farm household income is calculated deducting production cost from gross agricultural income.

With implementation of the project condition, agricultural net incomes of the objective farmers will be increased by 2.4 to 2.5 times

for the farming types 1 and 2 from the present levels. Moreover, over five times increases of income can be expected for those with the owing land of less than 5 ha, making them well above in comparison with the minimum annual income on a national level. Annex D Table D.3.1 summarized components of the farm household incomes.

4.5 Water Resources Development Plan

4.5.1 Water Sources

Water sources of the Project are the streams located in the Study Area. Except the major streams such as Tranquera, Rory and Rory-mi, streams situated in the western parts of the project area could not be incorporated into the water sources of the Project because specific discharges of these stream basin are less than 1 $1/sec/km^2$.

Streams located in the eastern parts of Rory-mi have 2 to 3 $1/sec/km^2$ of specific discharges in the drought season and those discharges can be available for rural water supply, however, it is not enough for irrigation water supply of that area. Taking the abovementioned into account, therefore, water sources of the project are concluded as presaid three major streams.

4.5.2 Available Discharge

Available discharge at each stream will be finalized as follows using the droughty discharge tabulated in 3.2.2.

The value ranked at the second in the table will be employed as the droughty discharge in a drought year (equivalent to 1 to 5 year of probability). The value estimated with sample mean of the table will be settled as the droughty discharge in an ordinary year.

Based on the results of discharge measurement at each stream, discharge amount observed is shown same values with equivalent to specific discharge of its streams. Therefore, discharge available at the intake point will be estimated by the area ratio using the calculated specific discharge of the stream.

Specific discharge in each stream is as follows.

Month	Tranquera				Rory				Rory-Mi			
	Discharge at the gauging Station		Specific Discharge		Discharge at the gauging Station		Specific Discharge		Discharge at the gauging Station		Specific Discharge	
	A=5.9km²		ℓ/sec/km²		A=11.6km²		ℓ/sec/km²		A=2.8km²		ℓ/sec/km²	
	ℓ/sec				ℓ/sec				ℓ/sec			
	A	B	A	B	A	B	A	B	A	B	A	B
JAN.	32	45	5.4	7.6	70	95	6.0	8.2	34	42	12.1	15.0
FEB.	34	46	5.8	7.8	72	97	6.2	8.3	35	43	12.5	15.2
MAR.	33	46	5.6	7.8	71	97	6.1	8.3	34	43	12.1	15.2
APR.	33	50	5.6	8.5	70	102	6.0	8.8	33	44	11.8	15.8
MAY	38	55	6.4	9.3	79	112	6.8	9.6	35	48	12.5	17.2
JUN	43	51	7.3	8.6	91	107	7.8	9.2	38	46	13.6	16.2
JUL.	40	48	6.8	8.2	81	101	7.0	8.7	37	44	13.2	15.9
AUG.	37	46	6.3	7.8	82	97	7.1	8.3	35	43	12.5	15.4
SEP.	34	44	5.8	7.4	83	91	7.2	7.8	32	41	11.4	14.7
OCT.	31	43	5.3	7.3	62	89	5.3	7.7	30	40	10.7	14.4
NOV.	34	46	5.8	7.8	73	94	6.3	8.1	32	42	11.4	15.1
DEC.	41	49	6.9	8.4	82	102	7.1	8.8	40	45	14.3	16.1

Note; A: Droughty discharge in a drought year
B: Droughty discharge in a ordinary year

4.5.3 Irrigation Plan

(1) Basic concept

Water use in the Area, can be divided into rural water supply and that for irrigation. The following points should be considered to establish the water use plan.

1) Water taken from a stream should preferentially be utilized in that stream system.

2) The existing water supply system should be thoroughly considered before setting up a new water source.

3) Water supply plan should be considered to deliver water from the stream by gravity system. When such manner could not be applied, water supply should be made in such a way as to minimize the running cost for projected facilities.

4) Rural water supply should be given priority since it has direct bearing on the farmers' living.

5) The amount of water available for irrigation is limited, therefore, irrigation should be applied to fruit and vegetables for which water can be most effectively used. For fruit, in particular, irrigation efforts should be

concentrated at the time of flowering and bearing. Irrigation should be applied to as large an area as possible which can be serviced by the given water supply, since it has a direct influence on the farmers' economy because of improved product quality and increase in output.

6) Water supply from the source to the Study Area, both for drinking and irrigation, will be made via pipe lines. The utilization of the pipe line has been determined by taking into account the land configuration, soil characteristics and the amount of available water at the source. For irrigation, sprinklers, drips or hoses will be used for their high irrigation efficiency.

As has been studied in 3.2.2 and 4.3.2, surface water from three streams, namely Tranquera, Rory and Rory-mi, will be used to irrigate the farm land and provide rural water supply in the Study Area. Basic condition of discharge of these streams is given below.

Streams	Specific discharge (l/sec/km^2)	
	Droughty year Droughty discharge	Ordinary year Droughty discharge
Tranquera	5.3	7.3
Rory	5.3	7.7
Rory-mi	10.7	14.4

The following three plans will be proposed to utilize water from these streams. These plans are different in terms of water-intake methods and presence of a reservoir.

Plan A: Use of gravity system to distribute water.

Plan B: Gravity system and pumping to distribute water.

Plan C: Addition of an artificial reservoir to Plan B.

On the other hand, distribution of the farm land in the Study Area is shown in the table below.

Unit: ha

Altitude	Mbocayaty	Rory-mi	Rory	Tranquera	Ybaroty	Total
140-160 m	31	103	31	62	31	258
160-180 m	399	200	113	154	72	938
180-200 m	72	41	206	249	357	925
Over 200 m	41	21	36	72	309	479
Total	543	365	386	537	769	2,600

With the aforementioned water volumes at the sources, the area of farm land and the land distribution by altitude, the area of farm land that can be irrigated for each plan A to C has been estimated as shown

below.

Plan A: 196 ha (existing fruit and vegetable fields)

Plan B: 680 ha (302 ha for existing fruit and vegetable fields)

Plan C: 900 ha (302 ha for existing fruit and vegetable fields)

In case of utilization of a pump system (with Plan B), it is possible to supply water to the farm land (479 ha) at an altitude of 200 meters or over, but this area has been excepted from the plan for the following reasons: farm households in the area are extremely scattered, the soil is graded low, and high pump heads will be necessary.

Because of the limitations placed on the water sources, the maximum farm land area that can be irrigated will be estimated to be 900 ha as suggested in Plan C. Each of these plans from A to C is carefully studied in order to make proposals on priorities of development.

(2) Basic dimension

About 8 l/sec of water for rural water supply is required for the urban districts and the farm household within the Study Area with a population of approx. 2,600. For irrigation, unit water requirement as shown below is estimated (detailes refer to Annex E).

Crops	Diversion Water Requirement (l/sec/ha)											
	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Vegetables	0.52	0.51	0.49	0.45	0.36	0.27	0.32	0.38	0.47	0.47	0.49	0.51
Fruit	-	-	-	0.07	0.05	0.13	0.26	0.15	0.08	-	-	-

Utilization of the farm land (2,600 ha) is classified by basin areas as shown below.

Basins	Vegetables, Fruit	* Others	Total
Eastern area (Mbocayaty)	-	543 ha	543 ha
Rory-mi	64 ha	301 ha	355 ha
Arroyo Rory	117 ha	269 ha	386 ha
Arroyo Tranquera	82 ha	455 ha	537 ha
Tranquera branch streams (Ybaroty)	39 ha	730 ha	769 ha
Total	302 ha	2,298 ha	2,600 ha

* Others: maize, cotton, sugarcane, poroto, mandioca.

In line with the basic concept, distribution by altitude of the 302 ha farm land of existing cultivated fruit and vegetables is shown in

the table below.

Unit : ha

Stream Altitude	Rory-mi		Rory		Tranquera		Total		
	Vege-table	Fruit	Vege-table	Fruit	Vege-table	Fruit	Vege-table	Fruit	Total
Lower stream area									
140 - 150 m	8	6	2	-	1	-	11	6	17
150 - 160 m	9	17	4	8	5	5	18	30	48
Middle stream area									
160 - 180 m	8	12	17	31	17	15	42	58	100
180 - 200 m	1	3	12	31	21	29	34	63	97
Upper stream area									
200 - 230 m	-	-	3	9	12	16	15	25	40
Total	26	38	38	79	56	65	120	182	302

As mentioned above, irrigation priorities will be put for the existing fruit and vegetable farm land. On the other hand, supporting small-scale farmers takes the important part of the plan to reduce income imbalances. From these viewpoints, it is desirable that the cotton and sugarcane farmers (Type 1 and 2) should introduce cultivation of fruit and vegetables with high profitability when irrigation water is available. With these considerations for irrigation development, it will also study the possibility that the farm households (196 families) in the objective area of irrigation (those at an altitude of 230 m or less, covered by the stream basin of Tranquera, Rory and Rory-mi) will each add 0.5 ha to the existing fruit and vegetable farm lands (302 ha), making a total farm land area of 400 ha that can be irrigated.

Unit: ha

Stream Altitude	Rory-mi		Rory		Tranquera		Total		
	Vege-table	Fruit	Vege-table	Fruit	Vege-table	Fruit	Vege-table	Fruit	Total
Lower stream area									
140 - 150 m	12	7	3	-	2	-	17	7	24
150 - 160 m	15	19	6	9	9	5	30	33	63
Middle stream area									
160 - 180 m	14	13	28	34	29	16	71	63	134
180 - 200 m	3	3	19	34	35	32	57	69	126
Upper stream area									
200 - 230 m	-	-	5	10	20	18	25	28	53
Total	44	42	61	87	95	71	200	200	400

(3) Comparison of the irrigation development plans

The three irrigation development plans mentioned above are compared using the basic information studied in (2).

1) Plan A: Water distribution using gravity system

Should only the gravity system be used to supply water, intake structures at the most upstream reaches will have to be located at an altitude of at least 230 meters for Tranquera and Rory and 200 meters for Rory-mi in order to be able to deliver water to the farmers and their farm land in the upper reach of the streams. For the farmers and their farm land located in the middle and lower reaches of the streams, intake structures at an altitude 180-200 meters will be able to distribute water for them. With these conditions, water available from each stream and the area of farm land that can be irrigated are estimated as shown in the table below. With this plan, all the basin of Rory-mi will be able to irrigate. However, for the farm land at the upper and middle stream reaches of Rory and Tranquera, which is the major area for cultivating fruit and vegetables, only 110 ha (drought period water discharge) or 140 ha (ordinary water discharge) of farm land will be irrigated, failing to guarantee water supply for the approx. 170 ha of the existing farm land.

Location of Intake	Intake Level(EL)	Catchment Area	Available Water Droughty	Available Water Ordinary	Irrigable Area Droughty	Irrigable Area Ordinary
Tranquera upstream	238 m	0.7 km2	4 l/sec	6 l/sec	14 ha	18 ha
Tranquera middlestream	188	3.0	13	17	41	54
Rory upstream	236	2.5	11	14	32	40
Rory middlestream	187	3.5	7	8	23	28
Rory-mi upstream	218	2.3	29	34	86	86
Toral					196 ha	226 ha

With this plan, rural water supply will be made with water from the upper streams of Rory and Rory-mi. In the above table, 1 l/sec and 7 l/sec of water have been subtracted from the available water of Rory-mi and Rory, respectively.

2) Plan B: Plan A and pumping

Plan B is further divided into two plans due to development scale: one is Plan B-1 which will cover 400 ha of farm land in the upper and middle stream reachs of Rory and Tranquera that have been mentioned Plan A, and the other is Plan B-2 which, by combining pumping and surface water, will offer a maximum 680 ha of farm land that can be irrigated. These two plans are studied as below.

(a) Plan B-1

By installing pumping facilities in the middle stream reaches of Rory and Tranquera, irrigation will be made possible for about 170 ha of the farm land in the upper and middle stream reaches to which water cannot be supplied by gravity system alone, bringing the total irrigable farm land to 400 ha (fruit and vegetables fields). In this case, the intake in the upper stream reach of Tranquera proposed in Plan A will be eliminated because conducting canal that such a facility requires are too long in view of the required capacity and the construction costs will also be higher than for other methods. Instead, pumping facilities to be installed in the middle stream reach will be used for obtaining required water which is added water amount from the intake located in the upper stream reach of Tranquera. Considering the amount of water used by a juice factory on the downstream reach of Tranquera, water available at the Tranqura basin will not be enough to irrigate the Tranquera and Rory basin. Therefore, another pumping station will be provided in the middle stream reach of Rory.

(b) Plan B-2

With this plan, besides approx. 200 ha of land in the upper and middle stream reaches of Tranquera and Rory, the eastern part of the area (Mbocayaty), about 280 ha of farm land located along Route 818 with no available water sources, will be irrigated by a pumping station to be installed at the point where Rory-mi converges with Rory. With this plan, the total irrigation area will be 680 ha.

3) Plan C: Plan B with artificial reservoir

A irrigation area of 680 ha will be the limit that can be irrigated with Plan B which combines a gravity system and pumping to obtain surface water from the three streams. As new water resources, the utilization plan for groundwater and artificial reservoirs are proposed for the extension of irrigation area. However, as the well-digging survey reveals, the storage capacity of the groundwater is so small that it will only be able to be used as a supplement to the rural water supply. As to the latter, the areas in the basin of the upper and middle stream reaches are not suited for constructing reservoirs due to the steep gradient of land and poor geology conditions for abutment on both sides of the shores. A possible candidate place is the marsh in the middle reach of

Tranquera. The proposed capacity of the new reservoir to be constructed there will be about 1.5 million m^3. The excess water from the Tranquera during the rainy season will be stored to fill the reservoir, which will be utilized to irrigate approx. 220 ha of land in the western and northern part of the Area. On the whole, a maximum of about 900 ha of farm land will be irrigated with the economic basis.

The following tables show the water available and required water amount as proposed in Plan B and C.

Irrigation Area : 400 ha — Unit:l/sec

Month	Water Available					Required Water				
	Rory-mi 2.3km2	Rory (1) 2.5km2	Rory (2) 9.1km2	Tran-quera 13.0km2	Total	Rory-mi 86ha	Rory (1) 148ha	Rory (2)	Tran-quera 166ha	Total 400ha
Jan.	27	8	47	70	152	23	31		49	103
Feb.	28	9	48	75	160	22	31		48	101
Mar.	27	8	48	73	156	22	30		47	99
Apr.	26	8	47	73	154	23	34		48	105
May	28	10	54	83	175	18	26		38	82
Jun.	32	13	63	95	201	17	28		35	80
Jul.	29	11	56	88	184	25	42		49	116
Aug.	28	11	57	82	178	23	36		46	105
Sep.	27	11	58	75	169	24	36		50	110
Oct.	26	6	40	69	139	21	29		45	95
Nov.	25	9	49	75	158	22	30		47	99
Dec.	32	11	57	90	190	22	31		48	101

Irrigation Area : 280 ha, 220 ha — Unit:l/sec

Month	Water Available				Required Water	
	Eastern Area			Northern & Western Area	Eastern Area	Northern & Western Area
	Rory-mi 9.2km2	Rory 7.2km2	Total	1.5 MCM	280 ha	220 ha
Jan.	110	36	146	115	144	113
Feb.	114	38	152	115	142	112
Mar.	110	37	147	115	138	108
Apr.	108	36	144	115	125	98
May	114	42	156	115	100	78
Jun.	124	49	173	115	75	59
Jul.	120	43	163	115	89	70
Aug.	114	44	158	115	106	84
Sep.	104	45	149	115	132	104
Oct.	97	35	132	115	132	104
Nov.	104	38	142	115	137	108
Dec.	131	44	175	115	142	112

* The balance of water obtained in Plan B-1

A breakdown of the estimated costs including those of construction and annual maintenance and management is shown in Annex E. The table below shows the total project costs for irrigation development and unit costs per one hectare classified by the plan.

Plans	Irrigation Area	Irrigation Development Cost(1,000G)	Cost per ha (1,000G)
Plan A : Gravity system	196	3,109,000	15,862
Plan B-1: Gravity system and pumping (2 units)	400	4,503,000	11,257
Plan B-2: Gravity system and pumping (3 units)	680	8,187,000	12,039
Plan C : Gravity system pumping (2 units) and reservoir	900	13,069,000	14,521

(4) Irrigation development plan

As has been seen, four plans characterized by the water available and required facilities have been studied for irrigation development of the Project Area. On the other hand, from such factors as urgency, necessity and effectiveness, the development plan to be made with stage-wise is proposed before these plans are actually put into practice, as has been indicated in the basic concept. From this viewpoint, priorities of the development and degrees of improvement will be selected based on the following conditions.

1) As mentioned in the section of water supply, irrigation priorities will be given to the existing cultivation of fruit and vegetables. With Plan A in which only the gravity system is used to distribute water, however, water cannot be delivered to the upper and middle stream reaches of Rory and Tranquera, a major production district of fruit and vegetables inside the Study Area. Considering this point along with the development cost efficiency per unit area, priorities for Initial Stage Development will be given to Plan B-1 (Plan A and pumping station in the middle stream reaches of Rory and Tranquera, irrigation area 400 ha).

2) The eastern, western and northwestern part of the Study Area

covering a farm land of about 500 ha will be developed when requirements of irrigation has increased in the future due to diversify of agricultural management. With this plan, uneven distribution of irrigation facilities in the area will be eliminated.

(5) Facility planning

1) Basic policies of facility planning

The following items should be considered in planning the construction of irrigation facilities.

a) Construction materials should be selected which are easy to procure within Paraguay,

b) Since intake facilities will be set up at the rapidly flowing part of the stream, investigation should be made about the following matters: stray logs, mud inflow, intake method at time of water shortage, measures for sand deposition and drainage on the premise of sprinkler or hose irrigation,

c) The pipeline method will be used taking into account the following points: land configuration,soil characteristics, ease of maintenance, increase of conveyance efficiency and use of gravity system to supply water,

d) Planning of pond and reservoir construction should include measures against water leakage, collapse of slope and mud inflow during rainfalls,

e) Cares should be paid to prevent erosion due to water channeling, and

f) Facilities should be designed without any particular technology because the facilities will be operated and maintained by the farmers.

2) Water distribution facilities

The capacity of the distribution channels will be planned taking into account the irrigation hours (16 hours) on farm land. Delivery of the intaked water will be made with 24 hours basis. On the contrary, distribution of the intaked water to the designated farm land will be planned with 16 hours basis. The regulating pond will be provided at the head reach of distribution channel to regulate the time lag between the intake and the distribution hours. In principle, the irrigation method on the farm land will be to irrigate with sprinklers and hoses using the

gravity system, therefore, the channel systems should be planned as a pipeline. The diameter of the pipeline should be designed to provide proper pressure for irrigation equipment on the farm land.

3) Outline of the required facility

Facilities to be used for the Initial and Future development stages are outlined in Table 4.2.

4.5.4 Improvement Plan for Rural Water Supply

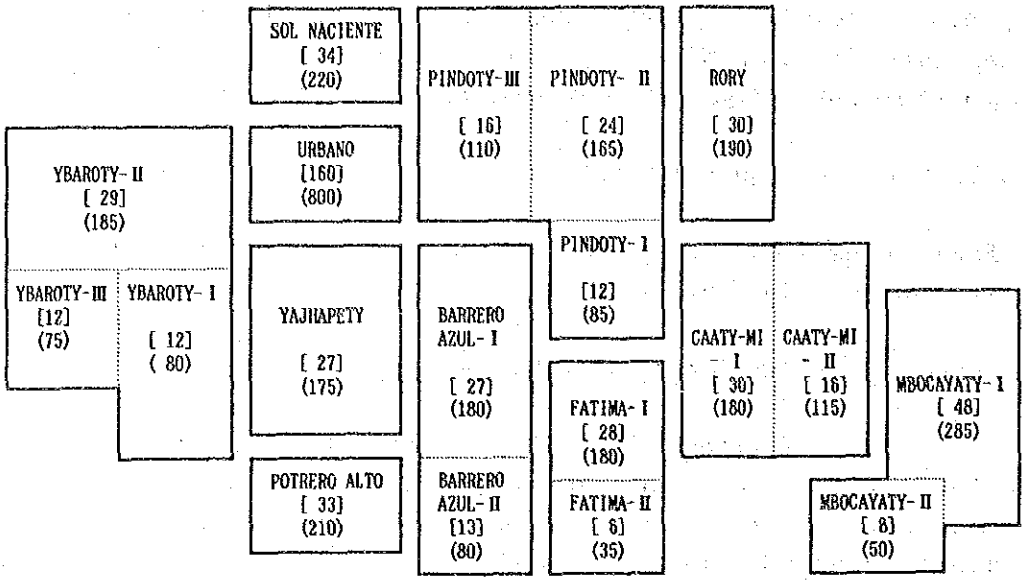
Necessity and urgency are high for development of rural water supply facilities, which are being planned as part of the living environment improvement project, to improve the water supply for drinking and miscellaneous use for rural areas. According to the plan, the utilization of the water resources within the Study Area will be for drinking, home use, agricultural use and irrigation. Considering the total water requirements and that of available water, however, priorities should be given to the rural water supply, then the remaining water is used for irrigation. For that reason, development efforts will be first concentrated on securing a supply of water for all the farm regions in the Study Area for drinking and miscellaneous use and on supplementing water supply to the urban areas. With these basic ideas, water distribution plans should be worked out that are both economic and efficient.

(1) Basic elements

The rural water is used for drinking, home activities and farming, with the volume of water required for each of them shown below.

Drinking	50 l/day
Home activities	100 l/day
Farming	50 l/day
Maximum daily supply	200 l/day

Water distribution for the rural water supply is based on administrative units, which are further divided into the following water-supply units according to their geographical conditions.



Water will be supplied to the 405 families, or 2,600 people, in the rural areas where drastic population fluctuations are not likely to occur, and will be used to supplement the water shortage for the 160 families, or 800 people in the urban areas, making a total of 565 families, or 3,400 people. Therefore, the total amount of water required is estimated as follows:

$$3,400 \times 200 \text{ (l/day)} = 680 \text{ m}^3\text{/day}$$

Use of the gravity system to deliver water to each farm household is of course most economical and desirable, but water cannot be supplied to those farmers living in the high altitudes using this method. For that reason, although the gravity method for water delivery will be adopted in principle, some pumping stations will be installed to supply the high altitude areas. Even so, the farm households for which water is pumped should be divided into several groups in order to minimize the number of such facilities. The intake works will also be shared as much as possible, and independent use of facilities for providing rural water should be kept to minimum.

The well-digging surveys conducted in and around Colmena city have confirmed that approx. 2 l/sec of water can be pumped up from two wells. Because of their proximity to the city and available water capacity, the wells will be of groundwater used as an auxiliary water source for the

urban areas.

(2) Comparison of improvement plans

Based on the various factors as studied above, the following four cases as possible candidates for the rural water supply improvement plan are proposed for the area.

CASE-1: In this case, water for rural water supply will be combined with that for irrigation and delivered to each farm household. Just the necessary amount of water will be disinfected for drinking by each farmer.

CASE-2: Water purification facilities will be established for each stream.

CASE-3: The purification facilities in CASE-2 will be combined as much as possible.

CASE-4: As the regulating pond for the irrigation facilities will be located at a high altitude, intake for rural water supply will be made together with that for irrigation. The water thus obtained will be diverted just before the regulating pond for irrigation, disinfected and sent to each farm household.

The details of these cases are given in Annex F, their summary is as follows.

The plan of Case-I is economical as the same facilities for irrigation will be used for intake and distribution of water for the rural water supply. However, disinfection of water by each family for drinking is likely to cause sanitation problems. Also, it will be difficult to secure a supply of water with uniform qualities.

In the CASE II, as many as four facilities each for intake and purification will be required. Moreover, independent intake works for rural water supply will be necessary at Tranquera and its a tributary of Piroy. Also, pumping stations will be required for the southern part of the area and for those places over 230 meters in altitude. Therefore, maintenance and management of the facilities in this plan will be more requested than in other cases.

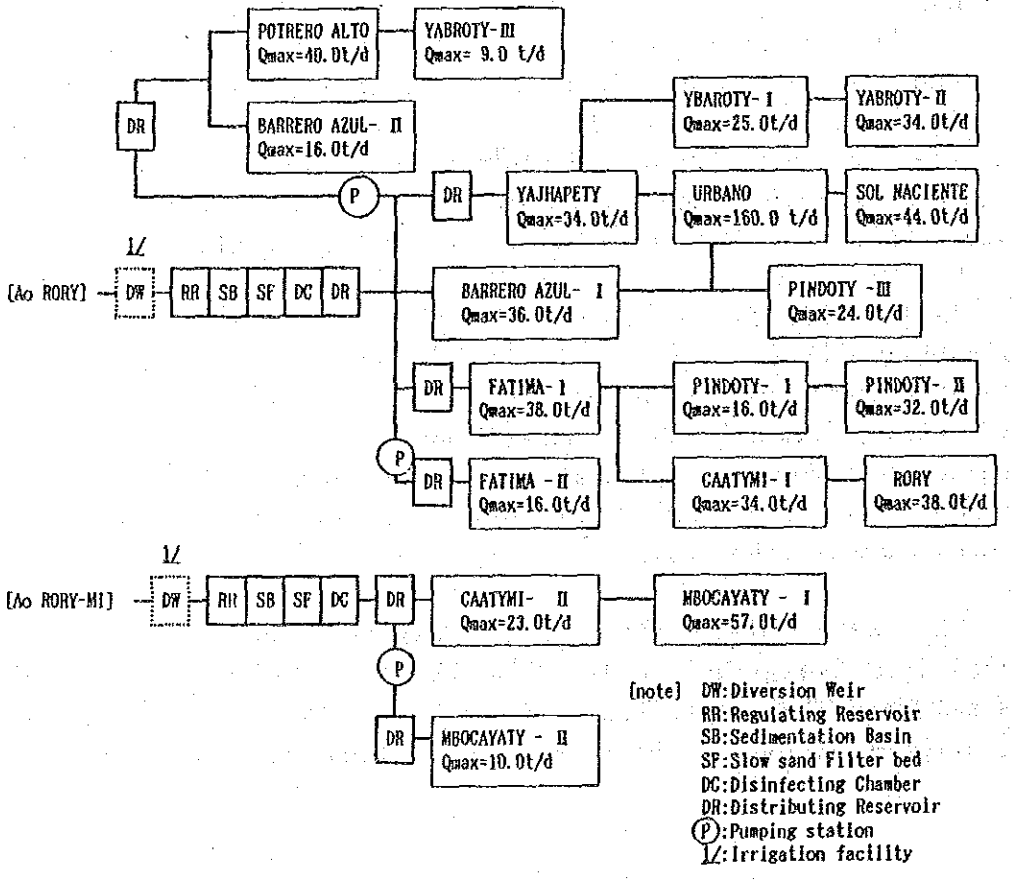
The water-purification facilities proposed in CASE-2 will be combined into two groups in the CASE II, one integrating the Rory-mi areas and the other to the basins of Rory, Tranquera and Piroy. In this case, long extension of the water distribution lines will be required,

linking the intake facilities with the distribution ponds, and the ponds with each water supply pipeline. Moreover, double piping for distribution will be partially provided.

In the CASE IV, the same water-intake facilities will be used both for irrigation and for rural water supply. Necessary amounts of water will be diverted just before the regulating pond to the water purification facilities. Although pumping must be used to draw water from Tranquera, but the necessary volume of water will be secured by means of gravity system from Rory. This way, an electricity blackout will cause no inconveniences in supplying the required amounts of rural water supply. The distribution of the facilities after the purification will be same as that in CASE-3, but this plan is more economical because there are fewer independent intake and distribution pipelines for rural water supply.

(3) Improvement plan

From the four plans described above, CASE-4 has been selected because it is economical and superior to the others in securing water with uniform quality for rural water supply use and in conducting maintenance and management of the facilities with ease. The water distribution system of CASE-4 is shown below.



In implementation of the plan, stage-wise improvement will be proposed based on the urgency, necessity and effectiveness as described in the basic concept of the improvement plan. With CASE-4, priorities of implementation will be first given to the development of the Area to which it is possible to distribute water using gravity system which are economically effective and easy to maintain. Then, after the farmers have become accustomed to maintenance and management of the facilities established in the early development, the remaining improvement plan will be made for the Area where the farm households are scattered at high altitudes and pumping is required to supply water.

4.5.5 Drainage Plan

(1) General situation

The following items are the causes of poor drainage in about 2,800 ha of land with an altitude of less than 150 meters located in the north and the west of the Study Area.

a) Small drainage capacity of the two rivers, Tranquera and Tebicuary-Mi.

b) The surface water cannot drain smoothly due to the bumpy surface in the poor drainage area.

c) The hard layer extends 50-100 cm below the ground surface and ground water level is high.

(2) Drainage improvement plan and land use

Drainage improvement will be made for the marshy 900 ha of land out of the 2,800 ha mentioned above. Drainage canals and bridges will be designed in the drainage plan. The outline of the facilities is shown in the table below.

Facilities	Quantity	Structure
Drainage Canal (5 Route)	10 km	Earth canal
Bridges	10 point	Culvert

* The expected water volume shown by these figures will be based on the amount of flood water with a return period of five years.

With drainage improvement plan, two drainage canals of 4 km length will be improved in the initial stage, because the drainage canals are located along the road and will be improved with the road. The remaining five drainage canal of 6 km in length will be improved at a future stage.

4.6 Rural Infrastructure Improvement Plan

(1) Basic concept

To formulate the rural infrastructure improvement plan in the Project Area, existing conditions of the rural infrastructure and its qualitative evaluated results have been stated in Chapter 3. In setting of the improvement level on the rural infrastructures, improvement differentials to arise in the Project Area will be eliminated as much as possible on the basis of presaid existing conditions. Furthermore, well-balanced improvement level of the social infrastructures will be proposed taking the existing and future improvement level at the rural and urban areas in Paraguay into considerations.

Possibilities and its constraints for the improvement in the Project Area were clarified in 4.1.3. Adding to these, especially for the potentiality related to the structural improvement, the following is pointed out: primary social infrastructures, organization and institutions have been built up, habitants in the Project Area have high intentions to improve the regional social infrastructures, human resources are high levels on both quality and quantity and land acquisition for the proposed facilities is easy.

With these, strategy for the establishment of the improvement plan will be set up with the long-term views which will be executed with the stage-wise improvement. The following are the basic strategies:

a) Improvement will be proceeded with the administrative districts as a unit,

b) Road improvement should be put as a core project, then, accumulation of the basic infrastructure will be made,

c) Full use of existing facilities is planned and upgrade will be proposed when improvement of facilities are required, and

d) Improvement of the quality will be proposed where basic infrastructures have been set up.

(2) Level of improvement

Qualitative levels of the structural improvement will be founded the classification for the quality of improvement as shown in Table 3.2 in conformity with the existing structural levels in Paraguay. A survey conducted for the farmers lived in the Project Area has revealed that they are not satisfied with utilities (roads and telephones), hygiene

(medical care and drinking water) and cultural factors (public meeting halls and libraries). The following is required to be improved:

a) Urgent item : roads, water works, electricity and medical care facilities.

b) Less urgent : telephone and emergency medical care.

c) In the future: facilities for exercise, sewage and agricultural research facilities.

Further, necessity of the improvement with the administrative-wise is summarized below based on the existing conditions of infrastructures:

- Road improvement : Sol Naciente
- Road and electricity improvement : Ybaroty, Yahapety, Caaty-mi, Mbocayaty and Potrero Alto
- Rural water supply : Pindoty, Rory, Fatima and Barrero Azul
- Core facilities in the Project Area : Urban area

The following shows the target to be realized with the basic concepts mentioned above:

Administrative Section / Facility	1. YBAROTY	2. YAHAPETY	3. PINDOTY	4. RORY	5. CAATY-MI	6. MBOCAYA-TY	7. FATIMA	8. BARRERO-AZUL	9. POTRERO ALTO	10. SOL NACIENTE	11. URBAN AREA
1. Diversion weir	–	–	–	–	–	●III	●III	●III	–	–	–
2. Reservoir	–	–	–	–	–	–	–	–	–	–	–
3. Irrigation	○II	◎II	●III	●III	●III	–	●III	●III	–	–	–
4. Drainage	●II	–	◎II	◎II	–	–	–	–	–	–	–
5. Collection & shippin	–	–	–	–	–	–	–	–	–	–	●IV
6. Meeting place	●II	–	–	–	–	●II	●II	–	●II	–	–
7. Main road	◎III	–	●IV	●IV	●IV	●III	–	–	–	◎III	●IV
8. Provincial road	–	●III	●III	–	–	–	–	●III	–	–	–
9. Farm road	●III	–	●III	●III	●III	●II	●III	●III	●II	◎III	–
10. Electricity	●III	●III	●III	●III	●III	●III	●III	●III	●III	●III	–
11. Rural water supply	◎IV	●IV	●IV	●IV	●IV	◎IV	●IV	●IV	◎IV	◎IV	–
12. Telecommunication	○II	○II	○II	○II	○II	○II	○II	○II	○II	○II	–
13. Medical care	–	–	–	–	–	–	–	–	–	–	●IV
14. Education	–	–	–	–	●III	–	●III	–	●III	–	–
15. Rural park	●III	–	–	–	–	●III	●III	–	●III	–	–
16. Garbage	–	–	–	–	–	–	–	–	–	–	●III
17. Sewage	–	–	–	–	–	–	–	–	–	–	–

[notes] Improvement Stage : ● (First) ◎ (Second) ○ (Future) – (Not Improvement)
Improvement Level : II (Low) III (Medium) IV (Advanced) V (Supreme)
(refer to Fig.)

Setting of the improvement level and contents of the project components for each items are described the following in detail.

4.6.1 Road Improvement Plan

(1) Assessment of the road to be improved

Existing roads in the Project Area are the fundamental facilities for living and productive activity and have high importance. The improvement of the roads, therefore, will be executed prior to other infrastructures. Road networks in the Project Area consist of 4 main roads, 3 provincial roads and 34 farm roads. The selection of roads to be improved will be decided taking the three major views such as relativity with the agricultural activities, effectiveness for the road network and executionability into account. Factors for assessment are set up as follows:

Relativity with the agricultural activities

- accessibility for farm land
- convenient for collection and shipping of agricultural products
- easiness of agricultural activities
- relativity with the water supply facilities

Effectiveness for the road net work

- numbers of related household(direct)
- numbers of related household(indirect)
- connectionability with other roads
- accessibility to the public facilities
- accessibility to the urban area
- requirement of local habitants

Executionability

- topographical features
- extent of improvement in sub-base
- extent of improvement on drainage facilities
- necessity of related structures such as bridge
- extent of enlargement of road width

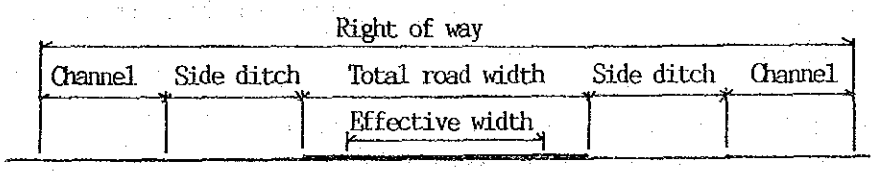
Table 4.3 shows the results of assessment and the priority set up of the existing roads.

(2) Criteria for road structure

Standards provided by the MOPC is used as the criteria for road structure. Road width for each road is as follows:

Road	Effective Width	Total Width
a. Main road	6.0 m	8.0 m
b. Provincial road	6.0 m	7.0 m
c. Farm road		
(common)	6.0 m	7.0 m
(connection)	3.5 m	5.0 m

The right of way has been settled at 30 m for the main road and 20 m for the provincial and farm roads. With these, side ditch and/or channels could be installed within a right of way. Cross sectional structure of the road is as follows:



(3) Improvement plan

Road improvement in the Project Area will be made taking the urgency, necessity, effectiveness and improvement level in other areas of Paraguay into consideration. In addition to these, implementation of such improvement should be in stage-wise. The stage of implementation will be set up the following view points:

a) The roads included in the Initial Stage improvement will be the roads which could be formed the road network in and around the Project Area. When the road network is created to rise the effectiveness of the road improvement in the Project Area, improvement will be required up to 20th lanked in Table 4.2 (64.3 km in total and 60% of the roads in the Project Area).

b) The roads to be improved in the Future Stage will be the farm roads which connect to the improved roads with the Initial Stage and has a lot of related farm households. The priority of 21st to 30th lanked in Table 4.2 will be improved (21.3 km in total and 80% of the roads will be improved together with Initial Stage improvement).

The roads lanked under 31st in Table 4.3 will be excluded from the improvement plan because these roads are satisfied the improvement level with the existing conditions and/or no need to improve with the frequency of use though roads are superannuated.

4.6.2 Rural Electricity Improvement Plan

Availability of electricity has an influence not only on the

improvement of living environment but on the modernization of agricultural management. It is, therefore, put emphasis on early establishment of power distribution line in the Area as the priority improvement. Some power distribution line has already been set up even in the rural areas, and the extension of existing facilities suffice to install full electricity supply to the whole area. For the time being, therefore, efforts will be placed on expansion of the existing power distribution line to the whole rural areas to realize the full supply rate. However, the cost to install a service wire into each household will be born by the recipient. Extent of the plan is as follows and implementation of the scheme will be proposed in the Initial Stage improvement.

Power distribution line	:	26 route
Power distribution facilities	:	48.8 km
Beneficial household	:	244 No.
Rate of power supply	:	100%

4.6.3 Telecommunication System Improvement Plan

According to the ANTELCO's extension plan, the present manually operated telephone switchboard will be improved with automatic ones and the number of lines will be increased to 200. From these, telecommunication system improvement in the Project Area will be set up for each administrative district for emergency and public use after completion of ANTELCO's scheme. The public telephones will be installed at the sub-center which will be mentioned later. In the Initial Stage, 3 lines with 14 km of telephone wire and 8 public telephones will be provided in parallel with the implementation program of the sub-center scheme. As for the Future Stage, 3 lines with 14.3 km of telephone wire and 12 public telephones will be installed in conformity with the improvement schedule of the sub-centers.

4.6.4 Medical Care Facilities Improvement Plan

It is desirable to set up the system of wide area medical center covering the area such as Tebicuary-mi, Martinez Cue, Cesar Barrientos and Chauria. It is also essential to strengthen emergency medical care facilities to dissolve the habitants anxiety about them. For these, following stage-wise improvement will be required:

a) In the Initial Stage improvement, preparedness of emergency medical care will be put the priority. Oxygen tent and ambulance will also be provided.

b) In the Future Stage, analytical equipment will be provided.

4.6.5 Education Facilities Improvement Plan

On a short-term basis, repair of superannuated school houses, elimination of long-distance walking to attend classes and upgrading of exercise facilities will be the items to be improved. From the present circumstances of the education facilities in Paraguay, repair of school houses at Potrero Alto and Caaty-mi will be lanked to the Initial Stage improvement. In the Future Stage, exercise facilities for each branch school (each 5,000 m^2, 6 places) will be planned.

4.6.6 Other Rural Facilities Improvement Plan

To rise the function of rural community and to further rural development, the following facilities will have to be set up: Extension, Operation and Maintenance Center, Sub-Center, Agricultural Research Center, Rural Park, Garbage Treatment Facility and Sewage Treatment Facility.

Extension, Operation and Maintenance Center will be the core facilities to execute the O & M of the facilities provided the project, extension of agricultural management and betterment of rural living standard. The Center will also be functioned for smooth management of project facilities and a base for rural community development. Sub-center is provided as the branch office of the Center at the each administrative district. The Sub-center offers operation and maintenance of the project facilities and extension of agricultural management under the guidance of the Center. Also, Sub-center has the functions of meeting hall in the regional habitants putting the rural park side with the sub-center. These facilities aim at the sense of social solidarity in the area. At the Initial Stage improvement, the Center will be installed in the urban areas and the Sub-center will be set up in Fatima, Potrero Alto, Mbocayaty and Ybaroty, all of which are located far from the urban areas. In the Future Stage, the Sub-center will be set up remaining 6 administrative districts.

The rural park will be constructed adjacent to the Sub-center. The park will have exercise ground with multi-purpose functions. The construction of the rural park, therefore, will be the same schedule of the construction works of the Sub-center.

For the time being, garbage will be disposed on an individual family basis in the rural areas; however, the amount of non-flammable

garbage is expected to increase in the future and a central treatment facility will have to be constructed. The situation is rather serious in the urban area where unlawful disposal of garbage is being practiced, seriously polluting the living environments. It is, therefore, strongly desired to construct a treatment facility (one place, 2,000 m^2) in the Initial Stage.

Treatment of sewage will be left, at least for the time being, to individual families. The matter will be reviewed after the completion of facilities for electricity and rural water supply. For the urban area, sewage will be handled by centralized sewers (one place, 2,500 habitants); for the rural areas, treatment plans should be conceived as independent items.

Further, a farm research center should be set up to facilitate development of the rural areas and their modernization. The center will also serve as a branch facility, maintaining close contact with other existing agricultural research centers throughout the nation. It will be constructed in the Extension and O & M Center.

4. 7 Agricultural Supporting and Promoting Plan

4.7.1 Basic Policies

The plan is established to increase total agricultural production for the Project Area and income for the farmers. By taking into account the characteristics of agricultural productivity in the Area, the plan will encourage the farmers to shift toward intensive suburban agriculture, growing crops with higher added-value. For this change, the following plans should be realized.

(1) Improvement of marketing and distribution system
(2) Improvement of processing facilities
(3) Improvement of agricultural supporting services

These improvements can be expected to expand the total agricultural products, improve quality, stabilize prices and enrich the domestic market with increased supply. Further, the export of fruit and vegetables can be expected in the future.

4.7.2 Improvement of Marketing and Distribution Facility

Effective enforcement of the Project will make it possible to substantially increase the agricultural production, mainly fruit and

vegetables, therefore, improve the collecting and shipping facilities are required in conformity with the increased production. Taking into account the present marketing and distribution system for agricultural products and its problems, the following improvement plans are proposed.

Item	Facility	Scale	Quantity
1. Shipping Facilities	①Shipping Floor Vegetables Floor Fruit Floor Other(miscelloneous) ②Machinery Implement Shed ③Carring Facility for Shipment Truck ④Administration Office	400 m² 150 150 100 100 m² 100 m² 40 m²	1 Ridge A = 640 m²
2. Fruit Sorting Facility	Grader	Weight sorting type	1 unit
3. Cooling and Storage	①Pre-cooling Facility ②Low temperature storage		1 unit 1 unit

This improvement will strengthen shipment of products to ABASTO, the largest market in the country. As a result, this will help the farmers in the Area to have a secure, stable market for their products.

Along with these above, the following can be expected.

(1) Stability and continuity of sales prices realized by shipment or produce suited to market situations.

(2) Maintenance of product freshness, quality improvement and uniformity of the standard by the grading of fruit.

4.7.3 Improvement Plan for Processing Facilities

This plan is mainly concerned with upgrading winery facilities, aimed at improving quality of wine, a very important agricultural industrial product in the Area. The following improvement plan of the winery should be established;

(a) Introduction of cooling devices in the winery for fermentation temperature adjustment, and improvement of brewing factories. Lack of this ability to control the temperatures has been a limiting factor to improve wine quality.

(b) Introduction of automatic measuring machines (truck scale) in order to maintain and improve freshness of the materials and

yield.

(c) Installation of processing machines for higher added values.

Item	Facilities	Types & Capacity	Quantity	Remark
1. Cooling Fasility	①Cooling installation for wine fermentation and brewing	Liquid circulation system(heat pump type) Fermentation / Brewing Capacity (1,000 l): 27 x 23casks / 20 x 2 casks — 25 x 7casks / 15 x 38casks Total cooling capacity (1,000 l): 661 / 745	3 unit (rotation system)	Cooling temperature of fermentation range keep 20 - 25 °c.
	②Low temperature storage	- Stainless steel tank storage capacity : 750,000 l/year	1 storage (3 tank) A = 60 m²	
2. Weighing Scale	Truck scale	- Weighing : 20 ton truck capacity - Minimum weighing range : 5 kg - Weighing bridge scale : 27 m x 6.5 m (A = 16 m²)	1 unit	
3. Wine sorting & Packing Facility	①Wine plugger ②Cork stopper	- Autoxatic monoblock type - Including the labelling system	1 unit 1 unit	
4. Improvement of Winery	①Roof improvement ②Floor improvement	- Dual structure by slate-roofed - Floor by tiles	A = 800 m² A = 500 m²	

Concerning the production of wine in the Project Area, cooling processes are required for fermentation and brewing. Peak of fermentation in the Project Area comes 3-5 days after the materials are processed. It is during this period that alcohol production rapidly expands, pushing up the fermentation heat to its maximum. This temperature control is the most important process in making fine wine as it has grave influence on the whole ensuing processes. In addition, the cooling during the late period of brweing is effective in removing tartaric acid. The cooling facilities used in these two process are indispensable for securing high grade wine and suitable prices to go with it.

4.7.4 Improvement Plan of Agricultural Supporting Services

(1) Plan for strengthening agricultural support organization

There are two types of organizations for farmers within the Area; the agricultural cooperative and the farmers' committee. The former has well-developed structure and functions, and thus can become a model for other organizations to be set up in the future. However, only 15% of the

farmers are members of the cooperative. The committee, on the other hand, is rather new and does not have organized activities, but a relatively large number of farmers (51% of the total) belong to the organization. Therefore, it is advisable to strengthen the existing committees for each company (companias) while aiming at realizing cooperative-level organization and functions.

At present, the committees are composed of 15 to 30 farm households and are operating on a small scale. In the future, they should be developed to district and Department levels.

Comision Distrital	----------	Department or regional level
Comision Vesional	----------	city or district level
Comite	----------	village level

(2) Strengthening of agricultural extension services

As the plan proceeds, an increase is expected in the number of farmers wishing to grow fruit and vegetables with high profitability and in more variety. However, given the present level of the number of the extension workers in the organization, it is difficult to carry out effective agricultural extension. Therefore, the following is proposed to increase the number of extension workers and to improve the facilities. Required equipments and extension workers will be settled in the Extension, Operation and Maintenance Center and carried out the cultivation experiment and guidance of farming techniques on fruit and vegetables using the Demonstration Farm.

1) Increase of extension workers

a)	Agricultural extension workers:		10
	Field crops	: 2	
	Vegetables	: 3	
	Fruit	: 3	
	Livestock	: 2	
b)	Forestry instructor	:	1
c)	Education and life advisor	:	2
d)	Assistant	:	3
	Total		16

2) Equipments improvement plan

a)	Vehicle (with radio)	:	2 cars
b)	Telephone	:	1 unit
c)	Radio transmission	:	1 unit
d)	Demonstration farm	:	1 farm
e)	Equipments and maintenance for the training and extension:		1 unit

(3) Plan for improving financing system

BNF and La Colmena Agro-Industrial Cooperative are available for financing in terms of farmers' needs. Therefore, the financing improvement plan shown below will have a compensatory nature.

1) Utilization of agricultural credit (CAH)

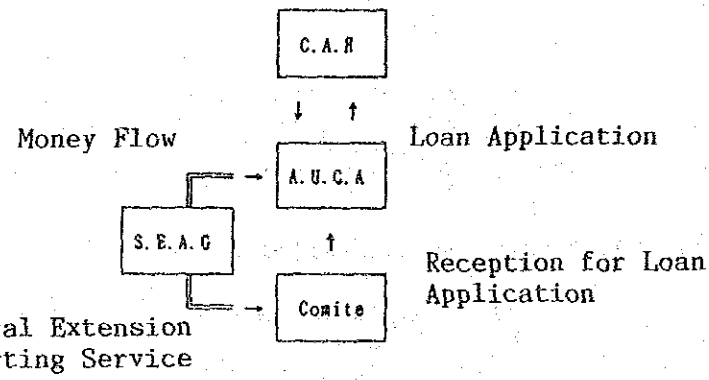
The CAH finance system will be applied to the farmers, especially those without landholding title who do not satisfy the loan conditions set by the above-mentioned two institutes. CAH loan conditions are as follows (as of September, 1988):

a) Annual interest : 22%
b) Loan limit : 1.2 million G
c) Grace period : 1 year (short term)
7 years (long term)
d) Loan conditions : Farm equipment (including livestock), houses as collateral

CAH makes loans available to farmers without landholding title, and is flexible in setting interest according to farm production conditions, farmers' income levels and their living standard. One drawback is that the loan limit is rather low compared with the other two; therefore, it is desirable that farmers switch to BNF once they obtain a landholding title.

2) Establishment of agricultural credit users association (AUCA)

Effective utilization of CAH requires setting up of an AUCA, through which loans will be made. At least ten members are needed to set up an AUCA and the menber of an AUCA limits at 20 to 30. It is possible, therefore, to use the committee which exists in each village. The nationwide SEAG offices are conducting the guidance services for the farmers who are members of AUCA along with CAH, giving the farmers both technical and financial information.



4.8 Evaluation of Improvement Level and the Integrated Rural Infrastructure Improvement Plan

As stated in the basic concepts of the integrated rural infrastructure improvement, the targets of the project are the increase of farmer's income and the acceleration of the farmer's settlement in the rural areas through improvements of structure on agricultural production and of rural living environments. To achieve these targets, promotion of the following structural improvements are proposed as the measures to solve the problems in the Area and to direct the production and living environments to be furnished in the rural areas located near urban areas through the study. These measures will also be verified through the present conditions of such facilities in Paraguay.

- Improvement of irrigation and drainage facilities
- Rural water supply improvement
- Road improvement
- Improvement of rural electricity
- Telecommunication system improvement
- Improvement of medical care facilities
- Improvement of O & M and Extension facilities
- Improvement of garbage and sewage treatment
- Improvement of agricultural processing facilities
- Improvement of collecting and shipping facilities

In the above-mentioned, qualitative and quantitative extents and levels of improvement were studied for each component. Further, implementation of these improvement will be carried out with two stages of the Initial and the Future taking the urgency, necessity and effectiveness of the improvement into account. Relation among the problems, method and levels of the improvement is shown in Fig. 4.2.

4.8.1 Evaluation

With the execution of the project, ratio of improvements on the major social infrastructures will vary as follows:

Item		Present	Initial Stage	Future Stage
Average farmer's income		160 *1	480 G *1	
Farmers' organization ratio		66%	100%	
Irrigation facilities	*2	6%	48%	80%
Rural water supply	*2	0%	82%	100%
Road improvement	*3	11%	67%	87%
Rural electricity	*4	15%	100%	100%
Telecommunication	*5	0%	2%	5%

Note:*1 10,000 G
*2 Beneficial farm household/Total farm household

*3 Improved length/Total road length
*4 Beneficial household/Total household
*5 No. of telephone/Total household

Items to be improved and its contents on each administrative district with the project are shown in Table 4.4 in connection with the time of completion on both Initial and Future stages.

The Tables 4.4 and 3.1 show that extreme uneven distribution of the social and agricultural infrastructures in the Project Area will be dissolved with the execution of the project between the urban and rural areas and among the rural areas though some components are physically and economically difficult to distribute evenly in the whole Project Area due to its improvement contents.

4.8.2 Integrated Rural Infrastructure Improvement Project in the Outskirts of the Urban Areas

Through the investigation and the study of La Colmena reagion, following procedures are adequate to proceed the infrastructure improvement in rural areas located around the urban areas.

(1) Establishment of improvement plan of agricultural management and road and development plan of water resources

With the present conditions of agricultural management, improvement plan to increase the farmer's income will be established. For this purpose, improvements united systematically will be promoted among the introducing the irrigation with the development of water resources, road improvement, improvement of marketing and agricultural processing facilities, organization and the agricultural management.

(2) Establishment of improvement plan of social infrastructures

The plan to be accelerated the farmer's settlement in the rural areas will be established with the improvement of rural environments. To avoid the regional differentials on such measures, administrative district-wise improvement will be the basic concept of the project formulation.

(3) Comprehensive improvement plan

(1) and (2) stated above are adequate with the well-balanced improvement levels. For this, comprehensive improvement plan with the stage-wise completion will be required.

4.9 Evaluation of the Project and Implementation Schedule

4.9.1 Implementation of the Project

The contents of the Project are mentioned already, the plans are desirable to carry out consistently and synthetically because components connect with each other. For the Project to succeed, the Plan including the aspect of software such as farm management, institution and organization must be operated properly.

The Project will put forward taking into consideration these possibility and it is assumed that the target year is set up at the tenth year after completion of the Project. The effect to be expected in the target year after completion of the Project and funds needed for the Project implementation are estimated as follows:

4.9.2 Project Cost

The proposed poject facilities are summarized in Table 4.5 and the total project cost for the implementation is estimated at 318.40 Million G as shown in Table 4.6.

4.9.3 Project Benefit

The expected benefit with the Project after the target year (after 10 years) is estimated as follows;

Unit: 1,000 G

- Increased of the agricultural production	:	1,027,293
- Quality improvement of the agricultural products	:	57,040
- Transportation cost saving through the road improvement	:	1,176,000
- Increase of the livestock production through the improved drainage	:	31,680
- Increase of the production materials	:	35,143 ton
- Increase of the agricultural employment opportunities (120 man/day per farm household)	:	58,000 man/day

Annex G Table G.3.2 to 3.7 shown breakdown of the Project benefit.

4.9.4 Project Implementation Schedule

The following implementation schedule will be proposed taking the conditions of implementation organization and works to be carried out.

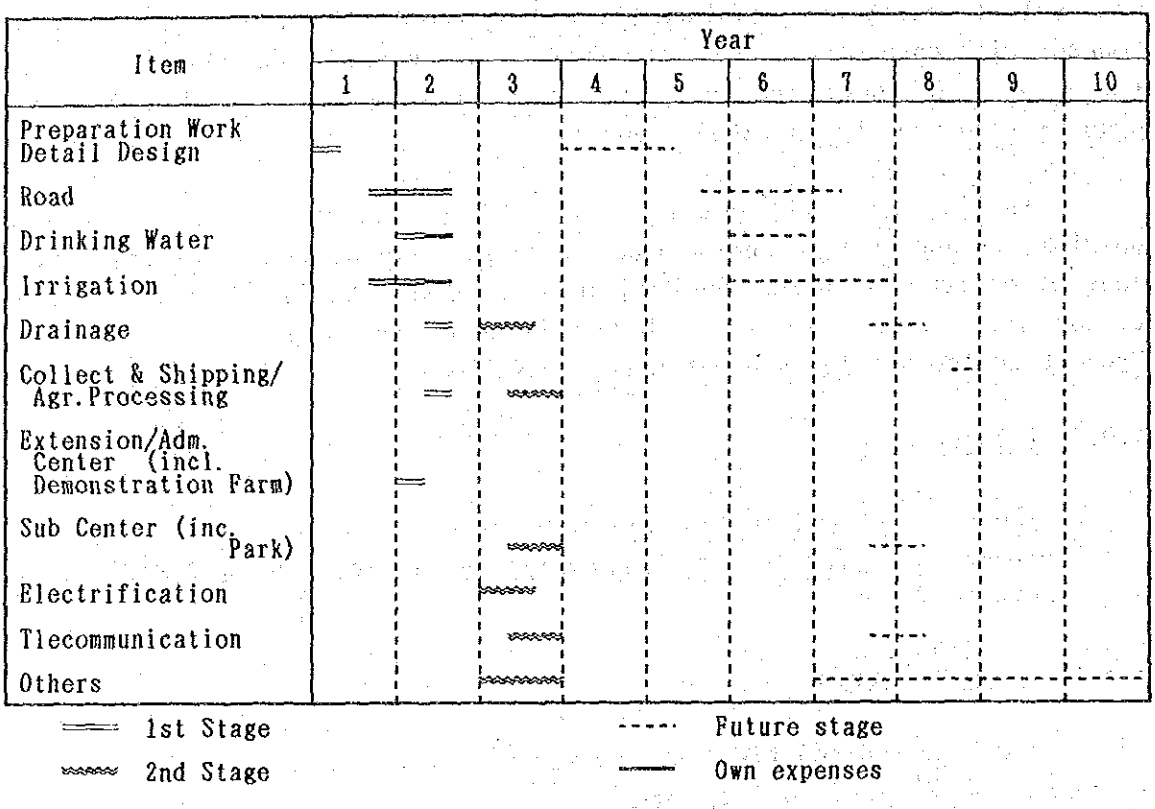


Table 4. 1 Expected Production Volume and Production Value

Crops	Cropping Area (ha)		Yield (ton/ha)		Production (ton)		Unit Price (G/kg)	Production Valu (1,000 G)		Remarks
	Without	With	Without	With	Without	With		Without	Whith	
Cotton	820	825	1.3	1.5 (1.8)1/	1,066	1,237.5 (1,282.5)	250	266,500	309,375 (320,625)	above: With project below: Without project ·Figure in the ()means after completion of the Master Plan .1/Irrigation area is 150 ha within the total cropping area of 825 ha. .2/Irrigation area is 350 ha within the total cropping area of 500 ha. Figure of 100 t/ha utilize for irrigation field.
Sugarcane	255	500	70.0	75.0 (100.0)2/	17,850	37,500 (46,250)	11	196,350	412,500 (508,750)	
Maize	355	481	1.2	1.2	426	577.2	85	36,210	49,062	
Porot beans	270	275	0.8	0.8	216	220	213	46,008	46,860	
Mandioca	450	300	18.0	18.0	8,100	5,400	40	324,000	216,000	
Other Miscellaneous crops	15	-	2.5	-	37.5	-	210	7,875	-	
Grape	43	75	20.0	22.0	860	1,650	170	146,000	280,500	
plum	74	75	4.6	7.0	340.4	525	213	72,505.2	111,825	
Citrus	25	40	5.0	8.0	125	320	85	10,625	27,200	
Other Fruit	40	10	3.0	8.0	120	80	85	10,200	68,000	
Onion	55	120	10.0	15.0	550	1,800	68	37,400	122,400	
Tomato	25	60	20.0	30.0	500	1,800	128	64,000	230,400	
Watermelon	15	30	20.0	25.0	300	750	45	13,500	33,750	
Melon	6	10	12.0	17.0	72	170	128	9,216	21,760	
Green Pepper	14	30	10.0	15.0	140	450	170	23,800	76,500	
Other Vegetables	65	150	15.0	25.0	975	3,750	85	82,875	318,750	
Total	2,577	2,981			31,677.9	56,229.7 (65,024.7)		1,347,264.2	2,263,682 (2,371,182)	

Table 4. 2 Summary of the Irrigation Facilities

Facilities	First Stage Improvement		Future Stage Improvement	
Intake Facilities (Gravity System) Q:Intake amount B:Weir width H:Weir height	Tranquera	Q= 49 l/s B=16.0 m H= 1.0 m	Rory-Mi-II	Q= 144 l/s B=15.0 m H= 1.5 m
	Rory-I	Q= 18 l/s B=17.5 m H= 3.0 m		-
	Rory-II	Q= 31 l/s B=10.0 m H= 1.0 m		-
	Rory-Mi-I	Q= 26 l/s B= 5.0 m H= 1.5 m		-
(Reservoir) V:Straging volume H:Dam height L:Dam length	-		Tranquera	V=150 MCM H= 6.0 m L=320.0 m (Rock fill, Asphalt facing)
Pumping Facilities				
Q:Pumping discharge H:Total head D:Pump diameter N:Number of pump P:Horse power	Tranquera-I	Q=1.47x2 2.94m3/min H=81 m D=100x80 N= 2 No. P=45kwx2	Tranquera-II	Q=3.39x2 6.78m3/min H=120 m D=150x100 N= 2 No. P=130kwx2
	Rory	Q=0.93x2 1.86m3/min H=90 m D= 80x50 N= 2 No. P=30kwx2	Rory-Mi	Q=4.32x2 8.62m3/min H=90 m D=150x100 N= 2 No. P=110kwx2
Regulating Pond V:Regulating capacity	Tranquera	V=2,900 m3 Rubber sheet	Mbocayaty	V=4,200 m3 Rubber sheet type
	Yajhapety	V= 500 m3 Rubber sheet	Ybaroty	V=2,700 m3 Rubber sheet type
	Rory-Mi	V= 800 m3 Rubber sheet	Pindoty	V= 600 m3 Rubber sheet type
Pipe Line (Conducting pipe line)	DCP D=200 mm PVC D=250 mm PVC D=200 mm	L= 2.3 km L= 4.4 km L= 3.5 km	DCP D=350 mm DCP D=200 mm PVC D=200 mm	L= 8.0 km L= 1.2 km L= 1.0 km
(Distributing pipe line)	PVC D=250 mm D=200 mm D=150 mm D=125 mm D=100 mm - -	L= 2.8 km L= 9.0 km L= 7.6 km L= 4.8 km L= 5.6 km	DCP D=350 mm PVC D=300 mm D=250 mm D=200 mm D=150 mm D=125 mm D=100 mm	km L= 1.5 km L= 2.5 km L= 7.5 km L=11.3 km L= 7.5 km L= 2.0 km L= 3.0 km

Table 4. 3 Priority of the Road Improvement

No	TY	Name	Length (km)	Total Repair Length (km)	Percentage (%)	Administrative Section
			105.5	11.0	10.4	
1	A	818	12.3	17.8	16.9	PINDOTY BARRERO RORY CAATI-MI MBOCAYATY
2	B	818-06	5.6	23.4	22.2	CAATI-MI MBOCAYATY FATIMA
3	B	818-01	5.2	28.6	27.1	BARRERO AZUL
4	A	805	2.8	31.4	29.8	SOL NACIENTE
5	B	818-04	3.6	35.0	33.2	PINDOTY
6	B	818-05	3.7	38.7	36.7	RORY
7	B	818-02	3.2	41.9	39.7	PINDOTY
8	D	818-03-3	2.4	44.3	42.0	BARRERO AZUL FATIMA
9	B	818-03	4.6	48.9	46.4	PINDOTY FATIMA
10	C	251-22	5.8	54.7	51.8	YAHAPETY POTRERO ALTO
11	C	251-17-3	2.0	56.7	53.7	YBAROTY
12	E	818-05-2	1.0	57.7	54.7	RORY
13	E	818-05-1	0.5	58.2	55.2	RORY
14	D	819-01-1	2.0	60.2	57.1	POTRERO ALTO
15	D	818-01-3	1.4	61.6	58.4	BARRERO AZUL POTRERO ALTO
16	E	818-03-2	1.7	63.3	60.0	FATIMA
17	C	251-16	2.4	65.7	62.3	YBAROTY
18	D	818-01-1	1.1	66.8	63.3	BARRERO AZUL PINDOTY
19	D	251-20	1.4	68.2	64.6	YBAROTY
20	E	818-07	2.1	70.3	66.6	CAATY-MI
21	A	819	2.8	73.1	69.3	YBAROTY
22	E	818-06-10	1.8	74.9	71.0	MBOCAYATY
23	C	818-04-1	2.4	77.3	73.3	PINDOTY RORY
24	D	805-02	2.5	79.8	75.6	SOL NACIENTE PINDOTY
25	D	805-01	1.3	81.1	76.9	SOL NACIENTE PINDOTY
26	B	251-17	3.7	84.8	80.4	YBAROTY
27	C	251-17-1	1.3	86.1	81.6	YBAROTY
28	D	819-01	3.6	89.7	85.0	YBAROTY
29	E	818-06	1.9	91.6	86.8	MBOCAYATY
30	E	251-21	1.0	92.6	87.8	YBAROTY
31	C	818-11	0.4	93.0	88.2	MBOCAYATY
32	C	818-08	0.4	93.4	88.5	CAATI-MI
33	D	818-03-1	1.2	94.6	89.7	PINDOTY CAATI-MI
34	E	818-09	2.7	97.3	92.2	CAATI-MI MOCAYATY
35	E	251-15	1.2	98.5	93.4	YBAROTY
36	E	818-12	1.2	99.7	94.5	MBOCAYATY
37	E	251-18	2.2	101.9	96.6	YBAROTY
38	D	818-01-2	1.4	103.3	97.9	BARRERO AZUL YAHAPETY
39	E	251-19	2.2	105.5	100.0	YBAROTY

(note) TY:Road Type

Table 4. 4 Improvement State of the Rural Facility by the Project Implementation

Improvement Level after completion of the Initial Stage

Administrative Section / Facility	1. YBAROTY	2. YAJHAPE-TY	3. PINDOTY	4. RORY	5. CAATY-MI	6. MBOCAYA-TY	7. FATIMA	8. BARRERO AZUL	9. POTORERO ALTO	10. SOL NACIENTE	11. URBAN AREA	TOTAL
1. Diversion weir	−50○50	−30○70	−30○70	−20○80	−40○60		−20○80	−30○70				−55○45
2. Reservoir	−50○50	−30○70	−30○70	−20○80	−40○60		−20○80	−30○70				−55○45
3. Irrigation	−50◎50	−30◎70	−30◎70	−20◎80	−40◎60		−20◎80	−30◎70				−55◎45
4. Drainage	−90◇10		−80◇20									−90◇10
5. Collection & shipping										◎100		−90◎10
6. Meeting place	◇100				◇100	◇100			◇100			−50◇40●10
7. Main road			◎100	◎100	◎100	○100				○100		◇ 5○ 5◎30●30
8. Provincial road		◎100	◎100				◎100	◎100	◎100			◎100
9. Farm road	△75○25		○100	○100	△30○70	△50○40	△25○75	△20○80	○100	△20○80		△35○65
10. Electricity	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100		◎100
11. Rural water supply	△30◎70	◎100	◎100	◎100	◎100	△10◎90	△15◎85	△ 5◎95		◎100		△ 3◇ 5◎92
12. Telecommunication	△98◇ 2				△98◇ 2	△98◇ 2			△98◇ 2		△60◎40	△70◇10◎20
13. Medical care												△90◎10
14. Education					○100				○100			△35◇25○35◎ 5
15. Rural park	○100				○100	○100			○100			−55○45
16. Garbage											○100	△90○10
17. Sewage												

Improvement Level after completion of the Future Stage

Administrative Section / Facility	1. YBAROTY	2. YAJHAPE-TY	3. PINDOTY	4. RORY	5. CAATY-MI	6. MBOCAYA-TY	7. FATIMA	8. BARRERO AZUL	9. POTORERO ALTO	10. SOL NACIENTE	11. URBAN AREA	TOTAL
1. Diversion weir	○100	−30○70	○100	○100	○100	○100	−20○80	−30○70		◎100		−20○80
2. Reservoir	○100	−30○70	○100	○100	○100	○100	−20○80	−30○70		◎100		−20○80
3. Irrigation	◎100	−30◎70	◎100	◎100	◎100	◎100	−20◎80	−30◎70		◎100		−20◎80
4. Drainage	◇100		◇100	◇100								◇100
5. Collection & shipping											◎100	−90◎10
6. Meeting place	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100		◎90●10
7. Main road	○40●60		◎100	◎100	◎100	◎100				○100		○30◎40●30
8. Provincial road		◎100	◎100				◎100	◎100	◎100			◎100
9. Farm road	△25◎75		◎100	◎100	△30◎70	△40◎60	△10◎90	△10○90	◎100	△20◎80		△15◎85
10. Electricity	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100		◎100
11. Rural water supply	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100	◎100
12. Telecommunication	△98◇ 2	△98◇ 2	△98◇ 2	△98◇ 2	△98◇ 2	△98◇ 2	△98◇ 2	△98◇ 2	△98◇ 2	△98◇ 2	△60◎40	△30◇50◎20
13. Medical care												△90◎10
14. Education												△35◇25○35◎ 5
15. Rural park	○100	○100	○100	○100	○100	○100	○100	○100	○100	○100		○100
16. Garbage	○100				○100	○100			○100		○100	△65○35
17. Sewage											●100	−45●55

Table 4. 5 Summary of the Proposed Facilities

Item	Content of Project	Initial Stage			Future Stage
		Total	First Stage	Second Stage	
1. Road Improvement	Pavement: 1 route L= 11.8km Improvement : 30 route L= 85.6km Bridge : 17 place Culvert : 25 place Road bed: 1 unit	Pavement: 1 route L= 5.5km Improvement :20 route L= 64.3km Bridge : 10 place Culvert : 35 place -	Pavement: 1 route L= 3.1km Improvement :14 route L= 54.2km Bridge : 9 place Culvert : 5 place -	Pavement: 1 route L= 2.4km Improvement : 6 route L= 10.1km Bridge : 1 place Culvert :10 place Road bed: 1 unit	Pavement: 1 route L= 6.3km Improvement : 10 route L= 21.3km Bridge : 7 place Culvert :16 place Road bed: 1 unit
2. Irrigation Facilities	Intake facility : 5 place Pump : 4 place Regulating pond : 6 place Conducting pipe: L= 20.4km Distribution pipe: L= 65.1km Reservoir: 1 place On farm facility : 900 ha	Intake facility : 4 place Pump : 2 place Regulating pond : 3 place Conducting pipe: L= 10.2 km Distribution pipe: L= 29.8 km - On farm facility : 400 ha	Intake facility : 4 place Pump : 2 place Regulating pond : 3 place Conducting pipe: L= 9.0 km Distribution pipe: L= 29.8 km - On farm facility : 400 ha	- - - - - - -	Intake facility : 1 place Pump : 2 place Regulating pond : 3 place Conducting pipe: L= 10.2 km Distribution pipe: L= 35.3 km Reservoir: 1 place On farm facility : 500 ha
3. Drainage Facility	Canal : 5 route L= 10.0 km	Canal : 2 route L= 4.0km	Canal : 1 route L= 1.8 km	Canal : 1 route L= 2.2 km	Canal : 3 route L= 6.0 km
4. Rural Water Supply Facilities	Conducting pipe: L= 800 m Regulating reservoir: 2 place Sedimentation basin : 2 place Filter bed:2 place Disinfecting chamber : 2 place Distribution reservoir: 7 place Distribution pipe: L= 70,050 m Pump : 3 place On farm facility : 1 unit	Conducting pipe: L= 800 m Regulating reservoir: 2 place Sedimentation basin : 2 place Filter bed:2 place Disinfecting chamber : 2 place Distribution reservoir: 4 place Distribution pipe: L= 56,650 m - On farm facility : 1 unit	Conducting pipe: L= 800 m Regulating reservoir: 2 place Sedimentation basin : 2 place Filter bed:2 place Disinfecting chamber : 2 place Distribution reservoir: 4 place Distribution pipe: L= 56,650 m - On farm facility : 1 unit	- - - - - - - - - -	- - - - - Distribution reservoir: 3 place Distribution pipe: L= 13,400 m Pump :3 place On farm facility : 1 unit
5. Electrification Facility	26 route: L=48.8km	26 route: L=48.8km	-	26 route: L=48.8km	-
6. Medical Facilities	Oxgent tent:1 unit Ambulance :1 car Analytic equip. :1 unit	Oxgent tent:1 unit Ambulance :1 car -	- - -	Oxgent tent:1 unit Ambulance :1 car -	- - Analytic equip. : 1 unit
7. Telecomunication Facility	6 route: L= 24.3km Telephone:20 place	3 route: L= 14.0km Telephone: 8 place	- -	3 route: L= 14.0km Telephone: 8 place	3 route: L= 10.3km Telephone:12 place
8. Education Facility	Improvement of school : 2 place Ground : 6 place	Improvement of school : 2 place -	- -	Improvement of school : 2 place -	- Ground : 6 place
9. Extension & Adm. Center	1 place: A= 800㎡	1 place A= 800㎡	1 place A= 800㎡	-	-
10. Sub-Center	10 place:A=2,000㎡	4 place: A= 800㎡	-	4 place A= 800㎡	6 place:A= 1,200㎡
11. Rural Park	10place:A=50,000㎡	4 place:A=20,000㎡	-	4 place:A=20,000㎡	6 place:A=30,000㎡

Item	Content of Project	Initial Stage			Future Stage
		Total	First Stage	Second Stage	
12. Sewage Disposal	1 place:A= 2,500㎡	-	-	-	1 place:A= 2,500㎡
13. Garbage Treatment	5 place:A=10,000㎡	1 place A= 2,000㎡	-	1 place:A= 2,000㎡	4 place:A= 8,000㎡
14. Agro. Processing Facilities	Cooling, weighing, and packing:1 unit Improvement of winery Cold storage	Cooling and Weighing : 1 unit Packing equipment : 1 unit Winery improvement	Cooling & Weighing : 1 unit - -	- Packing equipment : 1 unit Winery improvement	- - Cold storage
15. Marketing Facilities	Collect & shipment : 1 place A= 640㎡ Grader : 1 unit Low temperature storage: 1 unit	Collect & Shipment : 1 place A= 640㎡ - -	- - -	Collect & Shipment 1 unit: A= 640㎡ - -	- Grader: 1 unit Low temperature storage:1 unit
16. Demonstration Farm	1 place: A=5,000㎡	1 place: A=5,000㎡	1 place: A=5,000㎡	-	-
17. O & M Machinery	Buldozer, Grader, Roller, Backhoe	Buldozer, Grader, Roller, Backhoe	Buldozer, Grader, Roller	Backhoe	-

Table 4. 6 Summary of the Project Cost

Unit : 1,000 G

Description	First Stage	Future Stage	Total
Road Improvement	4,738,520	3,598,480	8,337,000
Irrigation Water Supply	4,036,154	7,523,846	11,560,000
Drainage Improvement	103,422	150,578	254,000
Rural Water Supply	988,454	888,546	1,877,000
Electricity	1,308,000	0	1,308,000
Medical Care Facilities Improvement	154,000	77,000	231,000
Telecommunication system Improvement	162,000	123,000	285,000
Education Facilities Improvement	100,000	92,000	192,000
O & M Center	169,000	0	169,000
Sub-center	185,000	277,000	462,000
Rural Park	154,000	231,000	385,000
Garbage & Sewege treatment	192,000	1,923,000	2,115,000
Agricultural Processing Facilities	423,000	539,000	962,000
Marketing & Sipping Facilities	462,000	400,000	862,000
Demonstration Farm	23,000	0	23,000
O & M Machines	577,000	0	577,000
Sub-Total	13,775,550	15,823,450	28,559,000
Consulting Fee	1,080,000	1,201,000	2,281,000
Grand Total	14,855,550	16,984,450	31,840,000

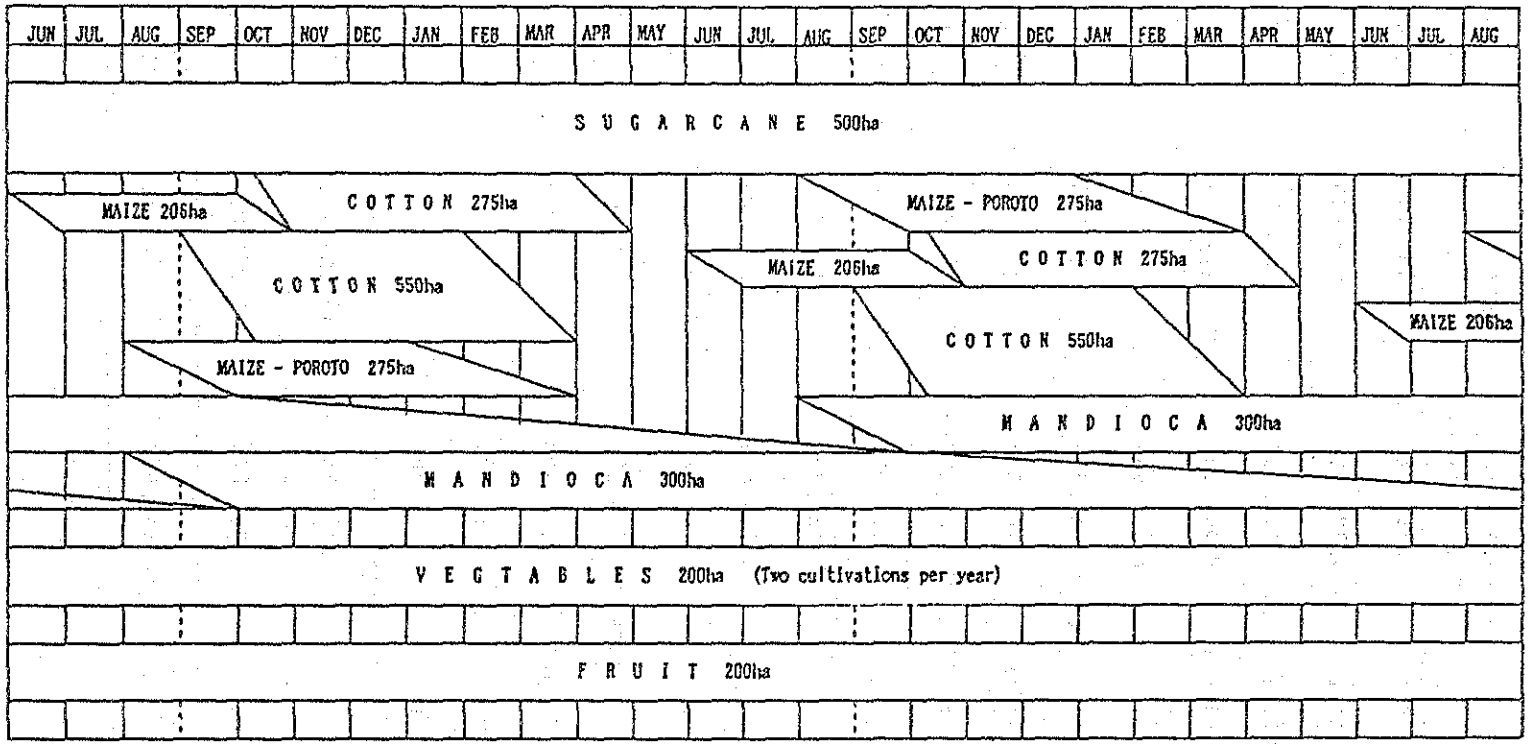


Fig. 4. 1 Proposed Cropping Pattern

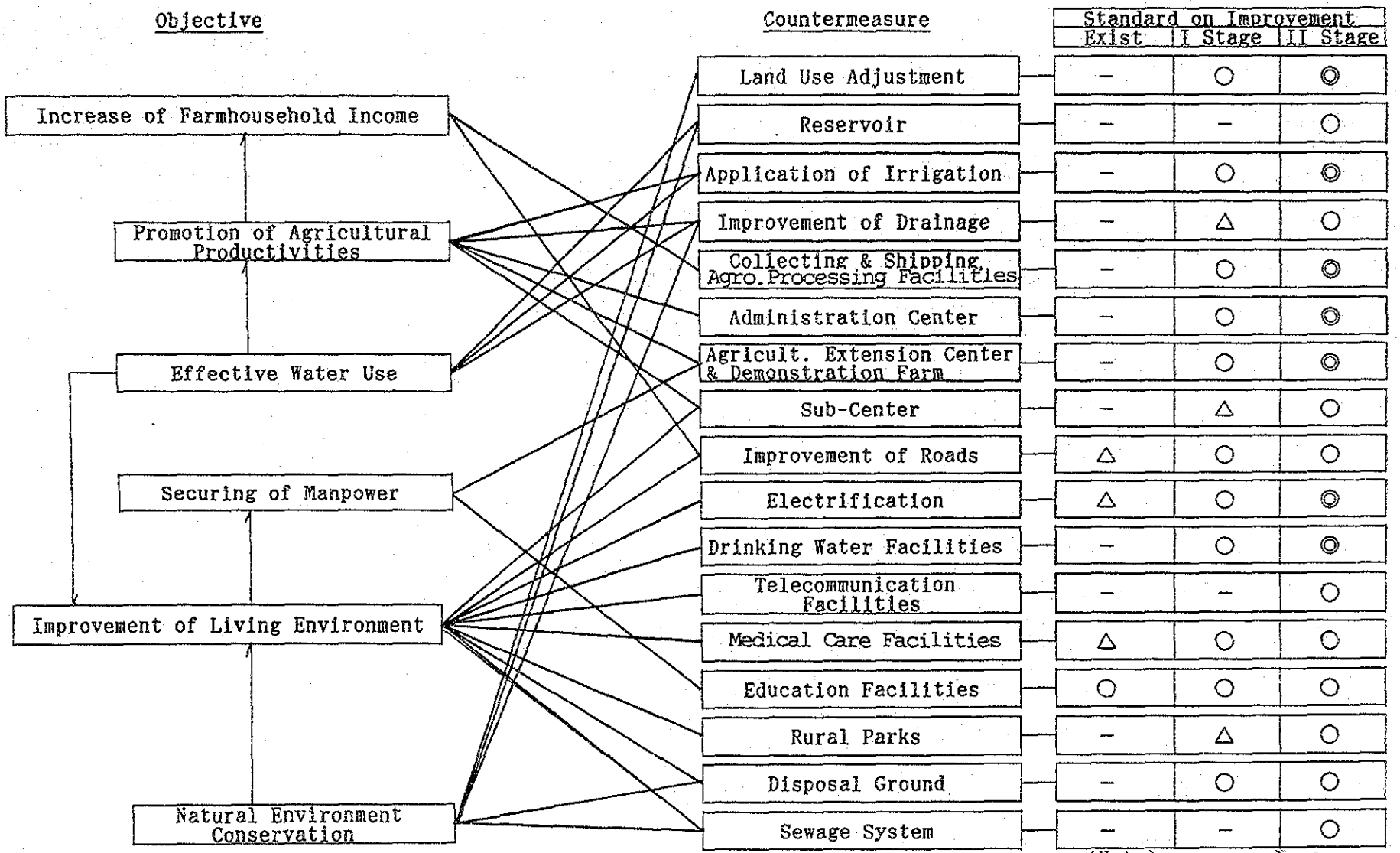


Fig. 4. 2 Project Components

CHAPTER 5 PRIORITY PROJECTS

CHAPTER 5 PRIORITY PROJECT

5.1 Selection of the Priority Project

5.1.1 Basic Concept

The priority of the project components are clarified in the master plan related to the integrated rural infrastructure improvement plan of the project. The components given priority cover the various fields, therefore, well-balanced implementation among the components will be required.

In the feasibility study of the project, comprehensive improvement plan covered whole project components will be established. Proposals such as extents to be put the priority and required improvement level will be concluded taking a specific characteristics of the region and the existing levels of infrastructure at the each administrative district into account.

Following should pay attention to the study on project possibility:

- Relativity and coordination among the components
- The pursuit of economical efficiency giving the serious consideration on the locality such as stream or administrative boundaries as a unit
- Preparedness to receive the project among the beneficial farmers

5.1.2 Project Components

Project consist of the following components:

- Road Improvement
- Irrigation and Drainage
- Rural Water Supply
- Electricity
- Telecommunication System
- Education Facilities
- Extension and O & M Center (including O & M machines)

Sub-Center and Rural Park

- Sewage and Garbage Treatment
- Agricultural Processing and Marketing Facilities
- Extension of Agricultural Management (including the demonstration farm)

Following should pay attention to settle the priority :

(1) Road improvement plan

Extent of the improvement will be proposed after examination on the ratio of utilization on the existing roads not only users in the project area but users living around the area.

(2) Irrigation and drainage plan

The plan will pursue of economical efficiency and pay attention the preparedness to receive the irrigated agriculture.

(3) Rural water supply plan

In addition to economical efficiency, public welfare which habitants as many as possible can enjoy its benefit will be considered.

(4) Implementation plan of agricultural processing facilities

The plan will proposed to stability the agricultural management and strengthen the organizations.

(5) Extension and O & M center plan

To give full of its function as the comprehensive improvement plan, the center will be positioned core facilities with combination of project organization.

(6) Implementation program of the project

The project implementations including the project executing body and O & M organizations will be studied to perform the project with better coordination among the components of the project and each administrative districts.

5.2 Projects Given Priority

5.2.1 Road Improvement Plan

The extent of the feasibility study on the road improvement in the project area will be proposed on the premise that the road network in and

around the project area could be created with the improvement of existing roads. The roads will further be classified following 4 types with the existing conditions of road utilization:

- The road which fulfill the role of main road (A)
- The road which has function of public use and fulfill the role of provincial road (B)
- Farm roads with high frequency of utilization (C)
- Farm roads with less frequency of utilization (D, E) than (C)

(classification of road is shown in Table 3.3)

The road width and the details of pavement will be set up as follows based on the road classification above mentioned:

Road class	Road width		Pavement			
			Road width		Material	
	1st	2nd	1st	2nd	1st	2nd
Main Road (A)	6.0m	-	6.0m	-	Asphalt	Asphalt
Provincial Road(B)	6.0m	-	3.5m	6.0m	Gravel	Gravel
Farm Road (C)	3.5-6.0m	6.0m	3.5m	3.5-6.0m	Gravel	Gravel
Farm Road (D,E)	-	3.5m	-	3.5m	Gravel	Gravel

As started in Chapter 4, at least 20 routes with 64.3 km in length of existing road improvement will be required to create the road network in and around the project area. Road improvement will be carried out with the following basic dimensions:

(1) Road width and pavement

Based on the road classification tabulated above, the road width of the major roads will be designed with effective width of 6.0m, shoulder width of 0.5m and side ditch width of 2.0m for one side. The location for the channel will be ensured at the outside of the side ditch. As for the farm roads and connection roads to the main roads, the road width is designed with effective width of 3.5m, shoulder width of 0.75m. And site for side ditch and channels will taken same values of major roads. Pavement is designed with the gravel. Crushed stone will be used for sub-base with the thickness of 20cm. For surface layer, gravel will be used with the thickness of 15cm. Route 818 which is the main road in the area will be paved with asphalt(t = 4cm) from the urban areas to the crossing point with the Rory-mi. Except the route 818, the width of pavement will be planned at central part of 3.5m in the effective width because these roads have little traffic. Pavement of route 818

will be planned with whole width of effective width.

(2) Related structures

At the crossing point of the streams, wooden bridge and/or cross drains with concrete pipe solely have been installed in the existing roads. These facilities are superannuated and number of structures is not sufficient. Therefore, improvement of such facilities will be required in parallel with the improvement of road sub-base. Existing wooden bridge will be replaced with RC slab. The width of new bridge will be designed with the same width of road effective width. As for the cross drain, concrete pipe will be protected by the concrete. To grade up the function and to keep the road conditions, new cross drain will be planned at the place where drainage structure is required.

(3) Outline of the improvement

The contents of the road improvement with the route basis is as follows:

Priority	Rote	Length	Effective width	Pavement		Related Structure	
				Asphalt	Gravel	Bridge	Cross Drain
		km	m	km	km	place	place
1.	818	11.8	6.0	5.5	6.3	6	3
2.	818-6	5.6	6.0	-	5.6	-	2
3.	818-1	5.2	6.0	-	5.2	1	2
4.	805	2.8	6.0	-	2.8	-	-
5.	818-4	3.6	6.0	-	3.6	-	2
6.	818-5	3.7	6.0	-	3.7	-	-
7.	818-2	3.2	6.0	-	3.2	-	1
8.	818-3-3	2.4	3.5	-	2.4	1	2
9.	818-3	4.6	6.0	-	4.6	-	3
10.	251-22	5.8	6.0	-	5.8	-	6
11.	251-17-3	2.0	6.0	-	2.0	1	-
12.	818-5-2	1.0	6.0	-	1.0	-	-
13.	818-5-1	0.5	6.0	-	0.5	-	2
14.	819-2	2.0	3.5	-	2.0	-	2
15.	818-1-3	1.4	3.5	-	1.4	-	3
16.	818-1-2	1.7	3.5	-	1.7	-	3
17.	251-16	2.4	6.0	-	2.4	-	2
18.	818-1-1	1.1	3.5	-	1.1	-	-
19.	251-20	1.4	6.0	-	1.4	-	1
20.	818-7	2.1	3.5	-	2.1	1	1

5.2.2 Water Use Plan

The feasibility Study on the water utilization plan will be carried out with the following scope.

- Irrigation and drainage plan:

  400 ha for irrigation for initial development involving cultivation of fruit and vegetables and construction of drainage canal with 4 km in length.

- Rural water supply:

  2,150 persons in rural areas and 800 persons in urban areas which are to be placed under the initial development.

(1) Irrigation plan

1) Plan for the irrigation system

The fundamental plan for the irrigation system will be established in the initial stage development plan in which elaboration of the water resources and the condition of the arable area were considered. The following aspects were taken into account in determining the irrigation system:

a) The water drawn from each stream will be used putting the priority to the area in that stream. For the effective utilization of the water resources, however, an irrigation distribution system will be established in such a manner as to provide reciprocal supply in case of a water shortage.

b) The amount of irrigation water required to the whole projected area will be the sum of the amount of water by gravity system plus the amount of the pumped water. When the available amount is low, it is planned that water available by gravity system is used at first then pump will be used.

Considering the abovementioned points, the plan for the irrigation system, comprising irrigation area, water requirement, intake facilities, regulating ponds, etc., for each stream is specified in Fig. 5.1.

2) Plan of intake facilities

The amount of intake water, location, level and manner of intake for the proposed facilities are as follows:

Stream	Location of Intake Facilities (elevation m)	Amount of Intake Water (e/s)	Manner of Intake
Tranquera	163.00	49	Weir & pump
Rory I	237.00	18	Gravity system by weir
Rory II	152.00	31	Weir & pump
Rory-mi	220.00	26	Gravity system by weir

3) Distribution plan

The irrigation water from each diversion weir will be distributed to the farm land through conducting pipe lines and distributing pipe lines. The irrigation water from the weir, first of all, will flow into the regulating pond through the conducting pipe and be regulated for flow into the distributing pipeline. In particular, the water taken during the night, except for the irrigation hour will be reserved in the regulating pond, and the water will be delivered in proportion to the irrigation hours.

Capacity of distribution system is as follows:

- Conducting pipeline:

  The required irrigation water will be delivered within 24 hours through the conducting pipeline which connects to the diversion weir. The design discharge of irrigation water will be estimated from the irrigation area multiplied by the unit diversion water requirement at the peak period.

- Distribution pipeline:

  The water regulated by the regulating pond is diverted from regulating pond to the distribution pipeline and delivered to the fields. The distribution pipeline is designed to have a capacity which can irrigate the irrigation block at the peak period for 16 hours per day.

- Regulating pond:

  The regulating pond will possibly be provided in a hilly area to deliver water to the whole irrigated area. It will be designed on a scale with regulated variance capacity of 8 hours to deliver to the conducting pipeline (24 hours) and the distributing pipeline (16 hours). One regulating pond will be planned in a hilly area in order to effectively use the water from the three intake facilities provided in Tranquera and Rory. Three regulating ponds in total will be provided in the project area. These ponds are located at the center of the hilly area of Tranquera and Rory, Rory-mi and Yahapety respectively.

4) On farm irrigation

Principal crops to be irrigated are fruit and vegetables. An even distribution to cultivated fruit and vegetables is covered for the entire irrigated area in the project. The target farm area is divided into two zones. One is gently sloped at 1^{o} to 3^{o} and the other is comparatively steep sloped at 4^{o} - 7^{o}. Because the soil of the area is almost sandy soil, the intake rate of the area is observed a larger value such as 70 mm per hour.

At present, border irrigation is carried out by exemplary farmers in the project area. In the future, an irrigation method utilizing equipment such as sprinklers, drips and hoses, etc. will be proposed in order to save irrigation water and labor force. Border irrigation, however, will also be carried out in the early stages of the irrigation development because of the poor irrigation techniques and the farmer's economic situation.

- Amount of irrigation water and irrigation interval:

The total readily available moisture (T.R.A.M) is different on crops and soil texture. As shown in Appendix E, 38 mm for vegetables and 93 mm for fruit is estimated.

Crops	Soil Texture	TRAM mm	Field Appli- cation	Water Require- ment	Water Demand per/ha m3/ha	Max. Etc. mm/day	Irrigation Interval day
Vegitables	Sandy	38	0.726	52	520	7	15
Fruit	Sandy	94	0.726	129	1,290	5	18

For this project, the irrigation interval at the peak water requirement will be planned as 5 days for vegetables and 15 days for fruit. The interval for the normal irrigation period will be adjusted irrigation hours per day.

- Daily irrigation hours and unit water requirements:

In the case where the irrigation hours for the farm land is planned at 16 hours per day in the project area, unit water requirements per hectare is estimated as follows:

Vegetables : 8 l/sec for five-day interval
Fruit : 18 l/sec for fifteen-day interval

Crops	Water Requirement at Peak mm/day	Irrigation Interval	Field Application	Total Water Demand per ha mm/ha	m3/ha	Inflow Water Amount 1/sec	Irrigation Area ha
Vegitables	7	5	0.726	48	480	8(16hr)	1.0
Fruit	5	15	0.726	103	1,030	8(16hr)	0.5

- Irrigation with rotation block:

400 ha of irrigative area is divided into four irrigation blocks according to each stream or hillblock providing the main distribution pipe line. The irrigation blocks are also divided into several rotation blocks which can be irrigated daily as one block. Considering the irrigation practice within 5 days, in the case where an area of one rotation block will be designed as five ha, irrigation area per day is estimated at one ha. The area of one ha will be a possible irrigation area for one or two farmers.

Peak water requirement for the whole irrigative area is estimated as 116 1/sec delivered within 24 hours. In the case where the water is delivered within 16 hours, it becomes 174 1/sec (116 x 1.5). Therefore, the irrigative area is divided into 22 rotation blocks (174/8), since the water requirement of one rotation block is 8 lt/sec. When fruit is planted in the rotation blocks, irrigation for fruit per day should be made with one-third of its irrigation area because irrigation interval for fruit is three times of vegitables.

5) Facilities plan of irrigation

Proposed irrigation facilities for the project are as follows:

- Intake works 4 nos
- Canal network (pipe line) 40.0 km
- Regulating ponds 3 nos
- Pump stations 2 nos
- Water distribution system 480 ha

a) Intake works

For the planning of the structure of the intake weirs, the following items will be taken into account:

- The weir to divert the streams is designed as a fixed concrete dam.

- Since the amount of water available is low, in times of drought it should be possible to allow the intake of the entire amount.

- In time of flood, stream flow contains a lot of sand (especially the fine sand), so some installation should be considered to prevent the sediment of sand into the canals.

- It must have an sand sluiceway at the weir to eliminate the sediment upstream of the weir.

- The maintenance and control of the weir should be simple.

The scale and installation of weir will be as detailed in the following figure:

Diversion weir	Height of Dam (m)	Flood Discharge (m3/sec)	Width of weir (m)	Intake Gate (m)	Sand Sluice (m)	Foundation type
Tranquera	1.0	61.0	16.0	1.5	1.5	Fixed to rock
Rory I	3.0	13.0	17.5	0.25	0.2	"
Rory II	1.0	56.0	10.0	1.5	1.5	"
Rory-mi	1.0	19.0	5.0	0.5	1.0	"

b) Irrigation canal

The structure of the conducting canal that connects the weir to the regulating pond, as the distribution pipe line that extends from the regulating pond to the area of reference, will be a pipeline, taking into account the topography of the area, type of soils and the irrigation methods. The reasons are as follows:

- When the volume of water discharged (18 - 49 1/sec) is low, a pipeline system is preferred over an open channel for the ease and simplicity of the maintenance and control.

- Because the channel will cross many marshes and undulating lands, the open channel system requires twice the length of the pipeline system, so the cost will be almost the same.

- In the open channel system, the channels will run along the contour line and occasionally they would be far from existing roads. It would become difficult to ensure the right of way and the roads for O & M are required.

- Conveyance efficiency of a small channel is lower than a pipeline. The open channel system, therefore, is not a practical system for this project.

- As the soil texture in the project area is almost sandy,

soil erosion easy occurs due to rainfall. With these, small open channels will suffer from soil erosion.

- The amount of water available for irrigation is limited, therefore, sprinkler, drip and hose irrigation for which water can be most effectively used will be proposed. It is necessary to have an internal pressure in the pipeline to apply those types of irrigation.

For safety operation of the pipeline, it is proposed that some installations such as air valve, blow off, sluice valve in response to geographical features and length of pipeline.

c) Regulating pond

Dimensions of regulating ponds are as follows:

Regulating pond	Inflow (l/sec)	Capacity (m^3)	Scale area (m^2)	Effectively depth (m)
Tranquera	75	2,900	1,450	2.0
Rory-mi	25	800	400	2.0
Yahapety	16	500	250	2.0

Sandy soil with high permeability is covered in the Area so that the regulating pond must be a special structure to avoid water leakage. The material used could be concrete, bricks sealed with asphalt coating, waterproof ruber sheets, etc. Taking into account the economics, ease in supply of materials, and technical aspects, the use of waterproof ruber sheeting is proposed for this project.

d) Pumping station

The water taken from the weirs of Tranquera I and Rory II will be diverted to the regulating pond at Tranquera by pumping. The pump will be derived on 24 hours, and in order to avoid risk of trouble, two units will be provided at both Tranquera and Rory pumping stations. The scale of the pump facilities is planned as follows:

Pump station	Discharge (m^3/min)	Actual Head (m)	Total Head (m)	Pump (mm)	Motor (kw)	No. of pump (unit)
Tranquera	1.47	71	81	100	45	2
Rory	0.93	82	90	80	30	2

e) On farm irrigation

Sprinkler irrigation on the farms is proposed. The sprinkler type is classified as below due to the kind of crops, soil erosion, and internal water pressure of pipe line.

- For an area requiring high pressure:
  Slow-rotating, full-circle type, medium pressure (nozzle pressure: 2 kg/cm^2 approx.)

- For an area not requiring high pressure:
  Slow-rotating, full-circle type, low pressure (nozzle pressure: 1.0 - 1.5 kg/cm^2 approx.

Irrigation systems other than sprinkler, drip and hose irrigation are also proposed for the project. At present, however, irrigation techniques and the installation of the equipment are an economic burden for the farmer. Therefore, at the early stage of development, it is supposed that border irrigation will be principal method.

6) Drainage plan

In order to improve the poor drainage, Sol Naciente and Pindoty areas will be selected in the initial stage improvement. Drainage improvement for these areas is important due to rehabilitation of the roads in the area. Scale of drainage facility is as follows:

Drainage Canal	Length of Drainage Canal (km)	Flood Discharge m^3/sec	Canal Section	Longitudinal Slope	Canal Structure
Sol Naciente	1.8	12.6	B = 8.0 H = 1.8	1/1,200	Earth canal
Pindoty-III	2.2	6.7	B = 6.0 H = 1.6	1/ 800	Earth canal

* Flood discharge is calculated based upon the 5-year probable rainfall.

(2) Rural water supply plan

The objective areas of the rural water supply in the Initial stage improvement will be the area where gravity system can be applied.

1) Basic dimension

Intake facilities installed at upstream reaches of Rory and Rory-mi by the irrigation plan of the project will be used for the rural water supply plan, in additions to these, wells drilled by the project during

the study period will be utilized as the supplemental water source. Objective population of water supply with Rory system is estimated 2,950 including the supplemental water to the urban areas. For Rory-mi system, such populations is estimated at 450. Required water amount for each system is as follows on the basis of the maximum daily water consumption of 200 l/day:

Rory system	590 t/day = 6.8 l/sec
Rory-mi system	90 t/day = 1.0 l/sec

In the irrigation plan, water taken from Rory by gravity and pumped up and from Tranquera by pumped up will integrated to the regulating pond to use water effectively. Among these, priority to use water taken from Rory by gravity will be put the rural water supply to avoid the troubles such as electric failar.

Conducting channels from the intake to the purifying facilities will be designed together with irrigation purpose for Rory system. As for the Rory-mi system, water will take from the right bank of the Rory-mi head works only for the purpose of the rural water supply and plan with 24 hours operation.

Purifying facilities will be installed at Rory and Rory-mi systems. The facilities compose regulating reservoir, sedimentations basin, slow sand filter bed and distribution reservoir, water will be disinfected by chlorine, then, distributes to each household by gravity.

Distribution reservoir has 8 hours capacity of the daily consumptions to meet the peak of utilizations. Further, water distributions to Yahapety and Fatima will be made using the supplemental distribution reservoir which disinfected water will storage and install at the elevated site in the area, because distance of water conduction from the purifying facilities to the area is long. Distribution pipeline will be designed by hourly maximum discharge with the related households.

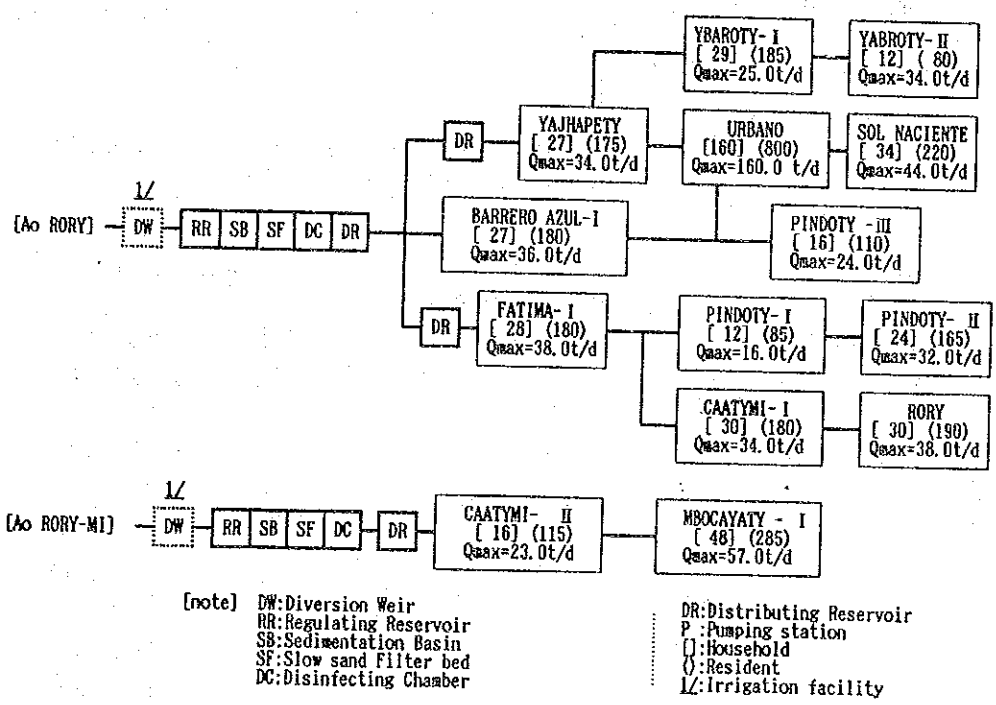
2) Outline of the facilities

Outline of the facilities are as follows:

Streams	Rory system	Rory-mi system
Diversion weir	same as irrigation	same as irrigation
Conducting pipe	same as irrigation	ϕ 75mm L = 800m
Regulating reservoir	V = 3 m3	V = 5 m3
Sedimentation basin	V = 113 m3 x 2	V = 35 m3 x 2

Streams	Rory system	Rory-mi system
Slow sand filter bed	V = 150 m3 x4	V = 40 m3 x 3
Disinfecting chamber	Chlorine	Chlorine
Distributing	Main : V =220 m3	Main : V = 35 m3
reservoir	Yahapety : V = 80 m3	-
	Fatima-I : V = 25 m3	-
Distribution	ϕ 50 mm L = 13,200 m	ϕ 50 mm L = 700 m
Pipeline	ϕ 70 mm L = 17,600 m	ϕ 70 mm L = 5,000 m
	ϕ100 mm L = 9,600 m	ϕ100 mm L = 4,150 m
	ϕ125 mm L = 3,600 m	ϕ125 mm L = 100 m
	ϕ150 mm L = 1,300 m	-
	ϕ200 mm L = 1,400 m	-

Water distribution diagram is as follows:



5.2.3 Rural Infrastructure Improvement Plan

Rural infrastructures to be provided in the Initial stage improvement, following structures will be proposed adding to the roads improvement and rural water supply plans:

Item	Contents
Electricity	26 route L = 48.8 km
Medical Care	Oxygen tent 1, Ambulance car 1
Telecommunication	3 route L = 14.0 km, Telephone 8 places
Education	Rebuilding of school houses 2 places (Caaty-mi, Potrero Alto)
Extension and O & M Center	1 place A = 800 m2, Machines: Bulldozer(1),Grader(1), Tire Roller(1), Mini back hoe(1)
Sub-Center	4 place A = 200 m2
Rural Park	4 place A = 5,000 m2
Garbage Treatment	1 place A = 2,000 m2
Agro. Processing (for winery)	Cooling & weighing equipment: 1 unit Processing machine : 1 unit Rebuilding of winery roof
Marketing	Collecting & shipment facility 1 place A = 640 m2
Demonstration farm	1 place A = 5,000 m2

5.3 Project Cost Estimate

The project cost for the implementation of the each component are estimated at 14,855 million G shown as follows:

Unit:1,000 G

Facilities	Total Amount	F/C	L/C
Road Improvement	4,738,521	0	4,738,521
Irrigation Water Supply	4,036,154	2,712,466	1,323,688
Drainage Improvement	103,422	0	103,422
Rural Water Supply	988,454	444,334	544,120
Electricity	1,308,000	0	1,308,000
Medical Care	154,000	154,000	0
Telecommunication	162,000	0	162,000
Education	100,000	0	100,000
Extension & Administration	169,000	0	169,000
Sub-Center	185,000	0	185,000
Rural Park	154,000	0	154,000
Garbage Treatment	192,000	0	192,000
Agr. Processing	423,000	380,700	42,300
Marketing	462,000	0	462,000
Demonstration Farm	22,999	16,099	6,900
O/M Machines	577,000	577,000	0
sub-total	13,775,550	4,284,599	9,490,951
Engineering Fee	1,080,000	1,080,000	0
Total	14,855,000	5,364,599	9,490,951

The following terms and parameters are employed in the estimate of the project cost:

(1) The price level of labors and materials is employed the market price as of beginning of December, 1988

(2) The Guarany(G) is used for cost estimate. The exchange rate of US$1.00 = 1,000 G is adopted.

(3) Preparation of construction machines and materials, construction method and schedule have been noted in Chapter 6.

(4) Foreign currency portion of the cost estimate is limited to procure the materials which could not obtain in Paraguay and the taxes of the imported materials will be exempted.

(5) Engineering fee is estimated at 7% of total project cost is foreign currency.

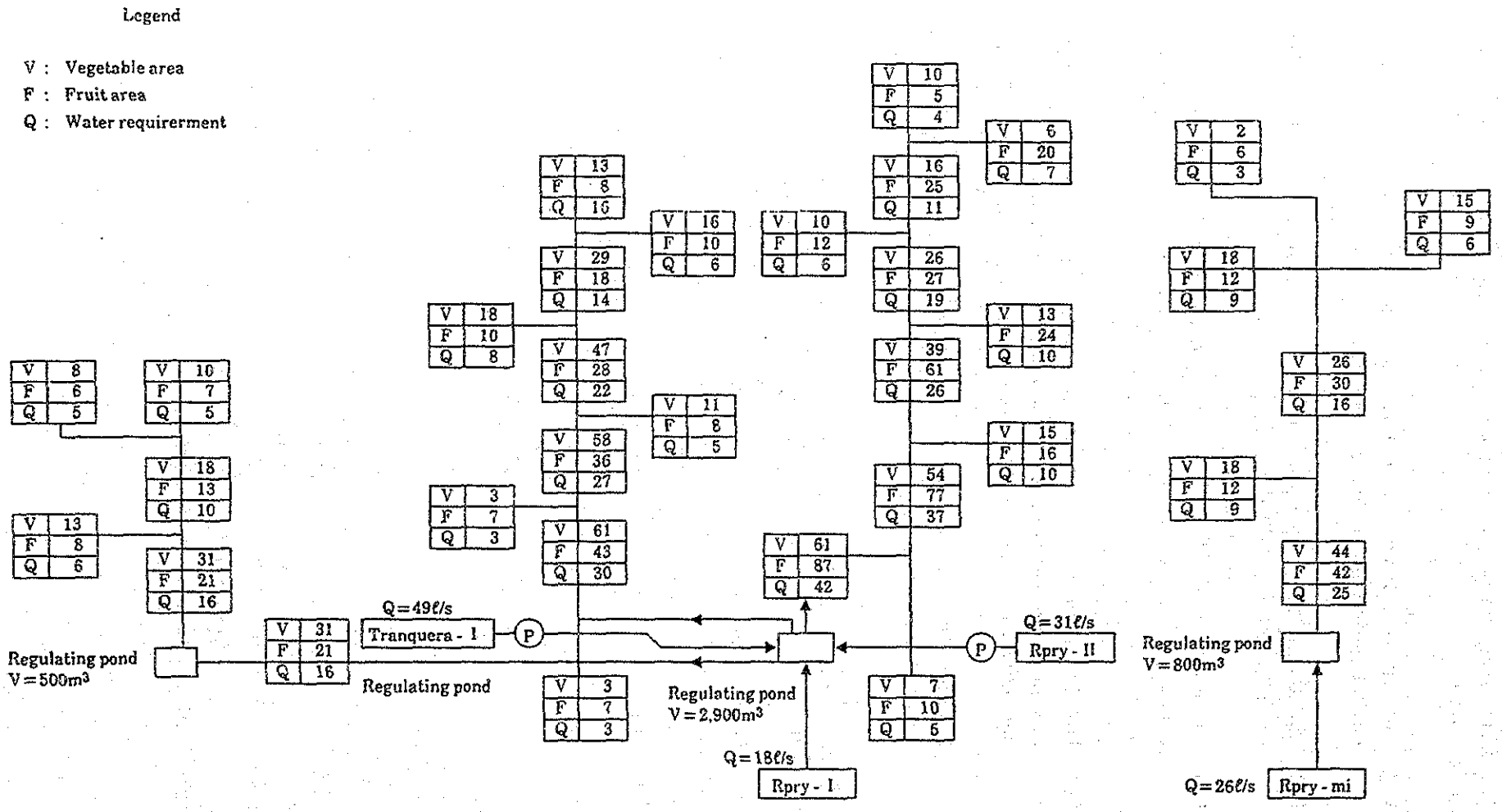


Fig. 5. 1 Irrigation Network

CHAPTER 6 PROJECT IMPLEMENTATION AND O & M PLAN

CHAPTER 6 PROJECT IMPLEMENTATION AND OPERATION AND MAINTENANCE PLAN

6.1 Project Implementation Plan

As the project encompasses various kind of work activities, a variety of public offices are involved, including Ministry of Agriculture and Livestock(MAG), Ministry of Public Construction and Communication(MOPC), Ministry of Welfare (MSP y BS) and Ministry of Education (ME y C). For smooth and effective enforcement and implementation of the project, it is desirable to set up liaison organizations.

Concerning this matter, it has been proposed that a joint operation committee and a project implementation institution (COORDINACION) be set up, as is shown in Fig. 6.1 "Project Implementation Organization Chart", as part of the council operation organs of MAG and other public offices.

6.2 Project Implementation Schedule

Priorities of the project components have been decided as described in Chapter 5. Actual implementation of the plan to which the priorities are given will be proceeded according to the work schedule shown in Fig. 6.2 which has been determined by taking into account various factors such as means of implementing the plan and work conditions.

The following factors are carefully studied in working out the implementation schedule.

(1) Order placing

This project involves construction of such items as roads improvement, other facilities to provide water for irrigation facilities and rural water supply,. etc. Required materials and equipment for each of these work activities can be independently ordered. However, these works are interrelated to each other as described below, it is more practical to place a lump-sum order for the work defined by the area, and not by kinds of construction work, for smoother implementation of the project and earlier realization of its possible benefits.

a) The road will be used for transporting construction materials and equipment of irrigation and rural water supply facilities. The pipelines will be installed along the road.

b) Water for irrigation and rural water supply will be distributed from the same water source and share the water-intake facility and conducting pipeline to the regulating pond. The both distribution pipeline, following the regulating pond will be installed in parallel.

c) The facilities for irrigation and rural water supply may have different sources of funds for their main and terminal facilities. However, effectiveness of the project implementation will be diminished if their work should not be carried out as a unit.

d) Work involving maintenance and management of the facilities and dissemination of the project's purposes should be prepared before the completion of the project by enriching such facilities as demonstration farms without delay. As has been mentioned, installation of cooling facilities for wine fermentation will have a great beneficial impact on the farm economy and therefore should be given first priorities. The table below shows the classification of the facilities described in 5.2, work of which should be implemented in a lump-sum manner.(refer to Annex G)

Item	First Stage Extent of Improvement	Second Stage Extent of Improvement
1. Road Improvement	Pavement : 1 route L= 3.1 km Improvement:14 routes L=54.2 km Bridge : 9 places Culvert :25 places	Pavement : 1 route L= 2.4 km Improvement : 6 routes L=10.1 km Bridge : 1 place Culvert :10 places Road bet : L.S.
2. Irrigation Facilities	Intake Facilities : 4 places Pump : 2 places Regulating Pond : 3 places Conducting Pipeline : L=10.2 km Distribution Pipeline: L=28.5 km On Farm Facilities : 400 ha	- - - - - -
3. Drainage Facilities	Drain 1 route L=1.8 km	Drain 1 route L=2.2 km
4. Rural Water Supply Facilities	Conducting Pipeline : L= 0.8 lm Regulating Reservoir : 2 places Sedimentation Basin : 2 places Filter bed : 2 places Disinfecting : 2 places Distribution Pond : 4 places Distribution Pipeline: L=56.65 km	- - - - - - -
5. Electrification Facility	-	26 routes L= 48.8 km

Item	First Stage Extent of Improvement	Second Stage Extent of Improvement
6. Medical Care Facility	-	Oxygen tent 1 unit Amburance Car 1 no.
7. Telecommunication Facility	-	3 routes l= 14.0 km 8 public telephones
8. Education Facility	-	Rebuilding of school houses: 2 schools
9. Extension and O & M Center	1 place A=800 m2	-
10. Sub-Center	-	4 places A= 800 m2
11. Rural Park	-	4 places A=2,000 m2
12. Gabage Treatment	-	1 place A=2,000 m2
13. Agro. Processing Facilities	Cooling and Measuring Device for winery : each 1 unit	Processing machinery for wine : 1 unit Rebuilding of roof on winery
14. Marketing Facility	-	Collecting & Shipping Fcility 1 place A=640 m2
15. Demonstration Farm	1 place A=5,000 m2	-
16. O & M Machines	Bulldozer, Grader, Roller and Mini-backhoe each 1 no.	-

Note: 1) The costs should be distributed among the beneficiaries. They are appropriated for the second stage in the Annex G Project Cost.

(2) Construction materials

a) Concrete aggregate, gravels for the road and road-paving materials will be produced at the construction site and sand will be purchased.

b) Excavated materials will be used at the embankment materials.

c) Domestically produced materials, such as cement, reinforcement steel, vinyl chloride pipes (100 mm in diameter or less), will be purchased.

d) Such items as pumps, dynamos, gates and pipes (large diamter) will be either directly imported from abroad or through domestic dealers.

(3) Costruction method

a) Road construction will immediately be carried out when the preparation works are completed. As mentioned before, the road will be used for transporting the construction materials and equipment and the pipes will be laid along it.

b) Construction will begin for intake facilities, sub-structures of bridge and culverts during the dry season between February and October.

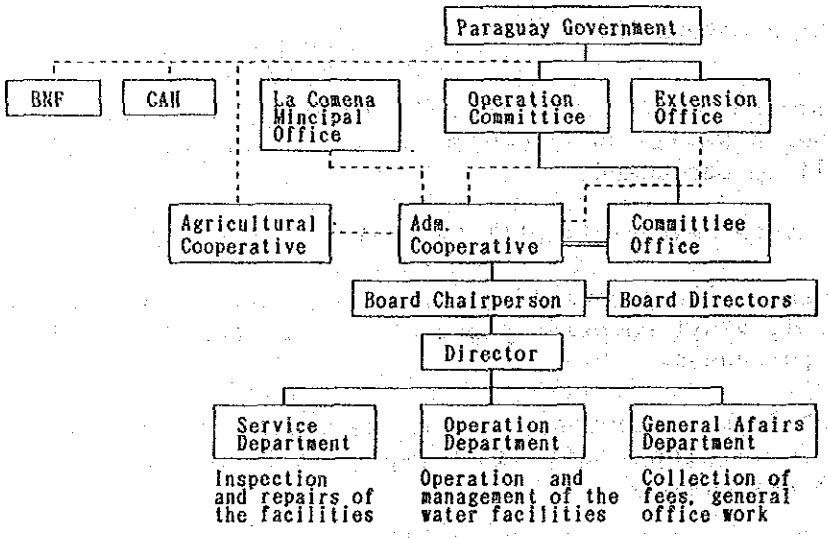
c) Concrete is to be mixed on site. As a rule, the metal form is used for cocrete works.

d) A small scale asphalt plant will be prepared since asphalt paving of the road will be a random one.

6.3 Operation and Maintenance Plan

6.3.1 Organizations for Operation and Maintenance

Under the supervision and instruction of the respective public offices, operation and maintenance committees (COMITE EJECUTIVO) will be set up in the area to carry out operation and maintenance work of the facilities. O & M machines will be maintained by the committees and kept at Extension and O & M Center. It is proposed that the beneficiaries form management cooperatives undertake part of the committees' duties, including inspection, repairs, management, operation of the facilities and collection of the necessary expenses. The following chart explains the relationship among the concerned organizations.



The operation committee is composed of people representing the related public offices, while members of the board of directors of the management cooperative come from the farming units. The board chairman is elected from among the board members. The position of director set up under that of the board chairnan will collectively supervise the activities of the following departments.

- General Affairs Department
  (book keeping, general office work, collection of water fees)
- Operation Department
  (operation and management of the irrigation and rural water supply facilities)
- Service Department
  (inspection and repairs of the facilities, store of equipment)

The following shows the institutions which will be responsible for various services which are not covered by said three departments.

Main roads (Route 251, 805, and 819)	:	MOPC
Drainage	:	Each administrative section (Companias)
Electricity	:	ANDE
Communication	:	ANTELCO
Medical care	:	Health center
Schools	:	Ministry of Education
Agricultural processing	:	La Colmena agricultural cooperative
Distribution	:	Agricultural cooperative association (new establishment)
Sub-centers	:	Each farming unit (Companias)
Parks	:	Each farming unit (Companias)
Garbage treatment	:	La Colmena Munincipal Office

6.3.2 Operation and Maintenance Cost

Among the facilities, costs of the facilities which will be maintained by the aforementioned management cooperatives and the agricultural cooperatives are estimated as follows:

Facilities	Annual increment of Maintenance Cost(1,000G)		Remarks	
1. Road Improvement	7,590	△ 900		
2. Irrigation	28,800	△ 1,560		(G)
3. Drainage	390		First stage	180,000
4. Rural Water Supply	6,940			
5. Extension & Administration Center	16,200			
6. Agro. Products Processing	4,500		First stage	3,540,000
7. Collecting & Shipment	3,890			
8. Demonstration Farm	-		Operated by sales of the products	
Total	60,850		-	

Note: (1) Refer to Annex G for the breakdown.
(2) The figures after mean the amount of the money saved.

The durable year of some facilities will expire before the termination of the project life(50years) and must be renewed when required. The table below shows the durable year of the facilities to be established in the project.

Facilities	Durable year
1. Asphalt pavement	20
2. Pumps, motors	20
3. Construction machines (O/M use)	15
4. Cooling devices	20
5. Sprinklers and other irrigation facilities	10
6. Gates	30
7. Pipes	20

6.3.3 Allocation of Maintenance and Management Cost

It seems reasonable that the cost of maintenance and management of the facilities should be borne accordingly by those who will have benefited from such improvements. The following table clarifies the allocation of the costs for the road, irrigation and rural water supply use.

	Cost	Road	Irriga-tion	Rural Water Supply	Total
Exclusive Use		4,683*1	23,800	6,940 *2 (7,430)	35,423 *2 (35,913)
Common Use	16,200	-	-	-	16,200
Benefit		924,636	549,801 *3	130,386	1,604,823
Ratio		57.6	34.3	8.1	100.0
Allocation for Common Use		9,331	5,557	1,312	16,200
Total		14,014	29,357	8,252 (8,742)	

Note: 1. 70% of the total of the road maintenance/management cost (7,590) is appropriated, 30% of it to be used by MOPC (road surface division).
2. The figures in ( ) indicate the case when wells (two units) are also used.
3. Benefit from irrigation

Unit: 1,000 G

	Production Volume	Production Cost
With Project	2,263,682	1,151,866
Without Project	1,343,889	924,835
Difference	919,973	427,032
Net Profits	492,761	-
Profits from improved quality	57,040	-
Total (benefits)	549,801	-

(refer to Annex G)

6.3.4 Method of Operatrion and Maintenance Cost Sharing

(1) Road

The cost needed for maintenance and management of the road is estimated to be about 14,014,000 G after the allocation. Because of the very high public nature of the road, it is desirable that the cost be borne by the City Hall and that part of it by the farmers. Should this plan be implemented, the proper amount of the burden sharing by the farmers will be 5,746,000 G which corresponds to 379,179,000 G (2,210 G/ha), or 41% of the benefits from the road improvements. This is the sum of 57,040,000 G from the reduction of produce damages during their transportation and 322,157,000 G from the reduction of the expenses needed to transport the agricultural products and other materials.

(2) Irrigation water

The maintenance and management cost of the irrigation facilities after the allocation of the common expenses is estimated to be 29,357,000 G a year of 73,400 G/ha. The annual volume of irrigation water is expected to be 2,930,000 m^3 on average, which means the cost of 10 G for

1 m^3.

(3) Rural water supply

The total of 8,252,000 G a year (3,742,000 G when the well is used) is estimated to be borne by the rural water supply. The water use is divided into two parts: one for the urban district and the other for the Study Area. The following shows the allocation of the water by volume

- Urban District (800 people): (refer to Annex G)
- Study Area (2,150 people) : (2,150 people x 0.2m^3 x 365 days)

When the maintenance costs are classified by the water volume:

- Urban District : (when the well is also used)
- Study Area : (when the well is also used)

For the Study Area:

- Per 1 m^3 : 38 G (41 G)
  One farm family : 18,066 G (1,506 G per month)
  (384 families)
  With well water : 19,138 G (1,595 G per month)

These figures are a little higher than the current water charge of 1,400 - 1,700 G per household in the urban district. However, it is not too bad considering the frequent water supply out that plagues the urban area.

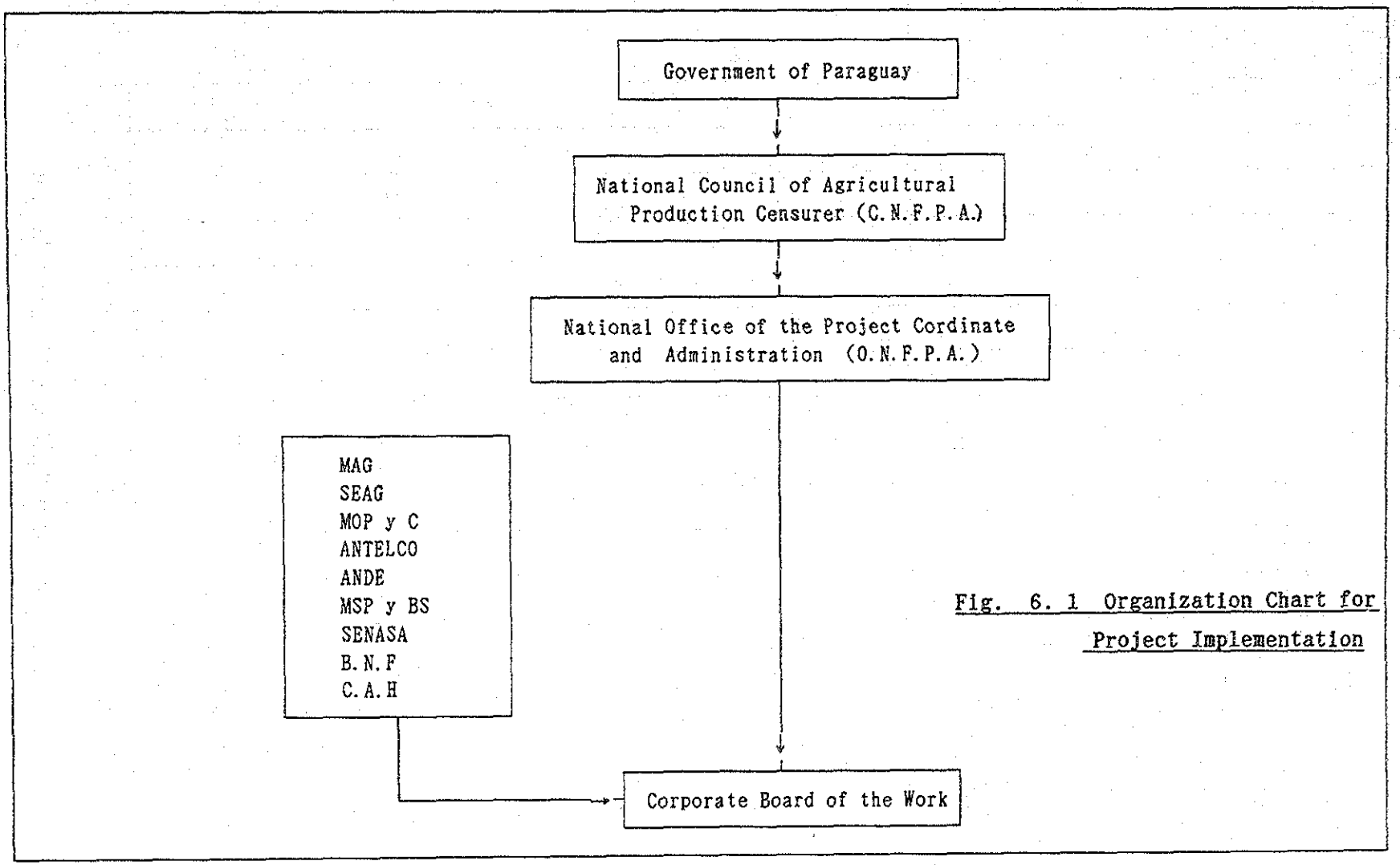


Fig. 6.1 Organization Chart for Project Implementation

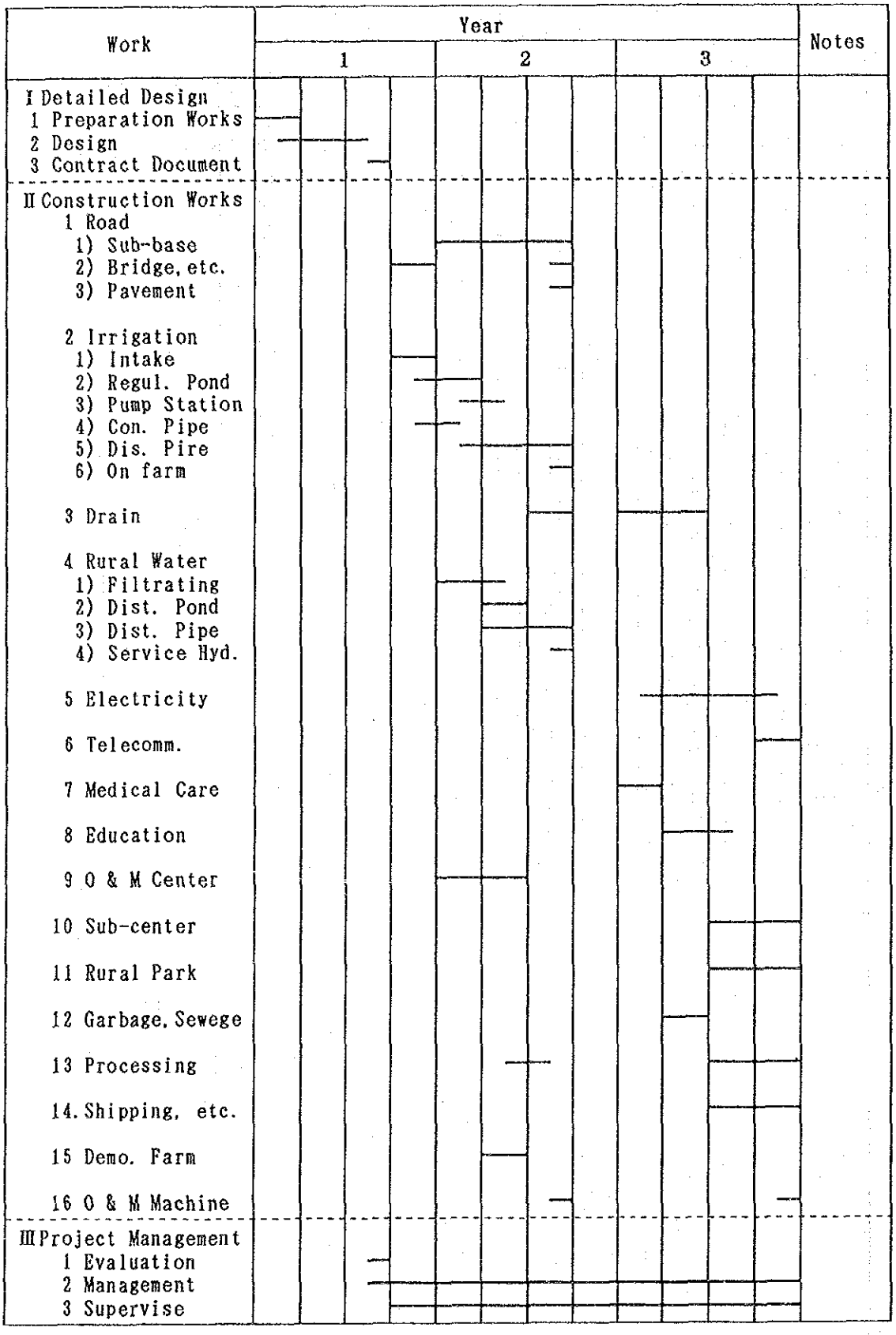


Fig. 6. 2 Project Implementation Schedule

CHAPTER 7 PROJECT EVALUATION

CHAPTER 7 PROJECT EVALUATION

7.1 General

Evaluation of the project is made by analyzing two different elements: one is the national economic conditions and the other the financial state of the model farmers.

The following preconditions are set for the evaluation.

(a) The benefits and costs to be used for the evaluation will be calculated based on the free market price of Paraguay as of December 1988.

(b) The foreign exchange rate of US$ 1 = G 1,000 = ± 130 as of December 1988 will be applied.

(c) The farm gate price of the producer is used as the agricultural price.

(d) The spot delivery price including the cost of transportation is used as the price of the construction materials.

(e) The life of the project is set at 50 years including the period of detailed designs and the construction.

7.2 Project Benefit and Cost

7.2.1 Anticipated Benefits

(1) Direct benefits

The anticipated benefits to be gained from the implementation of the project are as follows.

a) Benefits from increased agricultural produce and improved qualities (fruit and vegetables).

b) Reduction of transportation costs and the amount of damaged crops during the transportation due to improvements of road conditions and bridge repairs.

c) Elimination of water famine due to improved water supply facilities and reduction of costs involving work to obtain water from springs or rivers.

d) Supply of quality wine due to betterment of fermentation facilities.

e) Improvement of living conditions due to electrification and

installation telecommunication facilities.

f) More efficient land use due to drainage improvement.

(2) Indirect benefits

a) Procurement of labor force and materials for the construction.

b) Increased agricultural employment opportunities.

c) More stable supply of agricultural produce.

d) Favorable repercussion to the distribution industry stimulated by the increased agricultural produce, dairy products and production materials.

e) Farmers' expanded purchasing power due to the increase of agricultural income.

These benefits as a whole will definitely serve to stimulate the regional economy while installation of educational, medical and health facilities will be improved, the living environment and people's welfare. The benefits will also be extended to the living of inhabitants in the peripheral regions of the Project Area.

1) Agricultural production benefits

Improved irrigation and farming conditions are expected to result increase of agricultural production. Anticipated produce and net profit with the project and the without project are as shown below, and the increment of the net profit after completion of the project is estimated to be 492,761,000 G.

Unit:1,000 G

With Project			Without Project			Incremental
Production Value	Production Cost	Net Value	Production Value	Production Cost	Net Value	Net Value
2,263,682	1,151,867	1,111,815	1,343,889	724,835	619,054	492,761

(Note: Refer to Annex G Table G.3.3 for the breakdown by crops)

Production of quality of fruit and vegetables will be expected by application of irrigation and income increase of 57,040,000 G is estimated (524 tons of grapes for wine making are not included).

2) Benefits by improvement of roads and bridges

Economization expenses in transportation of agricultural products and in-put materials and reduction of bruise during transportation are expected by improvement of the roads and bridges. With the implementation of the project, 52,100 tons of products will be shipped to the market in annually while 12,400 tons of in-put materials will be sent into the farm. Bringing goods will be 64,500 tons in total. The road can also be used by the people in the surrounding areas. Benefits from them are estimated as shown below.

Unit: 1,000 G

- Agricultural products and in-put materials within the Study Area	:	322,157 G
- Agricultural products from the surrounding areas	:	545,439 G
- Reduction of bruise	:	57,040 G
Total	:	924,636 G

(Note: refer to Annex G Table G.3.8)

3) Benefits by improvement of rural water supply facilities

Benefits by improvement of rural water supply facilities may be deemed to be equal to the costs needed for alternative means.

Unit: 1,000 G

- Costs of operating shallow wells (333 units)	:	89,910 G
- Labor costs for conveyance of water when wells tend to run dry	:	26,460 G
- Supply to the urban area (for 800 people, equivalent to the water charge)	:	14,016 G
Total	:	130,386 G

(Note: refer to Annex G Table G.3.15)

4) Benefits by improvement of processing facilities

Production of quality wine is expected by means of temperature control (cooling) during the process of fermentation. At the moment, La Colmena agricultural cooperative is expected to ship 740,000 liters in annually to the market. With the improved quality, the market price of the wine can be raised from the current 210 G to 350 G per liter.

Therefore, with the implementation of the project, 103,600,000 G (740,000 liter x 140 G/ha) will be added to the farmers' income (detailes show in Annex G Table 3.16).

5) Benefits by improved drainage

Existing poor drainage area will be used as a pasture land after completion of the project because the land is insufficient in its capability for farming. When used for grazing, the improved drainage area of 250 ha is expected to result in the increased annual shipment of 50 heads of beef cattle, or 8,800,000 G, provided that the productivity increase is one head of cattle per ha with the annual shipping rate of 20% (refer to Annex G Table G.3.18).

6) Benefits by improved distribution facilities

With the poor collection and shipment facilities, as is the case now, transportation of the agricultural products has been made on a small scale vehicles and therefore is inefficient. With improvement of such facilities, however, the products can properly be classified and shipped to the market by larger vehicles.

From La Colmena to Asuncion, the difference of transportation cost between the large vehicle and the small one will be as much as 4,000 G per one ton of the cargo. With the annual shipping amount of fruit and vegetables (excluding grapes for wine making) being at 10,770 tons, transportation by large vehicles is estimated and the saving of 43,760,000 G a year (refer to Annex G Table G.3.17) is expected.

7) Total benefits and their variation

By simple calculation, the benefits from 1) to 6) amount to 2,188,018,000 G a year. However, such factors as the time needed to disseminate farming techniques and years necessary for seedlings to mature must be taken into consideration. With this understanding, the annual benefits are estimated as shown below.

Vegetable production:

Years after project completion	:	Ratio to the target yield
1st year	:	30%
2nd year	:	70%
3rd year	:	100 %

Fruit production (matured tree) :

1st year	:	50%
2nd year	:	100%

Fruit production (new tree planting):

1st year	:	0%
2nd year	:	20%
3rd year	:	50%
4th year	:	80%
5th year	:	90%
6th year	:	100%

From these data above, the variation of annual benefits after completion of the project have been calculated as shown below.

Unit: 1,000 G

1st year (3rd year after the beginning of the project)	:	1,480,297
2nd year (4th)	:	1,851,861
3rd year (5th)	:	2,088,109
4th year (6th)	:	2,138,928
5th year (7th)	:	2,163,473
6th year (7th)	:	2,188,018

7.2.2 Project Cost

The project costs include those of construction, engineering fees, operation and maintenance of the facilities, replacement of the facilities and production costs (increased amount).

The construction costs including the engineering fees are estimated to be 14,856 million G.

Disbursement of the expenditures are estimated as follows according to the implementation schedule of the project.

Unit: 1 million G

	Section A	Section B	Total
1st year	3,035	-	3,035
2nd year	7,596	-	7,596
3rd year	1,990	2,255	4,225
Total	12,601	2,255	14,856

(Note)
Section A: road, irrigation, drainage, water supply, extension and administration center, processing facilities, distribution facilities, demonstration farm, O/M machines, engineering fees.
Section B: electricity, telecommunication, medical care, education, sub-centers, rural parks, garbage treatment.

(Refer to Annex G Table G.4.1 for the breakdown)

7.3 Economic Internal Rate of Return (EIRR)

Based on the costs and benefits stated in 7.2, EIRR has been calculated as i = 12.1% in which the direct benefits during the 50 years of the project life can be quantitatively expressed.

The following shows the result of the sensitivity analysis of various situations.

(1) Investment exceed the estimated cost by 10%	:	11.0%
(2) Extended the construction period by one year	:	11.4%
(3) 5% less than expected in produce	:	11.7%
(4) Combination of (1) and (3)	:	10.7%
(5) Exchange rate of 1 US$ = 550 G	:	14.7%

Note: Refer to Annex G Table G.4.3 to G.4.8 for the details.

The above figures are considered to be appropriated as the effects of inflation have been eliminated in the estimation.

7.4 Financial Analysis

(1) Repayment schedule

Two plans, Case I and Case II, are being proposed to repay the total project costs of 14,856 million G with the annual interest of 3.5% and the five-year grace period over the next 20 years. The same amount of money will be repaid each year. With Case I, the interest during the grace period will be paid while it is not paid with Case II. Actual repayment figures are calculated as follows.

	Grace Period Interest (Unit: 1,000 G)	Amount of Repayment (Unit: 1,000 G)
Case I	519,971	1,045,251
Case II	-	1,241,441

(Refer to Annex G Table G.5.1)

(2) Loan repayment plan for terminal facilities of irrigation and water supply

1) The following shows the repayment figures for the loan of 924,000,000 G made to the irrigation terminals facilities. The repayment of this loan, which is included in the total amount stated in (1) above, has been calculated independently under the same conditions as in (1).

	Grace Period Interest (5 years) (1,000 G)	Amount of Repayment (20 years) (1,000 G)
Case I	32,340	65,014
	(80.9)	(162.5)
Case II	-	77,217
		(193)

Note: The figures in ( ) indicate the amount of payment per ha with the beneficiary land area set at 400 ha (refer to Annex G Table G.5.2).

2) In the same manner, repayment for the loan of 77,000,000 G made to the terminal facilities of rural water supply has been calculated as follows.

	Grace Period Interest (5 years) (1,000 G)	Amount of Repayment (20 years) (1,000 G)
Case I	2,695	5,418
	(8.1)	(16.3)
Case II	-	6,435
		(19.3)

Note: The figures in ( ) indicate the amount of payment per farm household with the number of beneficiary set at 333 (refer to Annex G Table G.5.3).

(3) Financial analysis of the model farmer

The following shows the comparison of the model farm income between the two cases: one with the project and the other without it.

Unit: 1,000 G

Farming Type	With Project			Without Project		
	Gross Agr. Income	Production Cost	Net Agr. Income	Gross Agr. Income	Production Cost	Net Agr. Income
1	5,007	2,162	2,845	1,400	790	610
2	4,080	1,310	2,769	3,229	230	970
3	5,418	21,887	3,229	2,400	850	1,550
4	2,928	812	2,116	1,840	800	1,040
5	5,982	1,319	4,663	4,920	2,720	2,200
6	10,003	2,802	7,200	7,400	3,800	3,640
7	8,358	2,239	6,628	8,586	5,206	3,380

(Refer to Annex D Table D.3.1 for the details)

From these figures above, the farm income for each model farmer will increase from 1,076,000 to 3,540,000 G a year. It is possible, therefore, to pay the cost for operation and maintenance estimated in 6.4 (73,400 G for the irrigation, 18,086 G per household for rural water supply) and to make repayment of the loans, which will be needed for the construction of the terminal facilities (162,500 -193,000 G/ha/year for irrigation, and 16,300 - 19,300 G/household/year for water supply).

CHAPTER 8 CONCLUSIONS AND RECOMMENDATIONS

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8.1 Conclusions

The integrated rural infrastructure improvement project in La Colmena has been formulated through the investigations and studies concerning the problems inherent in regional agriculture and rural environments in the area of 11,000 ha. Consecutively, feasibility study on the priority project proposed in the comprehensive study abovementioned were carried out. Following is the conclusions of these studies.

8.1.1 Master Plan

(1) The project area has the suitable conditions to promote the multiple farming with the upland crops at outskirts of Asuncion. Further, the project area will be positioned as the model rural areas of agricultural management with major crops of fruit and vegetables in the neighboring the metropolitan areas. With these, the project area is worthy to execute the comprehensive rural improvement.

(2) The projects to be executed with the following contents will be proposed (target is 10 years later).

Road improvement
: 85.6 km in total length

Provision of irrigation and drainage facilities
: 900 ha of beneficial areas

Improvement of rural water supply facilities
: 565 beneficial housholds including urban areas

Improvement of electricity and telecommunication system
: 48.8 km for electricity and 24.3 km of telecommunication

Strengthen of medical care and education facilities
: Ambulance, school, exercise ground, rural park, sewage and garbage treatment

Improvement of agricultural processing and marketing
: Winery, collecting and shipping facilities

Provision of agricultural extension and O & M facilities
: Main Center 1 place, Sub-Center 10 places

(3) The total amount 31,840 million G of investment will be required to realized the proposed projects, however, increase of agricultural product 1,027 million G, reduction of transportation cost 1,176 million G, increase of employment opportunity 58,000 persons and etc,. will be anticipated in conformity with the presaid investments.

8.1.2 Project given priority

(1) Among the proposed projects in the Master Plan, following projects are given priority :

Road improvement
: 64.3 km in total length

Provision of irrigation facilities
: 400 ha of beneficial area

Improvement of drainage facilities
: 100 ha of beneficial area

Improvement of rural water supply
: 493 beneficial households including urban areas

Electricity
: installation of 48.4 km of distribution line

Telecommunication
: Installation of 14.0 km of distribution line

Strengthen of medical care facilities
: Ambulance 1 no., oxygen tent 1 set

Improvement of education facilities
: Reconstruction of school houses 2 schools

Provision of agricultural extension and O & M center facilities
: Demonstration farm 5,000 m2, center 1 place, O & M machines Lump Sum

Provision of sub-center and rural park
: 4 places

Improvement of garbage treatment
: Lump Sum

Improvement of agricultural processing and marketing facilities
: Cooling facilities for winery, collecting and shipping facilities (640 m2)

(2) Early execution of these projects is desirable. Required investments to execute the projects will estimate 14,856 million G. As the implementation schedule of these projects will be proposed 3 years including the detailed design.

(3) Overall E.I.I.R(Economic Internal Rate of Return) of the project is estimated at 12.1% with the required investments and anticipated benefits. Furthermore, the results of sensitivity analysis shows 10.7% to 14.7% taking the changes of estimated conditions into account.

These show adequate figures on this kind of project(factor of inflation is not including).

(4) O & M costs for irrigation and rural water supply are estimated as follows :

- Irrigation (400ha) : 73,400 G/ha (10 G/m3)
- Rural water supply (2,950 persons, 200 l/person.day) : 38 G/m3

These figures show that costs for irrigation is cheaper than that of existing irrigated farmers and water charge for rural water supply is nearly same as existing water works being operated in the urban areas. In addition to these, stabilized water supply will be available in the project area.

(5) The results of trial balance (with project conditions) on the profit and loss and income of a model farm household with each farming type show that whole model farm households increase their benefit 2 to 4.7 times than that of without project conditions

With these facts, the project (priority project) is justified economically ,financially and socially.

8.2 Recommendations

(1) On the basis of the conclusions stated above, the early execution of the projects given priority are desirable

(2) Paraguay government should be performed necessary procedures to rise funds required for the project execution. In

parallel with these procedures, definite organization on executing body should be concluded.

(3) Following items should be prepared among the beneficiaries.

- Concrete plan of cooperative structure to execute the project
- Preparation of land aquisition of construction site to be required for the project
- Confirmation of a beneficiaries on irrigation and rural water supply
- Provision of an allotment of beneficiaries(fund for on-farm facilities)
- Concrete plan of O & M organization after completion of the project and plan for management fund of the organization

(4) Setting up the project implementation institution (COORDINACION) will be proposed to execute the planning, design and supervision as a whole since the extents of the project situates various kind of fields, the competent authorities are different and the project implements as a comprehensive operations. As for the operation and maintenace of the project facilities especially provincial roads, farm roads,irrigation and rural water supply, beneficiaries should be organized the association and managed its O & M under the guidance of concerned officials.

(5) To reveal the effects of the project implementation, establishment and extension of the farming technique including water management are indispensable. Also, official guidance is an earnest desired for strengthening of farmers' organization, financial assistance to the small scale farmers and etc. With these concerned officials should be taken part at the stage of project planning and implementation.

(6) The quantity of water system (water charge) for the irrigation and rural water supply will be proposed because water resources in the project area is not sufficient and effective use of water is dispensable.

(7) The project planning was made to elevate the regional welfare through the comprehensive improvement of rural

infrastructures on the premise that the conservation of natural resource and environments.

These concepts and agricultural management surrounding areas of urban areas as it ought to be will be a model to execute the regional development of similar areas in Paraguay.