very firm, sticky, hardness (20), fine particles increase gradually with depth to clay about at 200 cm.

The U.Fb series

Pit No. 2 : Located in Fatima, gentle slope with 190 m in elevation, vegetables.

Ap: 0-15 cm : Sand, no gravel, dark reddish brown (2.5YR 3/4), O.M. common, N.S., friable, hardness (24), fine root many, gradual boundary.

ABt: 15-25 cm : Sandy loam, no gravel, dark red (10R 3/5), O.M. few, N.S., firm, hardness (23) fine root many, gradual boundary.

Bt_1: 25-80 cm : Sandy clay loam, very fine gravel few, dark red (10R 3/5), O.M. few, firm, hardness (20), sticky, very fine root common, gradual boundary.

Bt_2: 80-125 cm : Sandy clay, very fine gravel common, dark red (10R 3/6), O.M. few, N.S., very firm, hardness (22) very sticky, below about 175 cm, gravel layer appears.

Pit No. 27 : Located in Fatima, flate land with 190 m in elevation, orchard (grape).

A : 0-25 cm : Sand, no gravel, dull reddish brown (2.5YR 5/3), O.M. common, N.S., hardness (15, 0-15 cm, but 25, 15-20 cm), fine root many.

Bt_1: 25-45 cm : Sandy loam, no gravel, dull reddish brown (2.5YR 4/2.5), O.M. few, N. S. firm, hardness (20), root few, gradual boundary.

Bt_2: 45-75 cm : Sandy clay loam, no gravel, dark reddish brown (2.5YR 3/3.5), O.M. few, W. s AB, firm, sticky, hardness (20), gradual boundary.

Bt_3: 75-100 + cm: Sandy clay, no gravel, dark red (10R 3/4), very sticky, other features are almost similar to Bt_2 from about 160 cm very fine gravel increase remarkably.

U.Fa.G series

Pit No. 17 : Located in Yajhapety, gentle slope land with 180 m in

elevation, grazing grasses.

A : 0-17 cm : Loamy sand, very fine gravel common, dull reddish brown (5YR 5/3), O.M. common, W. s AB, hardness (15, at 0 - 8 cm, 27, at 8 - 17 cm) friable, very fine - fine root many, gradual boundary.

Bt: 17-40 cm : Sandy loam, very fine gravel many, grayish brown (5YR 4/2), O.M. few, N.S., hardness (18), root common, abrupt boundary.

C_1: 40-60 cm : Gravel layer with fine round gravel, dark reddish brown (5YR 3/2).

Bt C: 60-95 + cm: Clay loam to clay, fine gravel many, dull reddish brown (5YR 4.5/3) very sticky.

Pit No. 24 : Located in Mbocayaty, flate land with 180 m in elevation, upland field (cotton).

Ap : 0-29 cm : Sand, very fine gravel common, dark reddish brown (10R 3/2), O.M. few, N.S., hardness (9), friable, gradual boundary.

Bt_1: 20-60 cm : Sand loam, very fine gravel common, dark reddish brown (10R 3/3), O.M. common, W. s AB, hardness (19) firm, gradual boundary.

Bt_2: 60-70 cm : Sandy clay loam, very fine gravel common, dark red (7.5R 3/5), O.M. few, W. s AB, hardness (20), firm, sticky, abrupt boundary.

C : 70-90 + cm : Gravel layer with medium round gravel (mostly quartz).

The U.OG series

Pit No. 7 : Located in Barrero Azul, gentle sloped hillside with 220 m in elevation, upland field (cotton).

A : 0-20 cm : Loamy sand, very fine gravel common, dark reddish brown (5YR 3/3), O.M. common, W. granular, hardness (18), friable, clear boundary.

BtC: 20-80 + cm : Loamy sand, fine to medium gravel very many, reddish brown (2.5YR 4/7), O.M. common, N.S., hardness (19).

Pit No. 12 : Located in Mbocayaty, gentle sloped hillside, upland field (cotton).

A : 0-15 cm : Loam, fine to medium round gravel (mostly quartz), very many, dark reddish brown (5YR 3/3), O.M. common, N.S., friable, gradual boundary.

BtC: 15-50 + cm : Loam, mostly similar to A except increased clay content.

The L.CM series

Pit No. 18 : Located in Ybaroty, lowland with 180 m in elevation, grazing grassland.

A : 0-15 cm : Sandy loam, no gravel, brownish black (7.5YR 3/2), O.M. common, N.S., hardness (15), friable, very fine to fine root many, gradual boundary.

C_1: 15-41 cm : Sand, no gravel, dark brow (7.5YR 3/3.5), O.M. common, W. s AB, hardness (15), friable, root common, gradual boundary.

C_2: 41-105 + cm : Sand, no gravel, brownish gray (7.5YR 4/1), O.M. few, M. s AB, hardness (15) firm, root common, iron mottling few, ground water: 105 cm.

The L.Fb series

Pit No. 6 : Located in Pindoty, lowland with 110 m in elevation, grazing grassland.

A : 0-10 cm : Sandy loam, no gravel, brownish gray (7.5YR 4/1), O.M. common, W. s AB, hardness (19), firm, fine root abundant, iron mottling few, gradual boundary.

AB: 10-31 cm : Similar to A except increased iron mottling common, hardness (22), gradual boundary.

Bt_1: 31-64 cm : Sandy loam, no gravel, brownish gray (10YR 5/1), O.M. few, W. s AB, hardness (20), very firm, sticky root many, iron mottling common, gradual boundary.

Bt_2: 64-87 + cm : Sandy clay, no gravel, gray (7.5Y 4/1), O.M. few, W. s AB, hardness (28), very firm, very sticky, root common, iron mottling (yellowish) common, groundwater:

120 cm.

Note: The hardness described above is the reading of YAMANAKA's Soil Hardness Tester. Index (mm) is a reading of the cone when it penetrates into the solum.

C.3 Physical and Chemical Properties

3.1 Physical Properties

Distribution of particle size and the three phases of the soils summarized in each series are given in Table C.3.1.

The moisture contents of the soils taken in August, until then almost no rain since June, are shown in Table C.3.2 (1) - (3). According to the data, under the severe dry condition, the moisture contents of the surface layer are about 5% by volume, being no different among the soil series. However, in the sub-soils although the moisture contents increase clearly than the surface soils for all samples, the differences among the series become remarkable, showing 10-14% for the U.CM, 13-27% for the U.Fa and 17-29% for the U.Fb. Consequently, the total moisture contents in the solum of about 1 m in depth are about 100 mm for the U.CM, while 190 mm for both of the U.Fa and U.Fb.

The measurement of the moisture stress in the soil was conducted by the tensiometer.

A tensiometer was equipped at bare land just near side of the pit of No. 2, the U.Fb, into three layers, 30, 60 and 100 cm in depth respectively, in early of August, but the stable values of them could be obtained from the beginning of October. The reading the values (mm Hg) were conducted at 10 a.m. and 6 p.m. every day.

The changes of the moisture stress (at 6 p.m. only) and their differences between the day and night in the experimental period area given in Fig. C.3.1 and Table C.3.3 respectively.

From the results, the following things became clear:

1) Even after few days of rather heavy rainfall, not only good drainage and drying were seen for the surface layer (30 cm), textured sand, but also the reductions of the stress in the sub-layers (60 and 100 cm), textured sandy clay loam and sandy clay,

were rather few, indicating relatively rather dry condition, almost the stress of the field capacity (about 30 mm Hg).

2) The differences of the stress at 10 p.m. and 6 p.m., being larger in the surface layer than the lower one, would indicate the moisture supply from the lower to the upper layer by the raising capillary water and vapor.

Thus the upland soils which have the fine textured sub-layer have a rather effective underground moisture reservoir as well as good drainage.

3.2 Chemical Properties

The chemical properties of the soils summarized in each series are given in Table C.3.4. As a standard of soil fertility, the criterion at the MAG of Costa Rica is shown in Table C.3.5 for the evaluation of the above mentioned data.

As the reliable data for the cation exchange capacity (CEC) had not been obtained by the laboratory work, the values of the CEC were estimated from the contents of the soil organic matter and clay and the sum of the exchangeable cations (Ca, Mg, K and Al). Thus, the CEC (me/100 g) are 2-10 for the CM, 3-20 for both the Fa and Fb, and the degrees of base saturation of the soils range between 35 to 80% for all soils with a few exceptions.

The reasons of the relatively high degree of the base saturation of the soils, in spite of the severely weathered parent materials and good drainage, are presumed that the existence of relatively thick layer textured fine to very fine as the sub-soil would catch the bases leached down from the upper layer, and these bases would be returned back to the upper one in the raising capillary water and the absorbed form in plant roots.

Based on the characteristics of the soils of the Area, to maintain the stabilized high productive agriculture, at least the following soil managements are strongly required.

(1) The dressing of the well balanced and adequate amounts of the fertilizers including the micro elements such as Mg, B and Zn.

(2) The maintaining the proper soil reaction for the aimed crops by the checking the soil pH regularly.

(3) Addition of the adequate amounts of the organic materials such as animal manure and green manure crops.

(4) Regular deep-ploughing.

C.4 Land Use

The relations of the soil types to their land capability are given in Table C.4.1. The Area of the land classified at each basin and administrative section is shown in Table C.4.2 and C.4.3 respectively.

Based on these data, the characteristics of the land at each basin and administrative section are summarized in Table C.4.4 and C.4.5.

The brief comparisons of the land condition at each basin are as follows:

For the topography, the West and the North have the upland and the lowland in about fifty-fifty rate but the others have them in about 90% and 10% respectively. Especially at the East, almost all are occupied by the upland. While, the rates of the steep slope are 38-37% for the Rory and the East, 22% for the Tranquera, 16-12% for the West and Rory-mi and zero% for the North.

For the soil types, the rates of the relatively low fertile and much troublesome soils (the gravely and stony soils and the throughout sandy soils) are 82% for the East, 70% for the Rory-mi, 64% for the Rory, 37-31% for the Tranquera and the West and 23% for the North. The other hand, the rates of relatively fertile and less troublesome soils (half sandy soils) are 57% for the East, 48% for the Rory-mi, 40% for the Tranquera, 32% for the North, 29% for the Rory and 15% for the West.

These topography and soil types are reflected in the land classification as follows:

The Tranquera occupies 65% for the II + III class, 11% for the V and 20% for the VI + VIII, thus the land condition is rather good. The Rory occupies 53% for the II + III, 9% for the V and 38% for the VI + VIII. It has more steepy slopes than the Tranquera and moderately good condition. The Rory-mi occupies the 47% for the II + III, 10% for the V and 27% for the VI + VIII, similar condition to the Rory. The West occupies 32% for the II + III, but as much as 52% for the V, the largest rate in the Area, and 15% for the VI + VIII. This basin can be said to be a moderately poor condition. The North occupies 55% for the II + III, 45% for the V and 0% for the VI + VIII. Thus it has no trouble for the

soil erosion and rather good arable land.

The East occupies 59% for the II + III, only 2% for the V, 39% for the VIII. It has very steep slope as well as good arable land.

The characteristics of the land condition of each administrative section are briefly described as follows:

Ybaroty:

This section has the largest area, 2,940 ha in the Study Area. The rate of the upland and the lowland is about fifty-fifty. The soil types of the upland are 27% (790 ha) for the U.CM, 13% (390 ha) for the U.Fa, 7% (195 ha) for the U.Fb and 4% (120 ha) for the U.OG.

For the lowland, the L.CM occupies as much as 44% (1,305 ha) while L.Fa only 5% (138 ha). Thus the land classification occupies 49% for the V, 39% for the II + III, but 12% for the VI + VIII, indicating the weight of the lowland use.

Yajhapety:

This section is occupied by the upland in 19% and the lowland in 5%. The soil types are 65% (413 ha) for the U.CM, 12% (74 ha) for the U.Fa, 7% (46 ha) for the U.Fb, 11% (73 ha) for U.OG and 5% (34 ha) for L.CM. therefore, the land class is such relatively good as 69% (440 ha) for the II + III and 0% for the VIII.

Pindoty:

This section is occupied by the upland in 63% and the lowland in 37%. The soils are 0% for the U.CM, 37% (515 ha) for the U.Fa, 25% (339 ha) for the U.Fb, 0.6% (8 ha) for the U.OG, 32% (442 ha) for the L.Fb and 6% (76 ha) for the L.CM. Thus, the U.Fa and U.Fb occupy the most part of the section. Therefore, the rate and area of the II are largest in the Area. Moreover, since the steepy slopes like the VI and VIII are almost not seen, the land in this section would seem to be good.

Rory:

This section consists of 43% of the upland and 57% of the lowland, being more than half of the section alluvium. The soils are 33% (238 ha) for the U.CM, 10% (69 ha) for the U.Fa, 0% for both the U.Fb and the U.OG, and 57% (413 ha) for the L.Fb. Thus, although at the upland the coase to medium textured soils occupy the large part,

at the lowland the fine textured one distribute widely. For the land classification, the II + III occupies 43% and the V 57%, having no steep slopes, similar to Pindoty.

Caaty-mi:

This section consists of 84% of the upland and 16% of the lowland which is alluvium along side of the rivers. The soils are 31% (272 ha) for the U.CM, 38% (339 ha) for the U.Fa, 11% (96 ha) for the U.Fb, 4% (37 ha) for the U.OG and 16% (146 ha) for the L.Fb. Thus, the rates of the U.CM and U.Fa occupy the most part of the section. Therefore, the land classification indicates 71% (630 ha) for the II + III, 16% (146 ha) for the V, 11% (95 ha) for the VI + VIII.

Mbocayaty:

This section almost consists of the upland. The soils are 42% (622 ha) for the U.CM, 20% (290 ha) for the U.Fa, 31% (451 ha) for the U.Fb, 6% (87 ha) for the U.OG and only 2% (30 ha) for the L.Fb.

The land classification shows 51% (741 ha) for the II + III, but 41% for the VIII. Thus, although the half of the land is moderately good arable, the remainder is very steep slopes.

Fatima:

This section all consists of the upland. The soils are 72% (818 ha) for the U.CM, 3% (35 ha) for the U.Fa, 9% (107 ha) for the U.Fb and 16% (180 ha) for the U.OG. Therefore, the land classification shows 34% (390 ha) for the II + III, 50% (556 ha) for the VI and 17% (195 ha) for the VIII, distributing on the steep slopes widely.

Barrero Azul:

This section, distributing from the south to the north long and slender, consists of the upland in 94% and the lowland in 6%. The soils are 25% (174 ha) for the U.CM, 28% (198 ha) for the U.Fa, 25% (177 ha) for the U.Fb, 16% (111 ha) for the U.OG and 6% (40 ha) for the L.CM. For the land classification, the II + III class distributes as much as 73% (509 ha), but the VIII also 18% (111 ha), distributing on the sandy steep slopes in the southern mountainside.

Potrero Alto:

This section all consists of the upland, located in the southern boundary of the Area. The soils are 55% (209 ha) for the U.CM and

45% (171 ha) for the U.Fa. The land classification shows 57% (215 ha) for the II + III and 43% (165 ha) for the VI, distributing on the mountains in the southern part.

Sol Naciente:

This section, located in the north-western boundary of the Area, consists of the upland in 37% and the lowland in 63%. Thus, more than half of the land is alluvium. The soils are 30% (118 ha) for the U.CM., 0% for the U.Fa, 5% (20 ha) for the U.Fb, 43% (166 ha) for the L.Fa and 20% (80 ha) for the L.Fb. Therefore, for the land classification, the V occupies as much as 63% (246 ha) and the II + III only 36% (138 ha). And the steep slopes and gravely lands scarcely exist.

Table C.2.1 Soil Type Distribution at Each Basin

	TRANQUERA		RORY		RORY-MI		WEST		NORTH		EAST		TOTAL	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
U CM P	590	23.4	370	24.7	110	10.7	500	16.1	360	22.8	0	0	1,930	17.5
U CM S	340	13.5	410	27.3	100	9.7	300	9.7	0	0	0	0	1,150	10.5
U CM G S	0	0	20	1.3	160	15.5	0	0	0	0	470	37.0	650	5.9
U Fa P	730	29.0	140	9.3	340	33.0	200	6.5	310	19.6	100	7.9	1,820	16.5
U Fa S	100	4.0	0	0	0	0	70	2.2	0	0	0	0	100	0.9
U Fa G P	0	0	0	0	120	11.7	0	0	0	0	50	3.9	170	1.5
U Fb P	170	6.7	290	19.3	30	2.9	200	6.5	200	12.7	570	44.9	1,460	13.3
U OG P	100	4.0	0	0	50	4.9	0	0	0	0	50	3.9	200	1.8
U OG S	140	5.5	140	9.3	20	1.9	140	4.5	0	0	0	0	440	4.0
City	70	2.8	0	0	0	0	70	2.3	0	0	0	0	140	1.3
L CM	130	5.2	0	0	0	0	1,250	40.3	0	0	0	0	1,450	13.2
L Fa	0	0	0	0	0	0	360	11.6	0	0	0	0	360	3.3
L Fb	150	6.0	130	8.7	100	9.7	10	0.3	710	44.9	30	2.4	1,130	10.3
Total	2,520	100	1,500	100	1,030	100	3,100	100	1,580	100	1,270	100	11,000	100

Table C.2.2(1) Soil Type Distribution at Each Administrative Section

SECTION / SOIL	1 YBAROTY ha	%	2 YAHAPETY ha	%	3 PINDOTY ha	%	4 RORY ha	%	5 CAATY-MI ha	%	6 MBOCAYATY ha	%
U CM P	559	19.0	323	50.5	0	0	238	33.1	194	21.8	0	0
U CM S	229	7.8	90	14.0	0	0	0	0	52	5.9	21	1.4
U CM G S	0	0	0	0	0	0	0	0	26	2.9	601	40.6
Sub-total	788	26.8	413	64.5	0	0	238	33.1	272	30.6	622	42.0
U Fa P	365	12.4	74	11.6	515	37.3	69	9.6	244	27.4	217	14.7
U Fa S	29	1.0	0	0	0	0	0	0	0	0	0	0
U Fa G P	0	0	0	0	0	0	0	0	95	10.7	73	4.9
Sub-total	394	13.4	74	11.6	515	37.3	69	9.6	339	38.1	290	19.6
U Fb P	195	6.6	46	7.2	339	24.6	0	0	96	10.8	451	30.5
U OG P	0	0	73	11.4	0	0	0	0	20	2.2	87	5.9
U OG S	120	4.1	0	0	8	0.6	0	0	17	1.9	0	0
Sub-total	120	4.1	73	11.4	8	0.6	0	0	37	4.1	87	5.9
City	0	0	0	0	0	0	0	0	0	0	0	0
Upland total	1,497	50.9	606	94.7	862	62.5	307	42.7	744	83.6	1,450	98.0
L CM	1,305	44.4	34	5.3	76	5.5	0	0	0	0	0	0
L Fa	138	4.7	0	0	0	0	0	0	0	0	0	0
L Fb	0	0	0	0	442	32.0	413	57.3	146	16.4	30	2.0
Lowland total	1,443	49.1	34	5.3	518	37.5	413	57.3	146	16.4	30	2.0
Total	2,940	100	640	100	1,380	100	720	100	890	100	1,480	100

Table C.2.2(2) Soil Type Distribution at Each Administrative Section

SECTION / SOIL	7 FATIMA ha	%	8 BARERO AZUL ha	%	9 POTRERO ALTO ha	%	10 SOL NACIENTE ha	%	11 URBAN AREA ha	%	TOTAL ha	%
U CM P	247	21.7	134	19.2	44	11.7	118	30.2	77	22.5	1,934	17.6
U CM S	556	48.8	40	5.7	165	43.3	0	0	0	0	1,153	10.5
U CM G S	15	1.3	0	0	0	0	0	0	0	0	642	5.8
Sub-total	818	71.8	174	24.9	209	55.0	118	30.2	77	22.5	3,729	33.9
U Fa P	35	3.0	198	28.3	103	27.1	0	0	0	0	1,820	16.5
U Fa S	0	0	0	0	68	17.9	0	0	0	0	97	0.9
U Fa G P	0	0	0	0	0	0	0	0	0	0	168	1.5
Sub-total	35	3.0	198	28.3	171	45.0	0	0	0	0	2,085	18.9
U Fb P	107	9.4	177	25.3	0	0	20	5.2	33	9.7	1,464	13.3
U OG P	0	0	0	0	0	0	0	0	22	6.6	202	1.8
U OG S	180	15.8	111	15.8	0	0	0	0	0	0	436	4.0
Sub-total	180	15.8	111	15.8	0	0	0	0	22	6.6	638	5.8
City	0	0	0	0	0	0	6	1.5	132	38.9	138	1.3
Upland total	1,140	100	660	94.4	380	100	144	37.0	264	77.8	8,054	73.2
L CM	0	0	40	5.6	0	0	0	0	0	0	1,455	13.2
L Fa	0	0	0	0	0	0	166	42.6	56	16.4	360	3.3
L Fb	0	0	0	0	0	0	80	20.4	20	5.8	1,131	10.3
Lowland total	0	0	40	5.6	0	0	246	63.0	76	22.2	2,946	26.8
Total	1,140	100	700	100	380	100	390	100	340	100	11,000	100

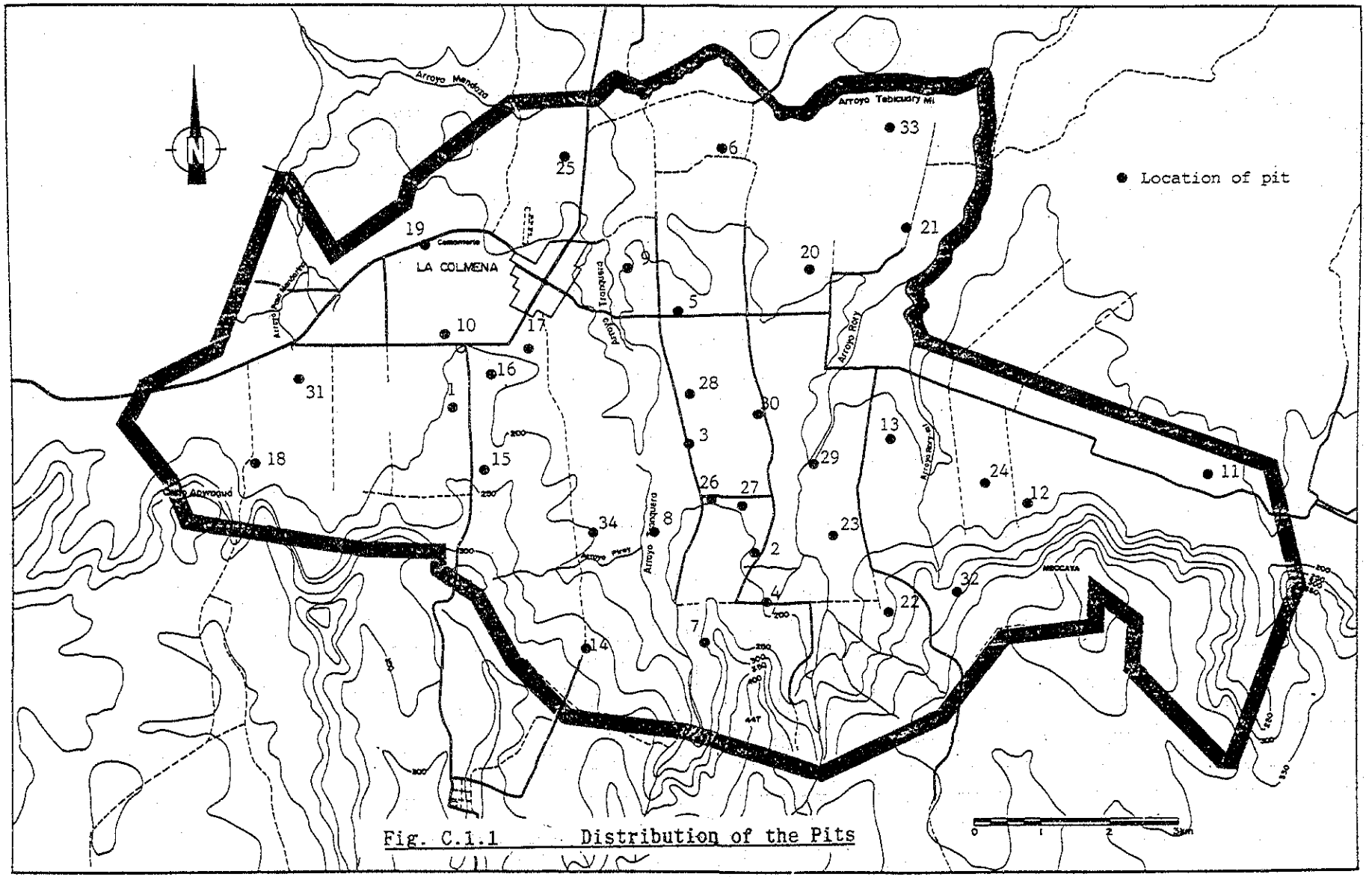

Fig. C.1.1 Distribution of the Pits

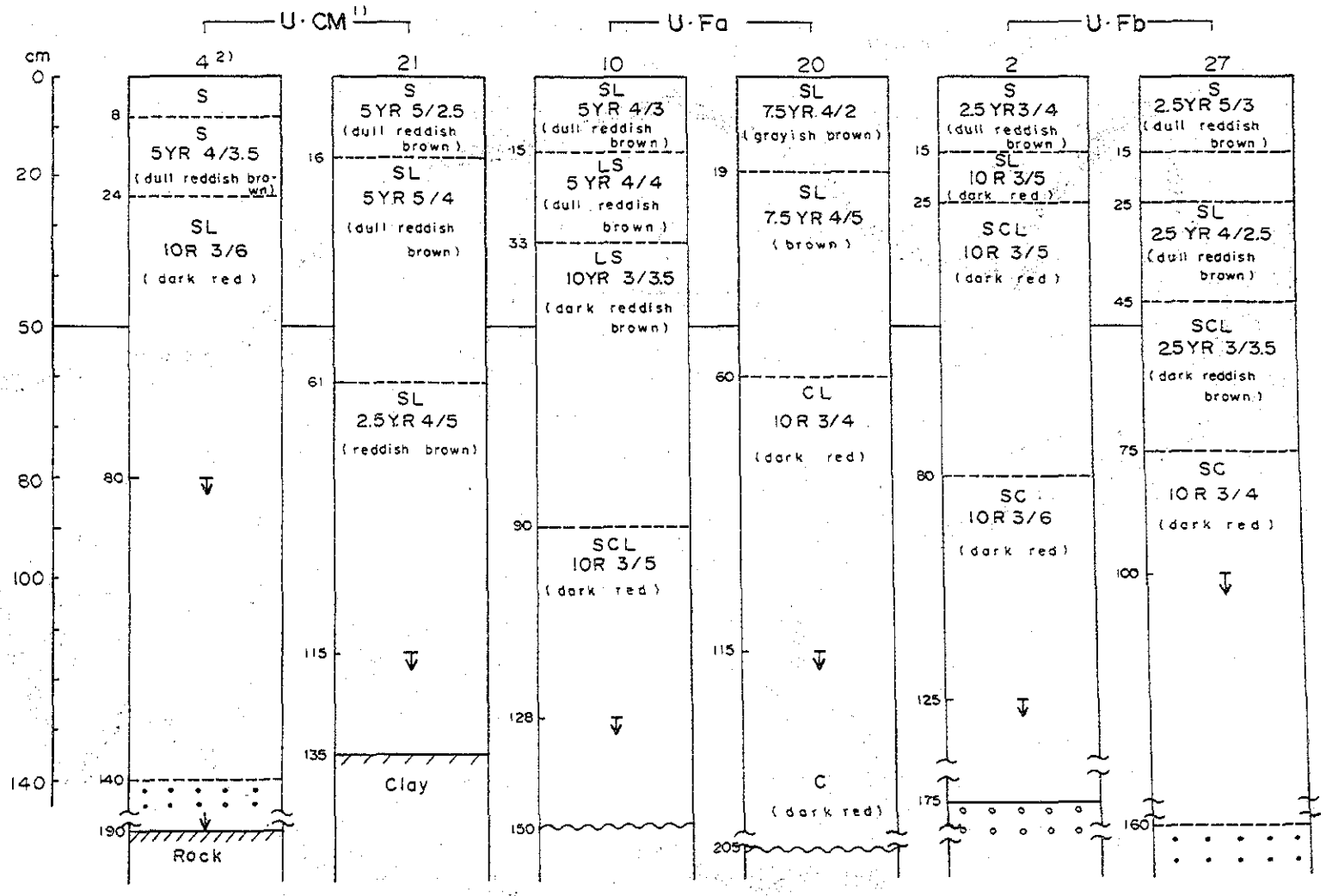

Fig. C.2.1 (1) Soil Monolith (1)

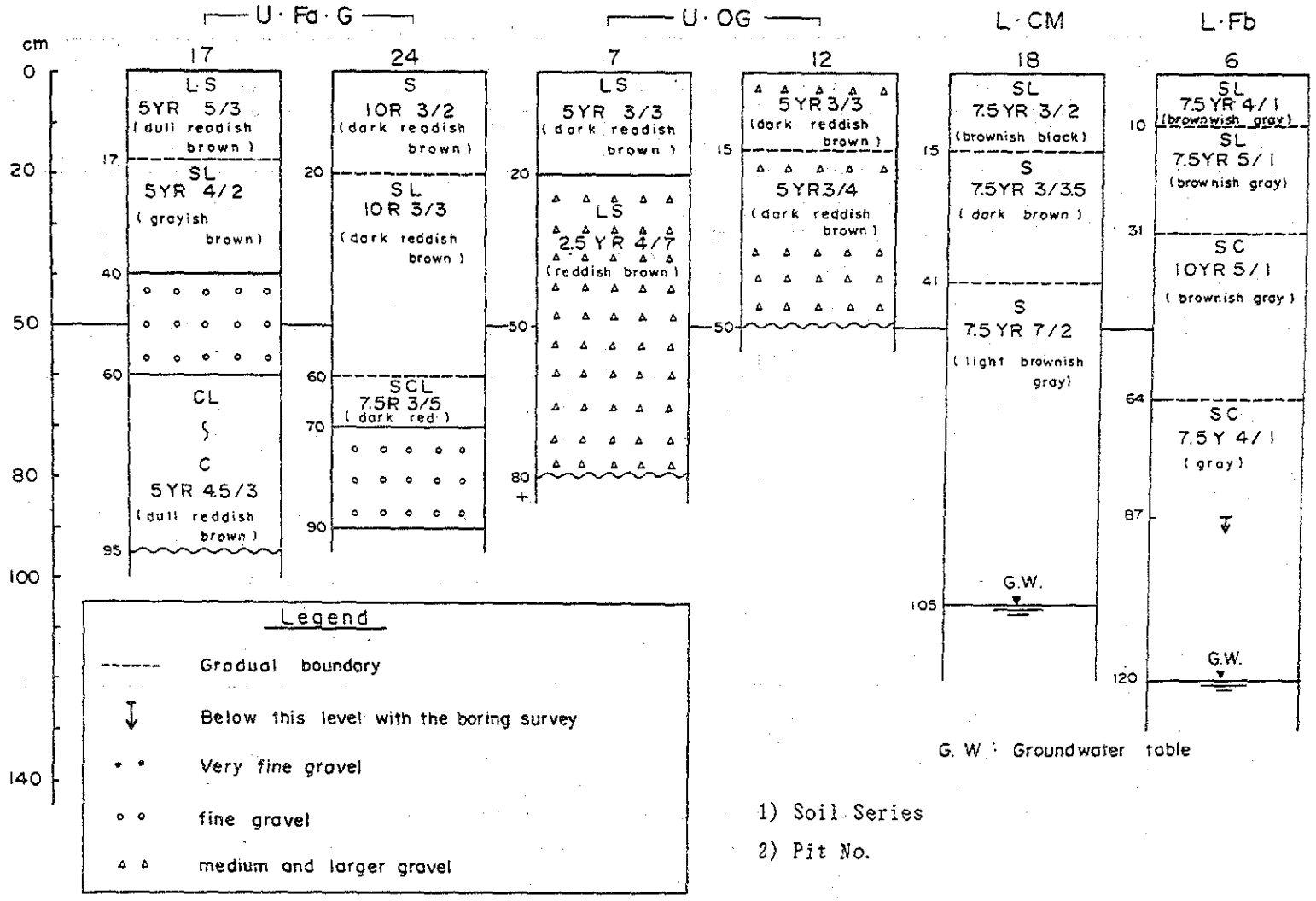

Fig. C.2.1 (2) Soil Monolith (2)

Table C.3.1 Distribution of Particle Size and the Three Phases of Soil (%)

Soil Layer Type		Sand	Silt	Clay	The Three Phased			Mo
					Sv	Mv	A	
U CM	I	89.3	7.1	3.7	59.7	5.8	36.6	3.7
	II	85.4	9.2	5.4	60.7	10.1	36.4	6.5
	III	83.0	9.5	7.6	63.2	13.7	27.4	8.2
U Fa	I	85.9	9.3	4.7	57.6	5.7	36.7	3.9
	II	80.7	12.0	7.3	64.2	13.5	22.3	8.0
	III	63.8	12.1	24.3	66.9	26.7	6.4	15.1
U Fb	I	83.3	10.5	6.1	62.9	8.5	28.6	5.0
	II	75.0	12.4	12.6	62.8	17.1	20.1	10.2
	III	59.4	10.8	29.8	64.0	28.8	7.2	17.0
U Fa G	I	86.6	8.1	5.4	60.0	12.0	35.2	7.6
	II	80.6	13.2	12.4	60.0	13.1	34.7	8.1
	III	69.3	15.4	15.3	73.7	26.3	0.0	13.5
U O G	I	68.8	18.7	12.5	-	-	-	-
	II	62.9	27.4	9.7	-	-	-	-
L CM	I	82.6	8.9	8.5	56.0	19.0	25.0	-
	II	92.6	3.0	4.4	59.2	18.8	22.0	12.0
	III	92.6	7.0	0.4	62.4	29.2	8.4	17.7
L Fb	I	80.2	15.0	4.8	62.7	23.8	13.5	14.3
	II	69.4	13.8	16.9	64.5	35.3	0.2	20.6
	III	62.5	6.2	31.3	64.7	35.3	0.0	20.6

Sv: Solid volume Mv: Moisture volume A: Air volume

Mo: Moisture content by whight

Layer: I : Upper (0～ca 20cm)

II : Middle (ca20～ 60cm)

III : Lower (ca60～ca100cm)

Table C.3.2(1) Moisture Contents of the Soils Under the Dry Season (U CM Soil)

Pit No.	Layer	Depth cm	Mv %	Moisture mm/layer
4	I	0～ 8	2.3	1.8
	II	8～ 24	1.8	2.9
	III	24～ 80	14.6	81.8
	Total	80	-	86.5
15	I	0～ 14	4.6	6.4
	II	14～ 34	24.0	48.0
		34～ 57	8.3	19.1
	III	57～ 90	11.1	36.6
	Total	90	-	110.1
21	I	0～ 16	4.6	7.4
	II	16～ 31	10.8	16.2
		31～ 61	11.9	35.7
	III	61～ 115	16.5	89.1
	Total	115	-	148.4
22	I	0～ 27	4.6	12.4
	II	27～ 45	5.4	9.7
		45～ 91	7.0	32.2
	III	91～ 175	9.4	79.0
	Total	175	-	133.3
23	I	0～ 16	6.5	10.4
	II	16～ 36	7.0	14.0
	III	36～ 95	11.0	64.9
	Total	95	-	89.3
25	I	0～ 16	8.9	17.8
	II	16～ 60	10.1	40.4
	III	60～ 115	19.8	108.9
	Total	115	-	167.1
Mean	I	-	5.3	9.4
	II	-	9.6	19.4
	III	-	13.7	76.7
	Total	112	-	105.5

Mv: Moisture % by Volum

Table C.3.2(2) Moisture Contents of the Soils Under the Dry Season (U Fa Soil)

Pit No	Layer	Depth cm	Mv %	Moisture mm/layer	Pit No	Layer	Depth cm	Mv %	Moisture mm/layer
	I	0～ 15	0.8	1.2		I	0～ 10	4.6	4.6
	II	15～ 77	10.4	64.5		II	10～ 27	5.1	12.8
1	III	77～ 140	21.6	136.1	13	III	27～ 43	15.0	57.0
	Total	140	–	201.8		Total	43～ 115	29.6	124.3
							115	–	198.7
	I	0～ 25	11.0	27.5		I	0～ 12	4.6	5.5
	II	25～ 48	16.2	37.3		II	12～ 27	12.1	18.2
5	III	48～ 88	9.2	36.8	14	III	27～ 70	31.0	133.3
	Total	88～ 155	27.0	180.9		Total	70～ 130	26.1	156.0
		155	–	282.5			130	–	313.6
	I	0～ 15	3.0	4.5		I	0～ 17	4.6	7.8
	II	15～ 25	6.7	6.7		II	17～ 37	14.5	29.0
8	III	25～ 75	10.6	53.0	16	III	37～ 78	13.0	53.3
	Total	75～ 130	23.4	128.7		Total	78～ 130	27.4	142.5
		130	–	192.9			130	–	232.6
	I	0～ 18	6.5	11.8		I	0～ 6	4.6	2.8
	II	18～ 33	14.4	21.6		II	6～ 19	7.1	9.2
9	III	33～ 64	19.9	59.5	20	III	19～ 60	11.5	47.2
	Total	64～ 96	29.5	94.4		Total	60～ 115	27.2	149.6
		175	–	187.3			115	–	208.8
	I	0～ 15	4.6	6.9		I	–	4.9	8.1
	II	18～ 33	7.7	13.9	Mean	II	–	13.1	44.8
10	III	33～ 64	19.1	108.9		III	–	26.7	135.7
	Total	90～ 128	28.5	108.3		Total	126	–	188.6
		128	–	238.0					

Table C.3.2(3) Moisture Contents of the Soils Under the Dry Season (U Fb Soil)

Pit No	Layer	Depth cm	Mv %	Moisture mm/layer	Pit No	Layer	Depth cm	Mv %	Moisture mm/layer
	I	0～ 15	6.1	9.2		I	0～ 15	5.3	8.0
	II	15～ 25	9.2	9.2		II	15～ 27	5.1	6.1
2	III	80～ 125	20.2	111.1	26	III	27～ 45	24.6	44.3
	Total	125	22.5	101.3		Total	45～ 115	23.8	166.6
			–	203.8			115	–	225.0
	I	0～ 5	4.6	2.3		I	0～ 15	4.6	6.9
	II	5～ 12	10.7	7.5		II	15～ 45	10.4	31.2
3	III	12～ 55	18.1	77.8	27	III	45～ 75	15.3	45.9
	Total	55～ 120	30.3	197.0		Total	75～ 100	31.2	78.0
		120	–	284.6			100	–	162.0
	I	0～ 12	4.6	5.5		I	0～ 4	4.6	1.8
	II	12～ 24	11.5	13.8		II	4～ 20	15.5	24.8
11	III	24～ 85	22.5	137.3	28	III	20～ 40	19.4	38.8
	Total	85～ 115	21.6	94.8		Total	40～ 115	13.1	233.3
		115	–	251.4			115	–	298.7
	I	0～ 12	4.6	5.5		I	0～ 18	5.1	9.2
	II	12～ 23	17.6	19.4		II	18～ 27	12.0	8.4
19	III	23～ 45	21.8	48.0	30	III	25～ 60	20.7	72.5
	Total	45～ 75	27.6	82.8		Total	60～ 95	31.0	108.5
		75～ 100	29.1	72.8			95	–	198.6
		100	–	228.5					
						I	–	6.1	8.1
					Mean	II	–	16.7	47.1
						III	–	28.8	131.5
						Total	175	–	186.7

Table C.3.3 Day and Night Change of the Moisture Stress in Soil

(Hg mm)

Date		Depth (cm)						Precipitation
		30		60		100		
	Time	10:00	18:00	10:00	18:00	10:00	18:00	
2/Oct	Min.	30	35	35	60	60	90	3/Oct 16mm
S	Max.	40	100	50	100	70	120	
10/Oct	Mean	1)35.6	81.1	38.9	83.3	62.2	108.9	
	±	2) 4.6	22.6	5.5	18.7	4.4	12.7	
	%	3)13.0	27.9	14.0	22.5	7.1	11.7	
11/Oct	Min.	30	35	30	30	20	20	10/Oct 57 mm
S	Max.	50	120	40	80	40	40	19/Oct 32 mm
19/Oct	Mean	12.8	81.7	35.6	52.2	30.6	28.9	
	±	6.7	26.0	4.6	14.8	7.7	8.9	
	%	15.6	31.8	13.0	28.4	25.1	30.9	
20/Oct	Min.	40	50	20	20	20	20	23/Oct 13 mm
S	Max.	60	100	30	40	40	40	31/Oct 115 mm
31/Oct	Mean	46.7	70.8	27.5	27.5	33.3	36.7	
	±	7.8	17.8	4.5	4.5	7.8	7.8	
	%	16.7	25.2	16.4	16.4	23.4	21.2	
1/Nov	Min.	30	30	20	20	20	20	
S	Max.	40	60	30	45	40	60	
13/Nov	Mean	36.5	46.2	26.5	29.2	34.6	40.0	
	±	4.7	8.7	4.7	6.1	7.8	10.6	
	%	13.0	18.8	17.9	20.8	22.4	26.5	

Soil Type: U Fb

1) Stress: Hg mm
2) Standard deviation (SD)
3) SD/Mean X 100 (%)

Table C.3.4 Chemical Properties of the Soils

Soil Type	Layer	OM	pH		Ca	Mg	K	P	Zn	Mn	Fe	Cu
		%	(H_2O)	(KCl)	me/100g			ppm				
U CM	I	2.9	6.2	5.1	2.7	0.67	0.07	5.0	4.8	26.5	38.8	2.0
	II	2.3	5.7	4.7	1.6	0.33	0.04	2.4	3.0	21.7	53.7	2.2
	III	1.9	6.2	5.0	2.8	0.47	0.05	1.8	2.5	14.7	19.9	2.7
U Fa	I	2.4	6.4	5.4	2.6	0.60	0.09	17.2	6.7	31.3	25.0	3.4
	II	2.1	6.3	5.2	3.5	0.51	0.09	7.2	3.6	23.4	23.4	3.4
	III	2.0	6.5	5.1	6.8	1.13	0.07	6.6	2.0	9.2	14.9	3.2
U Fb	I	1.7	6.1	5.0	2.7	0.56	0.07	19.4	5.5	34.6	32.0	4.0
	II	1.5	6.0	4.8	3.5	0.76	0.07	10.8	3.8	23.7	28.3	4.5
	III	1.5	6.1	4.8	6.2	1.36	0.08	1.9	2.0	11.1	21.1	3.8
U Fa G	I	1.7	6.1	5.1	2.8	0.84	0.08	7.0	6.5	41.2	36.0	5.9
	II	1.5	5.5	4.4	3.4	0.48	0.54	2.0	3.5	36.9	47.4	7.2
	III	1.0	6.1	5.0	4.7	0.84	0.05	1.0	3.6	14.0	24.2	8.6
U O G	I	4.0	7.5	6.6	14.8	2.85	0.20	42.0	34.4	22.8	23.5	19.0
	II	3.3	7.4	6.3	7.6	2.85	0.16	4.0	24.8	29.8	43.9	19.0
L CM	I	2.1	4.8	3.8	1.6	0.23	0.04	2.0	1.9	38.6	134.0	2.5
	II	2.4	4.9	4.1	0.7	0.27	0.05	3.0	1.4	10.5	134.0	1.6
	III	1.7	5.2	4.2	0.9	0.15	0.03	1.0	1.2	7.0	50.0	1.3
L Fb	I	2.5	5.4	4.1	2.3	0.61	0.07	1.0	2.5	18.1	13.8	2.2
	II	1.9	5.5	3.8	5.4	1.07	0.05	1.0	3.4	35.4	55.6	3.5
	III	1.7	6.0	4.0	12.8	2.85	0.07	1.0	3.6	13.6	34.8	4.1

O M: Organic Matter

Table C.3.5 A Standard of Soil Fertility[1)]

MAG's Standard

Category		Low	Optimum	High
pH	m.e/100 ml	5.0	5.5 ~ 6.5	7.0
Al	〃	-	0.3	1.5
Ca	〃	4.0	4 ~ 20	20
Mg	〃	1	1 ~ 10	10
K	〃	0.2	0.2 ~ 1.5	1.5
P	kg/ml	10	10 ~ 40	40
Mn	〃	5	5 ~ 50	50
Zn	〃	3	3 ~ 15	15
Cu	〃	1	1 ~ 20	20
Fe	〃	10	10 ~ 50	50
Ca/Mg	—	2	2 ~ 5	5
Mg/K	—	2.5	2.5 ~ 15	15
Ca+Mg/K	—	10	10 ~ 40	40
Ca/K	—	5	5 ~ 25	25

pH: (H_2O) 1:2.5

Al, Ca, Mg: NKCl 1:10

K, P, Mn, Zn, Cu, Fe: Olsen (Modificado)* 1:10

*{ 0.5 N $NaHCO_3$, 0.01 M EDTA - 2 Na Salt
Superfloc 127

1) Floria Bertsch H. M. Sc. (1986):
Manual para Interpretar La Fertilidad de los Suelos de Costa Rica. Univ. Costa Rica

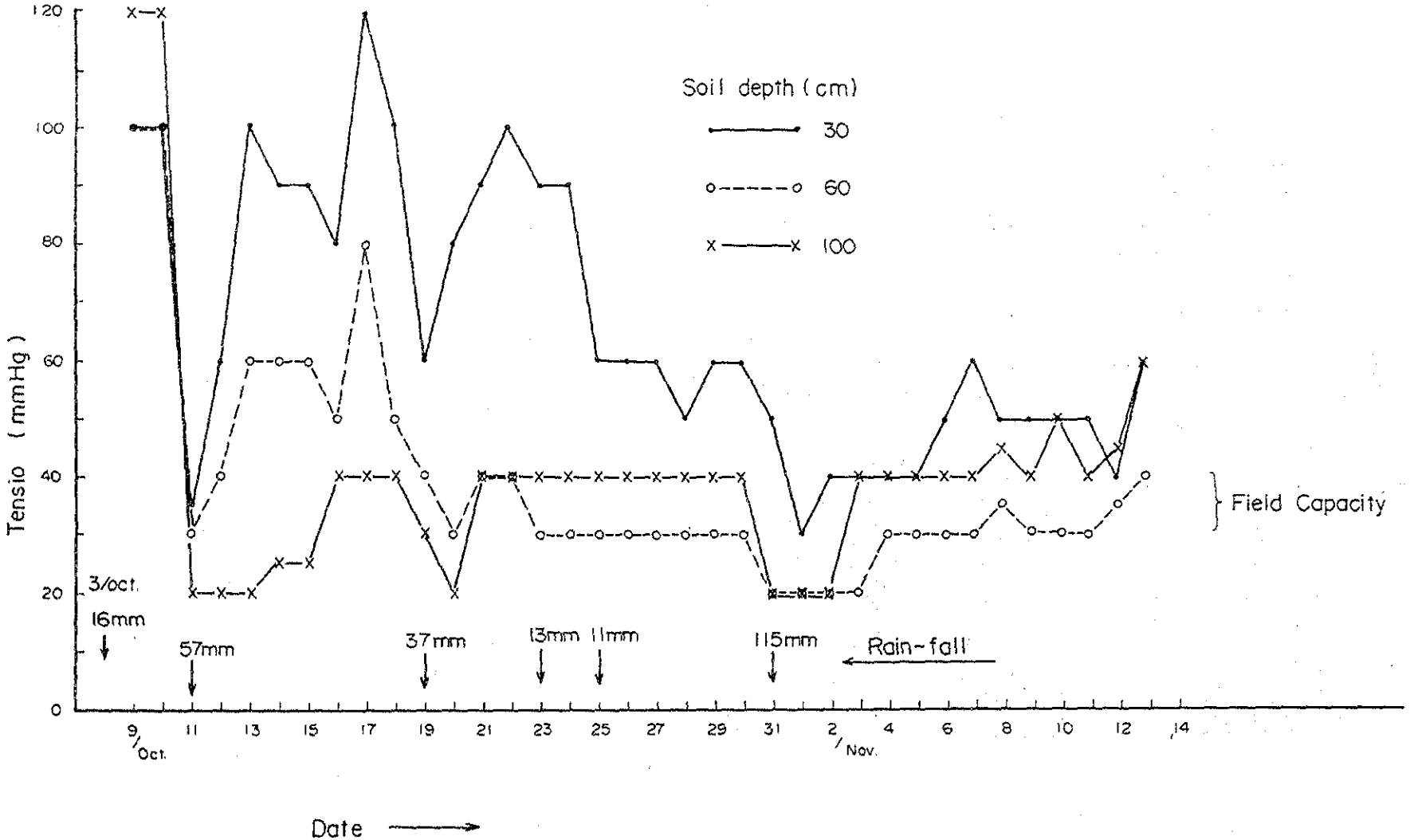

Fig. C.3.1 Change of the Moisture Stress in the Soil

Table C.4.1 The Soil Type Vs. The Land Capability

Soil Type	Limiting Factor					Evaluate
	e	t	w	n	d	
U Fa P	I	I	I	II	II	IInd
U Fb P	I	I	I	II	II	IInd
U CM P	III	II	I	III	III	IIIend
U Fa S	III	II	I	II	II	IIIe
U Fa G P	I	II	I	III	III	IIInd
U OG P	III	IV	I	III	IV	IVtd
L CM	I	I	V	III	I	Vw
L Fa	I	I	V	II	I	Vw
L Fb	I	I	V	II	I	Vw
U CM S	VI	VI	I	III	IV	VIet
U OG S	VII	VII	I	III	IV	VIIet
U CM G S	VII	VII	I	III	IV	VIIet

e: Erodibility
t: Tith
w: Drainage
n: Nutrition
d: Drought

Table C.4.2 Land Classified Area at Each Basin

Basin / Land Class	TRANQUERA		RORY		RORY-MI		WEST		North		East	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
I	0	0	0	0	0	0	0	0	0	0	0	0
II	900	36.7	430	28.6	370	35.9	400	13.2	510	32.3	670	54.9
III	690	28.2	370	24.7	110	10.7	570	18.8	360	22.8	0	4.1
IV	100	4.1	0	0	50	4.9	0	0	0	0	50	0
V	280	11.4	130	8.7	100	9.7	1,620	53.5	710	44.9	30	2.5
VI	340	13.9	410	27.3	100	9.7	300	10.0	0	0	0	0
VII	0	0	0	0	0	0	0	0	0	0	0	0
VIII	140	5.7	160	10.6	180	17.4	140	4.6	0	0	470	38.5
Total	2,450	100	1,500	100	1,030	100	3,030	100	1,580	100	1,270	100

Table C.4.3 Land Distribution at Each Administrative Section

		I	II	III	IV	V	VI	VII	VIII	Total
1 YBATOTY	ha	0	560	588	0	1,443	299	0	120	2,940
	%	0	19.0	20.0	0	49.1	7.8	0	4.1	100.0
2 YAJHAPETY	ha	0	120	323	73	34	90	0	0	640
	%	0	18.8	50.5	11.4	5.3	14.0	0	0	100.0
3 PINDOTY	ha	0	854	0	0	518	0	0	8	1,380
	%	0	61.9	0	0	37.5	0	0	0.6	100.0
4 RORY	ha	0	69	238	0	413	0	0	0	720
	%	0	9.6	33.1	0	57.3	0	0	0	100.0
5 CAATY-MI	ha	0	340	289	20	146	52	0	43	890
	%	0	38.2	32.5	2.2	16.4	5.9	0	4.8	100.0
6 MBOCAYATY	ha	0	668	73	87	30	21	0	600	1,480
	%	0	45.2	4.9	5.9	2.0	1.4	0	40.6	100.0
7 FATIMA	ha	0	142	247	0	0	556	0	195	1,140
	%	0	12.4	21.7	0	0	48.8	0	17.5	100.0
8 BARRERO AZUL	ha	0	375	134	0	40	40	0	111	700
	%	0	53.6	19.2	0	5.6	5.7	0	15.8	100.0
9 POTRERO ALTO	ha	0	103	112	0	0	165	0	0	380
	%	0	27.1	29.6	0	0	43.3	0	0	100.0
10 SOL NACIENTE	ha	0	20	118	0	246	0	0	0	384
	%	0	5.2	30.2	0	63.0	0	0	0	98.4
11 URBAN AREA	ha	0	33	77	22	76	0	0	0	208
	%	0	9.7	22.5	6.6	22.2	0	0	0	61.0
Total	ha	0	3,280	2,200	200	2,940	1,150	0	1,090	10,860
	%	0	30.0	20.0	2.0	27.0	11.0	0	10.0	*100.0

*(Except City 140)

Table C.4.4 Characteristics of Land Condition at Each Basin (%)

Land Condition \ Basin	TRANQUERA	RORY	RORY-MI	WEST	NORTH	EAST
Upland	89	91	90	48	55	98
Lowland	11	9	10	52	45	2
Plateau	66	53	63	31	55	61
Slope	23	38	12	16	0	37
Glavelly stony soils	10	11	34	5	0	45
Throughout sandy soils	37	53	36	26	23	37
Half sandy soils	40	29	48	15	32	57
Land Class II・III	65	53	47	32	55	59
Land Class IV	4	0	5	0	0	4
Land Class V	11	9	10	52	45	2
Land Class VI	14	27	10	10	0	0
Land Class VII	6	11	5	5	0	39

1) Rate of area at each basin
Plateau : <8, Slope : >8, Throughout sandy soils : U CM
Half sandy soils : U Fa + U Fb

Table C.4.5 Characteristics of Land Condition at Each Administrative Sevction (%)

Land Condition \ Basin	YBAROTY	YAJHAPETY	PINDOTY	RORY	CAATY-MI	MBOCAYATY
Upland	51	95	63	43	84	98
Lowland	49	5	37	57	16	2
Plateau	38	81	62	43	62	56
Slope	13	14	0	0	11	42
Glavelly stony soils	4	11	1	0	18	51
Throughout sandy soils	27	65	0	33	31	42
Half sandy soils	19	19	62	10	38	45
Land Class II・III	39	69	62	43	71	50
Land Class IV	0	11	0	0	2	6
Land Class V	49	5	38	57	16	2
Land Class VI	8	14	0	0	6	1
Land Class VII	4	0	1	0	5	41

Land Condition \ Basin	FATIMA	BARRERO AZUL	POTRERO ALTO	SOL NACIENTE	URBAN AREA	WHOLE AREA
Upland	100	94	100	37	78	73
Lowland	0	6	0	63	22	27
Plateau	34	73	39	37	78	52
Slope	66	22	61	0	0	21
Glavelly stony soils	0	0	0	0	7	3
Throughout sandy soils	72	25	55	30	23	34
Half sandy soils	12	54	27	5	10	30
Land Class II・III	34	73	57	35	32	50
Land Class IV	0	0	0	0	7	2
Land Class V	0	6	0	63	22	27
Land Class VI	49	6	43	0	0	11
Land Class VII	17	16	0	0	0	10

1) Rate of area at each administrative
Plateau : <8, Slope : >8, Throughout sandy soils : U CM
Half sandy soils : U Fa + U Fb

ANNEX D AGRICULTURE AND AGRO-ECONOMY

ANNEX D Agriculture and Agro-Economy

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ANNEX D. Agriculture and Agro-Economy

D. 1 National Economy and Agriculture

1. 1 Recent Economic Trends

(1) Trends in economic activity

The economy is predominant by agricultural and is therefore highly sensitive to climatic variations. However, a process of rapid industrialization took place concurrently with the development of the hydroelectric scheme at Itaipu in the 1070s and early 1980s. When civil works at Itaipu were completed, and capital inflows related to the project ceased, the economy went into recession. The government's fixed exchange rate policy tends to encourage high levels of contraband trade across the borders with Argentina and Brazil, at the expense of official external trade.

The authorities have been reluctant to devalue the Guarani, despite considerable pressure at home and form abroad, because of a fear of high inflation. Nonetheless, the printing of money to meet the public sector's increased borrowing requirements and the limited access to preferential dollars for private transactions - which has forced importers to turn to the free market - have each had an inflationary impact.

Paraguay is one of only two countries in Latin America which has not had to reschedule its debt to foreign commercial banks. Total debts servicing has, however, become burdensome and in 1987 Paraguay's foreign ministry was in the process of rescheduling the country's debt to Brazil.

(2) National accounts

In the decade from 1970-80 Paraguay's economy expanded at an average annual rate of almost 9.0 per cent, largely as a result of the Itaipu hydroelectric project. In 1980 alone GDP rose by 11.4 per cent and although the rate of growth slowed slightly in 1981/82', to 10.8 per cent, this was still the highest rate in Latin America. However, 1981 marked the end of Paraguay's economic boom and GDP fell in 1982 and 1983. There followed two years of positive growth, but GDP stagnated in 1986, principally because of a prolonged drought which seriously affected agricultural output. A return to normal weather in 1987, combined with a strong export performance, helped to lift growth to 4.3 per cent, according to official estimates.

Agriculture is by far the most important sector, not only in terms of its contribution to GDP but also as the main export earner and provided of employment. Its share of GDP increased slightly in the period 1980-85 but although this reflected some growth, it was also the result of recession in manufacturing and an even more serious contraction in construction activity, as work Itaipu came to an end.

(3) Foreign trade and currency

Paraguay differs from many other Latin American countries in that the USA is not an important trading partner. In fact Brazil and Argentina are, together, the most important destinations for exports and sources of imports.

According to Central Bank figures, total contracted foreign debt on March, 1988, was $79.1 million. Of this total, 98 per cent was owed by the public sector, of which 48 per cent was central government debt and the remainder autonomous state agency debt.

Paraguay's currency is the guarani(G), which from 1960 until 1984 had an official exchange rate of 126 to the dollar. Despite various modifications, incorporating exchange rates of two or more tiers, devaluation has not taken place quickly enough either to satisfy the multilateral lending agencies or the prevent the emergence of a black market. In May 1988 the following rates applied:

- G240=$1 for imports by three state companies an imports of services for the central administration. (The companies are the electricity corporation ANDE, the merchant fleet FME, and the public health utility Corposana.)
- G320=$1 for public sector foreign debt servicing.
- G400=$1 for imports of fuels and oil and for imports of goods by central government and state companies (excluding ANDE and FME and Corposana).
- G550=$1 for exports, agricultural imports and disbursement of credits from multilateral institutions.
- The free rate (G892=$1 on May 16, 1988) is applied to non-agricultural private sector imports; public and private sector service earnings; private sector service outflows for freight insurance, dividends and interest; and capital inflows such as foreign loans, supplier's credits, and short and long term capital repayments by the private sector.

Despite continuing pressure on the government from multilateral agencies and the domestic private sector, exchange rate

unification is not expected in the short term.

Table D.1.1 - D.1.8 are shown main economic indicators.

1. 2 Population and Society

The population in mid-1987 was estimated at 3.93 mn. The crude birth rate per thousand fell 14 per cent from 43 in 1960 to 37 in 1980-85 while the crude death rate fell 38 per cent from 13 in 1960 to eight in 1980-85. 44 per cent of the population was urban in 1987 compared with 34 per cent in 1960. The average growth rate of the urban population was 3 per cent between 1960 and 1970 and 4.0 per cent between 1970 and 1985. Most Paraguayans are bilingual; outside the capital, the Indian tongue Guarani is usually spoken in preference to Spanish. 92 per cent of the population was literate in 1984. Life expectancy at birth in 1980-85 was 65.2 years, compared with 56 years in 1960. Those enrolled in primary school, as a proportion of their age group, rose from 102 per cent in 1965 to 103 per cent in 1982 (this figure comprises more than the relevant age group), and the number of those enrolled in secondary schools increased from 13 per cent of the relevant age group in 1965 to 36 per cent in 1982.

Table D. 1.9 and D 1.10 are shown population trends.

1. 3 Trend of the Land Tenure

Land invasions by peasants are a recurring problem; it is estimated that some 85 per cent of small farmers have no title to their land; their numbers have been swollen by those workers who lost their jobs when the Itaipu civil works ended.

Land tenure and number of land holding by the nation, province of Paraguari and the Study Area are shown in Table D.1.11 - D.1.13.

Table D.1.1 Gross Domestic Production (GDP) and per Capita of GDP

Year	1981/'82	1983	1984	1985	1986	1987	1988
1. GDP (Million Guarani)		714,929	736,906	766,158	766,223	799,382	846,755
Growth rate(%)	10.8	-3.0	3.1	4.0	0.0	4.3	6.0
2. Per-Capita of GDP (G)		205,823	206,054	208,112	202,266	205,151	211,345
Growth rate(%)	6.0	-5.8	0.1	1.0	-2.8	1.4	3.0

Note : (1) Production Value is a costant price in 1982.
(2) Estimated Value in 1988.
Source : (1) Cuentas Nacionales 1976/1986, No.23, B.C.P
(2) Informaciones Economicas Basicas, MIC, 1988

Table D.1.2 Growth Rate and Distribution of GDP by Industry

Sector / Year	Growth rate (%) '83	'84	'85	'86	'87	Percent distribution (%) '83	'84	'85	'86	'87
Agriculture	-2.8	7.4	6.0	-12.6	9.7	15.6	16.2	16.6	14.5	15.2
Livestock	-1.8	4.1	2.9	2.0	2.5	7.8	7.9	7.8	7.9	7.8
Forestry	-1.8	2.5	0.9	11.7	6.0	2.5	2.5	2.4	2.7	2.8
Others	-4.3	2.0	3.0	3.0	3.0	0.2	0.2	0.1	0.1	0.1
Sub-total	-2.4	5.9	4.6	-6.1	7.0	26.1	26.8	26.9	25.2	25.9
Minig	-7.3	1.0	4.4	11.9	6.0	0.4	0.4	0.4	0.4	0.5
Industry	-4.2	4.5	5.0	-1.4	3.5	16.2	16.4	16.6	16.4	16.3
Construction	-5.7	-2.4	-1.0	1.0	2.0	6.5	6.2	5.9	6.0	5.8
Sub-total	-4.7	2.5	3.4	-0.6	3.2	23.1	23.0	22.9	22.8	22.5
Electricity	-4.8	2.2	5.9	11.1	8.0	2.1	2.1	2.1	2.4	2.4
Water supply and sanitation	18.1	2.0	6.1	5.5	5.0	0.4	0.4	0.4	0.4	0.4
Transport and communication	-1.2	3.6	5.1	5.0	5.0	4.3	4.3	4.4	4.6	4.6
Sub-total	-1.4	3.1	5.4	6.9	6.0	6.8	6.8	6.9	7.4	7.4
Finance and Commerce	-3.1	1.8	4.7	3.3	3.5	26.6	26.3	26.5	27.3	27.2
Public services	-2.1	2.4	3.0	2.0	2.0	4.5	4.4	4.4	4.5	4.4
Housing	-4.7	-	1.0	2.0	2.0	3.0	2.9	2.8	2.9	2.8
Others	-1.2	1.6	2.0	2.9	3.0	9.9	9.8	9.6	9.9	9.8
Sub-total	-2.7	1.7	3.7	3.0	3.1	44.0	43.4	43.3	44.6	44.1
T o t a l	-3.0	3.1	4.0	0.0	4.3	100.0	100.0	100.0	100.0	100.0

Source : (1) Cuentas Nacionales 1976/1986, No.23, B.C.P
(2) Informaciones Economicas Basicas, MIC, 1988

Table D.1.3 Major Exporting Goods

Unit : US$1,000 (FOB)

Year	1983	%	1984	%	1985	%	1986	%	1987	%
Soybeans	84,445	31.4	99,338	29.7	100,477	33.1	43,867	18.9	122,783	34.7
Cotton	85,126	31.6	131,156	39.2	141,811	46.7	80,745	34.7	100,957	28.6
Wood	20,391	7.6	22,245	6.7	9,731	3.2	17,657	7.6	25,084	7.1
Beef cattle	5,272	2.0	4,585	1.4	1,446	0.5	33,918	14.6	21,778	6.2
Cowhide	7,285	2.7	7,112	2.1	5,221	1.7	9,732	4.2	13,788	3.9
	13,839	5.1	12,392	3.7	6,396	2.1	8,766	3.8	12,502	3.5
Tobacco	10,171	3.8	15,253	4.6	6,033	2.0	5,448	2.3	9,860	2.8
Vegetable oil	19,487	7.2	18,965	5.7	13,656	4.5	9,215	4.0	9,555	2.7
Refined oil	1,777	0.7	3,154	0.8	5,615	1.8	3,976	1.7	5,825	1.6
Extracted oil	5,373	2.0	5,636	1.7	4,023	1.2	3,762	1.6	5,268	1.5
Others	16,010	5.9	14,666	4.4	9,943	3.2	15,447	6.6	25,977	7.4
T o t a l	269,176	100.0	334,502	100.0	303,902	100.0	232,533	100.0	353,377	100.0
Percent compared with the peceding year (%)										
	-18.4		24.3		-9.1		-23.5		52.0	

Source : (1) Cuentas Nacionales 1976/86, B.C.P, 1987
(2) Informaciones Economicas Basicas, MIC, 1988

Table D.1.4 Major Importing Goods

Unit : US$1,000 (CIF)

Year	1983	%	1984	%	1985	%	1986	%	1987	%
Machinery	107,802	22.5	92,160	18.0	101,700	23.0	163,529	32.1	151,952	29.4
Fuel oil	120,024	25.1	137,556	26.8	114,571	25.9	96,918	19.0	102,773	19.9
Machinery	29,437	6.2	102,636	20.0	30,515	6.9	30,663	6.0	47,869	9.3
Beverage and Tobacco	15,569	3.3	25,483	5.0	25,059	5.7	33,945	6.7	41,627	8.0
Chemicals	28,326	5.9	29,449	5.7	34,424	7.8	29,561	5.8	25,874	5.0
Steel and its products	39,584	8.3	23,469	4.6	17,855	4.0	28,803	5.7	24,371	4.7
Papers	7,045	1.5	7,803	1.5	9,303	2.1	8,801	1.7	10,464	2.0
Nonferrous metals	11,350	2.4	5,562	1.1	7,094	1.6	8,860	1.8	9,080	1.8
Foods	31,250	6.5	14,321	2.8	19,812	4.5	17,014	3.3	8,971	1.7
Agricultural machinery	6,896	1.4	11,790	2.3	11,660	2.6	6,362	1.2	8,302	1.6
Others	80,979	16.9	62,826	12.2	70,288	15.9	84,936	16.7	86,193	16.6
T o t a l	478,264	100.0	513,055	100.0	442,281	100.0	509,393	100.0	517,476	100.0
Percent compared with the preceding year (%)										
	-17.7		7.3		-8.6		15.2		1.6	

Source : Cuentas Nacionales 1976/86, B.C.P

Table D.1.5 Change of labor Force by Industry

Sector \ Year	1983 Population	1983 %	1985 Population	1985 %	1987 Population	1987 %
Agriculture and Livestock	473,553	42.7	538,643	47.0	493,544	39.9
Mining	10,864	1.0	1,376	0.1	3,773	0.3
Construction	230,609	20.8	232,179	20.3	282,161	22.8
Electricity and Water supply	6,137	0.6	3,369	0.3	4,148	0.3
Communication and Transport	31,410	2.8	31,606	2.8	39,006	3.2
Commerce and Others	357,237	32.1	338,725	29.5	413,564	33.5
T o t a l	1,109,810	100.0	1,145,898	100.0	1,236,196	100.0

Source : (1) Informaciones Economicas Basicas, MIC, 1988
(2) Sintesis de la Economia en Cifras, 1985/1987, B.C.P 1988

Table D.1.6 Trading Partner

Unit: %

Export	1985	1986	1987	Import	1985	1986	1987
1. ALADI:	32.0	65.0	45.0	1. ALADI:	56.0	47.0	46.0
Argentina	5.0	15.0	15.0	Argentina	17.0	14.0	9.0
Brasil	20.0	39.0	18.0	Brasil	36.0	31.0	33.0
Uruguay	2.0	3.0	3.0	Uruguay	1.0	1.0	1.0
Chile	4.0	6.0	6.0	Chile	1.0	1.0	1.0
Others	1.0	2.0	3.0	Others	0.0	0.0	1.0
2. E.C.	42.0	19.0	35.0	2. E.C.	12.0	17.0	21.0
3. European Countries (Except E.C.)	15.0	8.0	8.0	3. European Countries (Except E.C.)	6.0	3.0	2.0
4. U.S.A.	6.0	6.0	8.0	4. U.S.A.	9.0	15.0	12.0
5. Asia	4.0	1.0	3.0	5. Asia	7.0	11.0	11.0
6. Others	1.0	1.0	1.0	6. Others	10.0	7.0	8.0
Total	100.0	100.0	100.0	Total	100.0	100.0	100.0

Table D.1.7 Foreign Debt

Unit: millions US$

	Foreign Exchange Holding	Debt	Net money Reserve
1980	766.5	17.8	748.7
1981	810.0	29.7	780.3
1982	686.8	36.6	650.2
1983	684.1	58.7	625.4
1984	669.2	152.3	516.9
1985	578.0	98.8	479.2
1986	475.5	77.9	397.6
1987	526.5	91.3	435.2
1988			
Jan.	426.7	71.1	355.6
Feb.	404.9	71.3	333.6
Mar.	433.7	79.1	354.6

Source : Boletin Estadistico, No. 356, B.C.P, 1988

Table D.1.8 Expected Agricultural Production at the National Developmen Plan

Year / Crops	1985	1986	1987	1988	1989	Annual Rate(%)
1. Cereals and Legumina						
Wheat	100	154	109	115	121	4.9
Rice	100	103	108	111	116	3.8
Maize	100	104	108	111	116	3.8
Mandioca	100	104	107	111	115	3.6
Soybeans	100	113	128	146	165	13.0
Poroto	100	104	107	112	116	3.8
2. Vegetable and Fruit						
Onion	100	106	109	113	119	4.4
Pumpkin	100	103	109	114	112	4.7
Orange	100	105	111	114	119	4.4
Plum	100	106	106	113	113	3.1
Mango	100	101	106	109	112	2.9
Melon	100	103	106	110	111	2.6
Pineapple	100	103	106	109	112	2.9
Grape	100	103	106	109	112	2.9
3. Inductrial Crops						
Sugarcane	100	110	121	133	146	9.9
Cotton	109	112	125	140	157	12.9
Tobacco	100	101	102	103	104	1.0

Source : National Development Plan (1984 - 1989)

Table D.1.9 Population Division in Paraguari Province and La Colmena

	Paraguari Province						La Colmena					
				Rural						Rural		
Age	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total
0～ 4	15,364	14,983	20,347	12,793	12,490	25,283	311	294	605	201	162	363
5～ 9	14,332	14,063	28,395	12,041	11,692	23,733	267	309	576	170	130	300
10～14	14,265	13,029	27,294	11,678	10,430	22,108	335	314	649	196	147	343
15～19	10,984	10,113	21,097	8,237	7,825	16,062	200	244	464	133	136	269
20～24	8,984	8,276	17,260	7,151	6,393	13,544	197	182	379	112	91	203
25～29	6,814	6,533	13,347	5,415	5,026	10,441	135	157	292	72	75	145
30～34	5,417	5,188	10,605	4,276	3,937	8,213	124	129	253	64	66	130
35～39	4,461	4,887	9,348	3,508	3,803	7,311	127	113	240	67	60	127
40～44	4,229	4,475	8,704	3,346	3,503	6,849	112	98	210	60	55	115
45～49	3,397	3,621	7,018	2,729	2,901	5,630	83	79	162	49	46	95
50～54	3,792	4,015	7,807	3,077	3,106	6,183	83	65	148	49	31	80
55～59	2,790	3,071	5,861	2,224	2,315	4,539	63	67	130	32	30	62
60～64	2,459	2,861	5,320	1,944	2,170	4,114	58	64	122	32	27	59
65＞	5,332	6,664	11,996	4,123	4,987	9,110	119	113	232	63	60	123
Total	102,620	101,779	204,399	82,542	80,578	163,120	2,234	2,228	4,462	1,300	1,166	2,414

Source: Censo Nacional de Populacion y Viviendas, 1982

Table D.10 Economic Activity Population

Generation	Possible Economically active population	Economic Activity Population			un empoi-yment population	Non-economic activity
		Employment	unemploy	total		
Paraguari	134,504	62,246	2,669	64,943	69,201	360
men	67,128	52,585	2,451	55,036	11,867	225
women	67,376	9,661	246	9,907	57,334	135
La Colmena	3,022	1,476	33	1,509	1,509	4
men	1,526	1,210	29	1,239	284	3
women	1,496	266	4	270	1,225	1

Source : Censo Nacional de Poblacion y Viviendas, 1982

Table D.11 Number of Household and Land Holding Area

Province	Area Zone (km^2)	No. of Distritos	No. of Companias	No. of Land-holding Farmers & Area	
				1]	2]
1. Easr Zone					
① Concepcion	18,051	7	175	12,787	1,708
② San Pedro	20,002	14	280	25,261	1,488
③ Cordillera	4,948	19	234	19,857	304
④ Guaira	3,846	17	250	16,218	254
⑤ Caaguazu	11,474	12	319	35,659	731
⑥ Caazapa	9,496	10	207	15,426	537
⑦ Itapua	16,525	22	277	29,945	983
⑧ Misiones	9,556	10	107	8,840	725
⑨ Paraguari	8,705	17	282	26,436	620
⑩ Alto Parana	14,895	9	159	13,610	643
⑪ Central	2,465	18	196	13,292	163
⑫ Neembucu	12,147	16	116	8,832	829
⑬ Amambay	12,933	3	34	4,074	821
⑭ Canindeyu	14,667	6	92	7,613	523
* Asuncion	117	-	-	-	-
Sub-total	159,827	180	2,728	237,350	10,329
2. West Zone					
⑮ Presidente Hayes	72,907	7	38	1,830	6,078
⑯ Alto Paraguay	45,982	5	13	264	3,385
⑰ Chaco	36,367	1	4	60	528
⑱ Nuevo Asuncion	44,961	1	1	7	142
⑲ Boqueron	46,708	2	10	2,141	1,480
Sub-total	246,925	16	66	4,302	11,613
Total	406,752	196	2,794	241,652	21,942

Source : (1) Censo Nacional de Poblacion y Viviendas, 1982
(2) Censo Agropecuario, 1981, MAG

Note : 1] Number of household
2] Land holding area (unit:1,000 ha)

Table D.1.12 Number of Landholding Farmers in Paraguari Province

Disrticts	Household			Population			% of increase and decrease 1972 ~ 1982
	Urban	Rural	Total	Urban	Rural	Total	
① Paraguari	1,248	1,378	2,626	6,592	7,052	13,644	-0.1
② Acabay	516	2,368	2,884	2,548	13,271	15,819	-0.4
③ Caapucu	516	970	1,486	2,162	5,095	7,257	-0.7
④ Caballero	303	1,342	1,645	1,256	7,117	8,373	-1.1
⑤ Carapegua	676	4,461	5,137	3,300	23,785	27,085	0.0
⑥ Escobar	133	1,079	1,212	598	5,609	6,207	-1.6
⑦ La Colmena	405	430	835	1,996	2,466	4,462	-1.2
⑧ Mbuyapey	374	1,770	2,144	1,686	10,426	12,112	1.0
⑨ Pirayu	694	1,707	2,401	3,308	8,597	11,905	0.9
⑩ Quiindy	799	2,511	3,310	3,605	12,796	16,401	0.0
⑪ Quyquyho	507	1,251	1,458	983	6,592	7,575	-0.4
⑫ Roque, Sta.	362	1,740	2,102	1,669	9,634	11,303	-1.0
⑬ Sapucuai	507	846	1,353	2,194	4,586	6,780	-2.2
⑭ Tebicuary-Mi	-	700	700	-	4,168	4,168	-2.4
⑮ Yaguaron	954	3,131	4,085	4,476	16,825	21,301	1.0
⑯ Ybycui	794	3,288	4,082	3,739	19,124	22,863	-1.1
⑰ Ybytimi	252	1,086	1,388	1,167	5,977	7,144	-0.9
Total	8,740	30,058	38,798	41,279	163,120	204,399	-0.4

Source : Censo Nacional de Populacion y Viviendas, 1982

Table D 1.13 Number of Farm Household by the Land Holding Scale

Land holding Sacale (ha)	Nation		Dept. of Paraguari		Study Area	
	No. of Farm House hold	%	No. of Farm House hold	%	No. of Farm House hold	%
< 5	82,376	34.1	14,185	53.7	22	5.4
6 ~ 10 ha	49,511	20.5	5,714	21.6	97	24.0
11 ~ 20 ha	56,476	23.4	3,769	14.3	140	34.0
21 ~ 50 ha	36,007	14.9	1,796	6.8	109	26.9
51 ~ 100 ha	7,008	2.9	455	1.7	26	6.4
101 ~ 200 ha	4,012	1.7	209	0.8	6	1.5
201 ~ 500 ha	2,920	1.2	142	0.5	5	1.2
501 ~ 1,000 ha	1,053	0.4	62	0.2	0	0.0
> 1,000 ha	2,289	0.9	104	0.4	0	0.0
Total	248,930	100.0	26,939	100.0	405	100.0

Source: (1) Censo Agropecuario, 1981
(2) Agricultural Farm Survey, 1988, JICA

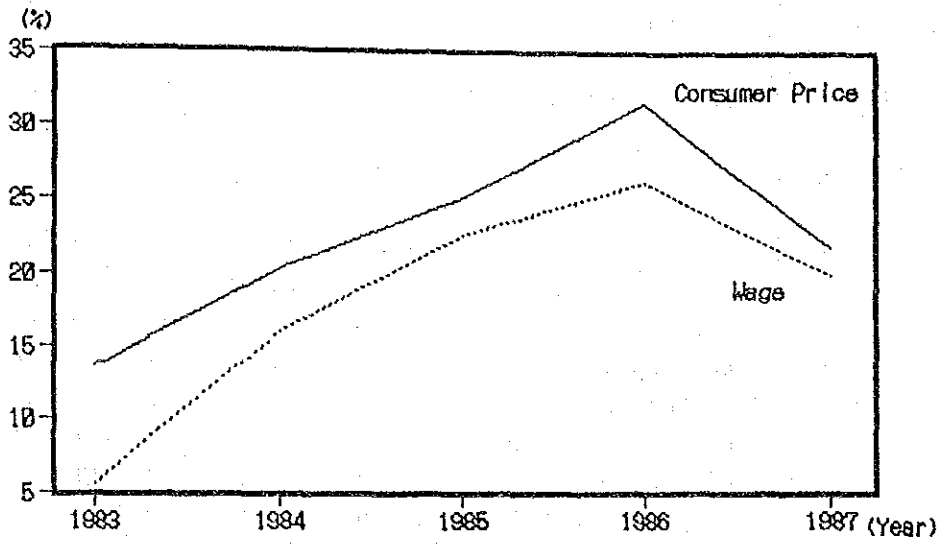


Fig. D.1.1 Change of Consumer Price and Wage

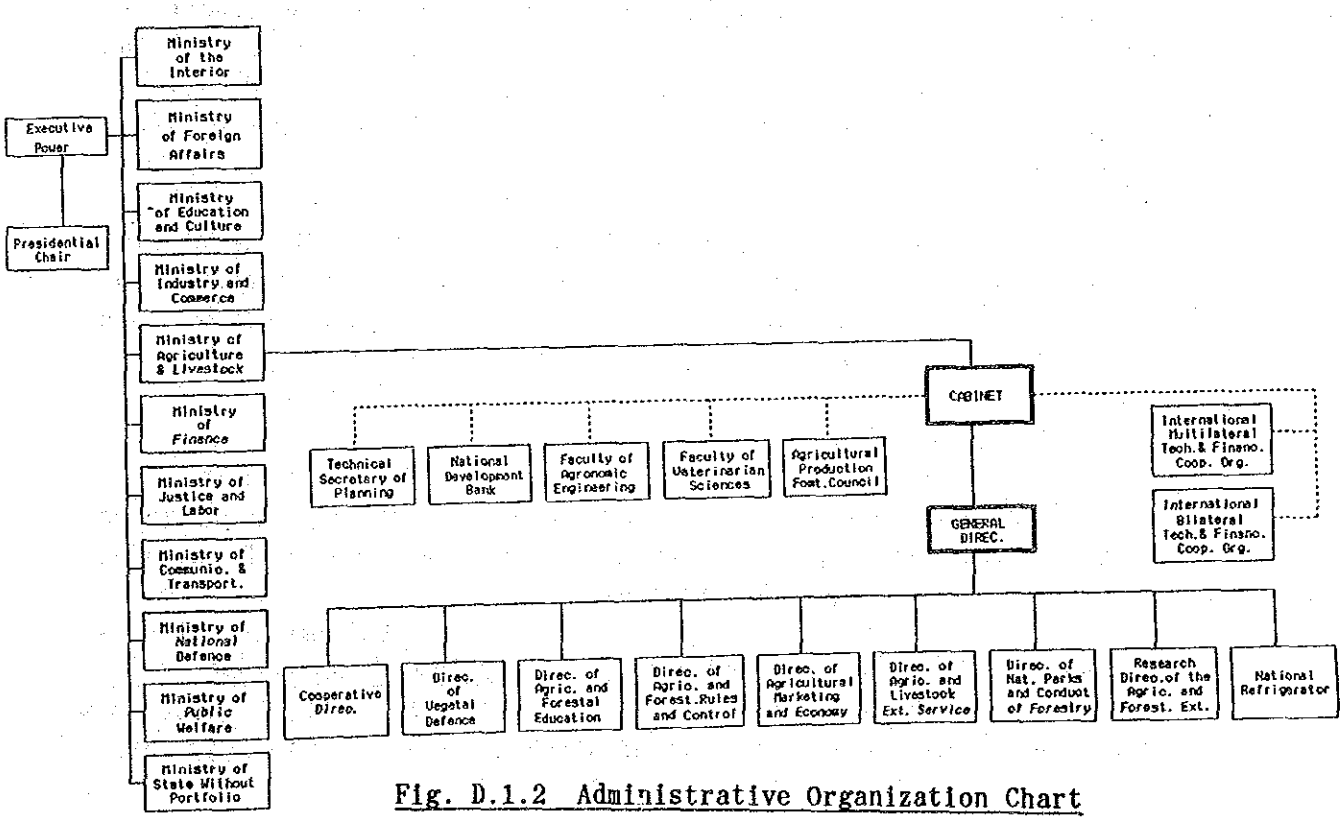


Fig. D.1.2 Administrative Organization Chart

D.2 Agricultural Production

2.1 Trend of Agricultural Production

(1) General

In 1983 heavy rains contributed to a fall in agricultural production of about 7 %. The next two years saw strongly positive growth, but in 1986 it was the turn of drought to reduce crop output levels by 12.6 %. Both cotton and soya, which account for 35 % of agricultural output and are the principal export crops, were badly hit. In 1987, however, better weather and producers' prices helped a recovery, with growth(excluding livestock) estimated at 9.7 %. in real GDP terms.

Livestock raising used to be the basis of the Paraguayan economy but in recent years it has become less important with exports of cotton and soya overtaking those of meat. Livestock has nonetheless made an important contribution to overall agricultural growth since 1984,and in 1986 cattle slaughterings, according to FAO estimates, were 785,000 head compared with the average for the 1979-'81 period of 566,000 head. In 1986 cattle numbered 7.2 mn head. Sheep and pigs numbered 388,000 and 1,403,000 respectively in 1986.

Approximately 51 % of the land area is forested. 70 % of the forestry resources are in the Chaco, but 90 % of this cannot be exported and in the remaining area transport costs are prohibitively high.

(2) Alcohol production

The Paraguayan Government has an alcohol production project, which uses domestically grown sugarcane. The following shows the alcohol production plan from 1988 to 1997.

Unit:million liters

year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Q'ty	33.9	39.1	44.4	48.1	50.6	52.0	55.5	58.0	60.4	62.9

(Source: Proyeccion de consumo de alcohol carburante hidratado MIC)

2.2 Regional Agricultural Production

(1) Agricultural production by region

Among the main agricultural products in the Project Area, are

cotton and sugarcane which are grown on a nationwide scale. However, the production areas of vegetables and fruit are unevenly distributed in areas such as Caaguazu, Central, Cordillera, Itapua, Alto Parana, Paraguari. These regions provide 90 % of the total supply of fruit and vegetables at ABASTO market.

The Paraguari region included in the Project Area is the main production district for the following vegetables and fruit.

Crops	Paraguari(%)	Project Area(%)
Pumpkin	24.2	16.5
Onion	49.0	10.0
Plum	78.4	25.4
Peach	64.0	25.4
Pears	100.0	25.4
Grape	87.0	54.0

% is the total supply rate at the ABASTO

The quantity of shipment of the main vegetables and fruit by individual region and shipment period are shown Table D.2.1 and 2.2. Fig.2.1(1) to (7) shows the relation between the amount of the product arrivals to ABASTO and wholesale prices throughout the year.

(2) Productivity

The following Table D. 2.3(1) to (2) shows the productivity of the main crops in the Project Area as compared with other regions according to earning rates.

The productivity of the main crops in the Project Area is higher than the yield per ha should be pointed out as the reason for high productivity.

2.2.3 Summary of the Farm Management Survey

The summary of the farm management survey in the Study Area is shown Table D.2.4 (1) to (10) by each administration section.

At present all farmland in the Area is private land owned by individuals or corporations. However, 344 farm household, or about 15 % of the total farm households, have title deeds acquired by completing the land registration. Many farmers who have unregistered land because of the following points:

(1) The registration charge is high
(2) The registration process is complicated
(3) Land ownership is acquired by long-term residence even if the farmer does not go through formaties of land registration.

Over 50% of gross income from vegetables and fruit farms and also large land holding is spent on production costs. For farming type 1,2 and 4, food expenses 70 % of living expenses. For the other types, light and fuel, clothing and school expenses account for over 70 % of living expenses.

Table D.2.1 Quantity and shipment of the Main Vegetable & Fruit

Unit: ton

Area / Crops	Caaguazu	Cordill-era	Central	Itapua	Alto Parana	Paragu-ari	Others	Sub-Total	Import	Total
1.Vetables										
Lettuce	2.6	1.7	900.4	-	0.8	1.2	0.3	906.7	-	906.7
(%)	0.3	0.2	99.3	-	0.1	0.1	-	100.0	-	100.0
Cabbages	3,543.1	88.9	278.8	2.0	132.2	50.3	38.8	4,134.1	3.3	4,137.4
(%)	85.6	2.1	6.7	0.1	3.2	1.3	0.9	99.9	0.1	100.0
Green Pepper	853.3	496.2	438.7	36.7	114.5	71.2	194.5	2,115.1	452.8	2,567.9
(%)	33.2	15.8	17.1	1.4	4.5	2.8	8.6	82.4	13.6	100.0
Tomate	5,602.2	1,824.5	6,994.7	16.1	1,963.1	366.5	128.7	16,095.8	2,534.0	18,629.7
(%)	30.1	5.5	37.5	0.1	10.5	2.1	0.4	97.2	2.8	100.0
Pampkin	30.0	18.3	78.5	-	6.4	42.5	-	175.7	5.0	180.7
(%)	16.6	10.1	43.4	-	3.5	23.5	-	97.2	2.8	100.0
Onion	1,346.9	62.3	23.1	20.7	66.2	1,703.3	253.2	3,475.7	4,441.1	7,916.7
(%)	17.0	0.8	0.3	0.3	0.8	21.5	1.0	43.9	56.1	100.0
Mandioca	46,181.5	15.0	3.1	8.5	-	-	51.9	46,310.4	-	46,310.4
(%)	99.7	0.0	0.0	0.0	-	-	0.3	100.0	-	100.0
Carrots	1,263.8	17.5	42.8	1,456.5	119.5	1.7	48.2	2,941.0	951.8	3,892.8
(%)	32.5	0.4	1.1	37.4	3.1	0.0	1.2	75.6	24.4	100.0
2.Fruits										
Plum	-	7.0	-	-	1.5	30.9	-	39.4	0.3	39.8
(%)	-	17.7	-	-	3.9	77.6	-	99.2	0.8	100.0
Peach	2.4	-	-	-	4.1	7.0	-	11.1	4.6	15.8
(%)	0.2	-	-	-	26.1	44.3	-	70.5	29.5	100.0
Mandarin	515.7	205.6	114.6	0.9	26.1	50.7	21.4	935.0	24.1	959.1
(%)	53.8	21.4	12.0	0.1	2.7	5.3	2.2	97.5	2.5	100.0
Melon	183.6	905.3	532.9	-	231.6	84.9	62.6	2,000.9	30.4	2,031.3
(%)	9.0	44.6	26.2	-	11.4	4.2	2.2	98.5	1.5	100.0
Naranja	3,058.1	318.7	280.5	4,793.5	820.4	23.8	737.8	10,032.8	6,777.1	16,810.0
(%)	18.2	1.9	1.7	28.5	4.9	0.1	5.5	59.7	40.3	100.0
Pears	-	-	-	-	-	2.5	-	2.5	5.7	8.2
(%)	-	-	-	-	-	30.7	-	30.7	69.3	100.0
Pineappl	67.5	3,341.5	385.6	3.5	35.7	3.5	368.1	4,205.4	160.5	4,365.9
(%)	1.5	76.5	8.8	0.1	0.8	0.1	8.4	96.3	3.7	100.0
Watermelon	770.5	5,252.7	96.8	5.3	13.0	66.1	357.1	6,492.5	12.7	6,493.3
(%)	10.8	80.9	1.5	0.1	0.2	1.0	5.5	99.7	0.3	100.0
Grape	-	-	3.9	-	10.1	70.4	-	80.9	12.7	93.6
(%)	-	-	0.4	-	10.8	75.2	-	86.4	13.6	100.0

Souse: (1) Informe Anual, 1986, 1987, ABASTO

(2) Volumen General de Ingreso de Hortalizas y Frutas

1982/ 1987, ABASTO.

Table D.2.2 Shipment Period of the Main Vegetable & Fruit

Unit: ton

Area	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Caaguazu	6,085	5,270	5,604	5,255	6,384	6,526	7,923	6,175	6,667	6,718	6,690	6,095	75,391
(%)	8.1	7.0	7.4	7.0	8.5	8.7	10.5	8.2	8.8	8.9	8.9	8.1	100.0
2. Central	828	618	442	258	758	648	1,308	1,109	2,088	2,710	2,195	1,075	14,249
(%)	5.8	4.3	3.1	3.9	5.3	4.5	9.2	7.8	14.1	19.0	15.4	7.5	100.0
3. Cordill-	2,402	894	565	485	598	547	906	807	1,004	1,388	3,371	3,958	16,917
era(%)	14.2	5.3	3.3	2.9	3.5	3.2	5.4	4.8	5.9	8.2	19.9	23.4	100.0
4. Itapua	318	339	257	83	36	69	203	838	1,907	1,474	658	273	6,437
(%)	4.8	5.3	4.0	1.3	0.6	1.1	3.2	12.9	29.6	22.9	10.2	4.2	100.0
5. Alto Pa-	848	487	440	290	169	106	233	434	142	159	373	429	4,184
rana(%)	20.5	11.9	10.7	7.1	4.1	2.6	5.7	10.6	3.5	3.9	9.1	10.5	100.0
6. Paragu-	450	132	78	47	89	66	94	97	107	333	647	820	2,961
ari (%)	15.5	4.6	2.7	1.6	3.1	2.3	3.2	1.3	3.7	11.4	22.3	23.8	100.0
7. Others	867	514	603	1,084	598	732	1,229	1,099	645	519	934	789	9,234
(%)	9.4	5.6	6.5	10.9	6.5	7.9	13.3	11.9	7.0	5.6	10.1	8.5	100.0
Total	11,782	8,246	7,989	7,422	8,624	8,694	11,896	10,491	12,488	13,301	14,868	13,439	129,233
(%)	9.1	6.4	6.2	5.7	6.7	6.7	9.2	8.1	9.7	10.3	11.5	10.4	100.0
Imports	2,235	2,011	3,086	2,017	1,821	2,523	2,443	1,917	1,323	1,095	820	1,622	22,914
(%)	9.8	8.8	13.5	8.8	7.9	11.0	10.7	8.4	5.8	4.8	3.6	7.1	100.0

: "Off Season" in the Study Area

: "Off season" in the Nation

Sourse: (1) Informe Anual , 1986,1987, ABASTO

(2) Volumen General de Ingreso de Hortalizas y Frutas, 1982/ 1987, ABASTO.

Table D.2.3 Comparison of the Agricultural Productivity

(1) Cotton:

Unit: G

Area	Yield (ton)	Production Cost	Gross Income	Earning	Earning Rate (%)	Earning Index
1. Stroessner	1.8	278,400	360,000	81,600	22.7	118
2. Caasapa	1.8	384,000	450,000	66,000	14.7	77
3. Ybycui	1.5	229,200	330,000	139,000	42.1	219
4. Stduy Area	1.5	223,600	325,000	101,400	31.2	162
5. National	1.5	278,800	345,000	66,200	19.2	100

(2) Sugarcane

Unit: G

Area	Yield (ton)	Production Cost	Gross Income	Earning	Earning Rate (%)	Earning Index
1. Villarrica	60	273,600	660,000	386,400	58.5	125
2. San Pedro	70	317,280	560,000	242,720	43.3	92
3. Ybycui	65	412,900	715,000	302,100	42.3	90
4. Study Area	70	359,000	770,000	411,000	53.4	114
5. National	60	350,500	660,000	309,500	46.9	100

(3) Tomato

Unit: G

Area	Yield (ton)	Production Cost	Gross Income	Earning	Earning Rate (%)	Earning Index
1. Auncion	40	4,593,600	6,600,000	2,006,400	30.4	148
2. Yguazu	35	4,313,900	5,775,000	1,461,100	25.3	123
3. Caaguazu	30	3,613,500	4,950,000	1,336,500	27.0	132
4. Study Area	20	1,832,000	2,560,000	728,000	28.4	138
5. National	30	3,935,200	4,950,000	1,014,800	20.5	100

(4) Onion:

unit: G

Area	Yield (ton)	Production Cost	Gross Income	Earning	Earning Rate (%)	Earning Index
1. Asuncion	17	698,360	1,105,000	406,640	36.8	141
2. Yguazu	12	553,000	780,000	227,000	29.1	111
3. Caaguazu	14	510,000	910,000	400,000	44.0	168
4. Study Area	10	380,000	650,000	270,000	41.5	158
5. National	7.3	350,000	474,500	124,500	26.2	100

(5) Grape:

unit: G

Area	Yield (ton)	Production Cost	Gross Income	Earning	Earning Rate (%)	Earning Index
1. Alto Parana	10.0	1,450,000	2,000,000	550,000	27.5	91
2. Central	11.0	1,480,500	2,200,000	719,500	32.7	101
3Independencia	13.0	1,405,000	2,600,000	1,195,000	46.0	153
4. Study Area	13.0	1,129,200	2,600,000	1,470,800	56.6	186
5. National	10.0	1,400,000	2,000,000	600,000	30.0	100

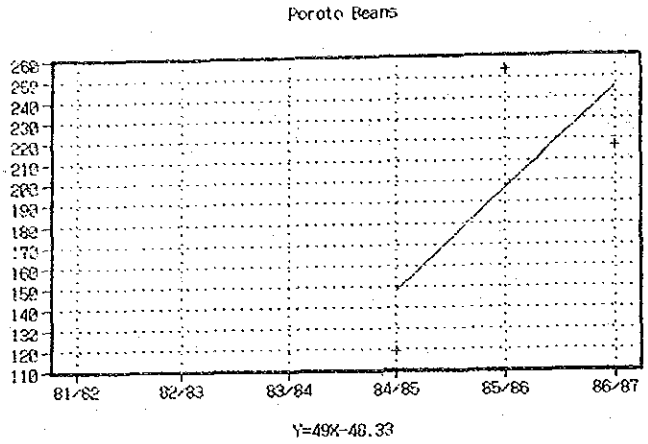
(6) Plum:

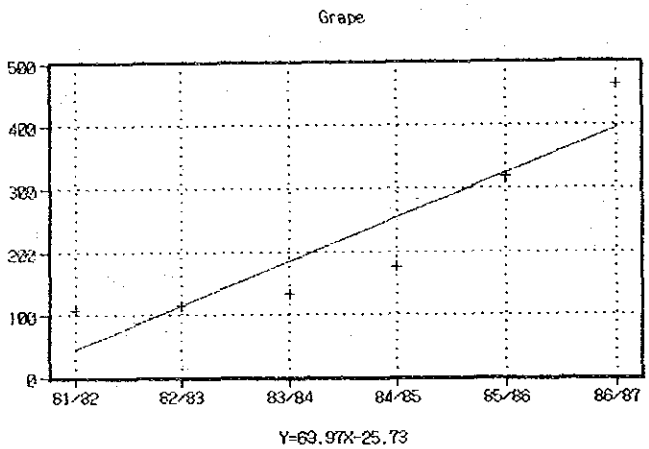
unit: G

Area	Yield (ton)	Production Cost	Gross Income	Earning	Earning Rate (%)	Earning Index
1. Alto Parana	3.0	550,300	639,000	88,700	13.9	100
2. Cordillera	4.0	690,500	852,000	161,500	19.0	136
3Independencia	3.5	612,200	745,500	133,300	17.9	128
4. Study Area	4.6	796,300	979,800	183,500	18.7	134
5. National	3.5	642,200	745,500	103,300	13.9	100

Source : (1) to (6)
(1) Costo de Produccion : Elaborado por el Gabinete Tecnico del MAG, 1988
(2) Costo de Produccion : B.N.F, 1988
(3) Farm Management Survey, JICA, 1988

Fig. D.2.1 Trend of the Producers' Price (1)





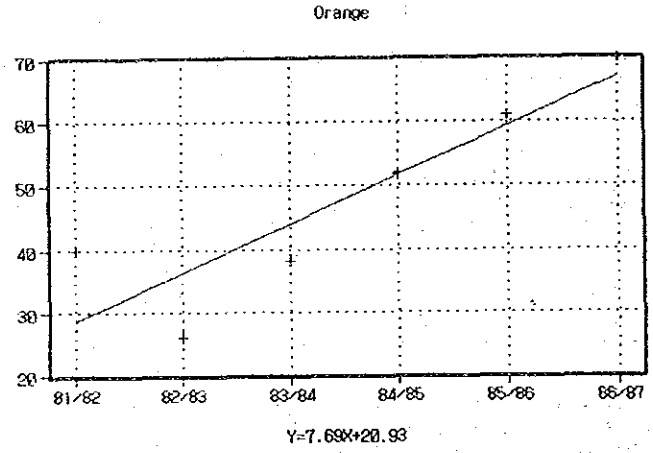
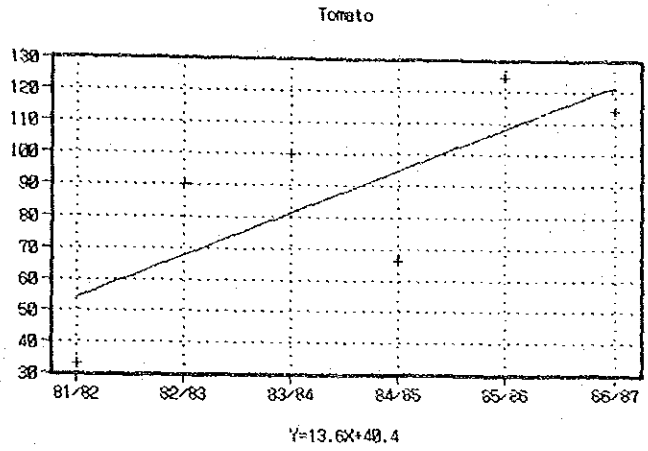
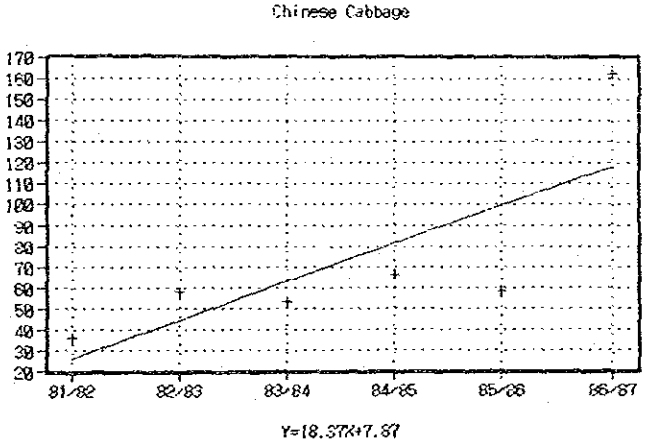


Fig. D.2.1 Trend of the Producers' Price (2)





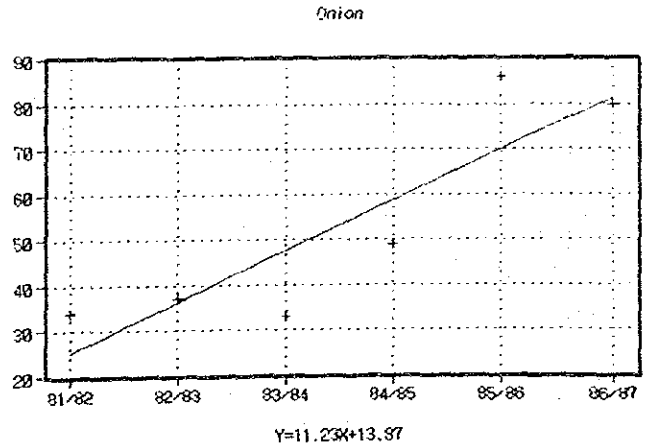
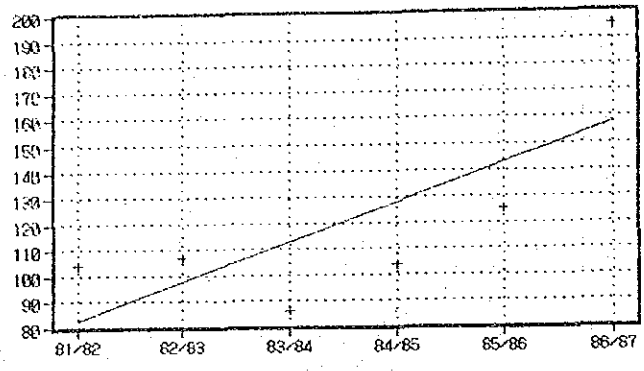


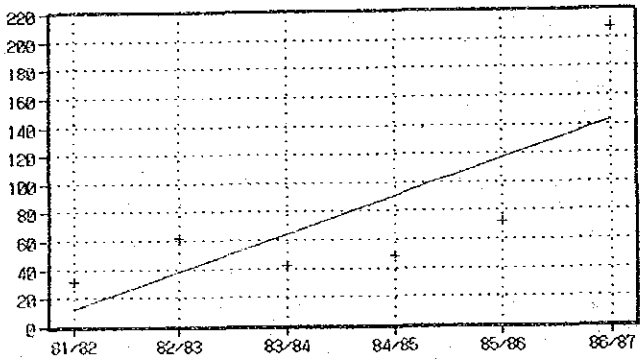
Fig. D.2.1 Trend of the Producers' Price (3)

Green Pepper



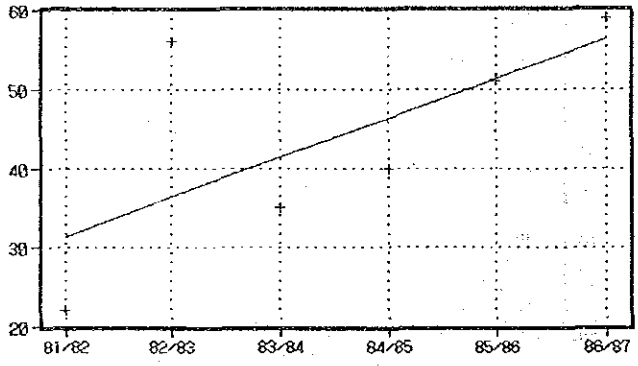
Y=15.06X+67.47

Cauliflower



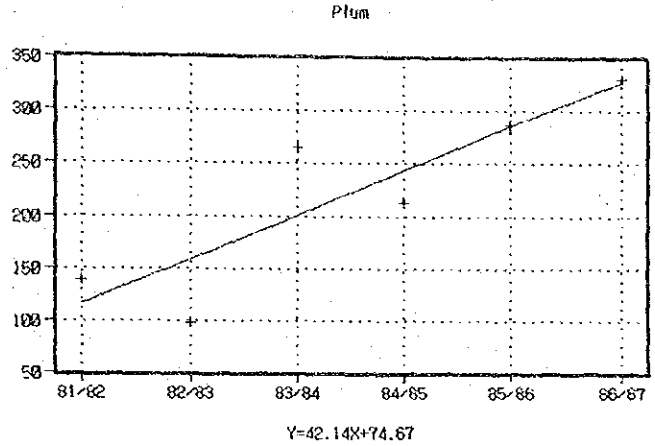
Y=26.2X-14.2

Cabbage



Y=5X+26.33

Fig. D.2.1 Trend of the Producers' Price (4)



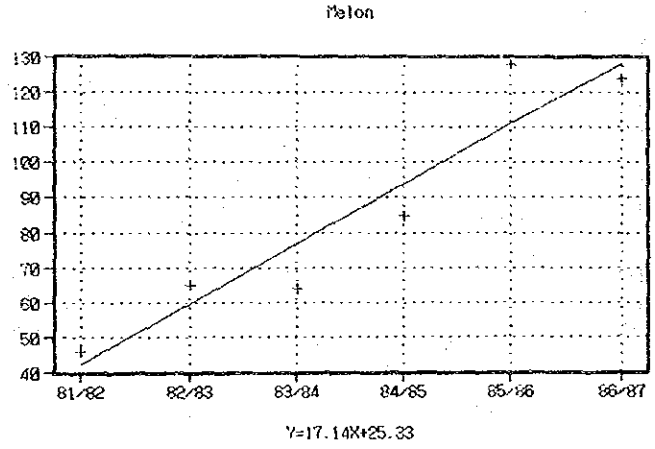
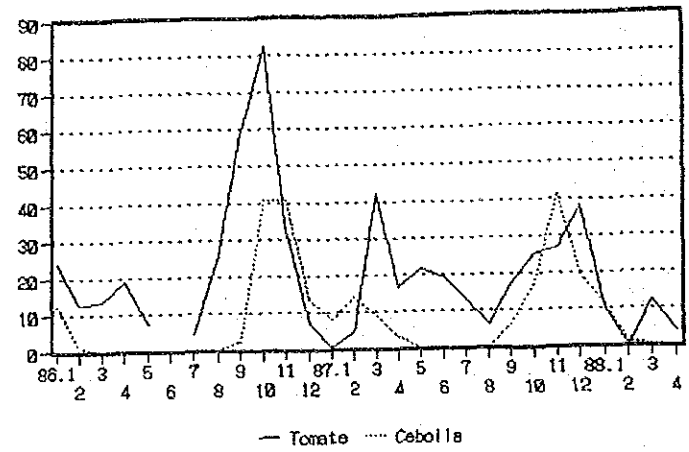
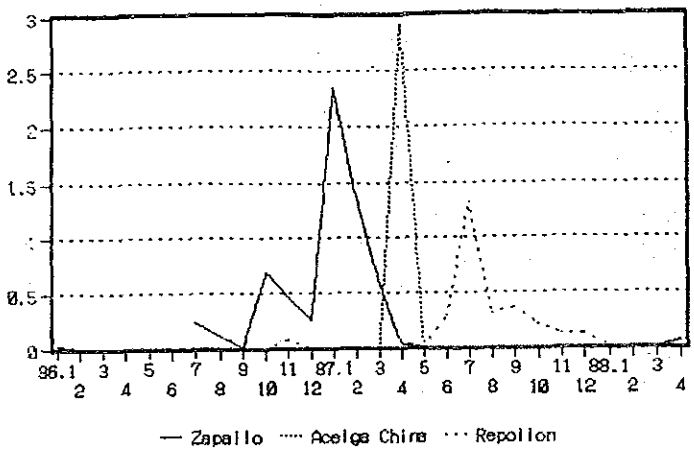


Fig. D.2.2 Trend of the Shipment of Main Agricultural Products (1)





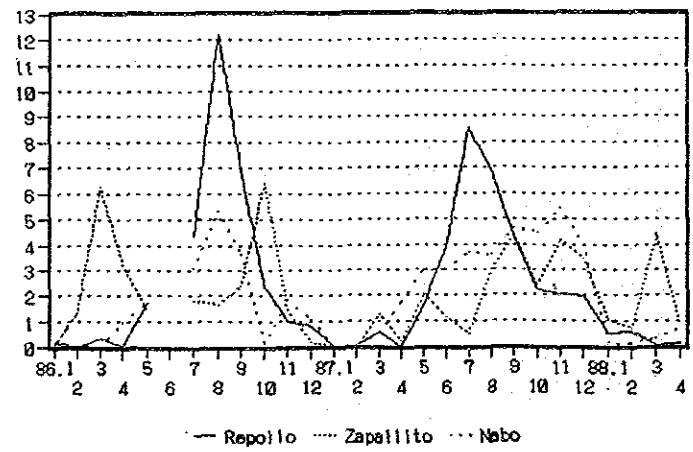
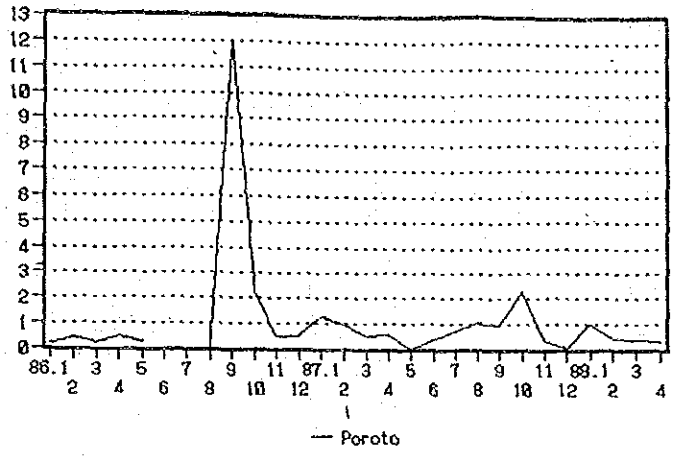
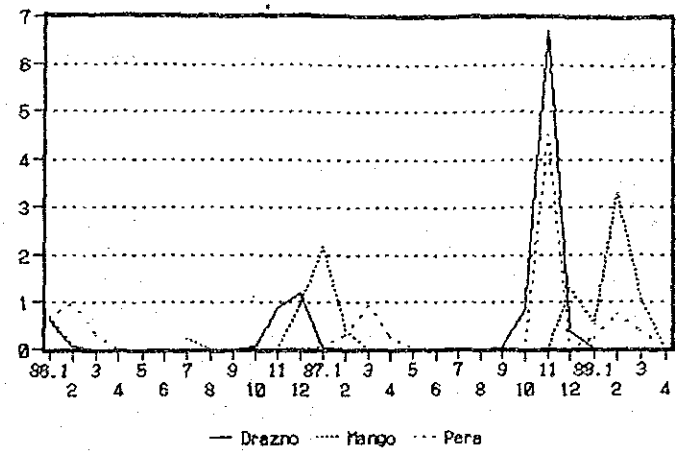


Fig. D.2.2 Trend of the Shipment of Main Agricultural Products (2)





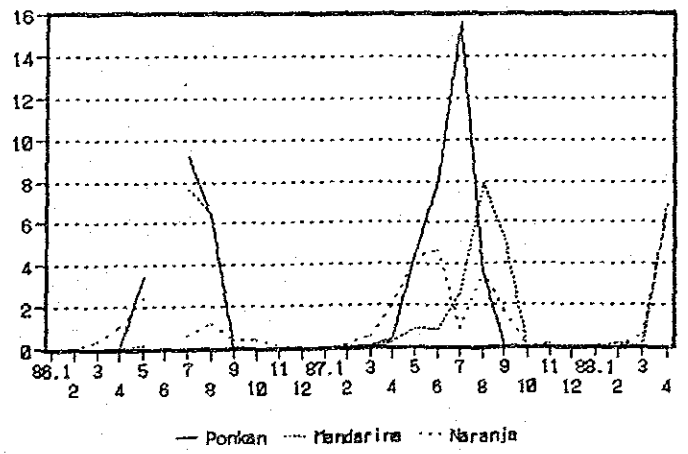
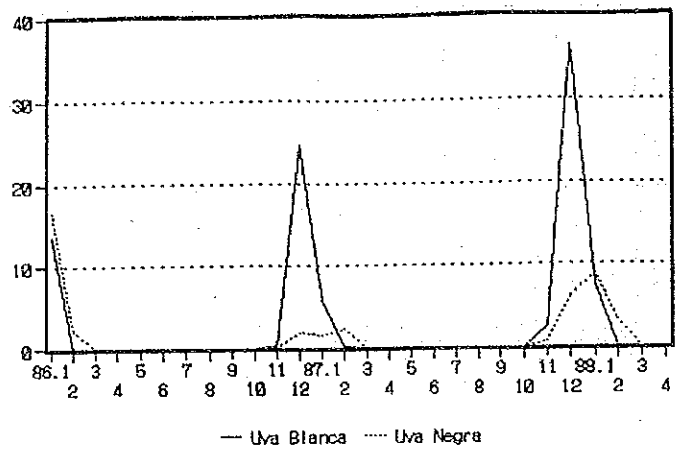


Fig. D.2.2 Trend of the Shipment of Main Agricultural Products (3)



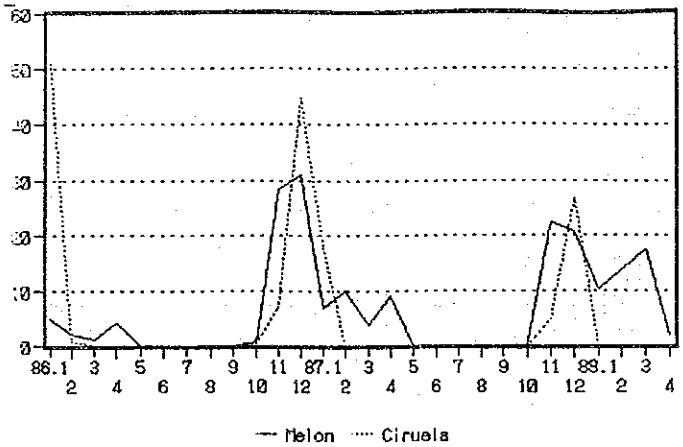


Table D.2.4 Summary of Farm Household Survey (1)

Village(Compania) : Ybaroty

No	General			Cropping System				Household Economy	
	①No. of family ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 9(person) ② 3 ③300 day/year	25.0	Committee B.N.F	Cotton : 2.5 Poroto : 0.5 Tomato : 0.1 Other : 1.0	1.0 0.9 18 -	5.0 15.0 (pasture)	SEAG	1,400,000 None	Total 100,000 45,000 55,000
2	① 7(person) ② 3 ③280 day/year	15.0	Committee None	Cotton : 2.0 Maize : 0.1 Other : 1.0	1.3 1.2 -	10.0	SEAG	1,200,000 100,000	Total 80,000 30,000 50,000
3	① 5(person) ② 2 ③300 day/year	60.0	None None	Cattle : 50 head Other : 1.0	300kg/head -	50.0 (pasture)	None	2,000,000 None	Total 150,000 50,000 50,000
4	① 5(person) ② 1 ③310 day/year	10.0	Committee None	Sugarcane : 2.0 Other : 0.2	70.0 -	5.0	SEAG	600,000 None	Total 80,000 35,000 45,000
5	① 7(person ② 4 ③310 day/year	20.0	Agr. Cooperative	Fruit : 1.5(Grape) Melon : 0.2 Tomato : 0.1 Other Veg. :0.5	21.0 10.0 22.0 16.0	10.0	Agr. Cooperative	3,000,000 None	Total 180,000 50,000 100,000

Table D.2.4 Summary of Farm Household Survey (2)

Village(Compania) : Yahapety

No	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 4(person) ② 2 ③300 day/year	18	Committee B.N.F	Cotton : 1.5 Maize : 0.3 Other : 0.5	1.7 1.3 -	10.0 2.0 (Forestry)	SEAG	600,000 100,000	Total 80,000 50,000 30,000
2	① 3(person) ② 1 ③310 day/year	5.0	None	Sugarcane : 2.5 Other : 0.2	60.0 -	1.0	None	700,000 None	Total 65,000 35,000 30,000
3	① 5(person) ② 3 ③320 day/year	25.0	Agr. Cooperative	Fruit : 1.0(Grape) 1.0(Plum) Tomato : 0.5 Onion : 0.1 Green p. : 0.2	21.0 4.5 25.0 12.0 10.0	10.0 10.0 (Forestry)	Agr. Cooperative	3,500,000 None	Total 200,000 75,000 125,000
4	① 4(person) ② 3 ③320 day/year	20.0	Agr. Coopperative	Fruit : 1.0(Grape) 0.8(Mango, Orange) Melon : 0.2 Onion : 0.2 Other veg. : 0.2	20.0 5.0 3.0 12.0 13.0 -	15.0	Agr. Cooperative	2,850,000 None	Total 200,000 50,000 150,000

Table D.2.4 Summary of Farm Household Survey (3)

Village(Compania) : Mbocayaty

	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 8(person) ② 2 ③300 day/year	7.0	Committe None	Sugarcane 3.0 Other 1.0	60.0 18.0 (Mandioca)	3.0	SEAG	1,200,000 None	Total 100,000 55,000 45,000
2	① 6(person) ② 2 ③280 day/year	15.0	Committee B.N.F	Cotton 2.0 Other 1.5	1.5 20.0 (Mandioca)	10.0	SEAG	700,000 None	Total 80,000 60,000 20,000
3	① 6(person) ② 1 ③300 day/year	20.0	Committee B.N.F	Sugarcane 3.5 Other 1.0	70.0 0.8 (Poroto)	15.0	SEAG	850,000 None	Total 100,000 50,000 50,000
4	① 2(person) ② 1 ③300 day/year	9.0	Committee None	Sugarcane 2.5 Other 1.0	68.0 -	6.0	-	700,000 None	Total 50,000 3,000 2,000
5	① 9(person) ② 4 ③280 day/year	12.0	Committe None	Cotton 1.0 Sugarcane 3.0 Other 2.0	1.0 70.0 -	5.0	SEAG	1,400,000 None	Total 100,000 50,000 50,000

Table D.2.4 Summary of Farm Household Survey (4)

Village(Compania) : Rory

	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 5(person) ② 2 ③290 day/year	20.0	Committee B.N.F	Cotton 2.0 Tomato 0.1 Onion 0.1 Other 1.5	1.0 15.0 8.0 -	10.0 5.0 (Forestry)	SEAG	600,000 150,000	Total 80,000 40,000 40,000
2	① 4(person) ② 3 ③300 day/year	20.0	Committee None	Sugarcane 3.0 Onion 0.2 Other 1.5	72.0 10.0 -	10.0	SEAG	1,500,000 None	Total 100,000 50,000 50,000
3	① 2(person) ② 1 ③310days/yea	6.0	Committee None	Cotton 2.0 Other 1.5	1.2	2.0	None	400,000 100,000	Total 50,000 30,000 20,000
4	① 6(person) ② 4 ③320days/year	25.0	Agr. Cooperative	Fruit 1.0(Grape) 0.5(Plum) Tomato 0.5 Green Peper 0.1 Other Veg. 0.2(Watermelon)	20.0 4.5 23.0 11.0 15.0	10.0 10.0(Forestry)	Agr.Coop.	3,300,000 None	Total 180,000 60,000 130,000

Table D.2.4 Summary of Farm Household Survey (5)

Village(Compania) : Fatima

No	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 8(person) ② 1 ③300days/year	5.0	None -	Cotton : 1.0 Other : 1.5	0.8 -	3.0	None	150,000 550,000	Total 75,000 50,000 25,000
2	① 5(person) ② 2 ③300days/year	5.0	None -	Sugarcane : 1.0 Other : 1.5	55.0 -	2.0	None	600,000 None	Total 50,000 30,000 20,000
3	① 5(person) ② 2 ③300days/year	20.0	Committee None	Cotton : 2.0 Tomato : 0.5 Onion : 0.1 Other : 1.0	1.0 18.0 8.0 -	5.0 10.0 (Forestry)	SEAG	1,000,000 None	Total 70,000 40,000 30,000
4	① 6(person) ② 3 ③310days/year	30.0	Agr. Cooperative	Fruit : 2.0(Mango) Tomato : 1.0 Onion : 0.5 Other Veg. : 0.5	3.0 20.0 10.0 10.0	5.0 10.0 (Forestry)	Agr.Coop.	2,500,000 None	Total120,000 550,00 65,000

Table D.2.4 Summary of Farm Household Survey (6)

Village(Compania) : Portero Alto

No	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 6(person) ② 2 ③290days/year	25.0	Committee None	Cattle : 10 head Cotton : 1.0 Other : 1.0	350kg/head 1.0 -	15.0 (Pasture)	SEAG	1,100,000 None	Total 90,000 50,000 40,000
2	① 5(person) ② 2 ③300days/year	10.0	Committee B.N.F	Cotton : 2.0 Tomato : 0.1 Onion : 0.1 Other : 1.0	1.3 15.0 8.0 -	5.0	SEAG	1,000,000 None	Total 80,000 50,000 30,000
3	① 6(person) ② 1 ③310days/year	4.0	None	Cotton : 0.5 Other : 1.5	0.8 -	2.0	None	100,000 650,000	Total 70,000 50,000 20,000
4	① 7(person) ② 3 ③300days/year	15.0	Agr. Cooperative	Tomato : 0.5 Onion : 0.5 Melon : 0.1 Other Veg. : 0.1 Royal Jelly: 0.2 Others : 1.0	22.0 13.0 13.0 15.0 - -	5.0 5.0 (Forestry)	Agr.Coop.	2,700,000 None	Total 120,000 60,000 60,000

Table D.2.4 Summary of Farm Household Survey (7)

Village(Compania) : Caaty-mi

	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 10(person) ② 3 ③300days/year	15.0	Committee B.N.F	Cotton : 3.0 Tomato : 0.1 Other : 1.5	1.3 15.0 -	5.0	SEAG	1,200,000 None	Total 100,000 80,000 20,000
2	① 7(person) ② 5 ③300days/year	11.0	Committee B.N.F	Sugarcane : 5.0 Other : 2.0	70.0 -	3.0	SEAG	1,650,000 None	Total 85,000 65,000 20,000
3	① 7(person) ② 3 ③320days/year	20.0	Agr. Cooperative	Fruit : 2.5(Plum) 1.0(Orange) Tomato: 0.1 Other veg. :0.5	4.6 5.0 15.0 17.0	10.0	Agr.Cooperative	1,950,000 None	Total 120,000 60,000 60,000
4	① 6(person) ② 4 ③310days/year	10.0	Committee B.N.F	Fruit : 0.3(Grape) Onion : 0.1 Other Veg. : 1.5 Others : 1.5	10.0 10.0 9.0 -	5.0	SEAG	1,000,000 150,000	Total 90,000 70,000 20,000

Village(Compania) : Pindoty

Table D.2.4 Summary of Farm Household Survey (8)

	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 8(person) ② 4 ③310days/year	30.0	Committee B.N.F	Sugarcane: 3.0 Cattle : 22.0 head Others : 2.0	65 300kg/head -	2.0	SEAG	2,000,000 None	Total 120,000 80,000 20,000
2	① 9(person) ② 3 ③300days/year	20.0	Committee B.N.F	Cotton : 1.5 Tomato : 0.1 Onion : 0.1 Others : 2.0	1.3 15.0 9.0 -	15.0	SEAG	700,000 300,000	Total 80,000 50,000 30,000
3	① 6(person) ② 2 ③290days/year	20.0	Agr.Cooperative	Fruit : 1.0(Grape) Cattle : 10 head	22.0 300kg/head	5.0	Agr.Coop.	4,500,000 None	Total 200,000 90,000 110,000
4	① 6(person) ② 3 ③300days/year	35.0	Agr.Cooperative	Fruit : 1.5(Grape) : 0.5(Orange) 1.0(Plum) Others : 1.0	23.0 5.0 4.5 -	5.0 15.0 (pasture)	Agr.Coop.	4,200,000 None	Total 250,000 100,000 150,000

Village(Compania) : Barrero Azul

Table D.2.4 Summary of Farm Household Survey (9)

	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 4(person) ② 2 ③310days/year	12.0	Committee B.N.F	Cotton : 1.0 Tomato : 0.5 Onion : 0.1 Others : 1.5	1.5 20.0 17.0 -	6.0	SEAG	1,250,000 None	Total 100,000 50,000 50,000
2	① 3(person) ② 2 ③330days/year	10.0	Committee None	Sugarcane : 3.0 Others : 2.0 Cattle : 5 head	65.0 - 280kg/head	1.0 4.0(pasture)	SEAG	1,550,000 None	Total 100,000 35,000 65,000
3	① 5(person) ② 2 ③300days/year	20.0	Agr.Cooperative	Fruit : 3.5(Plum) : 1.0(Orange) Tomato : 0.1 Other Veg. 0.1 Onion : 0.1 Others : 1.0	5.0 6.0 15.0 10.0 12.0 -	10.0	SEAG	1,600,000 None	Total 120,000 40,000 80,000

Table D.2.4 Summary of Farm Household Survey (10)

Village(Compania) : Sol Naciente

	General			Cropping System				Household Economy	
	①No. of family(person) ②No. of family labor ③Working day	Land holding area(ha)	①Farmers' organization ②Credit	Farm management type & area(ha)	Yield (t/ha)	Fallow land/ others	Technical assistance	①Agricultural Income ②Non-agricultural Income (G/year)	①Living cost (G/month) ②Food ③Others(electric, water, etc)
1	① 8 (person) ② 2 ③310days/year	8.0	Committee B.N.F	Cotton : 2.0 Tomato : 0.5 Onion : 0.5 Others : 1.5	1.5 18.0 16.0 -	2.0	None	1,150,000 None	Total 120,000 70,000 50,000
2	① 7(person) ② 3 ③330days/year	17.0	Committee None	Cotton : 3.0 Sugarcane: 3.0 Others : 1.0	1.3 60.0 -	8.0	SEAG	1,950,000 None	Total 110,000 55,000 55,000
3	① 5(person) ② 2 ③300days/year	20.0	Committee None	Cattle : 30 head Others : 1.0	350kg/head -		SEAG	1,500,000 None	Total 100,000 40,000 60,000
4	① 2(person) ② 1 ③300days/year	5.0	None None	Cotton : 1.0 Others : 1.5	1.5 -	2.0	SEAG	100,000 700,000	Total 60,000 40,000 20,000
5	① 6(person) ② 2 ③310days/year	8.0	Committee	Sugarcane : 2.0 Cattle : 5 head Others : 2.0	70.0 300kg/head -	1.0	SEAG	1,250,000 None	Total 85,000 50,000 35,000

D.3 Improvement of Agricultural Income and Processing Facility of Winery

3.1 Agricultural Income

As shown Main Report(Chapter 7), implementation of the project, agricultural net incomes will be increased. The following Table D.3.1(1) to (4) shows the details of the agricultural income components.

By the introducing of an irrigation, the intensive farm management will be promoted. In particulary, exemplary good farmers are considerring intensive management based on cash crops, i.e. vegetables and fruit, and leaving out the miscellaneus crops category.

Vegetables are more seriously affected than fruit by drastic price fluctuations. Thus it is desirable for the farmers to switch in later years to either combined (vegetables and fruit) management with more weight placed on the fruit, or specialized fruit cultivation. However fruit cultivation not only requires big investment to set up orchards but time until the trees bear fruit. Therefore, only rich farmers have the chance of switching entirely to fruit cultivation, and others will engae in intensive management of both fruit and vegetables.

If irrigation is facilitated, the farmers who currently practice cultivation of other crops will probably switch to the types of farming shown in main report 4.3.2.

3.2 Improvement of Processing Facility of Winery

In the Project Area brewing period coincides with the peak of summer, the hottest time of the year, rising the brewing temperature and thus making it difficult to maintain and improve product quality.

Fig. D.3.1 and 3.2 are proposed the cooling installation system and low temperature storage for fermentation and brewing of wine.

Table D.3.1 Agricultural Income Plan Components (1)

Pattern : < 5 ha

Item	Planted Area(ha)	Yield (t/ha)	Production(t)	Producers' Price(G/kg)	Gross Income(G)
1. Income					
(1) Sugarcane	1.0	75.0	75.0	11,000(t/ha)	825,000
(2) Onion	0.5	15.0	7.5	68	510,000
(3) Tomato	0.5	30.0	15.0	128	1,920,000
Total					3,255,000
2. Outgo					
(1) Production Cost(G)					
- Labor					158,401
- Seed					124,260
- Fertilizer					498,886
- Agro. Chemical					255,626
- Others					105,600
(2) Total					1,142,773
3. Agricultural Income(G)					2,112,227

Pattern : Type 1

Item	Planted Area(ha)	Yield (t/ha)	Production(t)	Producers' Price(G/kg)	Gross Income(G)
1. Income					
(1) Cotton	1.5	1.5	2.25	250.0	562,2500
(2) Green Paper	0.5	15.0	0.75	170.0	1,275,000
(3) Tomato	0.5	30.0	15.0	128.0	1,920,000
(4) Other Veg.	1.0	25.0	25.0	50.0	1,250,000
Total					5,007,500
2. Outgo					
(1) Production Cost(G)					
- Labor					142,500
- Seed					410,500
- Fertilizer					821,150
- Agro. Chemical					561,700
- Others					226,525
(2) Total					2,162,375
3. Agricultural Income(G)					2,845,125

Table D.3.1 Agricultural Income Plan Components (2)

Pattern : Type 2

Item	Planted Area(ha)	Yield (t/ha)	Production(t)	Producers Price(G/kg)	Gross Income(G)
1. Income					
(1) Sugarcane	2.0	75.0	150.0	11,000(t/ha)	1,650,000
(2) Onion	0.5	15.0	7.5	68	510,000
(3) Tomato	0.5	30.0	15.0	128	1,920,000
Total					
2. Outgo					
(1) Production Cost(G)					
- Labor					158,402
- Seed					124,260
- Fertilizer					566,912
- Agro. Chemical					267,652
- Others					193,600
(2) Total					1,310,826
3. Agricultural Income(G)					2,769,174

Pattern : Type 3

Item	Planted Area(ha)	Yield (t/ha)	Production(t)	Producers' Price(G/kg)	Gross Income(G)
1. Income					
(1) Tomato	0.5	30.0	15.0	128.0	1,920,000
(2) Green Paper	0.5	15.0	7.5	170.0	1,275,000
(3) Onion	0.5	15.0	7.5	68.0	510,000
(4) Melon	0.5	17.0	8.5	128.0	1,088,000
(5) Other Veg.	0.5	25.0	12.5	50.0	625,000
Total					5,418,000
2. Outgo					
(1) Production Cost(G)					
- Labor					105,129
- Seed					507,172
- Fertilizer					997,842
- Agro. Chemical					473,442
- Others					105,130
(2) Total					2,188,715
3. Agricultural Income(G)					3,229,285

Table D.3.1 Agricultural Income Plan Components (3)

Pattern : Type 4

Item	Planted Area(ha)	Yield (t/ha)	Production(t)	Producers' Price(G/kg)	Gross Income(G)
1. Income					
(1) Sugarcane	2.0	75.0	150.0	11,000(t/ha)	1,650,000
(2) Beef Cattle	18.0	300kg/ head	2.4/ head	175,417/head	1,278,000
Total					2,928,000
2. Outgo					
(1) Production Cost(G)					
- Labor					88,000
- Seed					-
- Fertilizer					136,053
- Agro. Chemical					24,053
- Others					88,000
(2) Beef Cattle					476,400
(3) Total					812,506
3. Agricultural Income(G)					2,116,000

Pattern : Type 5

Item	Planted Area(ha)	Yield (t/ha)	Production(t)	Producers Price(G/kg)	Gross Income(G)
1. Income					
(1) Grape	1.2	22.0	26.4	200.0	5,280,000
(2) Plum	0.6	5.5	3.3	213.0	702,900
(3)					
Total					5,982,900
2. Outgo					
(1) Production Cost(G)					
- Labor					138,600
- Seed					-
- Fertilizer					559,800
- Agro. Chemical					191,760
- Others					138,000
- Interest					291,000
(2) Total					1,319,760
3. Agricultural Income(G)					4,663,140

Table D.3.1 Agricultural Income Plan Components (4)

Pattern : Type 6

Item	Planted Area(ha)	Yield (t/ha)	Production(t)	Producers' Price(G/kg)	Gross Income(G)
1. Income					
(1) Grape	1.3	22.0	28.6	200.0	5,720,000
(2) Green paper	0.5	15.0	7.5	170.0	1,275,000
(3) Tomato	0.5	30.0	15.0	128.0	1,920,000
(4) Melon	0.5	17.0	8.5	128.0	1,088,000
Total					10,003,000
2. Outgo					
(1) Production Cost(G)					
- Labor					211,030
- Seed					390,412
- Fertilizer					1,208,981
- Agro. Chemical					553,642
- Others					211,030
- Interest					227,500
(2) Total					2,802,595
3. Agricultural Income(G)					7,200,405

Pattern : Type 7

Item	Planted Area(ha)	Yield (t/ha)	Production(t)	Producers' Price(G/kg)	Gross Income(G)
1. Income					
(1) Grape	1.1	22.0	24.2	200.0	4,840,000
(2) Tomato	0.5	30.0	15.0	128.0	1,920,000
(3) Onion	0.5	15.0	7.5	68.0	510,000
(4) Melon	0.5	17.0	8.5	128.0	1,088,000
sub-total					8,358,000
(5)Royal Jerry					752,000
Total					9,110,000
2. Outgo					
(1) Production Cost(G)					
- Labor					192,867
- Seed					303,172
- Fertilizer					921,591
- Agro. Chemical					436,142
- Others					192,867
- Interest					192,500
sub-total					2,239,000
(2) Royal Jelly					242,800
(3) Total					2,481,800
3. Agricultural Income(G)					6,628,060

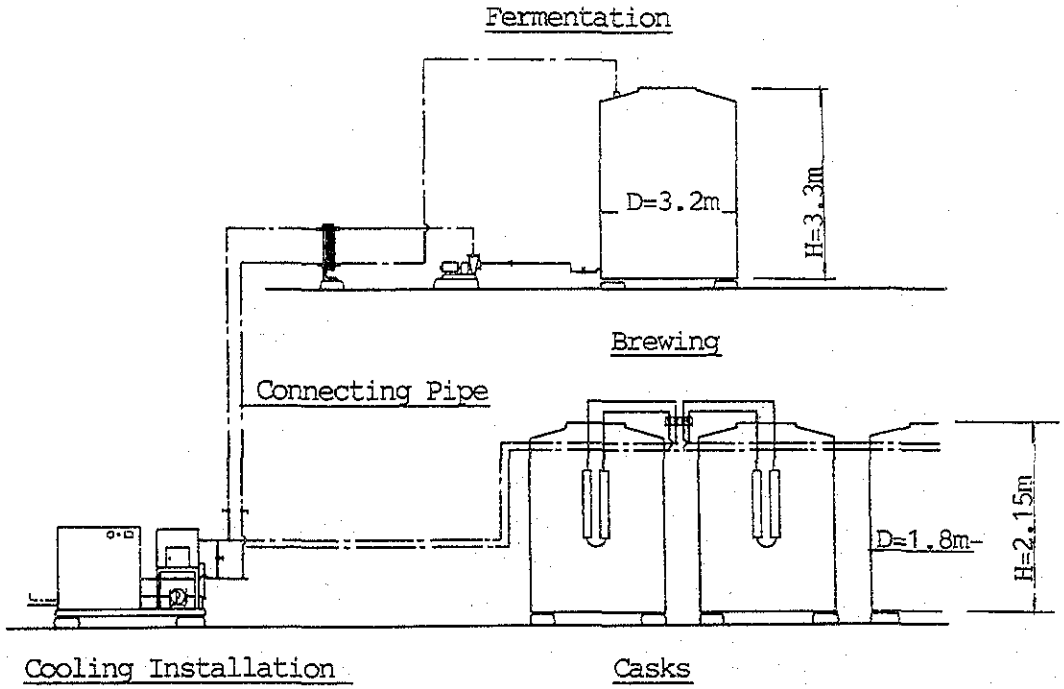


Fig. D.3.1 Proposed Cooling Installation System

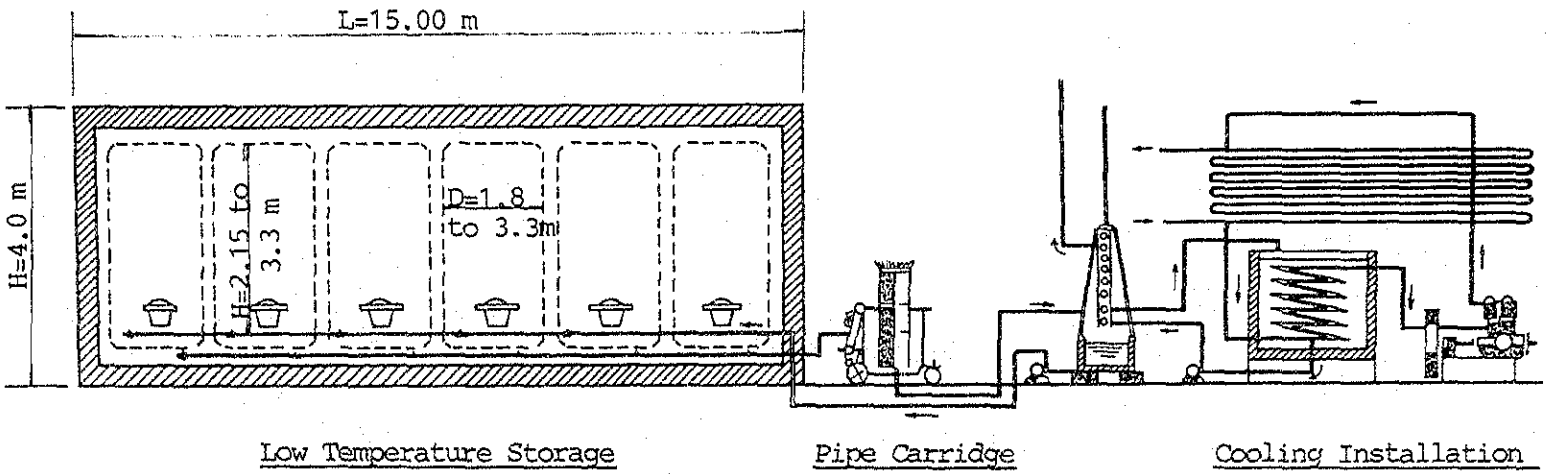


Fig. D.3.2 Propsed Low Temperature Storage System

ANNEX E IRRIGATION AND DRAINAGE

ANNEX E IRRIGATION AND DRAINAGE

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ANNEX E Irrigation and Drainage

E.1 Irrigation

1.1 General

The annual rainfall is approx. 1,600 mm, however, rainfall distribution is irregular and spells of hot weather over 20 days without precipitation occur several times a year in the project area.

There are many small streams in the project area and these streams flow into Tebicuary-mi river as the main drainage course of the area. With these streams, however, the topographical feature of the area is complex land shapes and undulation, and the annual ordinary discharge is low. Therefore, these water resources could not be utilized simply by natural flow and gravity. As water resources except rivers (Tranquera, Rory and Rory-mi), there are springs and wells. At present, about ten superior farmers use pumps to irrigate even on a small-scale on their land. The utilization of pump irrigation in the project area is shown in Table E.1.1. Total irrigated area by pump irrigation is only 10 - 15 ha in the project.

Those without irrigation equipment haul water by cattle cart to water their crops during seeding and transportation periods.

All irrigation water, however, is used on a small scale with high running cost for irrigation. Because of this, they are used only for vegetables and fruit with high profitability and only when necessary. Here is an example:

Tomato: 3-4 mm /day in summer, 1-2 mm/day in winter
Grape : 1 mm/day at the time of budding and before flowering

From the above-mentioned irrigative conditions, implementation of irrigation services will be expedited for improvement of agricultural production and management.

1.2 Water Resource

The water resources for irrigation will be three streams, Tranquera, Rory, Rory-mi. From the result of the investigation of groundwater, the utilization for irrigation cannot be expected due to the low capacity of ground water. To estimate the quantity of water available from Tranquera, Rory and Rory-mi, water measurement was carried on from August to December 1988 by JICA. The results of observation and analysis are

shown in ANNEX A. The discharge of each stream and amount of water available of distinctive elevation are shown in Main Report.

1.3 Available Water and Water Intake Method

In the project area, during the whole year, rains are irregular and the streams are irregular and small and because of the steep slopes. The water flows fast over the surface of the ground when it rains. Under these conditions, it is generally desirable to regulate the water flow by means of a reservoir. However, in the area of the project, the slope is steep and there are few adequate places for the installation of reservoirs. Because of this, it was determined to take water in weirs for intake water and then deliver it directly to the areas requiring it. Available water amount, which is taken by the intake works and distributed by gravity is limited by the altitude of the farm land to be irrigated and located intake works.

The farm land to be irrigated are located at a lower level than 220 m in the streams. In the case of accomplishing irrigation by a gravity system in cultivated land for which the level is below 220 m, it will be necessary to intake water at level EL 230 to 240 m. Based on comparative studies (see parag. 1.4) of the levels of intake works and available water, the five intake works were selected. The amount will irrigate areas of about 200 ha. The following means will be proposed as the water supply system if delivery of the irrigation water for fields larger than 200 ha is desired.

- To pump from the middle of each stream.
- To provide a reservoir at the middle areas of the Tranquera and to supply the water by pumping.

1.4 Irrigation Development Plan

Based on the available water and intake water method, three irrigation plans for the project are proposed as follows;

Plan A: Water distribution using gravity system.
Plan B: Gravity system plus pumping to distribute water.
Plan C: Addition of an artificial reservoir plus Plan B.

(1) Plan A: Water distribution using gravity system

In case of establishing an irrigation plan by a gravity system, a diversion weir is necessary for water-intake not only at one

place on a stream, but at two or three places of the same stream in order to enlarge the volume of water as much as possible. The location of weirs for the water-intake and the volume of available water by gravity are as follows;

Location of Intake Weir	Intake Weir Level (m)	Catchment Area (km^2)	Available Water (l/sec)	Irrigable Area (ha)	Intake Manner
Tranquera I (upper part)	238	0.7	4	14	Gravity system
Tranquera II (middle part)	188	3.0	13	41	- do -
Rory I (upper part)	236	2.5	11	32	- do -
Rory II (middle part)	187	3.5	7	23	- do -
Rory-mi (upper part)	218	2.3	29	86	- do -
Total			64	196 ha	

From the results of the above table, two diversion weirs will be provided at Tranquera and Rory respectively. In case of Rory-Mi, the volume of water-intake in terms of one diversion upstream will irrigate the entire farm land of these streams. The volume of water available for the gravity system will be 66 l/sec and irrigable area will be about 200 ha. The location of the irrigation area and alignment of irrigation facilities are shown in Fig. E.1.1.

(2) Plan B: Gravity system plus pumping to distribute water

Plan B due to increase of irrigable area by pump and gravity system is divided into two development stages as follows.

1) Plan B-1

By pumping facilities installed in middle reaches of Tranquera and Rory, irrigable area of about 400 ha (vegetable and fruit) will be made possible.

Location of Intake Weir	Intake Level (m)	Catchment Area (km^2)	Available Water (l/sec)	Irrigable Area (ha)	Intake Manner
Tranquera I	162	13.0	49	166	Pump up
Rory I	236	2.5	11	32	Gravity system
Rory II	153	9.0	31	116	Pump up
Rory-mi	218	2.3	25	86	Gravity system
Total			116	400	

The location of irrigative area and alignment of irrigation facilities are shown in Fig. E.1.2

Relating to distribution of farmers, Plan B-1, zoning of the Project Area may be made by the elevation for examination of irrigation plan.

In case, A zone is higher than 200 m in elevation, B zone is 140 m through 200 m and C zone is lower than 140 m, the number of the farmers in each zone is as shown in Table E.1.2.

2) Plan B-2

As a possible irrigation area by pumping, the eastern part of the area (Mbocayaty), about 280 ha of land located along route 818 with no available water sources, will be irrigated by a pumping station to be installed at the point of the confluence of the Rory and Rory-mi. The total area of irrigation will be 680 ha.

Location of Intake Weir	Intake Level (m)	Catchment Area (km^2)	Available Water (l/sec)	Irrigable Area (ha)	Intake Manner
Tranquera I	162	13.0	49	166	Pump up
Rory I	236	2.5	11	32	Gravity system
Rory II	153	9.0	31	116	Pump up
Rory-mi	218	2.3	25	86	Gravity system
Rory & Rory-mi	148	27.0	144	280	Pump up
Total			260	680	

The location of the irrigation area and alignment irrigation facilities are shown in Fig. E.1.3.

(3) Plan C: Plan B plus artificial reservoir

The land area of 680 ha is the limit that is irrigated with Plan B which combines gravity and pumping to obtain surface water from the three streams. As other water resources, the proposed capacity of the reservoir to be constructed in the middle part of Tranquera is estimated at about 1.5 million m^3. The excess water of Tranquera during the wet season will be used to fill the pond, which will be utilized to irrigate approx. 220 ha of land in the western and northern part of the area. Therefore, a maximum 900 ha on the whole will be irrigated in the project area.

Location of Intake Weir	Intake Level (m)	Catchment Area (km^2)	Available Water (l/sec)	Irrigable Area (ha)	Intake Manner
Tranquera I	162	13.0	49	166	Pump up
Rory I	236	2.5	11	32	Gravity system
Rory II	153	9.0	31	116	Pump up
Rory-mi	218	2.3	25	86	Gravity system
Rory & Rory-mi	148	27.0	144	280	Pump up
Tranquera reservoir	150	16.0	113	220	
Total			373	900	

The locations of the irrigation area and alignment irrigation facilities are shown in Fig. E.1.4

The table below shows the total project costs and irrigation development cost per unit area classified by plan.

Plan	Irrigation Area	Facility Costs unit: 1,000 G	Cost per ha unit: 1,000 G
Plan A	196	3,109,000	15,862
Plan B-1	400	4,503,000	11,257
Plan B-2	680	8,187,000	12,039
Plan C	900	13,069,000	14,521

The breakdown of the estimated costs including construction and maintenance and management is shown in Table E.1.3 to E.1.4.

The four irrigation development plans characterized by the available water volume and needed facilities are divided into two stages, taking into account priorities of the development and degrees of improvement.

(i) First stage

Irrigation priority will be given to the existing cultivation of vegetables and fruit. With Plan A in which only the natural force is used to draw water, however, water cannot be delivered to the upper and middle reaches of Rory and Tranquera, a major production district of vegetables and fruit inside the Study Area. Considering this point along with the development cost efficiency per unit area, early development priorities will be given to Plan B-1 (Plan A + pumping station at the middle stream of Rory and Tranquera, irrigation area 400 ha). The irrigation diagram of the First Stage is shown in Fig. E.1.5.

(ii) Future stage

The eastern, western and northwestern part of the Study Area covering the land area of about 500 ha will be developed for irrigation when needs for more irrigation have increased in the future. With this plan, uneven distribution of irrigation facilities in the area will be eliminated. The irrigation diagram of the Future Stage is shown in Fig. E.1.6.

1.5 Irrigation Water Requirement

(1) General

For the estimation of crop water requirement, meteorological data at the Villarrica station were used since data for the study of other meteorological stations are not available. Mean monthly meteorological values observed at Villarrica station are as follows:

Items	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Temperture	26.4	26.0	24.6	22.9	20.1	17.8	18.6	17.8	19.5	22.0	23.7	25.4
Relative Humidity	73	76	77	83	85	84	80	75	71	72	73	73
Sunshine Hours	8.1	7.9	7.3	7.3	6.4	5.4	6.1	6.4	6.0	7.2	8.7	8.3
Wind Velocity	3.1	3.2	3.2	3.5	3.8	4.0	4.5	4.1	4.0	3.8	3.3	3.2

(2) Potential evapotranspiration (ETo)

In order to determine an appropriate method for estimation of the potential evapotranspiration in the Study Area, modified Penman is applied based on the climate data obtained in Villarrica station, because the modified Penman method would offer the best results with minimum possible error of plus or minus 10 percent in summer, and up to 20 percent under low evaporative conditions.

Summary of estimated ETo values by the modified Penman method is as follows and details are shown in Table E.1.5.

Unit mm

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
*	7.0	6.4	5.3	3.9	2.8	2.3	3.0	3.7	4.7	5.8	6.8	7.0
**	216.8	179.1	165.1	117.9	87.1	70.1	94.0	113.3	141.1	180.4	205.1	217.7

* Day

** Month

(3) Crop coefficient

The crop coefficients adopted for this study are used the value which is established by FAO since there are no experimental data on the crop coefficients in the Study Area.

(4) Consumptive use of water

The consumptive use of water is estimated by multiplying the calculated ETo values by the crop coefficients (Kc) which express the relation between potential and actual evapotranspiration during distinct vegetative stage of the crop.

(5) Irrigation efficiency

Water losses are unavoidable during the conveyance from intake to the farm. Irrigation water requirement at the head of water source were estimated in consideration of net irrigation water requirement, operation of irrigation system, conveyance by water way. Taking into consideration the type of water way, related structures and the soils, the gross irrigation efficiency was estimated to be 72.6% on the basis of the following assumptions:

(1)	Application efficiency	0.85
(2)	Operation efficiency	0.95
(3)	Conveyance efficiency	0.90
	Overall irrigation efficiency	0.726

(6) Total readily available water quantity

Water quantity for irrigation of the fields is represented by the difference between the field capacity and the moisture at initial wilting point retained by the soil at such a depth where roots absorb water efficiency.

Following procedure would be applied in estimating the total readily available water quantity.

Available moisture of a soil layer was estimated by the following formula:

$$AMI = 1/100 \times (FC - WPF) \times H$$

where, AMI: available moisture in mm of a soil layer
FC : field capacity in percentage
WPF: moisture at initial wilting point in volumetrical percentage
H : thickness of a soil layer in mm

The field capacity and the moisture at initial wilting point where determined based on the soil type of the Study Area.

According to the field survey and results of soil tests, the above soil moistures would be concluded as follows:

Soil type	Soil Moisture (%)
Field capacity (PF. 1.5)	23.2
Initial wilting point (PF. 3.5)	10.0

The thickness of a soil layer favorable for efficient water absorption by plants was estimated to be 10 cm for vegetables and 25 cm for fruit. Accordingly, the available moisture of a soil layer (AMI) was calculated as follows:

Vegetables: AMI = 1/100 x (23.2-10.0) x 100 = 13.2 mm
Fruit : AMI = 1/100 x (23.2-10.0) x 250 = 33.6 mm

The total moisture efficiently absorbed by plants was estimated by the following formula:

$$WDI = AMI \times 100/RMEI$$

where, WDI : moisture absorbed by plants in mm according to soil characteristics
RMEI : ratio of absorbed moisture in each soil layer in percent

The results are summarized below:

Soil Layer	Ratio of water absorption	Moisture absorbed by plants due to soil characteristics	
		Vegetables	Fruit
1st	35%	37.7 mm	94.3 mm
2nd	30	44.0	110.0
3rd	25	53.0	132.0
4th	10	132.0	330.0

The total readily available moisture was determined as the minimum value of moisture efficiently absorbed by plants. As shown in the above table, the total readily available moisture would be 37.7 mm for vegetables and 94.3 mm for fruit.

(7) Watering periods

The maximum period of waterings was estimated according to the following formula:

$$\text{Maximum period of waterings} = \frac{\text{Total readily available moisture in mm}}{\text{Peak water consumption by crops in mm}}$$

The peak water consumption by crops was estimated to be 7 mm per day for vegetables and 5 mm per day for fruit. Therefore, the watering period would be as follows:

Vegetables 37.7/7 = 5 days
Fruit 94.3/5 ÷ 18 = 15 days

(8) Diversion water requirement

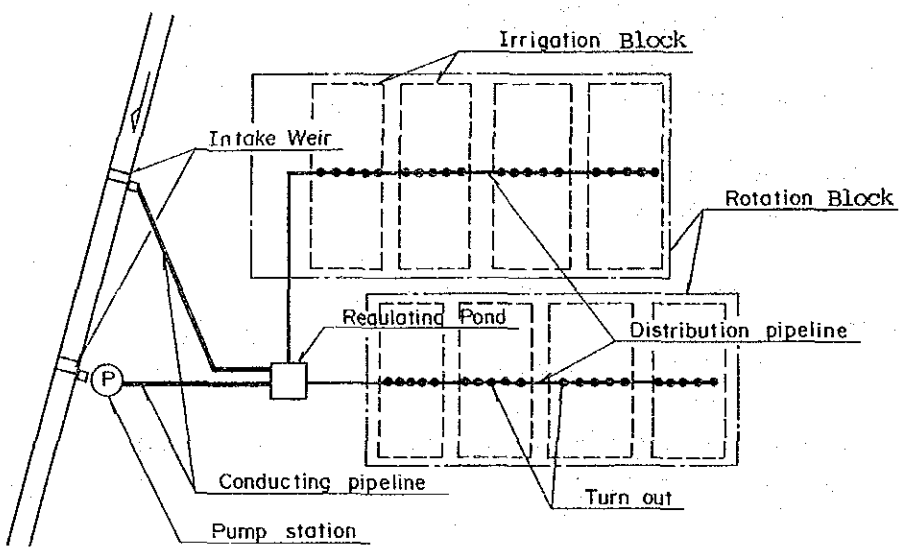
Using the consumptive use of crop mentioned above, diversion water requirement is estimated for irrigation system of 400 ha (First Stage) based on the cropping pattern and the area for this cultivation plan and are shown in Table E.1.6.

Maximum water requirement for 400 ha of first stage is 116 l/sec in July and minimum is 95 l/sec in October.

1.6 Facility

(1) Distribution system

The irrigation water from each diversion weir will be distributed to the farm area through conducting pipelines and distributing pipe lines. The irrigation water from the weir, first of all, will flow into a regulating pond through the conducting pipe and be regulated for flow into the distributing pipeline. In particular, the water taken during the night, is reserved in the regulating pond, and the water will be delivered in proportion to the irrigation work hour. A diagram of the distribution system is as follows;



(2) Irrigation system

- 400 ha of irrigative area is divided into four irrigation blocks according to each stream or hill block, providing the main distribution pipe line. The irrigation blocks are also divided into several rotation blocks which can be irrigated every day as one block.

- Peak water requirement for the whole irrigative area is estimated as 116 lt/sec as delivered within 24 hours. In the case where the water requirement is delivered within 16 hours, it becomes 174 lt/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.

- Considering the irrigation within 5 days, in the case where an area of one rotation block is designed as five ha, irrigation area per day is estimated one ha. The area of one ha will be a possible irrigation area for one or two farmers.

- Turn outs (hydrant) for farmers is provided four or five in one rotation block and these locations will be selected at center or boundary of farmer's land.

The irrigation block and rotation block are shown in Fig. E.1.7.

(3) Intake works

A total of four diversion weirs will be provided in order to ensure the water requirements for the irrigation development.

Amount of intake water, location level and manner of intake for proposed intake works are shown in Table E.1.7. The scale and the structures of weir are shown in Table E.1.8.

For the planning of the structure for 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 volume of water flow is low, in times of shortage of water it should be possible to allow the intake of all the volume.

- In times of flood, a lot of sand flow occurs (especially fine sand). Some installations should be considered to prevent sand from entering the canals.

- The weir is provided with an outlet gate to remove the sand that has accumulated upstream of the weir.

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

(4) Pipe line

a) Capacity of pipe line

The pipe lines which are provided from the diversion weir to the irrigation field are classified into the following two

categories:

- The conducting pipe that delivers from the diversion weir to the regulating pond.

  The irrigation water will be delivered within 24 hours through the conducting pipeline. Designed discharge of irrigation water will be estimated by means of irrigation area multiplied by unit water requirement at the peak time in 24 hours.

- The distribution pipe that delivers from the regulating pond to the field.

  Distribution pipelines divert the water to regulate the regulating pond from the regulating pond to the field Distribution pipelines are designed according to the capacity which can be irrigated in the irrigation block in the day time at the peak times for 16 hours per day.

b) Hydraulic plan

According to the irrigation diagram established by block location, the flow capacity of pipelines is estimated by unit water requirement and commanding area of the irrigation block, and shown in Fig. E.1.7

Hydraulic calculations made by Heizen William are based on the irrigation diagram, and diameter of the pipe is estimated taking into account the water pressure in the pipe making possible the operation of the irrigation equipment. As the result of the hydraulic calculation, the pipe diameter is shown in Table E.1.9. to E.1.12 and Fig. E.1.8. PVC pipe is used in the pipe line for the gravity system and Ductile pipe is provided in the pumping transportation system taking into account the high pressure caused by water hammer.

(5) Regulating pond

Supposing that the water intake from the diversion weir and pump station area is accomplished over 24 hours, and that the irrigation inside the farm land is accomplished during 16 hours, the capacity of the reservoir of the regulating pond will be determined by the volume used, to control the time taken by both functions, water intake and irrigation.

Three regulating ponds are provided in the project area. One is provided at Caaty-Mi to regulate of intake water from Rory-Mi. Others are provided at Barrero Azul-I and Yajhapety. Tranquera regulating pond reserves water resources from three intake works of Tranquera's and Rory's one. For the Yajhapety area separated from Arroyo Tranquera, a regulating pond is provided to regulate water resources from Barrero Azul. The location and facilities of the regulating pond are shown in Table E.1.14.

The regulating pond will be located in a high area in such a way that the gravity pressure in the regulating pond would allow the distribution of water to the whole area, and would also allow irrigation using sprinklers.

(6) Pumping plant

The water for distribution collected in weirs of Tranquera-I and Rory II will be sent to the regulating pond of Tranquera by pumping. 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 pumps (unit)
Tranquera	1.47	71	81	ø100	45	2
Rory	0.93	82	90	ø 80	30	2

In order to plan the pumps, the following items will be taken into account:

- Installation level of pump is set higher than flood water level of Tranquera and Rory.
- The pump is designed absorbing pump type.
- The pump is run intermittently according to the water level of the regulating pond.

For safety of the pipeline, the pump will be provided with water hammer prevention devices.

The results of analysis of water hammer is as follows:

- Tranquera

1) Basic Data

- Pump

Number Installed	:	2 units
Number Operating	:	2 units
Rated Pump Capacity	:	1.47 m^3/min
Rated Pump Total Head	:	81 m
Rated Speed of Rotation	:	3530 min-1

- Motor and Value of GD2

Motor Output	:	45 kw
Motor Type	:	Squirrel Cage
Motor Voltage	:	400V
Number of Poles	:	2P
Motor GD2	:	0.406 kg.m^2
Pump GD2	:	0.43 kg.m^2

- Check Valve

Valve Bore	:	125 mm
Valve Type	:	Ordinary Check Valve

- Pipeline

Material	:	Ductile C.I. Pipe
Diameter	:	200 mm
Thickness	:	7.5 mm
Value of K/E	:	0.013
Wave Speed	:	1227 m/sec
Length	:	1100 m
Head Loss	:	14.5

- Operating Conditions

Flow Quantity	:	2.94 m^3/min
Suction Water Level	:	NWL 162.50 EL m
Discharge Water Level	:	NWL 233.5 EL m
Actual Head	:	71.0 m
Total Head Loss	:	8.0 m
Head Loss in Pump Station	:	2.0 m
Pump Capacity ratio	:	100 %
Pump Head ratio	:	100 %

ii) Calculation Results

		Distance	Elevation
Minimum Pressure:	-2.905 kgf/cm^2	750 m	220 EL m

Water column separation will occur. Countermeasures are necessary.

MAX/MIN PRESSURE LINES are shown in Figure E.1.9.

(c) Recommendation of Prevention Devices against Water Hammer

- Addition of Flywheel

Flywheel GD2 :	2.29 kg.m^2
total GD2 :	3.123 kg.m^2
Flywheel Type:	Coupling Type

(d) Calculation of Results after Prevention Devices are installed

		Distance	Elevation
Minimum Pressure:	-0.452 kgf/cm^2	799.9 m	225 EL m
Maximum Pressure:	11.346 kgf/cm^2	0 m	163 EL m

Negative pressure is small, occurrence of water column separation is not anticipated. It appears that Max. pressure is within allowable limits.

- Rory

i) Basic Data

- Pump

Number Installed	:	2 units
Number Operating	:	2 units
Rated Pump Capacity	:	0.93 m^3/min
Rated Pump Total Head	:	90 m
Rated Speed of Rotation	:	3530 min-1

- Motor and Value of GD2

Motor Output	:	30 kw
Motor Type	:	Squirrel Cage
Motor Voltage	:	400V
Number of Poles	:	2P
Motor GD2	:	0.266 kg.m^2
Pump GD2	:	0.335 kg.m^2

- Check Valve

Valve Bore	:	100 mm
Valve Type	:	Ordinary Check Valve

- Pipeline

Material	:	Ductile C.I. Pipe
Diameter	:	200 mm
Thickness	:	7.5 mm
Value of K/E	:	0.013
Wave Speed	:	1227 m/sec
Length	:	1200 m

- Operating Conditions

Flow Condition	:	Designed Quantity
Flow Quantity	:	1.86 m^3/min
Suction Water Level	:	NWL 151.50 EL m
Discharge Water Level	:	NWL 233.5 EL m
Actual Head	:	82.0 m
Total Head Loss	:	6.0 m
Head Loss in Pump Station	:	2.0 m
Pump Capacity ratio	:	100 %
Pump Head ratio	:	100 %

(b) Calculation Results

		Distance	Elevation
Minimum Pressure:	-3.301 kgf/cm^2	675 m	208.37 EL m

Water column separation will occur. Countermeasures are necessary.

MAX/MIN PRESSURE LINES are shown in Figure E.1.9.

(c) Recommendation of Prevention Devices against Water Hammer

- Addition of Flywheel

Flywheel GD2 :	2.365 kg.m^2
total GD2 :	2.966 kg.m^2
Flywheel Type:	Coupling Type

(d) Calculation of Results after Prevention Devices are installed

		Distance	Elevation
Minimum Pressure:	-0.427 kgf/cm^2	999.9 m	229 EL m
Maximum Pressure:	12.215 kgf/cm^2	0 m	152 EL m

Negative pressure is small, occurrence of water column separation is not anticipated. It appears that Max. pressure is within allowable limits.

(7) Survey of intake rate

The survey of intake rate is carried out in 4 places in the Project Area due to selection of field irrigation method and condition affect the intake rate of the soil. The locations of survey are shown in Fig. 1.10 and the results of analyzed survey are shown in Table E.1.15 to E.1.18.
The intake rate of the area is observed more large value than 70 mm per hour. Therefore, sprinkler and drip irrigation will be appropriated for the soil in the Project Area.

YBAROTY		YAJHAPETY		FATIMA		PINDOTY	
No.	Intake Rate mm/hr	No.	Intake Rate mm/hr	No.	Intake Rate mm/hr	No.	Intake Rate mm/hr
No.6	100	No.4	155	No.1	80	No.3	17
No.9	115	No.5	20	No.2	156	No.8	254
				No.7	178	No.10	24
Total	225		175		414		295
Average	112.5		87.5		138.0		98

2. Drainage

2.1 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 (See Fig. E.1.11).

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) A hard layer occurs 50-100 cm below the surface and ground water level is high.

2.2 Drainage Improvement Plan

Drainage improvement will be carried out for the marshy 900 ha of land out of the 2,800 ha area mentioned above. Drainage canals and bridges will be designed as 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	Bridge & culvert

In order to improve the poor drainage, Sol Naciente and Pindoty-III areas will be selected in the scope of the First Stage. Drainage improvement for these areas is important due to rehabilitation of the roads in the area. The total length of these drainage canals of improvement is 4 km. Scale of drainage facility is as follows:

Drainage Canal	Length of Drainage Canal (km)	Flood Discharge m^3/sec	Canal Section (m)	Longitudinal Slope	Canal Structure
Sol Naciente	1.8	12.6	B = 8.0 H = 1.8	1/800	Earth canal
Pindoty-III	2.2	6.7	B = 6.0 H = 1.6	1/1000	Earth canal

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

Remaining five drainage canals of 6 km will be improved at Future Stage.

Table E.1.1 Condition of Farmer's Irrigation Facilities

No. of Farmer	Irrigation Crops	Irrigation Period	Irrigation Area (ha)	Contents of Irrigation Facilities			Water Resource	Pond
				Power	Pump (inch)	Length of pipe		
1	Vegetable	Jun. - Oct.	0.2	Engine	φ 2	800 m	Spring	×
2	- do -	Jan. - Dec.	0.75	- do -	φ 1.5	200 m	Well	×
3	- do -	- do -	1.0	- do -	φ 1.5	300 m	Spring	○
4	- do -	Aug. - Dec.	0.25	- do -	φ 2	550 m	Spring	○
5	- do -	Jan. - Dec.	1.0	- do -	φ 1 1/4	150 m	Rain water	○
6	- do -	- do -	1.0	- do -	φ 1.5	300 m	Spring	○
7	- do -	- do -	0.5	- do -	φ 2	150 m	Spring	○
8	- do -	- do -	0.5	- do -	φ 2	500 m	Spring	○
9	- do -	- do -	1.5	- do -	φ 2	500 m	Spring	○
10	- do -	- do -	1.0	- do -	φ 2	600 m	Spring	○
11	- do -	- do -	1.5	- do -	φ 2	800 m	Ao. Rory	○
12	- do -	- do -	1.5	- do -	φ 2	450 m	Spring	○
13	- do -	- do -	1.0	- do -	φ 1.5	400 m	Tranquera	○
14	- do -	- do -	0.5	- do -	1	300 m	Well rain water	○
15	Fruit	Jul. - Sep.	2.0	Electric	1 1/4	500 m	Well	○
16	- do -	- do -	2.0	Engine	2	400 m	Spring	○

Table E.1.2 Number of Household by Zone

Village	No. of Household	Zone			Remarks
		A Zone	B Zone	C Zone	
YBAROTY	53	13	7	33	A Zone: High land more than EL 200 m
YAJHAPETY	27	1	26	-	B Zone: Benefited area by irrigation
MBOCAYATY	56	8	-	48	C Zone: Remaining area
RORY	30	-	30	-	(Irrigated in Future)
FATIMA	34	17	17	-	
POTRERO ALTO	33	25	8	-	
CAATI-MI	46	-	41	5	
PINDOTY	52	-	42	10	
BARRERO AZUL	40	15	25	-	
SOL NACENTE	34	-	-	34	
TOTAL	405	79	196	130	
	(100%)	(20%)	(48%)	(32%)	

Table E.1.3 Irrigation Facility Cost (1)

Irrigation Development Plan - A — Unit: 1,000 G

Facility Items	Contents		Facility Cost
Intake facility	Tranquera	2 place	375,000
	Rory	2 place	
	Rory-mi	1 place	
Pipe line	PVC φ250	6.4 km	2,142,000
	φ200	16.9 km	
	φ150	11.4 km	
	φ100	1.6 km	
	DIC φ200	1.0	
	φ150	1.5 km	
Regulating pond	Reservoirs (Total volume 2,200 m3)	4 place	132,000
Field irrigation equipment	Irrigation equipment	196 ha	452,000
Maintenance	Maintenance cost		8,000
Total			3,109,000
Unit cost/ha	Service area	198 ha	15,862

Irrigation Development Plan B-1 — Unit: 1,000 G

Facility Items	Contents		Facility Cost
Intake facility	Tranquera	1 place	297,000
	Rory	2 place	
	Rory-mi	1 place	
Pipe line	PVC φ250	7.2 km	2,127,000
	φ200	12.5 km	
	φ150	7.6 km	
	φ125	4.8 km	
	PCP φ100	5.6 km	
	DIC φ200	2.3 km	
Regulating pond	Reservoirs (Total volume 3,700 m3)	3 place	217,000
Pump station	- Tranquera		494,000
	Pump (Q=1.47m3/min H=81m 45kw)	2 piece	
	- Rory		
	Pump (Q=0.93m3/min H=90m 30kw)	2 piece	
Field irrigation equipment	Irrigation equipment		922,000
Maintenance	Running cost		446,000
	Maintenance cost		
Total			4,503,000
Unit cost/ha	Service area	400 ha	11,257

Table E.1.4 Irrigation Facility Cost (2)

Irrigation Development Plan - B-2 Unit: 1,000 G

Facility Items	Contents			Facility Cost
Intake facility	Tranquera		1 place	
	Rory		2 place	375,000
	Rory-mi		2 place	
Pipe line	PVC φ250		9.7 km	
	φ200		16.1 km	
	φ150		10.8 km	
	φ125		4.8 km	4,088,000
	φ100		5.6 km	
	DCP φ350		5.5 km	
	φ200		2.3 km	
Regulating pond	Reservoirs (Total volume 7,500 m3)		4 place	330,000
Pump station	- Tranquera (Q=1.47m3/min H=81m 45kw)	Pump	2 piece	
	- Rory (Q=0.93m3/min H=90m 30kw)	Pump	2 piece	960,000
	- Rory-mi (Q=4.32m3/min H=90m 110kw)	Pump	2 piece	
Field irrigation equipment	Irrigation equipment		680 ha	1,568,000
Maintenance	Running cost Maintenance cost			866,000
Total				8,187,000
Unit cost/ha	Service area		680 ha	12,039

Irrigation Development Plan - C Unit: 1,000 G

Facility Items	Contents			Facility Cost
Intake facility	Tranquera		1 place	
	Rory		2 place	375,000
	Rory-mi		2 place	
Pipe line	PVC φ300		2.5 km	
	φ250		14.7 km	
	φ200		24.3 km	
	φ150		15.1 km	5,985,000
	φ125		7.8 km	
	φ100		9.6 km	
	DCP φ350		8.0 km	
	φ200		3.5 km	
Reservoir	Rock Fill Dam H = 6.0m Asphalt Facing L = 320m			1,384,000
Regulating pond	(Total volume 11,000 m3)		1 place	486,000
			6 place	
Pump station	- Tranquera I (Q=1.47m3/min H=81m 45kw)	Pump	2 piece	
	- Tranquera II (Q=3.39m3/min H=120m 130kw)	Pump	2 piece	1,260,000
	- Rory (Q=0.93m3/min H=90m 30kw)	Pump	2 piece	
	- Rory-mi (Q=4.32m3/min H=90m 110kw)	Pump	2 piece	
Field irrigation equipment	2,300,000 G/ha			2,070,000
Maintenance	Running cost and Maintenance cost			1,509,000
Total				13,069,000
Unit cost/ha	Service area		900 ha	14,521

Table E.1.5 Evapotranspiration

Item		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
(1) Tmean	°C	26.4	26.0	24.6	22.9	20.1	17.8	18.6	17.8	19.5	22.0	23.7	25.4
(2) ea	mbar	34.4	33.6	30.9	27.9	23.6	20.4	21.4	20.4	22.7	26.4	29.3	32.5
(3) RHmean	%	73	76	77	83	85	84	80	75	71	72	73	73
(4) ed	mbar	25.1	25.5	23.8	23.2	20.0	17.1	17.2	15.3	16.1	19.0	21.4	23.7
(5) ea-ed	mbar	9.3	8.1	7.1	4.7	3.5	3.3	4.3	5.1	6.6	7.4	7.9	8.8
(5) U	Km/day												
(6) U2	Km/day	267	273	280	301	331	344	389	351	348	327	283	278
(7) f(u)		0.99	1.01	1.03	1.08	1.16	1.20	1.32	1.22	1.21	1.15	1.03	1.02
(8) (1-W)		0.24	0.25	0.26	0.28	0.31	0.34	0.33	0.34	0.32	0.29	0.27	0.25
(9) W		0.76	0.75	0.74	0.72	0.69	0.66	0.67	0.66	0.68	0.71	0.73	0.75
(10) Ra	mm/day	17.64	16.40	14.30	11.78	9.52	8.48	8.88	10.68	13.11	15.46	17.20	17.84
(11) n		8.10	7.90	7.30	7.30	6.40	5.40	6.10	6.40	6.00	7.20	8.70	8.30
(12) N		13.70	13.10	12.30	11.60	10.80	10.40	10.60	11.20	12.00	12.80	13.40	13.80
(13) n/N		0.59	0.60	0.59	0.63	0.59	0.52	0.58	0.57	0.50	0.56	0.65	0.60
(14) (0.25+0.5	n/N)	0.55	0.55	0.55	0.56	0.55	0.51	0.54	0.54	0.50	0.53	0.57	0.55
(15) Rs	mm/day	9.62	9.05	7.82	6.65	5.20	4.32	4.78	5.72	6.56	8.21	9.88	9.82
(16) Rns		7.22	6.78	5.86	4.99	3.90	3.24	3.58	4.29	4.92	6.16	7.41	7.37
(17) f(T)		16.0	15.9	15.6	15.2	14.6	14.2	14.3	14.2	14.5	15.0	15.3	15.8
(18) f(ed)		0.12	0.12	0.13	0.13	0.14	0.16	0.16	0.17	0.16	0.15	0.14	0.13
(19) f(n/N)		0.63	0.64	0.63	0.67	0.63	0.57	0.62	0.61	0.55	0.61	0.68	0.64
(20) Rnl		1.21	1.20	1.23	1.30	1.33	1.27	1.40	1.46	1.30	1.35	1.43	1.27
(21) Rn		6.01	5.58	4.63	3.69	2.58	1.97	2.19	2.83	3.61	4.81	5.98	6.10
(22) RHmax	%	80	80	84	84	88	84	85	80	79	75	82	79
(23) Uday	m/sec	3.1	3.2	3.2	3.5	3.8	4.0	4.5	4.1	4.0	3.8	3.3	3.2
(24) Unight	m/sec												
(25) Uday/Unight		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
(26) c		1.03	1.03	1	0.96	0.92	0.89	0.91	0.92	0.94	0.99	1.04	1.03
(27) ETo	mm/day	6.99	6.39	5.33	3.93	2.81	2.34	3.03	3.65	4.70	5.82	6.84	7.02
(28) ETo	mm/month	216.8	179.1	165.1	117.9	87.1	70.1	94.0	113.3	141.1	180.4	205.1	217.7

Place La Colmena
Altitude m 150

Table E.1.6 Irrigation Water Requirement

Divisions	(ha)	Discharge (l/s)											
		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Tranquera													
Vegetable	95	49	48	47	43	34	26	31	36	44	45	47	48
Fruit	71	-	-	-	5	4	9	18	10	6	-	-	-
Sub-total	166	49	48	47	48	38	35	49	46	50	45	47	48
Rory													
Vegetable	61	31	31	30	28	21	17	19	23	29	29	30	31
Fruit	87	-	-	-	6	5	11	23	13	7	-	-	-
Sub-total	148	31	31	30	34	26	28	42	36	36	29	30	31
Rory-Mi													
Vegetable	44	23	22	22	20	16	12	14	17	21	21	22	22
Fruit	42	-	-	-	3	2	5	11	6	3	-	-	-
Sub-total	86	23	22	22	23	18	17	25	23	24	21	22	22
Total	400	103	101	99	105	82	80	116	105	110	95	99	101

Table E.1.7 Altitude & Manner of Intake Water

Items	Tranquera	Rory I	Rory II	Rory-Mi
Altitude of Intake Water (E.L)	163.00	152.00	236.50	220.00
Diversion Water Requirement (l/sec)	49	18	31	26
Manner of Intake Water	Weir & pump	Gravity method by weir	Weir & pump	Gravity method by weir

Table E.1.8 Structure of Intake Works

Items	Unit	Tranquera	Rory I	Rory II	Rory-Mi
Catchment area	km^2	13	2.1	9.0	2.1
Unit discharge	m^3/s	4.7	6.2	6.2	9.0
Flood discharge	m^3/s	61	13	56	19
Width of weir	m	16	17.5	10	5
Height of dam up	m	1	3	1.0	1.5
Dam height	m	1.7	3.5	1.7	2.5
Dam length	m	5.0	4.5	5.0	6.45
Over flow depth	m	1.5	0.7	2.0	1.5
Intake gate	m	1.5	ϕ 250	1.5	0.5
Scouring gate	m	1.5	ϕ 200	1.5	1.0
Pix to rock	m	Fix to rock	Fix to rock	Fix to rock	Fix to rock

Table E.1.9 Hydraulic Calculation of Pipe Line (1)

TR-1

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	182.00						248.00	7.84
NO.2	200.00	200.00	183.00	201.10	130.00	200.00	49.00	2.52	245.48	6.25
NO.4	200.00	400.00	193.00	200.25	130.00	200.00	49.00	2.51	242.97	5.00
NO.6	200.00	600.00	205.00	200.36	130.00	200.00	49.00	2.51	240.46	3.55
NO.8	200.00	800.00	225.00	201.00	130.00	200.00	49.00	2.52	237.94	1.29
NO.10	200.00	1000.00	232.00	200.12	130.00	200.00	49.00	2.51	235.43	0.34
NO.11	100.00	1100.00	232.00	100.00	130.00	200.00	49.00	1.25	234.18	0.22

TR-2

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	231.50						231.50	0.00
NO.2	200.00	200.00	230.00	200.01	150.00	250.00	48.00	0.62	230.88	0.09
NO.4	200.00	400.00	217.00	200.42	150.00	250.00	40.00	0.45	230.43	1.34
NO.6	200.00	600.00	208.00	200.20	150.00	250.00	40.00	0.45	229.98	2.20
NO.8	200.00	800.00	199.00	200.20	150.00	250.00	40.00	0.45	229.53	3.05
NO.10	200.00	1000.00	192.00	200.12	150.00	250.00	40.00	0.45	229.08	3.71
NO.12	200.00	1200.00	183.00	200.20	150.00	250.00	40.00	0.45	228.63	4.56
NO.14	200.00	1400.00	178.00	200.06	150.00	200.00	32.00	0.87	227.76	4.98
NO.16	200.00	1600.00	176.00	200.01	150.00	200.00	32.00	0.87	226.89	5.09
NO.18	200.00	1800.00	177.00	200.00	150.00	200.00	32.00	0.87	226.02	4.90
NO.20	200.00	2000.00	176.00	200.00	150.00	200.00	32.00	0.87	225.15	4.92
NO.22	200.00	2200.00	174.00	200.01	150.00	200.00	32.00	0.87	224.28	5.03
NO.24	200.00	2400.00	172.00	200.01	150.00	200.00	32.00	0.87	223.41	5.14
NO.26	200.00	2600.00	169.00	200.02	150.00	200.00	32.00	0.87	222.54	5.35
NO.28	200.00	2800.00	167.00	200.01	140.00	150.00	24.00	2.37	220.17	5.32
NO.30	200.00	3000.00	166.00	200.00	140.00	150.00	24.00	2.37	217.80	5.18
NO.32	200.00	3200.00	170.00	200.04	140.00	150.00	24.00	2.37	215.43	4.54
NO.34	200.00	3400.00	178.00	200.16	140.00	150.00	24.00	2.37	213.06	3.51
NO.36	200.00	3600.00	174.00	200.04	140.00	150.00	24.00	2.37	210.69	3.67
NO.38	200.00	3800.00	171.00	200.02	140.00	125.00	16.00	2.72	207.97	3.70
NO.40	200.00	4000.00	171.00	200.00	140.00	125.00	16.00	2.72	205.25	3.43
NO.42	200.00	4200.00	169.00	200.01	140.00	125.00	16.00	2.72	202.53	3.35
NO.44	200.00	4400.00	164.00	200.06	140.00	125.00	16.00	2.72	199.81	3.58
NO.46	200.00	4600.00	155.00	200.20	140.00	100.00	8.00	2.24	197.57	4.26
NO.48	200.00	4800.00	148.00	200.12	140.00	100.00	8.00	2.24	195.33	4.73
NO.50	200.00	5000.00	150.00	200.01	140.00	100.00	8.00	2.24	193.09	4.31
NO.52	200.00	5200.00	154.00	200.04	140.00	100.00	8.00	2.24	190.85	3.68
NO.54	200.00	5400.00	153.00	200.00	140.00	100.00	8.00	2.24	188.61	3.56
NO.56	200.00	5600.00	150.00	200.02	140.00	100.00	8.00	2.24	186.37	3.64
NO.58	200.00	5800.00	149.00	200.00	140.00	100.00	8.00	2.24	184.13	3.51
NO.60	200.00	6000.00	150.00	200.00	140.00	100.00	8.00	2.24	181.89	3.19

TR-3

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	230.00						230.88	
NO.2	200.00	200.00	220.00	200.25	140.00	125.00	8.00	0.76	230.12	1.01
NO.4	200.00	400.00	216.00	200.04	140.00	125.00	8.00	0.75	229.37	1.34
NO.6	200.00	600.00	208.00	200.16	140.00	125.00	8.00	0.75	228.62	2.06
NO.8	200.00	800.00	213.00	200.06	140.00	125.00	8.00	0.75	227.87	1.49
NO.10	200.00	1000.00	205.00	200.16	140.00	125.00	8.00	0.75	227.12	2.21
NO.12	200.00	1200.00	205.00	200.00	140.00	125.00	8.00	0.75	226.37	2.14

TR-2-1

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	174.00						210.69	3.67
NO.2	200.00	200.00	165.00	200.20	140.00	100.00	8.00	2.24	208.45	4.34
NO.4	200.00	400.00	160.00	200.06	140.00	100.00	8.00	2.24	206.21	4.62
NO.6	200.00	600.00	152.00	200.16	140.00	100.00	8.00	2.24	203.97	5.20
NO.8	200.00	800.00	150.00	200.01	140.00	100.00	8.00	2.24	201.73	5.17
NO.10	200.00	1000.00	155.00	200.06	140.00	100.00	8.00	2.24	199.49	4.45
NO.12	200.00	1200.00	160.00	200.06	140.00	100.00	8.00	2.24	197.25	3.73
NO.13	100.00	1300.00	160.00	100.00	140.00	100.00	8.00	1.12	196.13	3.61

Table E.1.10 Hydraulic Calculation of Pipe Line (2)

RO-1

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	236.00						236.50	0.05
NO.2	200.00	200.00	230.00	200.09	150.00	250.00	18.00	0.10	236.40	0.64
NO.4	200.00	400.00	225.00	200.06	150.00	250.00	18.00	0.10	236.30	1.13
NO.6	200.00	600.00	220.00	200.06	150.00	250.00	18.00	0.10	236.20	1.62
NO.8	200.00	800.00	212.00	200.16	150.00	250.00	18.00	0.10	236.10	2.41
NO.10	200.00	1000.00	210.00	200.01	150.00	250.00	18.00	0.10	236.00	2.60
NO.12	200.00	1200.00	196.00	200.49	150.00	250.00	18.00	0.10	235.90	3.99
NO.14	200.00	1400.00	190.00	200.09	150.00	250.00	18.00	0.10	235.80	4.58
NO.16	200.00	1600.00	184.00	200.09	150.00	250.00	18.00	0.10	235.70	5.17
NO.18	200.00	1800.00	185.00	200.00	150.00	250.00	18.00	0.10	235.60	5.06
NO.20	200.00	2000.00	185.00	200.00	150.00	250.00	18.00	0.10	235.50	5.05
NO.22	200.00	2200.00	176.00	200.20	150.00	250.00	18.00	0.10	235.40	5.94
NO.24	200.00	2400.00	188.00	200.36	150.00	250.00	18.00	0.10	235.30	4.73
NO.26	200.00	2600.00	186.00	200.01	150.00	250.00	18.00	0.10	235.20	4.92
NO.28	200.00	2800.00	186.00	200.00	150.00	250.00	18.00	0.10	235.10	4.91
NO.30	200.00	3000.00	206.00	201.00	150.00	250.00	18.00	0.10	235.00	2.90
NO.32	200.00	3200.00	222.00	200.64	150.00	250.00	18.00	0.10	234.90	1.29
NO.34	200.00	3400.00	224.00	200.01	150.00	250.00	18.00	0.10	234.80	1.08
NO.36	200.00	3600.00	223.00	200.00	150.00	250.00	18.00	0.10	234.70	1.17
NO.38	200.00	3800.00	226.00	200.02	150.00	250.00	18.00	0.10	234.60	0.86
NO.40	200.00	4000.00	228.00	200.01	150.00	250.00	18.00	0.10	234.50	0.65
NO.42	200.00	4200.00	230.00	200.01	150.00	250.00	18.00	0.10	234.40	0.44
NO43+50	150.00	4350.00	234.00	150.05	150.00	250.00	18.00	0.08	234.32	0.03

RO-2

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	153.00						241.00	
NO.2	200.00	200.00	180.00	201.81	130.00	200.00	31.00	1.08	239.92	5.99
NO.4	200.00	400.00	192.00	200.36	130.00	200.00	31.00	1.08	238.84	4.68
NO.6	200.00	600.00	205.00	200.42	130.00	200.00	31.00	1.08	237.76	3.28
NO.8	200.00	800.00	214.00	200.20	130.00	200.00	31.00	1.08	236.68	2.27
NO.10	200.00	1000.00	229.00	200.56	130.00	200.00	31.00	1.08	235.60	0.66
NO.12	200.00	1200.00	234.00	200.06	130.00	200.00	31.00	1.07	234.53	0.05

RO-3

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	231.50						231.50	0.00
NO.2	200.00	200.00	224.00	200.14	150.00	250.00	64.00	1.06	230.44	0.64
NO.4	200.00	400.00	214.00	200.25	150.00	250.00	64.00	1.06	229.38	1.54
NO.6	200.00	600.00	205.00	200.20	150.00	250.00	64.00	1.06	228.32	2.33
NO.8	200.00	800.00	192.00	200.42	150.00	250.00	64.00	1.07	227.25	3.53
NO.10	200.00	1000.00	186.00	200.09	150.00	250.00	56.00	0.83	226.42	4.04
NO.12	200.00	1200.00	180.00	200.09	150.00	250.00	56.00	0.83	225.59	4.56
NO.14	200.00	1400.00	179.00	200.00	150.00	250.00	56.00	0.83	224.76	4.58
NO.16	200.00	1600.00	175.00	200.04	150.00	250.00	56.00	0.83	223.93	4.89
NO.18	200.00	1800.00	170.00	200.06	150.00	200.00	48.00	1.85	222.08	5.21
NO.20	200.00	2000.00	163.00	200.12	150.00	200.00	48.00	1.85	220.23	5.72
NO.22	200.00	2200.00	168.00	200.06	150.00	200.00	48.00	1.85	218.38	5.04
NO.24	200.00	2400.00	177.00	200.20	150.00	200.00	48.00	1.85	216.53	3.95
NO.26	200.00	2600.00	181.00	200.04	150.00	200.00	48.00	1.85	214.68	3.37
NO.28	200.00	2800.00	184.00	200.02	150.00	200.00	40.00	1.32	213.36	2.94
NO.30	200.00	3000.00	183.00	200.00	150.00	200.00	40.00	1.32	212.04	2.90
NO.32	200.00	3200.00	180.00	200.02	150.00	200.00	40.00	1.32	210.72	3.07
NO.34	200.00	3400.00	179.00	200.00	150.00	200.00	40.00	1.32	209.40	3.04
NO.36	200.00	3600.00	175.00	200.04	140.00	150.00	32.00	4.03	205.37	3.04
NO.38	200.00	3800.00	171.00	200.04	140.00	150.00	32.00	4.03	201.34	3.03
NO.40	200.00	4000.00	163.00	200.16	140.00	150.00	32.00	4.04	197.30	3.43
NO.42	200.00	4200.00	165.00	200.01	140.00	150.00	32.00	4.03	193.27	2.83
NO.44	200.00	4400.00	165.00	200.00	140.00	150.00	24.00	2.37	190.90	2.59
NO.46	200.00	4600.00	163.00	200.01	140.00	150.00	24.00	2.37	188.53	2.55
NO.48	200.00	4800.00	161.00	200.01	140.00	150.00	24.00	2.37	186.16	2.52
NO.50	200.00	5000.00	160.00	200.00	140.00	125.00	16.00	2.72	183.44	2.34
NO.52	200.00	5200.00	160.00	200.00	140.00	125.00	16.00	2.72	180.72	2.07
NO.54	200.00	5400.00	159.00	200.00	140.00	125.00	16.00	2.72	178.00	1.90
NO.56	200.00	5600.00	156.00	200.02	140.00	125.00	16.00	2.72	175.28	1.93
NO.58	200.00	5800.00	155.00	200.00	140.00	100.00	8.00	2.24	173.04	1.80
NO.62	400.00	6200.00	148.50	400.05	140.00	100.00	8.00	4.47	168.57	2.01

Table E.1.11 Hydraulic Calculation of Pipe Line (3)

RO-4

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	192.00						218.00	
NO.2	200.00	200.00	194.00	200.01	140.00	125.00	8.00	0.75	217.25	2.33
NO.4	200.00	400.00	190.00	200.04	140.00	125.00	8.00	0.75	216.50	2.65
NO.6	200.00	600.00	202.00	200.36	140.00	125.00	8.00	0.76	215.74	1.37

YA-1

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	231.50						231.50	
NO.2	200.00	200.00	230.00	200.01	150.00	200.00	16.00	0.24	231.26	0.13
NO.4	200.00	400.00	211.00	200.90	150.00	200.00	16.00	0.24	231.02	2.00
NO.6	200.00	600.00	196.00	200.56	150.00	200.00	16.00	0.24	230.78	3.48
NO.8	200.00	800.00	185.00	200.30	150.00	200.00	16.00	0.24	230.54	4.55
NO.10	200.00	1000.00	175.00	200.25	150.00	200.00	16.00	0.24	230.30	5.53
NO.12	200.00	1200.00	165.00	200.25	150.00	200.00	16.00	0.24	230.06	6.51
NO.14	200.00	1400.00	176.00	200.30	150.00	200.00	16.00	0.24	229.82	5.38
NO.16	200.00	1600.00	204.00	201.95	150.00	200.00	16.00	0.24	229.58	2.56
NO.18	200.00	1800.00	202.00	200.01	150.00	200.00	16.00	0.24	229.34	2.73
NO.20	200.00	2000.00	206.00	200.04	150.00	200.00	16.00	0.24	229.10	2.31
NO.22	200.00	2200.00	216.00	200.25	150.00	200.00	16.00	0.24	228.86	1.29
NO.23	100.00	2300.00	223.00	100.24	150.00	200.00	16.00	0.12	228.74	0.57

YA-2

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	223.00						225.00	0.20
NO.2	200.00	200.00	216.00	200.12	150.00	200.00	24.00	0.51	224.49	0.85
NO.4	200.00	400.00	206.00	200.25	150.00	200.00	24.00	0.51	223.98	1.80
NO.6	200.00	600.00	192.00	200.49	150.00	200.00	24.00	0.51	223.47	3.15
NO.8	200.00	800.00	186.00	200.09	150.00	200.00	24.00	0.51	222.96	3.70
NO.10	200.00	1000.00	198.00	200.36	150.00	200.00	24.00	0.51	222.45	2.44
NO.12	200.00	1200.00	197.00	200.00	150.00	200.00	24.00	0.51	221.94	2.49
NO.14	200.00	1400.00	186.00	200.30	150.00	200.00	24.00	0.51	221.43	3.54
NO.16	200.00	1600.00	180.00	200.09	150.00	200.00	24.00	0.51	220.92	4.09
NO.18	200.00	1800.00	185.00	200.06	150.00	200.00	24.00	0.51	220.41	3.54
NO.20	200.00	2000.00	187.00	200.01	140.00	150.00	8.00	0.31	220.10	3.31
NO.22	200.00	2200.00	196.00	200.20	140.00	150.00	8.00	0.31	219.79	2.38
NO.24	200.00	2400.00	200.00	200.04	140.00	150.00	8.00	0.31	219.48	1.95
NO.26	200.00	2600.00	203.00	200.02	140.00	150.00	8.00	0.31	219.17	1.62
NO.28	200.00	2800.00	188.00	200.56	140.00	150.00	8.00	0.31	218.86	3.09
NO.30	200.00	3000.00	199.00	200.30	140.00	150.00	8.00	0.31	218.55	1.96
NO.32	200.00	3200.00	207.00	200.16	140.00	150.00	8.00	0.31	218.24	1.12
NO.34	200.00	3400.00	206.00	200.00	140.00	150.00	8.00	0.31	217.93	1.19
NO.36	200.00	3600.00	202.00	200.04	140.00	150.00	8.00	0.31	217.62	1.56
NO.38	200.00	3800.00	204.00	200.01	140.00	150.00	8.00	0.31	217.31	1.33
NO.40	200.00	4000.00	204.00	200.00	140.00	150.00	8.00	0.31	217.00	1.30
NO.42	200.00	4200.00	202.00	200.01	140.00	150.00	8.00	0.31	216.69	1.47
NO.44	200.00	4400.00	198.00	200.04	140.00	150.00	8.00	0.31	216.38	1.84

YA-3

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	171.00						220.41	4.94
NO.2	200.00	200.00	156.00	200.56	140.00	100.00	8.00	2.24	218.17	6.22
NO.4	200.00	400.00	166.00	200.25	140.00	100.00	8.00	2.24	215.93	4.99
NO.6	200.00	600.00	178.00	200.36	140.00	100.00	8.00	2.24	213.69	3.57
NO.8	200.00	800.00	184.00	200.09	140.00	100.00	8.00	2.24	211.45	2.74
NO.10	200.00	1000.00	182.00	200.01	140.00	100.00	8.00	2.24	209.21	2.72
NO.12	200.00	1200.00	180.00	200.01	140.00	100.00	8.00	2.24	206.97	2.70
NO.14	200.00	1400.00	171.00	200.20	140.00	100.00	8.00	2.24	204.73	3.37
NO.16	200.00	1600.00	161.00	200.25	140.00	100.00	8.00	2.24	202.49	4.15

Table E.1.12 Hydraulic Calculation of Pipe Line (4)

ROM-1

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	218.00						220.00	
NO.2	200.00	200.00	217.00	200.00	150.00	200.00	25.00	0.55	219.45	0.24
NO.4	200.00	400.00	216.00	200.00	150.00	200.00	25.00	0.55	218.90	0.29
NO.6	200.00	600.00	214.00	200.01	150.00	200.00	25.00	0.55	218.35	0.43
NO.8	200.00	800.00	215.00	200.00	150.00	200.00	25.00	0.55	217.80	0.28
NO.10	200.00	1000.00	215.00	200.00	150.00	200.00	25.00	0.55	217.26	0.23
NO.12	200.00	1200.00	214.00	200.00	150.00	200.00	25.00	0.55	216.70	0.17

ROM-2

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	203.00						213.00	1.00
NO.2	200.00	200.00	203.00	200.00	150.00	200.00	40.00	1.32	211.68	0.87
NO.4	200.00	400.00	197.00	200.09	150.00	200.00	40.00	1.32	210.36	1.34
NO.6	200.00	600.00	191.00	200.09	150.00	200.00	40.00	1.32	209.04	1.80
NO.8	200.00	800.00	184.00	200.12	150.00	200.00	40.00	1.32	207.72	2.37
NO.10	200.00	1000.00	177.00	200.12	150.00	200.00	40.00	1.32	206.40	2.94
NO.13	300.00	1300.00	174.00	300.01	150.00	200.00	40.00	1.98	204.42	3.04
NO.14	100.00	1400.00	171.00	100.04	150.00	200.00	32.00	0.44	203.98	3.30
NO.16	200.00	1600.00	174.00	200.02	150.00	200.00	32.00	0.87	203.11	2.91
NO.18	200.00	1800.00	175.00	200.00	150.00	200.00	32.00	0.87	202.24	2.72
NO.20	200.00	2000.00	174.00	200.00	150.00	200.00	32.00	0.87	201.37	2.74
NO.22	200.00	2200.00	171.00	200.02	150.00	200.00	32.00	0.87	200.50	2.95
NO.24	200.00	2400.00	166.00	200.06	150.00	200.00	32.00	0.87	199.63	3.36
NO.26	200.00	2600.00	159.00	200.12	150.00	200.00	32.00	0.88	198.75	3.98
NO.28	200.00	2800.00	152.00	200.12	150.00	200.00	32.00	0.88	197.87	4.59
NO.30	200.00	3000.00	151.00	200.00	150.00	200.00	32.00	0.87	197.00	4.60
NO.32	200.00	3200.00	147.00	200.04	150.00	200.00	32.00	0.87	196.13	4.91
NO.34	200.00	3400.00	148.00	200.00	150.00	200.00	32.00	0.87	195.26	4.73
NO.36	200.00	3600.00	146.00	200.01	150.00	200.00	32.00	0.87	194.39	4.84
NO.39+50	350.00	3950.00	150.00	350.02	150.00	200.00	32.00	1.53	192.86	4.29
NO.40	50.00	4000.00	158.00	50.64	140.00	150.00	24.00	0.60	192.26	3.43
NO.42	200.00	4200.00	161.00	200.02	140.00	150.00	24.00	2.37	189.89	2.89
NO.44	200.00	4400.00	162.00	200.00	140.00	150.00	24.00	2.37	187.52	2.55
NO.46	200.00	4600.00	164.00	200.01	140.00	150.00	24.00	2.37	185.15	2.12
NO.48	200.00	4800.00	165.00	200.00	140.00	150.00	24.00	2.37	182.78	1.78
NO.50	200.00	5000.00	162.00	200.02	140.00	150.00	24.00	2.37	180.41	1.84
NO.52	200.00	5200.00	159.00	200.02	140.00	150.00	24.00	2.37	178.04	1.90
NO.54	200.00	5400.00	154.00	200.06	140.00	150.00	24.00	2.37	175.67	2.17
NO.56	200.00	5600.00	158.00	200.04	140.00	150.00	16.00	1.12	174.55	1.66
NO.58	200.00	5800.00	156.00	200.01	140.00	150.00	16.00	1.12	173.43	1.74
NO.60	200.00	6000.00	154.00	200.01	140.00	150.00	16.00	1.12	172.31	1.83
NO.62	200.00	6200.00	149.00	200.06	140.00	150.00	16.00	1.12	171.19	2.22
NO.64	200.00	6400.00	150.00	200.00	140.00	150.00	16.00	1.12	170.07	2.01
NO.66	200.00	6600.00	149.00	200.00	140.00	150.00	16.00	1.12	168.95	1.99
NO.68	200.00	6800.00	150.00	200.00	140.00	125.00	8.00	0.75	168.20	1.82
NO.70	200.00	7000.00	147.00	200.02	140.00	125.00	8.00	0.75	167.45	2.04
NO.72	200.00	7200.00	149.00	200.01	140.00	125.00	8.00	0.75	166.70	1.77
NO.74	200.00	7400.00	148.00	200.00	140.00	125.00	8.00	0.75	165.95	1.79
NO.76	200.00	7600.00	147.00	200.00	140.00	125.00	8.00	0.75	165.20	1.82
NO.78	200.00	7800.00	145.00	200.01	140.00	125.00	8.00	0.75	164.45	1.94
NO.80	200.00	8000.00	143.00	200.01	140.00	125.00	8.00	0.75	163.70	2.07

ROM-3

NO	LO(M)	LI(M)	FH(M)	L(M)	C	D(MM)	Q(L/S)	HF	WL(M)	P(KG/CM)
NO.0	0.00	0.00	154.00						175.67	
NO.2	200.00	200.00	147.00	200.12	140.00	100.00	8.00	2.24	173.43	2.64
NO.4	200.00	400.00	141.00	200.09	140.00	100.00	8.00	2.24	171.19	3.02
NO.5	100.00	500.00	144.00	100.04	140.00	100.00	8.00	1.12	170.07	2.61

LEGENDR

NO.	: Station number	D (MM)	: Diameter of pipe
LO (M)	: Distance	Q (L/S)	: Quantity
LI (M)	: Aditional distance	HF (M)	: Head loss of friction
FH (M)	: Formation height	WL (M)	: Water level
L (M)	: Pipe length	P (KG/CM)	: Pressure head
C	: Coefficient of head loss		

Table E.1.13 Pipe Material & Length

Name of Pipeline	Classification of Pipeline	DCTP	PVC	PVC	PVC	PVC	PVC	PVC(S)	L
		Diameter (mm)							
		200	250	200	150	125	100	100	(km)
TR-1	C	1.1							1.1
TR-2	D		1.2	1.4	1.0	0.8		1.6	6.0
TR-3	D					1.2			1.2
TR-2-1	D						1.3		1.3
YA-1	C			2.3					2.3
YA-2	D			1.8	2.6				4.4
YA-3	D						1.6		1.6
RO-1	C		4.4						4.4
RO-2	C	1.2							1.2
RO-3	D		1.6	1.8	1.4	0.8		0.6	6.2
RO-4	D					0.6			0.6
ROM-1	C			1.2					1.2
ROM-2	D			4.0	2.6	1.4			8.0
ROM-3	D						0.5		0.5
Total		2.3	7.2	12.5	7.6	4.8	3.4	2.2	40.0

Notes: C: Conditing Pipe

Dcip	D200	L= 2.3	km
Pvc	D250	L= 4.4	km
Pvc	D200	L= 3.5	km
Total		10.2	km

D: Distribution Pipe

Pvc	D250	L= 2.8	km
Pvc	D200	L= 9.0	km
Pvc	D150	L= 7.6	km
Pvc	D125	L= 4.8	km
Pvc	D100	L= 5.6	km
Total		29.8	km

Table E.1.14 Structure of Regulating Pond

Items	Unit	Tranquera & Rory	Rory-Mi	Yajhapety
Inflow Volume	l/s	75	25	16
Storage Capasity	m^3	2,900	800	500
Size of Pond	m	45.5x45.5	23.5x32.5	19.9x27.5
High Water Level	EL	233.5	215.0	227.0
Low Water Level	EL	231.5	213.0	225.0
Drain Pipe	ϕ mm	150	150	150
Spill Way	m	0.5	0.5	0.5

Table E.1.15. Survey of Intake Rate (1)

No. 1 Site [MIYAMOTO (1)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	5	32	384	1.609	3.466	2.590	5.578
2	10	46	168	2.303	3.829	5.302	8.816
3	20	57	66	2.996	4.043	8.974	12.112
4	30	78	126	3.401	4.357	11.568	14.818
5	45	101	92	3.807	4.615	14.491	17.568
6	60	127	104	4.094	4.844	16.764	19.834
7	90	177	100	4.500	5.176	20.248	23.292
8	120	224	94	4.787	5.412	22.920	25.908
				27.497	35.741	102.857	127.925

Dc = (10.8) T** (0.61) (mm)
Ic = (393.0) T** (-0.39) (mm/hr)
Ib = (46.3) (mm/hr) Tb = 235.0 (min)

No. 2 Site [MIYAMOTO (2)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	5	30	360	1.609	3.401	2.590	5.474
2	10	57	324	2.303	4.043	5.302	9.309
3	15	77	240	2.708	4.344	7.334	11.763
4	25	104	162	3.219	4.644	10.361	14.950
5	35	144	240	3.555	4.970	12.640	17.669
6	45	169	150	3.807	5.130	14.491	19.528
7	60	219	200	4.094	5.389	16.764	22.065
8	90	264	90	4.500	5.576	20.248	25.091
9	120	344	160	4.787	5.841	22.920	27.962
				30.583	43.338	112.650	153.811

Dc = (9.6) T** (0.75) (mm)
Ic = (434.2) T** (-0.25) (mm/hr)
Ib = (124.1) (mm/hr) Tb = 150.0 (min)

No. 3 Site [UESUGI (1)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	5	18	216	1.609	2.890	2.590	4.652
2	10	22	48	2.303	3.091	5.302	7.117
3	20	26	24	2.996	3.258	8.974	9.760
4	30	31	30	3.401	3.434	11.568	11.680
5	45	37	24	3.807	3.611	14.491	13.746
6	60	43	24	4.094	3.761	16.764	15.400
7	90	54	22	4.500	3.989	20.248	17.950
8	120	61	14	4.787	4.111	22.920	19.681
				27.497	28.145	102.857	99.985

Dc = (8.9) T** (0.39) (mm)
Ic = (206.7) T** (-0.61) (mm/hr)
Ib = (5.6) (mm/hr) Tb = 366.7 (min)

Table E.1.16. Survey of Intake Rate (2)

No. 4 Site [HIGUTI (1)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	2	14	420	0.693	2.639	0.480	1.829
2	4	23	270	1.386	3.135	1.922	4.347
3	5	26	180	1.609	3.258	2.590	5.244
4	10	42	192	2.303	3.738	5.302	8.606
5	20	78	216	2.996	4.357	8.974	13.052
6	30	95	102	3.401	4.554	11.568	15.489
7	45	157	248	3.807	5.056	14.491	19.247
8	60	199	168	4.094	5.293	16.764	21.673
9	90	281	164	4.500	5.638	20.248	25.372
10	120	351	140	4.787	5.861	22.920	28.058
				29.577	43.530	105.260	142.916

Dc = (7.4) T** (0.80) (mm)
Ic = (351.9) T** (-0.20) (mm/hr)
Ib = (132.7) (mm/hr) Tb = 121.9 (min)

No. 5 Site [HIGUTI (2)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	5	5	60	1.609	1.609	2.590	2.590
2	10	9	48	2.303	2.197	5.302	5.059
3	15	13	43	2.708	2.534	7.334	6.861
4	20	16	36	2.996	2.747	8.974	8.230
5	30	20	24	3.401	2.976	11.568	10.120
6	45	27	28	3.807	3.277	14.491	12.475
7	60	31	16	4.094	3.418	16.764	13.993
8	90	35	9	4.500	3.550	20.248	15.973
9	120	42	14	4.787	3.735	22.920	17.883
				30.205	26.043	110.191	93.185

Dc = (2.0) T** (0.66) (mm)
Ic = (78.7) T** (-0.34) (mm/hr)
Ib = (12.5) (mm/hr) Tb = 206.6 (min)

No. 6 Site [KANAZAWA (1)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	1	16	960	0.000	2.773	0.000	0.000
2	2	27	660	0.693	3.296	0.480	2.285
3	3	33	360	1.099	3.497	1.207	3.841
4	4	39	360	1.386	3.664	1.922	5.079
5	5	42	180	1.609	3.738	2.590	6.016
6	10	52	120	2.303	3.951	5.302	9.098
7	20	77	150	2.996	4.344	8.974	13.013
8	30	90	78	3.401	4.500	11.568	15.305
9	60	150	120	4.094	5.011	16.764	20.515
10	90	265	230	4.500	5.580	20.248	25.108
11	120	345	160	4.787	5.844	22.920	27.976
				26.869	46.195	91.976	128.235

Dc = (16.0) T** (0.58) (mm)
Ic = (560.7) T** (-0.42) (mm/hr)
Ib = (56.6) (mm/hr) Tb = 249.3 (min)

Table E.1.17. Survey of Intake Rate (3)

No. 7 Site [MIYAMOTO (3)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	1	16	960	0.000	2.773	0.000	0.000
2	2	22	360	0.693	3.091	0.480	2.143
3	3	28	360	1.099	3.332	1.207	3.661
4	4	35	420	1.386	3.555	1.922	4.929
5	5	38	180	1.609	3.638	2.590	5.854
6	10	60	264	2.303	4.094	5.302	9.428
7	20	100	240	2.996	4.605	8.974	13.796
8	30	133	198	3.401	4.890	11.568	16.633
9	60	247	228	4.094	5.509	16.764	22.557
10	90	361	228	4.500	5.889	20.248	26.499
11	120	471	220	4.787	6.155	22.920	29.466
				26.869	47.532	91.976	134.966

Dc = (13.1) T** (0.72) (mm)
Ic = (562.5) T** (-0.28) (mm/hr)
Ib = (130.7) (mm/hr) Tb = 170.4 (min)

No. 8 Site [UESUGI (2)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	1	20	1200	0.000	2.996	0.000	0.000
2	2	40	1200	0.693	3.689	0.480	2.557
3	3	70	1800	1.099	4.248	1.207	4.667
4	4	80	600	1.386	4.382	1.922	6.075
5	5	90	600	1.609	4.500	2.590	7.242
6	10	110	240	2.303	4.700	5.302	10.823
7	20	140	180	2.996	4.942	8.974	14.804
8	30	200	360	3.401	5.298	11.568	18.021
9	55	330	312	4.007	5.799	16.059	23.239
10	80	465	324	4.382	6.142	19.202	26.915
11	90	545	480	4.500	6.301	20.248	28.352
12	110	635	270	4.700	6.454	22.095	30.335
13	120	675	240	4.787	6.515	22.920	31.189
				35.864	65.966	132.568	204.219

Dc = (25.8) T** (0.66) (mm)
Ic = (1023.3) T** (-0.34) (mm/hr)
Ib = (169.1) (mm/hr) Tb = 203.3 (min)

No. 9 Site [KANAZAWA (2)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	1	40	2400	0.000	3.689	0.000	0.000
2	2	50	600	0.693	3.912	0.480	2.712
3	3	60	600	1.099	4.094	1.207	4.498
4	4	70	600	1.386	4.248	1.922	5.890
5	5	80	600	1.609	4.382	2.590	7.053
6	10	100	240	2.303	4.605	5.302	10.604
7	20	120	120	2.996	4.787	8.974	14.342
8	30	150	180	3.401	5.011	11.568	17.042
9	60	260	220	4.094	5.561	16.764	22.767
10	90	315	110	4.500	5.753	20.248	25.885
11	120	390	150	4.787	5.966	22.920	28.563
				26.869	52.008	91.976	139.356

Dc = (36.1) T** (0.47) (mm)
Ic = (1012.4) T** (-0.53) (mm/hr)
Ib = (47.0) (mm/hr) Tb = 319.4 (min)

Table E.1.18. Survey of Intake Rate (4)

No. 10 Site [UESUGI (3)]

No.	T	Dc	DD	logT	logDc	(logT)**2	logT*logDc
1	3	5	94	1.099	1.548	1.207	1.700
2	5	6	42	1.609	1.808	2.590	2.910
3	10	10	44	2.303	2.282	5.302	5.255
4	20	15	29	2.996	2.681	8.974	8.032
5	30	20	32	3.401	2.996	11.568	10.189
6	32	21	18	3.466	3.025	12.011	10.485
7	42	26	31	3.738	3.246	13.970	12.134
8	45	27	28	3.807	3.300	14.491	12.560
9	53	31	29	3.970	3.434	15.763	13.634
10	60	35	31	4.094	3.544	16.764	14.510
11	65	37	28	4.174	3.608	17.426	15.062
12	79	43	26	4.369	3.759	19.092	16.424
13	90	47	23	4.500	3.854	20.248	17.344
14	94	48	16	4.543	3.877	20.642	17.616
15	111	54	21	4.710	3.995	22.180	18.812
16	120	58	21	4.787	4.052	22.920	19.398
				57.566	51.009	225.148	196.067

Dc = (2.0) T** (0.70) (mm)
Ic = (82.8) T** (-0.30) (mm/hr)
Ib = (17.0) (mm/hr) Tb = 182.7 (min)

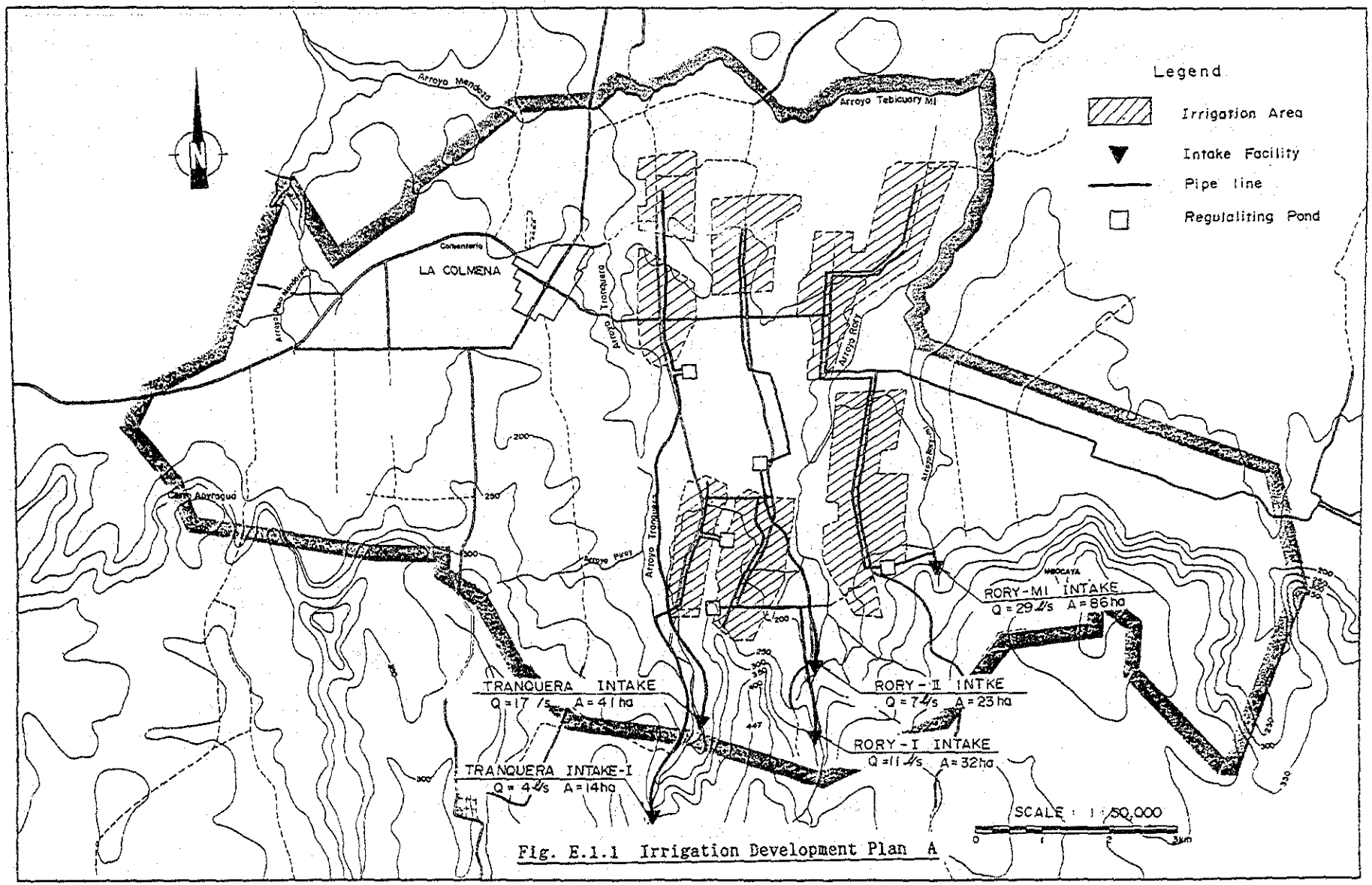


Fig. E.1.1 Irrigation Development Plan A

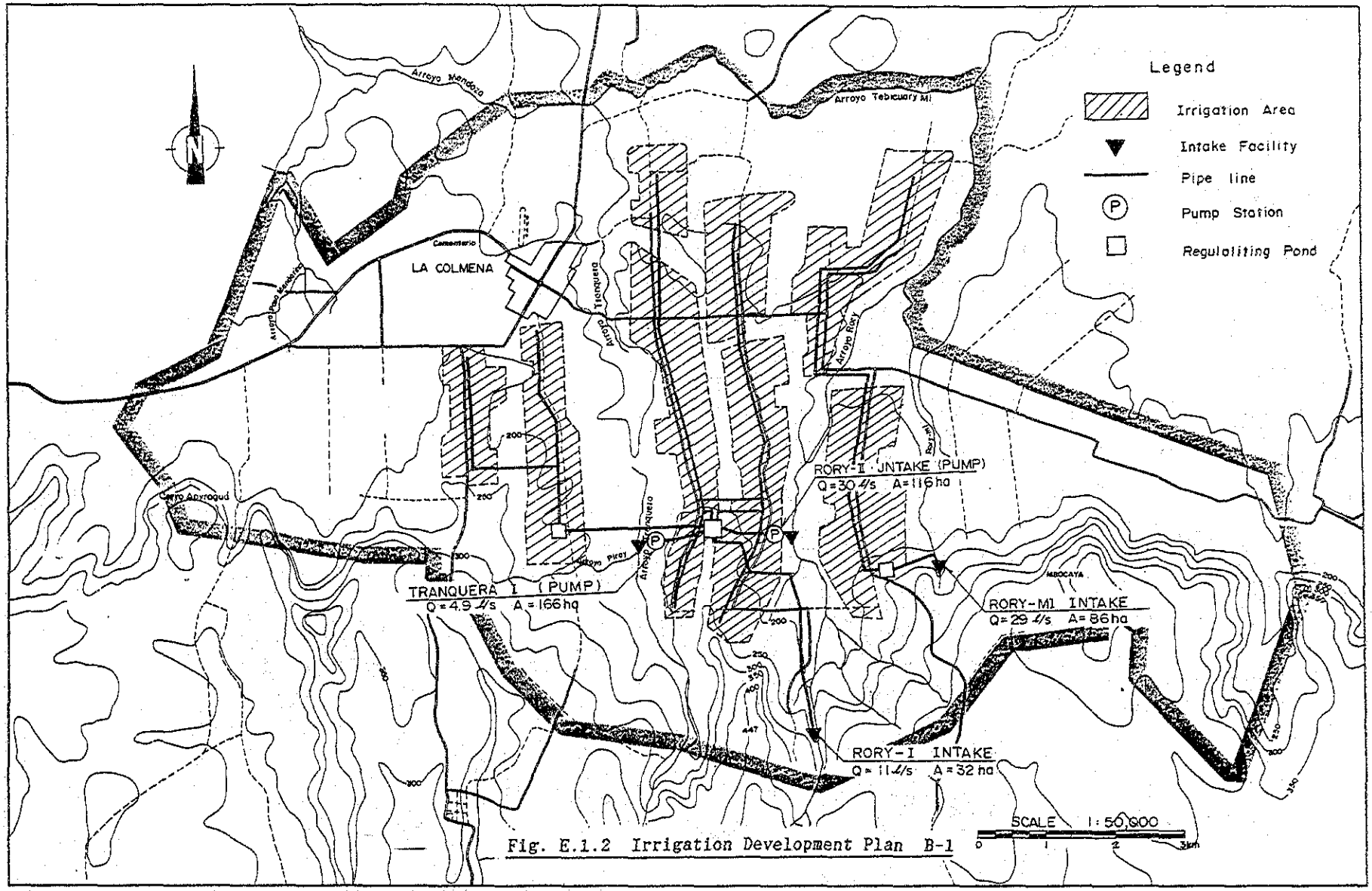


Fig. E.1.2 Irrigation Development Plan B-1

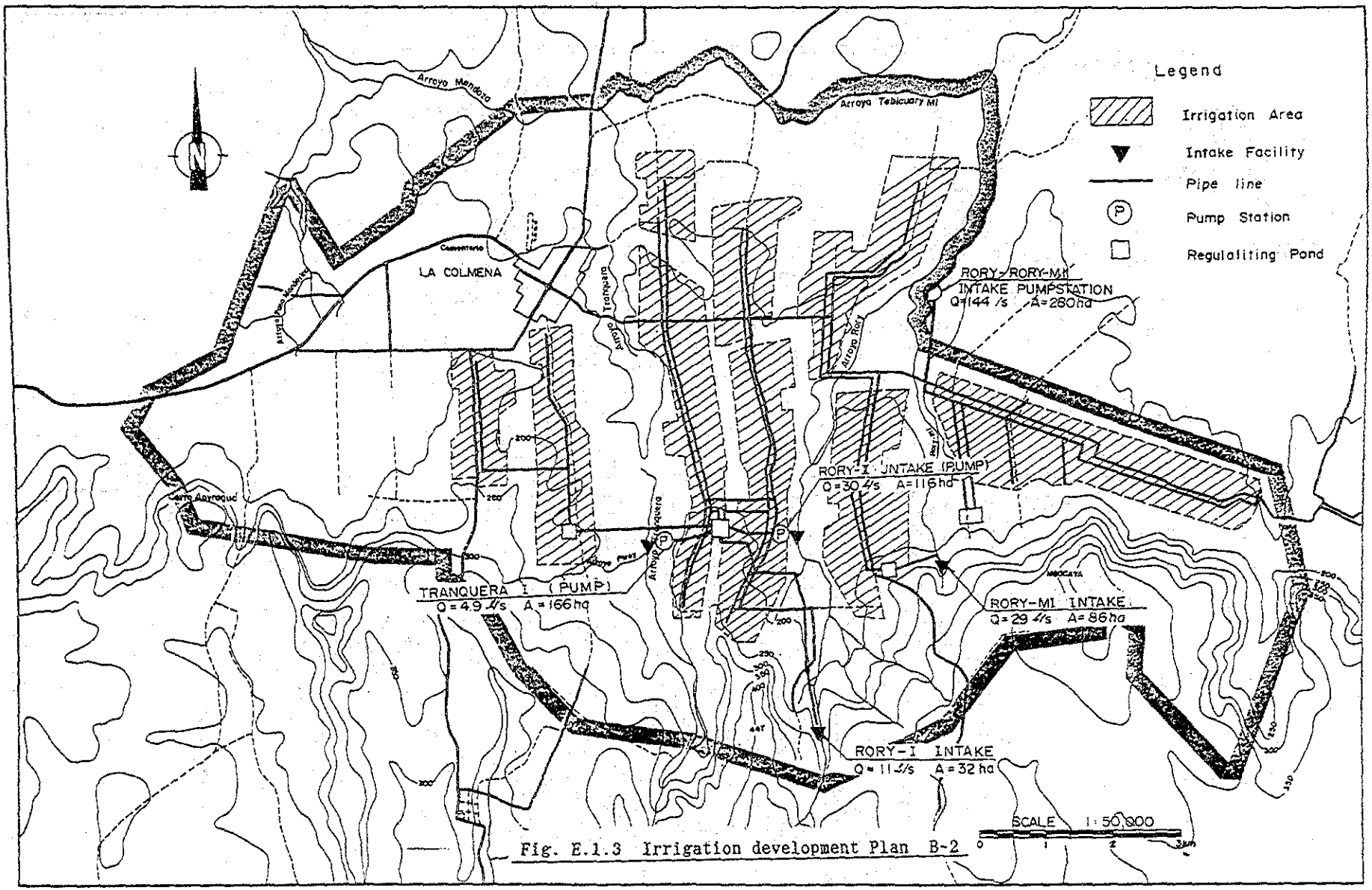


Fig. E.1.3 Irrigation development Plan B-2

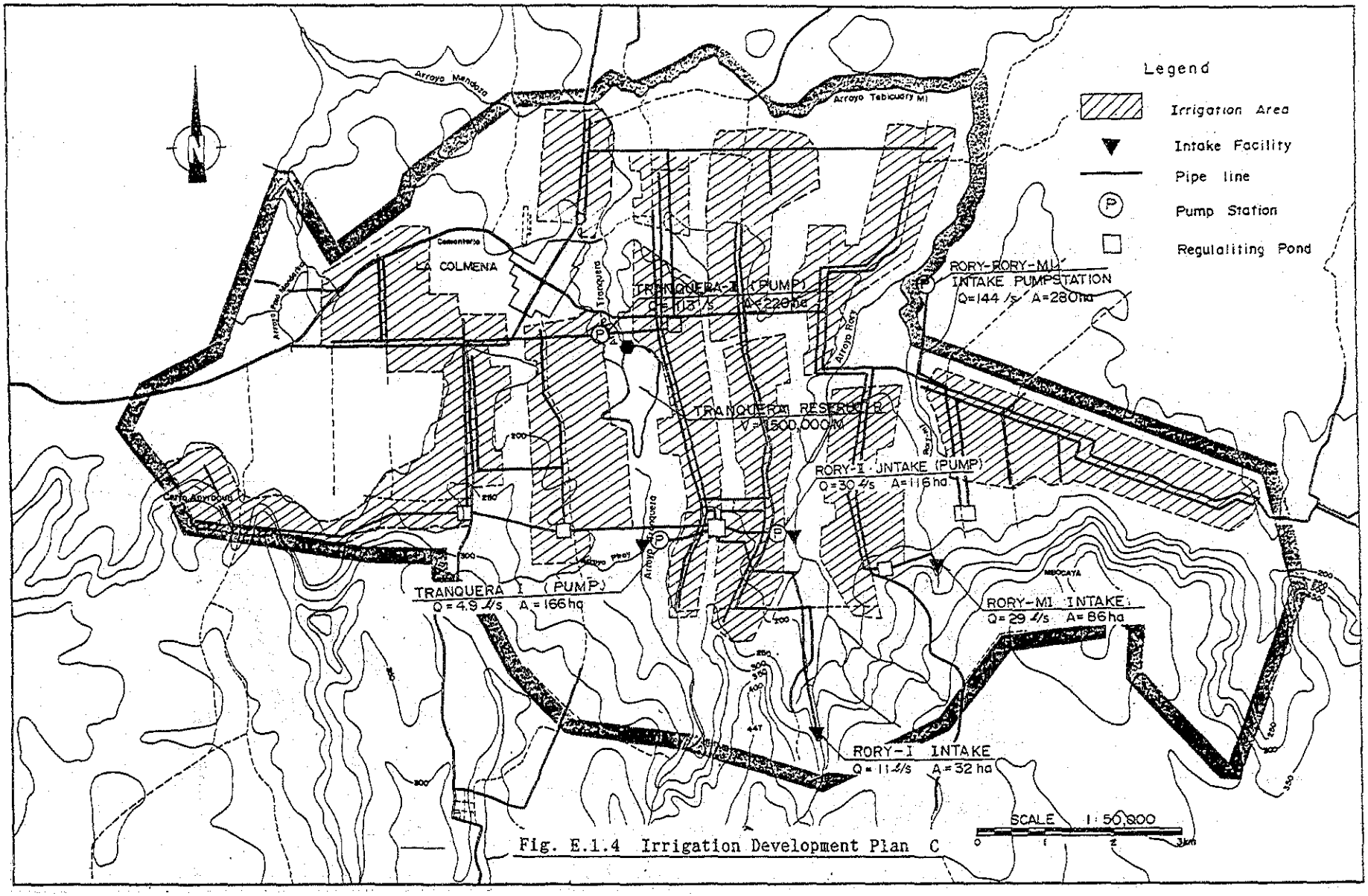


Fig. E.1.4 Irrigation Development Plan C

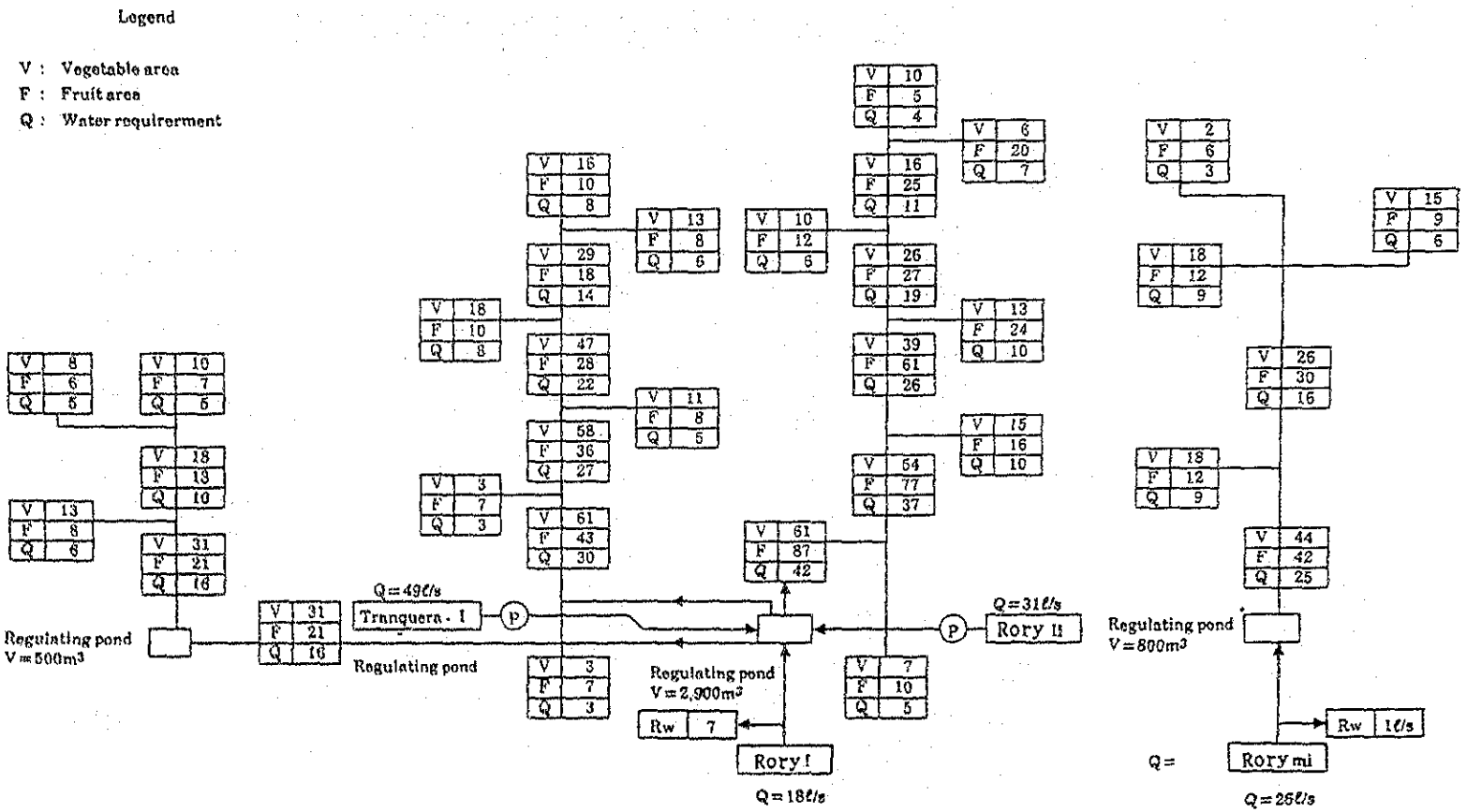


Fig. E.1.5 Irrigation Diagram (First Stage)

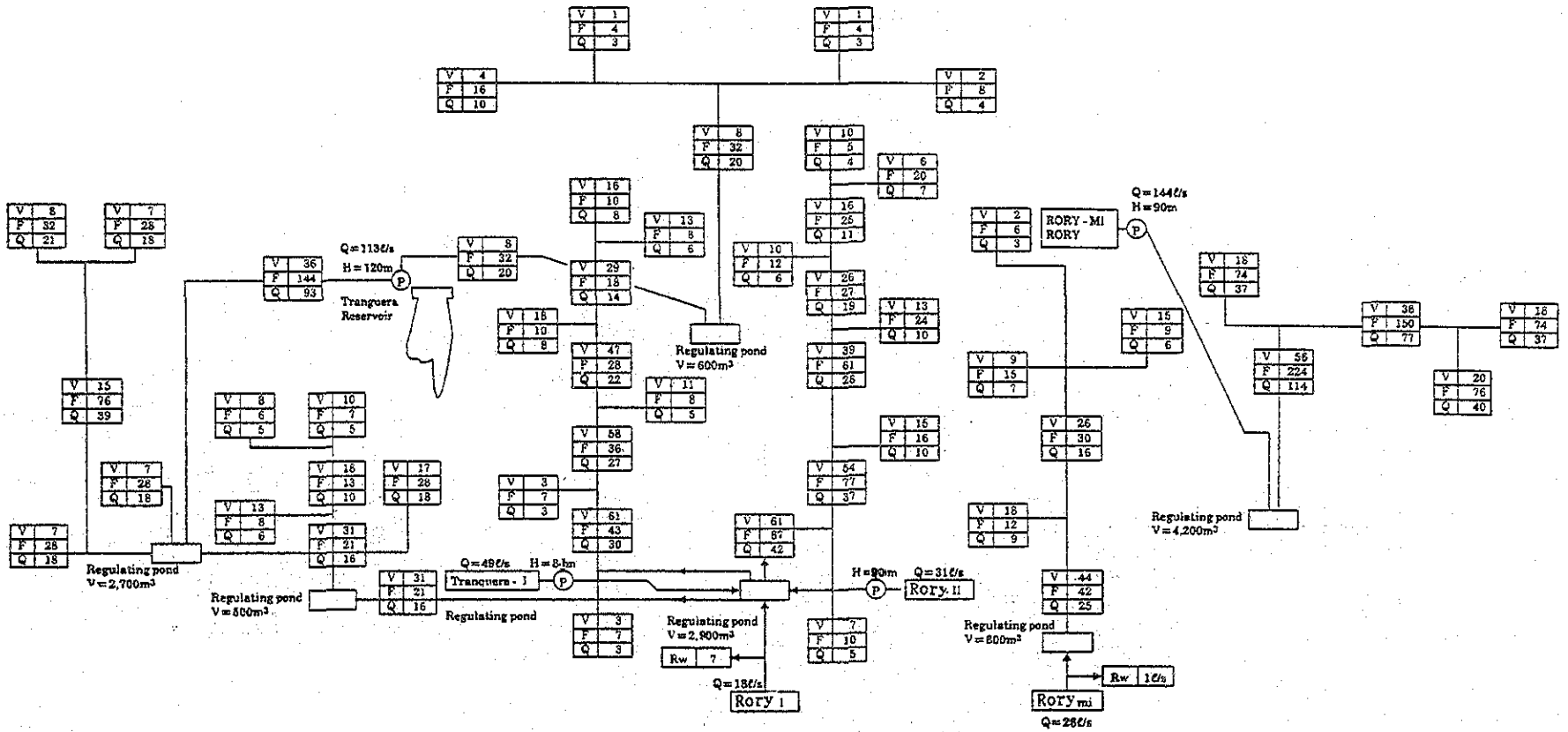


Fig. E.1.6 Irrigation Diagram (Future stage)