CHAPTER 3 PRESENT CONDITIONS OF THE STUDY AREA

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3.1 General Features

3.1.1 Physical Condition

The Study Area is located in 130 km south-east of Asuncion and situated on the plateau forming the most upstream reach of Tebicuary-Mi river. Elevations of the Area vary from 130 m to 500 m and incline from south to north. Many small streams flow into Tebicuary-Mi river which provides the main drainage course for the Area. With these streams, undulating topographical features are formed to the east or west in the Area.

Geologically, the Area is composed sand stone and conglomerate and the faults extend from east to west. Sandy soils cover the the surface layer following the clayey soils are distributed. A thick sandy soil layer has accumulated in the western part and thinner accumulation of sandy soil is found in the eastern part.

The major three streams named Tranquera, Rory and Rory-Mi are the water sources in the Study Area and some farmers are irrigated by pumping up the water from these streams. Public water works uses deep well to supply water to the urban area, however, farmers in the rural area depend entirely on shallow wells. When there is a prolonged drought, the shallow wells sometimes run dry. In such cases, farmers who have such shallow wells get water directly from the nearest streams.

3.1.2 Social Infrastructure

Route 251 which branched off Route 1 at Carapegua is connected to the Study Area. This national road is paved with asphalt up to urban area of La Colmena. Roads in the eastern part of the Study Area coming from the urban areas and the roads situated in the Study Area have no pavement except within the urban areas. With these, there are problems with dust due to traffic and muddly road surface due to rainfall. Some farm roads which connect with the main roads have some sections that are impassable for cars.

Medical care services and education are well-organized, however, improvement of equipment and facilities is required. Electrification is not prevalent in the areas where houses are situated far from the urban area and /or the main roads.

3.1.3 Social and Economical Conditions

The Study Area is divided into 10 companies (villages) and one city as administrative divisions: Ybaroty, Yajhapety, Mbocayaty, Rory, Fatima, Potrero Alto, Caaty-mi, Pindoty, Barrero Azul and Sol Naciente. The total population of the Area is about 5,000 and half and half are distributed in the rural and urban areas. The economically active population is 3,000, and the labor force is about 1,500. The younger generation accounts for 40% of the total population. On the other hand, population of aged 20 to 30 years declined remarkably (refer to Fig. 3.1).

The major industry of the Area is agriculture and cotton, sugarcane, fruit and vegetables are mainly cultivated. Over 80% of the total households are engaged in agricultural production. The rest are involved in the retail trade (90 households), cottage industry (12 households) and services (30 households). The main agricultural supporting agencies are SEAG, BNF and Cooperative.

3.2 Meteorology and Hydrology

3.2.1 Physical Condition

(1) Meteorology

The climate in Paraguay is governed by the air masses generated by the Amazon and the Atlantic Ocean and characterized as a sub-tropical climate. The summer, of which January is the middle of the season, has high temperatures and much rainfall. The winter of which July is the middle of the season, has low temperatures and little precipitation. Annual mean temperature decreases from 25°C in the northern parts to 21°C in the southern parts. On the contrary, annual mean precipitation decreases from 1,700 mm in the southern parts to 500 mm in the northern parts.

There are 62 meteorological observation stations in Paraguay governed by the Department of Meteorology, Ministry of National Defense. Of these 52 stations are continuing meteorological observations. To measure precipitations, 193 stations including the meteorological stations stated above are registered by the Department of Meteorology, however, only 60 stations are now operating. In the Study Area, there are no registered meteorological and/or rainfall observation stations. Only rainfall record observed by La Colmena Agricultural Cooperative is available from 1974 upto the present. Locations and observation periods

for the meteorological and/or rainfall stations around the Study Area are shown in Annex A Table A.1.1. Stations which have stopped observations at present are excluded from the study because the observation period of such stations is short and there exist other alternative stations which are making continuous observations in the neighborhood. The observation records of the following six meteorological stations were collected for the study.

Station	Item	Duration
Villarrica	Rainfall	1940 - 1987
	Temperature	1971 - 1987
	Relative Humidity	1971 - 1987
	Sunshine Hour	1976 - 1980
	Evaporation	1952 - 1987
	Wind Velocity	1980 - 1987
Carapegua	Rainfall	1981 - 1987
	Temperature	1970 - 1987
	Relative Humidity	1970 - 1987
	Evaporation	1970 - 1980
Paraguari	Rainfall	1981 - 1987
	Temperature	1981 - 1987
	Humidity	1981 - 1987
Caacupe	Rainfall	1961 - 1987
	Temperature	1961 - 1987
	Relative Humidity	1961 - 1987
	Evaporation	1961 - 1987
	Sunshine Hour	1975 - 1987
San Juan B.M	Rainfall	1942 - 1948
		1955 - 1987
	Temperature	1956 - 1987
	Relative Humidity	1956 - 1987
	Evaporation	1956 - 1984
	Sunshine Hour	1973 - 1980
	Wind Velocity	1980 - 1983
Caazapa	Rainfall	1973 - 1987
	Temperature	1973 - 1985
	Relative Humidity	1973 - 1985

Mean monthly values of each meteorological item are shown in Annex A Table A.1.2. Meteorological conditions around the Study Area on the annual mean basis are summarized as follows:

Rainfall	:	1,600 mm/year
Temperature	:	22°C
Humidity	:	77%
Sunshine hours	:	7 hr/day
Wind velocity	:	3.6 m/sec

Rainfall record data have been observed by the Agricultural Cooperative at La Colmena in the Study Area. This data, however, were not found to be reliable when verification of the data was made by the rainfall record of the neighboring registered stations because the data of the Agricultural Cooperative are not registered by the Department of Meteorology. Therefore, area rainfall estimated by the area ratio of Villarrica and Carapegua based on the Thiessen Method will be used as the rainfall data for the Project.

The meteorological data of Villarrica station will be employed for the estimation of the crop water requirements because adequate data were obtained and the station is situated near the Study Area.

The probable daily, two-day, three-day rainfall in the Study Area estimated using the area rainfall for every year from 1940 are as follows:

Probable year	Daily	Continuous Rainfall Two-day	Three-day
1/ 5	125.6 mm	158.4 mm	170.6 mm
1/ 10	142.4	176.6	189.4
1/ 20	157.9	192.4	205.2
1/ 50	177.1	211.0	223.3
1/100	191.0	223.9	235.5

The probable days of dry spell estimated on the basis of the rainfall record is as follows:

Probable year	A	B
1/ 5	27 days	41 days
1/ 10	30	47
1/ 20	34	52
1/ 50	38	60
1/100	41	65

A : Only days without rainfall are used in the calculation
B : Days for which rain is less than 5 mm are counted in the calculation

(2) Hydrology

The river system in Paraguay consist of the Rio La Plata which has as tributaries the Rio Paraguay and Rio Parana. The Study Area is located at tributary of Rio Tebicuari which flows into Rio Paraguay. the water level gauging stations in Paraguay have been established at 59 stations in Rio Paraguay and 52 stations in Rio Parana river systems. Gauging stations of Rio Tebicuary-Mi for which the Study Area is included in its river basin are located at 20 km in northeast from the Study Area

and its gauging is now continuing.

Streams in the Study Area form a water shed of about 30 km^2. On the other hand, the water shed of Rio Tebicuary-Mi is estimated at about 2,500 km^2 at the said gauging station. Taking the water shed ratio between the Rio Tebicuary-Mi and streams in the Study Area and the data at gauging stations (discharge record is not available) into account, the water level record of Rio Tebicuary-Mi could not be utilized in the runoff analysis for the small streams located in the Study Area. With these circumstances, the runoff analysis of major streams in the Study Area will be carried out on the basis of data which were obtained from the automatic water level recorder installed and the result of discharge measurement executed by the Project.

The runoff analysis of the low water stage will be carried out the Tank Model method using the above mentioned discharge records.

The flood discharge of the streams will be estimated as the peak discharge of the flood with the probable year basis by using the Rational Method because those discharges should be made with a conservative estimation for the structures related to the streams.

3.2.2 River Discharge

Major streams in the Study Area, named Tranquera, Rory and Rory-Mi, have waterfalls for which the heads range from 5 m to 10 m in the most upstream reaches and 2 to 3 km in the upstream river. These flow down forming small waterfalls on the outcropped rocks. Flow width and depth of the streams are 1 to 3 m and 10 to 50 cm on the average, respectively. These streams join to A. Tebicuary-Mi meandingly. Major dimensions of the Streams are as follows:

Streams	River Basin	River Length	River Bed Slope		
			Upper	Middle	Lower
Tranquera	30.4 km^2	12.0 km	1/10	1/90	1/280
Rory	37.2	12.0	1/25	1/70	1/240
Rory-mi	11.5	4.5	1/ 5	1/20	1/200

Tributaries of the streams stated above and of small streams flow directly to A. Tebicuary-Mi in the Study Area. However, discharge of such small streams is not sufficient for the project use.

The Tank Model Method is employed for the runoff analysis of the low water-stage of major streams in the Study Area. Construction of the

model coefficients and verification of the model on a daily basis is executed using the data obtained after installation of the automatic water level gauge. Low-water stage discharge in last 10 years (1978 to 1987) with the verified model is as follows:

Tranquera: River basin area 5.9 km2

Unit : ℓ/sec

Month / Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Jan.	32	31	49	46	39	55	57	47	39	56
Feb.	34	30	50	50	39	59	57	45	39	59
Mar.	33	31	54	47	39	57	54	46	48	54
Apr.	33	30	51	44	37	64	63	46	73	61
May	30	53	63	45	38	93	57	54	54	61
Jun.	29	43	55	44	44	73	55	50	56	60
Jul.	29	40	51	40	45	71	50	46	54	56
Aug.	27	39	49	37	43	65	48	49	49	55
Sep.	27	41	46	34	40	61	44	46	47	50
Oct.	28	40	45	31	41	58	42	46	48	49
Nov.	34	43	51	30	40	59	62	44	49	51
Dec.	34	53	47	48	56	58	48	41	56	53
Annual (mm) Rainfall	1151	1682	1596	1304	1773	2009	1489	1349	1926	1779

Rory : River basin area 11.6 km2

Unit : ℓ/sec

Month / Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Jan.	70	66	104	97	82	121	121	96	77	100
Feb.	72	65	107	104	80	128	119	93	79	118
Mar.	71	65	116	96	82	126	112	94	91	114
Apr.	70	65	110	89	78	133	126	95	133	116
May	64	105	124	93	79	179	119	112	113	130
Jun.	61	93	118	91	85	162	114	102	116	126
Jul.	61	84	106	81	95	156	102	94	112	117
Aug.	58	82	104	75	90	141	97	100	102	115
Sep.	57	89	96	67	83	130	88	95	98	102
Oct.	60	87	94	62	86	123	84	94	100	100
Nov.	73	92	98	61	85	126	114	88	104	103
Dec.	73	108	98	84	118	123	99	82	120	111
Annual (mm) Rainfall	1151	1682	1596	1304	1773	2009	1489	1349	1926	1779

Rory-mi : River basin area 2.8 km2

Unit : ℓ/sec

Month / Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Jan.	34	30	42	40	37	49	53	45	38	52
Feb.	35	30	40	44	36	51	53	44	38	54
Mar.	34	30	43	42	36	51	51	44	44	51
Apr.	33	30	42	39	35	54	56	44	57	53
May	31	45	46	40	35	74	53	50	50	57
Jun.	30	39	46	40	38	64	52	47	51	55
Jul.	30	37	42	37	41	63	48	44	50	52
Aug.	28	36	42	35	39	59	46	46	47	52
Sep.	28	38	40	32	37	56	43	44	45	48
Oct.	28	38	39	30	38	53	41	44	46	47
Nov.	32	39	42	30	38	55	52	42	46	48
Dec.	33	46	41	40	48	54	46	40	52	50
Annual (mm) Rainfall	1151	1682	1596	1304	1773	2009	1489	1349	1926	1779

The flood discharge of each stream is calculated using the Rational Method on the basis of probable daily rainfall. These values are shown below:

Probable year	Rory-Mi	Rory	Tranquera
1/ 5	8.1 $m^3/sec/km^2$	5.4 $m^3/sec/km^2$	4.1 $m^3/sec/km^2$
1/ 10	9.2	6.2	4.7
1/ 20	10.2	6.8	5.2
1/ 50	11.4	7.7	5.8
1/100	12.3	8.3	6.3

The water quality analysis is carried out by INTN at the upper and middle stream reaches of the three major streams. Analyzed results show that the stream water can be used as drinking water under Paraguayan water quality regulations, however, utilization after chlorination is recommended. Details of analyzed results are shown in Annex A Table A.3.1.

3.3 Geology and Groundwater

3.3.1 Geological Features

The stratum in the old geologic age is distributed in La Colmena and its surrounding areas. Beds such as porphyry, schist, quarzit, silexite and shale of the Archaezoic Era and Preterozoic Era in the Pre-Cambrian period form the grass land and/or woods with slightly undulating topography in the southern part of the area. Although these strata had

been altered to some degree, structural lines and faults are found in few since tectonic movement seems to be relatively weak. Also, the consolidation of the rock is very strong and groundwater is scarce in the very limited part of the surface beds, faults and crushing zones.

Over these old formations, conglomerate which belongs to the CAACUPE group of the PALEOZOIC Era in the Silrian period is formed at the most bottom bed with 50 meters thick which contains sand stone and is characterized of PARAGUARI, over the vast area spreading from the southern part to the north in the area. Over this conglomerate, there are 400-500 m beds of sand stone, which contain medium to rough grained light quartzite gravels and abundant plant fossils, forming small mountains and gentle sloping areas.

On top of these, formations of sandstone (200-250 meters thick, forming sound rock beds) belonging to the ITACURUBI group are found. On these lies a relatively thin bed of slate (10-15 meters thick) containing plant fossils and a few cracks, groundwater is not contained. Further, sandstone (medium-grained, 100 m thick), containing mica schist with an abundance of mica, scarcely any groundwater and characterized by CARIY, was deposited during the last days of the Silrian period on these formations.

These Silrian conglomerate and sandstone are found in the southern end of La Colmena in the form of hills about 500 meters high. They are divided by the structural lines running east-west and, in the north, come in contact with the conglomerate belonging to the Misiones Formation of the MESOZOIC Era. The conglomerate contains reddish sand stone, sandy slate and gravel with sandstone, is about 250 meters thick and forms hills with a slight unduration. It is distributed over a wide area reaching north-west of Asuncion.

The part of the surface bed of the conglomerate shows sandy or clay-like soils due to weathering. From about 40 meters and below, the stratum becomes sound, has few cracks and therefore contains scarece groundwater. Along the River Tebicuary-mi in the northern part of the area, there is a distribution of sand and clay soil layers in the alluvium, however, they are at the most about 10 meters thick. These alluvium layers are also seen in the area sandwiched by the large structure lines running from the north of Asuncion to the southeast, but they consist of about 10 m deposits of clay, mud and fine sand with an uneven distribution both horizontally and vertically. Scarcely any groundwater is contained in such formations.

These sedimentary rocks are the main geological structures in and around the area. Besides, there is a very limited distribution of erupted volcanic rocks in several places from the west to the north and in the east of the area. The volcanic rock is basalt of the Mesozoic Era and is thought to have been formed by eruptions immediately after the deposit of the conglomerate. Other than this, rock dikes are developed in the area extending from the north to the northwest of La Colmena. They are basic, alkalic extrusive rock or intrusive rock and were formed during the Late Triassic or Late Tertiary period.

These geological features are shown in Fig. 3.2.

The southern part of the Study Area is composed of the aforementioned sandstone and conglomerate in Palaeozoic Era. The sandstone belongs to CAACUPE series and shows a reddish or brownish color and is silty medium to coarse grained. It forms cross-bedding and has micaseous sandstone, shale and several thin conglomerate beds as the basic strata with occasional thin beds of white sandstone. The beds have a strike of about N30^{o} and are sloped to either east or west at a gradient of about 5^{o}, forming gentle undurating topography. Weathering is advanced up to several meters from the surface and joints and/or cracks are also found but the bed rock located below this sandstone is firm and sound. However, the portion of weathered rocks can be easily broken up into small pieces by striking with a hammer and into coarse sand directly without forming fine and medium gravels. The outcrops of such rocks are often seen at the mountainous areas in the southern part and in the Tranquera or other stream basins. Although there is a description of faults running east-west in the geological map, their existence could not be confirmed during the field survey. There are many parts that appear hilly from the field survey and geographical map, but many other areas are thought to be of Kern Col or Kern But. It is likely that these structures have been caused by the great faults running east-west and by small faults.

Many outcrops are seen in the stream reaches of Tranquera and small waterfalls appear at an interval of about 10-100 meters. This peculiar formation is thought to have been caused by erosion of sand stone and conglomerate beds lying horizontally, just like Cuesta, leaving the hard and sound part about 3.0-10 meters wide at interval of 20-30 meters or 50-60 meters. The valleys of Rory and Rory-mi are relatively "rough" due probably to the strong effects of the faults, and no sites suited for dam sites were found. However, construction of intake facilities such as consolidation dams 3.0-5.0 meters high present no problems in terms of bearing capacity and permeability when such

facilities are installed near the waterfall classified as the upper CM-CL in the rock classification.

Talus sedimented beds are found on a small scale in some part of the slope extending to the southern part of the mountainous areas. Such talus are mixed with large stones measuring 1.5 x 3.0 meter or more and large blocks of rock that may have fallen off the walls of the valley. Fine-medium sand composes most of the talus together with very limited amounts of fine gravel and other fine pebbles such as quartz and chart contained in the basic rock bed. A part of the area appears to consist of hilly terrace sedimentary beds, but only one to two places were confirmed to have such structure as a result of the field survey.

The central part of the north of the Area forms terrace features, but few terrace deposits were found. However, some sandstone beds with occasional thin beds of conglomerate which might be called layers of gravely sand or clay are often seen at the cut-off part of the road. Close observation including the sand layer reveal that there is a good selection in relation to each grain size and the gravels are in particular placed in an orderly parallel bedding. These findings confirm that the layers were not the result of sedimentation in relatively recent years of gravel, sand and clay, as in the case of the terrace sediments.

The layers constituting the most part of central and north of La Colmena are conglomerate formed in the Misiones formation under the Cretaceous of the MESOZOIC Era. Most of them are fine-medium grained sandstone with occasional thin beds of parallel bedding conglomerate ranging from well-polished crystals 2-4 mm in diameter to medium and large gravels 60-70 mm in diameter. The direction of strike is N10^{o} E, and sloped to west-east with a gradient of about 5^{o} resembling the rock bed of the PALAEOZOIC Era in the south. Some part of the beds lies nearly horizontal. They are widely distributed, covering most of the Area and extending west and north to Asuncion, and have a thickness of at least 200 meters. Generally, they provide hilly features with undulating topography.

Weathering is noticeably advanced up to about 40 meters from the surface, turning the rock into soft reddish-brown sand and/or silt including small amounts of sand and gravels. As mentioned in the paragraph on electric prospection, although the rock beds fall in the same geological category, they exhibit a large degree of changes in a horizontal direction, showing a strong heterogeneous trend. These characteristics have been caused mainly by the north-south fault originating in the great east-west fault found in the mountains in the

south. Tranquera and Rory, for instance, may have been the result of the same cause. With these, items such as index on strata and existence of groundwater will be changed depending on whether such items are concluded from the viewpoints of engineering or hydrology.

Furthermore, considering the extremely low electric resistance as revealed in the electric exploration, presence of even fossil water and rock salt deposits can be taken into account.

Fig. 3.3 shows the geological features in and around the Study Area.

3.3.2 Electric Prospective Survey

In order to select the well-drilling points and grasp the hydrological conditions in the area, an electric prospection was conducted by the four-electrode method of Wenner at 82 points in the area. The prospection started by determining the relationship between the geology and the pumping rate at four existing wells in the area, and preparing analytical data for the remaining points. The area will be classified by specific resistivity as follows:

Mountainous area in southern part	:	2,000 ohm-m or more
Hilly area in eastern part	:	300 to 100, 20 ohm-m or more
Town area	:	30 to 10 ohm-m
Lowland area in western part	:	500 to 100, 80 to 40 ohm-m

Location of electric prospective survey and typical p - a curves are shown in Fig. 3.4 to 3.6.

3.3.3 Groundwater

The sandstone and conglomerate of the PALAEOZOIC Era configuring the mountain in the southern part of the Area, as seen in the surface beds and outcrops along the streams, has few instances of rockbed cracking or joints, indicating substantially no groundwater recharged. Along the streams of the Rory-Mi river in the eastern part of the Area, however, there is seen many crackings which appear to be affected by faults and contain many crackings/joints or small faults or fracture zones. A similar observation is made from the runoff of the Rory-Mi river, indicating that the recharge storage in the eastern part of the mountain is larger than that in the western part.

The central 200 m to 150 m in elevation of the Area is a gentle slope like a hill, to the south of which there is a weathered bed of "sand" in a thickness of several meters. At the approach to La Colmena, this weathered bed thickens with a level of free groundwater about 5 to 9 m. The portion under this weathered bed is also weathered to a depth of about 30 m with many crackings and hence a considerable recharge storage. At a depth of 50 m or more, however, the recharge storage may be very small, judging from the information that deep wells of the urban areas have a low pumping rate and that boring to the depth of 70 to 80 m shows that the digging of a well is difficult. Unless a fault or a fracture zone is met, therefore, it seems difficult to secure a sufficient amount of groundwater.

Well drilling has been carried out at four selected places in conformity with the abovementioned and the results of electric prospection. Location and the results of well drilling are as follows:

	Location	Depth	pumped capacity
No.1	Eastern part	42 m	198 to 233 m3/day
No.2	Western part	53 m	-
No.3	Northern part	87 m	26 to 43 m3/day
No.4	Southern part	57 m	95 m3/day

From the above results and pumping rate of the existing wells in the Area, it can be concluded that groundwater available for pumping up exists in the eastern parts of the Area and is scarce in the western parts of La Colmena. Furthermore, available aquifer is distributed in sandstone strata and could not be recognized in conglomerate stratum. When ground water as a new water source is required in the area, it is concluded that wells of water sources should be settled at the sandstone beds distributed in the eastern parts of La Colmena with depth of 40 to 50 m from the ground surface.

3.3.4 Geology on the Site of the Facilities

The site of the intake facility 250 m in elevation is comprised entirely of a conglomerate and sandstone of the PALAEOZOIC Era, with exposed riverbed and many small falls. The rocks are deeply weathered. In view of the proposed scale of the facility, however, if the riverbed and abutment are exposed, problems of support or permeability will not be presented to the foundation or abutment. Nevertheless, the sand deposit is considered large, requiring settling basin or outlet structure.

Construction of small dams or regulating ponds at the upstream reaches of the streams in the Area would have a small in effective

storage capacity in comparison with the construction cost due to the steep slope riverbeds and abutments. Further, the thick talus deposit on the sides of the streams would result in a large excavation volume. In short, there is no economical location to construct dams or regulating ponds in the upstream reaches of the streams. The geology of a promising location for constructing a regulating pond in the midstream reaches of the Tranquera river, on the other hand, is characterized mainly by a conglomerate bed of the MESOZOIC Era with alternate beds of sandstone and a thin upward Alluvian stratum. It is necessary to install a cut-off wall reaching to the foundation rock.

The igneous rock (basalt) of the MESOZOIC Era distributed in the northern part of the urban area will be used as concrete aggregate or gravel for road surfacing. The sandstone in the mountainous area at the southern part of the Area is not suitable for this purpose as it is strongly weathered.

3.4 Soil and Land Use

3.4.1 General

In order to collect the information on kind, characteristics and distribution of the soils in the Study Area, which contribute to adequate land use and farm management, the following soil survey was conducted.

a) On 34 pits, investigation of soil profiles and collecting samples for the common physical and chemical analysis and core-samples for the measurements of the three soil phases and the water constants from each horizon of a profile.

b) Of the samples taken, 111 samples for common physical and chemical analysis, 129 core-samples for measurement of the solid, liquid and gas volume in the soil with the soil three phases meter, and 20 samples for the water constants such as the field capacity, the easily available moisture (pF 3.0) and the non easily available moisture (pF 4.2) were conducted respectively.

c) On 180 points, investigation with boring-stick to estimate the boundary of the soil distributions classified.

d) The measurement of the changes of moistures stress in the three depths of soil (about 30, 60 and 100 cm) for three months from August to November with three tensiometers.

Based on the results obtained, the kinds of soils and their characteristics were clarified and classified as follows. Also, for

these soils their distribution in the Area and land classification for agricultural use were acquired. Thus, many of the basic materials for land use planning were obtained.

In the southern part of the Study Area, the Apyragua mountains, about 400 to 500 m in elevation, run from east to west with a gentle slope toward the north. This sloping area consists of two land forms, the upland at 130 m to 250 m and the lowlands at 110 m to 120 m in elevation. The former is dissected by three major streams; the Tranquera, Rory and Rory-mi, flowing down from the mountains to the north. The latter is an alluvium formed by the streams such as the Tebicuary-Mi, Mendoza and Paso which streams mentionedabove flow together. The basic rock in these lands is mostly Paleozoic or Mesozoic conglomerate and sandstone.

Although the soils in the Area are divided roughly into the upland and the lowland type depending on the land forms, because the soil texture is mostly sandy from the surface to a rather deep layer in both types with the exception of part of the lowlands, the fertility and moisture-holding capacity of the soils are generally low. This requires careful control maintaining the farm management. However, the existence of several kinds of soils is recognized, depending on the location, as follows and their characteristics differ to some extent.

3.4.2 Soil Classification

The parent materials of the soils in the Area are derived from the deeply weathered sandstone or conglomerate and the minerals in the soils are rich in felsic mineral such as quartz but poor in mafic one. The climate is sub-tropical rainforest having about 1,600 mm of rainfall a year. The distribution throughout the year is shown to be fairly irregular, with heavy rainfall and drought, often alternating so that the soils of the upland are apt to suffer from drought for some periods of the year.

Also, the soils of the uplands have developed under the forest with good drainage, while the lowland soils, being of alluvium from the mountains and the upland, have developed under poor drainage with shallow groundwater levels, less than 1.5 m, and the main vegetation is grasses and thin shrubbery.

In the case of the upland soils including the mountain areas, the movements of silt and clay from the surface down to sub-surface to deeper horizons are obvious, and the textures shown are coarser and sandy at the

surface, changing to medium to fine and very fine gradually on depth in the sub-soil. In some cases the existence of somewhat thick clay-like layers are observed below 70 to 80 cm or more in depth. There are also soils with gravely layers or a rock bed within about 1.5 m in depth locally. The above-mentioned changes in texture and the existence of gravel and rock in the sub-soils play an important role in distinguishing the kind of the soils in the Area.

The amounts of organic matter in the surface soil is seen to be low and the differences in the subsurface soils in color are not clear in many cases. Although the movement of the chemical components such as exchangeable bases from the surface layer to the lower layer are recognized, the changes are gradual, resulting in obscured development of the layers and an over-all dark red color in the profiles. However, the degree of the exchangeable base saturation of the soils is generally high, more than about 40%. Based on the features in the soil genesis mentioned above, the soils in the Area are classified as indicated below according to the Soil Taxonomy of the USDA.

Thus, although the down-movement and accumulation of silt and clay from the upper horizons to the lower ones would indicate that the soils of the Area are extremely near to Ultisol, the soils are classified in the Alfisol category, because the base saturations are generally more than 35% which is the upper limit of Ultisol. The classification from the sub-order to the family categories is based on moisture states, colors, temperatures and the states of the argillaceous horizon. Since the differences in texture and the existence of gravels and stones in the sub-soils are presumed to have much effect on the plant growth through the supply of plant nutrition and moisture, the series are classified according to these conditions. Moreover, the soils of the upland type are classified into the two phases, "Plateau" and "Slope", depending on the degree of the slope which has an important effect on the land management.

The soil classification is presented the following table. According to the data, the areas of the upland type occupy about 73% and the lowland type 27% of the Area. Among the upland type, the area of the U.CM soils, with coarse to medium textures deeper than the 1 m horizon and the U.F soils, with fine textures within 1 m in the sub-soil, are 34% and 33% respectively, being almost the same area. However, for the lowland type, the area of L.F soils, with fine textured sub-soil is seen to be twice that of the L.CM soils, which have coarse to medium textured sub-soils.

Land Form	Order	Sub Order	Great Group	Sub Group	Family	Series	Phase	Area 6)	
								ha	%
Upland 1) (U)	Alfisol	Ustalf	Rhodustalf	Typic Rhodustalf	Psamm, Typic rhodustalf, Tropic	U.CM 2)	U.CM.P 5)	1,930	17.8
							U.CM.S 5)	1,150	10.6
						U.CM.G 3)	U.CM.G.S	650	6.0
							Sub-total	3,730	34.4
					Psamm, Typic rhodustalf, Luo argiric, Tropic	U.Fa 2)	U.Fa.P	1,820	16.7
							U.Fa.S	100	0.9
						U.Fa.G 3)	U.Fa.G.P	170	1.6
						U.Fb 2)	U.Fb.P	1,460	13.4
							Sub-total	3,550	32.6
						U.O.G 4)	U.OG.P	200	1.9
							U.OG.S	440	4.1
							Sub-total	640	6.0
Lowland 1) (L)		Aqualf	Tropaqualf	Typic Tropaqualf	Psamm, Tropaqualf	L.CM	-	1,450	13.3
					Clayey, Tropaqualf, Luo argiric	L.Fa	-	360	3.3
						L.Fb	-	1,130	10.4
							Sub-total	2,940	27.0
							Total	10,860 6)	100.0

1) Groundwater level: U: > 150 cm, L: < 150 cm
2) Textures of subsoil (30 - 150 cm): CM: Coarse - Medium, F: Fine - Very fine (a: below 50 cm in depth, b: below 30 cm in depth)
3) G: Gravelly or stone below 30 cm in depth
4) O.G: Gravelly or stony from 0 - 30 cm in depth
5) Slope: P (Platue) < 8', S (Slope) > 8'
Soil texture: CM: S, LS, SL, SICL, F: SCL, SICL, CL, SC, C, HC
6) Excluded the urban area

Figure 3.7 shows the distribution map of the soils.

3.4.3 Soil Properties

Since the main characteristics of the soils in the Area are conducive to causing a deficiency in plant nutrients and moisture stress, one of the major problems for the agriculture in the Area, because of the sandy soils as a whole, the soil properties are described briefly by focusing on these problems.

(1) Physical Properties

The physical properties of the soil such as the distribution of particle sizes and three phases (solid, liquid, gas) are not only concerned directly with the drought problems through the moisture holding capacity, but also with the soil fertility through the decomposition of soil organic matter and the behavior of the dressed plant nutrients in the soil.

The distribution of particle sizes and three phases in each horizon for the typical soil series in the Area are presented in Figure 3.8.

Thus, the content of sand in the first layer is as high as 80 to 90%, but silt and clay are only 7 to 15% and 4 to 6% respectively for all series, showing few differences among the series. While, in the second and third layers, these differences among the series become larger, in that the sand content decreases but silt and clay increase with soil depth, changing the textures gradually to sandy clay loam or sandy clay with the exception of the L.CM soils. These are sandy for all layers although in the first layer only a relatively small increase in silt and clay is seen.

The following characteristics are shown for the distribution of the three soil phases. Thus, the solid phase is remarkably high as a whole, 56 to 67%, showing a tendency to increase from the upper to lower layers, with few differences among the series. The porosities (liquid phase + gas phase) are 33 to 42%, showing a tendency to decrease gradually with soil depth, contrary to the change of the solid phase, and few differences are noted among the series. The samples for this survey were taken in August, the dry season, in the case of the upland type soils, the liquid phase in the upper layer is very low, only 6 to 9%, but for the U.Fa and U.Fb soils, these values increase to 14 to 29% below the second layers, and the gas phase decreases to 6 to 7% in the third phase. However, in the case of the lowland type soils, for both the L.CM and L.Fb soils, the liquid phase is as much as 19 to 35% and shows slight differences among the series even in the dry season. Moreover, for the L.Fb soils, being rich in clay, the second and third layers are almost saturated with moisture, showing less than 1% of the gas phase.

As above, regardless of the sandy texture in the surface layer the content of fine particles and the compactness of the soil are increased with depth, except for the L.CM which has almost no changes in texture within 1 m in depth.

In the case of the lowland type soils, the existence of excess water all the year round due to the high level of groundwater, limits the land use and plant productivity considerably. For the upland type soil, the moisture shortage in the soil during the dry season would be apt to limit agricultural productivity. Therefore, the characteristics of the soil moisture in the upland type are described as follows:

Unit: % by vol.

Texture	S - LS	SL	CL	C
Field capacity (>pF 1.5)	15.0 (100)[1]	21.5 (100)	23.8 (100)	32.6 (100)
Available moisture (pF 1.5 - 4.2)	11.0 (73)	11.4 (53)	8.5 (36)	9.4 (29)
Easily available moisture (pF 1.5 - 3.0)	10.0 (67)	9.7 (45)	7.6 (32)	6.2 (19)
None easily available moisture (pF 3.0 - 4.2)	1.0 (6)	1.7 (8)	0.9 (4)	3.2 (10)
None available moisture (pF 4.2 - 7.0)	4.0 (27)	10.1 (47)	15.3 (64)	23.2 (71)

1) : ( ) % in field capacity

Although the field capacity ranges between 15 to 33% increasing with the clay content, the available moisture for plants ranges between 9 to 11% decreasing with the clay content. Namely, the influence of the clay content is remarkable on depression of the easily available moisture, increasing the rates of the less easily available and unavailable moisture, which indicates the existence of high rates of moisture in very fine capillaries and the hygroscopic state in the clay-like layers. Since the texture of the sub-soil is markedly different among the series, the values of the field capacity and the available moisture in both the surface and sub-soil, and whole soil, calculated from the above data, for three typical series, are as shown in Figure 3.9.

Within 1 m in depth, the field capacity of the soils ranges between 200 to 260 mm, showing higher values for the soils containing higher clay indicated by U.CM < U.Fa < U.Fb. However, the available moisture for plants in the range between about 100 - 110 mm, shows but slight difference among the series, although slightly higher values are shown for the U.CM soil. On the other hand, the layers with higher moisture holding capacity such as the sub-soils, have textures ranging from clay loam to clay, and high rates of moisture in the very fine capillary and hygroscopic state. These would supply the moisture to the surface soil, as capillary water and vapor, playing a role as an groundwater reservoir. These facts are observed by changes of the moisture stress measured with the tensiometers (Refer to Annex C Table C.3.1). Also, high percentages of the easily available moisture in the

surface soil means the existence of a high volume of capillaries with large pores, which is apt to reduce the raising of the capillary water from lower layers, preventing losses of the soil moisture by evaporation during the dry season. Consequently, the moisture in the sub-soil of the Fa and Fb soils would show relatively small losses, even during the dry season. However, rather good drainage is recognized for the Fb soil, which has a fine-textured sub-soil, by observation with the tensiometers.

(2) Chemical Properties

Since the soils in the Area are generally sandy with plenty of coarse pores in the surface horizon, they are apt to be kept under oxidizing conditions. Moreover, the climate gives relatively warm temperatures around the year. So the decomposition rate of the soil organic matter is fairly high, resulting few its contents in the soils. While permeability of the soils is generally good, the natural supplying powers of nitrogen and potassium seem to be low.

Due to the degree of base saturation is relatively high, the pH of the soil ranges from weakly acidic to neutral with few exceptions. However, as the buffer action of the soils is generally weak, excess dressing with fertilizer or over-liming for long pericas would easily cause acidification or alkalization of the soils. Maintaining proper soil-pH is especially needed to keep the fertility of the soils.

The distribution of exchangeable bases, soluble phosphorus and zinc in the soil layers of the typical soil series is given in Figure 3.10. According to the figure for the exchangeable bases, the movement from the surface to sub-soil and the accumulation in the clay-type sub-soil of the U.Fa, UFb and L.Fb soils can be seen.

Also, the U.CM soil has characteristics such as markedly low content of exchangeable bases and strong acids, the content of soluble phosphorus and zinc in the soils is higher in the surface layer and decreases toward the sub-layers, but the levels are deficient or almost deficient for normal plant growth, except the U.Fa and UFb soils. The relatively high content of soluble phosphorus observed in the second layers of the U.Fa and UFb soils, would result from the large quantities of fertilizers used for vegetables or fruit trees, which are popular in these soil series, and would move down to lower layers with the clay particles. As the movement of phosphorus as well as exchangeable bases to the sub-horizons are thus observed, the return effect of these nutrients to the surface horizon by deep-plowing would be expected for plant growth.

3.4.4 Land Use

(1) Land Classification

As the macro-climatic factors in the Area do not seem to be much different locally, the classification for the agricultural use of the land was made on the following items based on the USDA method.

a) Soil erodibility (slope, texture and drainage, etc.).
b) Soil tilth (slope, stoniness and drainage, etc.).
c) Drainage (landform, texture and groundwater level).
d) Supply of plant nutrition and moisture (texture, chemical property and water holding capacity).

The land was classified into the eight categories described below, classes I to VIII, and the results obtained are summarized in the following table.

Class	I	II	III	IV	V	VI	VII	VII	Total
ha	0	3,280	2,200	200	2,940	1,150	0	1,090	10,860[1)]
%	0	30	20	2	27	11	0	10	100

1) Excluding the 140 ha of the city area.

The distribution of the land classifications is given in Figure 3.11. Also, the area of the land in each administrative section and basin is presented in Annex C Tables C.4.2 and C.4.3.

The features of each class are described as follows:

Class I : The soils of this class are defined as having almost no limiting factors for land-use. However, due to the possibility of drought damage for the upland type soils and of water damage caused by poor drainage for the lowland type soils and the low level of plant nutrients for both soils, no land corresponding to this class exists in the Area.

Class II : Since the limiting factors above mentioned would be somewhat overcome by use of adequate technology for supplying moisture and plant nutrients, the production of many kinds of crops such as common upland crops, vegetables and fruit trees as well as grasses and forest could be possible. The U.Fa.P and U.Fb.P soils have relatively thick fine to very fine textured sub-soils which have relatively good moisture holding capacity and plant nutrients, and

flat to moderate slope in land form. 3,280 ha of land fall in this class and occupying 30% of the Area.

Class III : Due to more severe limiting factors for crop production than the soils of class II, more careful and intensive technology would be required for the cultivation of common upland crops, vegetables and fruit trees to obtain reasonable yields. The U.CM.P soil has a thick coarse textured sub-soil, so careful control would be required not only for moisture and plan nutrient supply but also for soil erosion, even on gently sloped land, the same as for the U.Fa.S soil.

The U.Fa.G.P soil has a gravely or stony layer, so there is a greater possibility of depletion of moisture and plant nutrients. The land corresponding to this class occupies 2,200 ha in the Area, 20% of the total.

Class IV : Because of extremely severe limiting factors, the kinds of crops for cultivation cannot be diverse but are strictly limited. For the U.OG.P soil, which has a gravely or stony layer on the surface, there is a difficult tilth and a high possibility of drought damage which makes the land suitable only for grazing, forest, and the cultivation of mandioca. The corresponding area is 200 ha and occupies only 2% of the Area.

Class V : The corresponding land is such that there is almost no possibility of erosion damage, but it has other limiting factors that can only be conquered with great difficulty. The soils of the lowland type would fall in this class, and the improvement of drainability to enable the culture of common upland crops, vegetables and fruit trees would be considered extremely difficult. The land is limited to grazing, forest and paddy rice culture and would be available depending on conditions. Occupies 27% of the total and 2,940 ha.

Class VI : The land is almost completely unsuitable for farming and cultivation, having severe limiting factors. The land use of the U.CM.S soil would be limited to grazing and forest, because of the deep, sandy sub-soil with a steep slope which means a high possibility of erosion damage. Those areas amount to 1,150 ha, occupying 11% of the total area.

Class VII : The type of land has more severe limiting factors than Class VI, but does not exist in the Area.

Class VIII : This land has such extreme limiting factors that plant production for market would be impossible. It is only suitable for recreation, wildlife habitat, riverhead and sight-seeing.

This type corresponds to the soils of the U.CM.G.S which have a steep slope with a shallow stony layer or a rock bed. The area is 1,090 ha, occupying 10% of the total area.

(2) Physical Condition of the Land

The features of the Area, as a whole, is described that the Area comprises 70% uplands (including the mountains) and 30% lowlands based on the results of land use and soil classification. Fifty two percent of the uplands has a flat to gentle slope of less than 8^{o} which is supposed to have few effects on the agricultural practices. Steep slopes of more than 8^{o} occupy 21% of the Area. Although the texture of the soil is generally remarkably sandy, the relatively fertile soil with fine textured sub-soil also amounts to 30%, while the gravely and stony soil makes up only 3% of the Area. Thus, the capability of the land for agriculture would be rather high, with 50% arable use and only 2% marginally arable land.

However, the lowlands which have fairly severe limitations in use, occupy as much as 27% and the land which is not suitable for arable use and that which should be protected from exploitation, occupy 11% and 10% respectively. Since both have steep slopes, much attention must be given to the prevention of soil erosion.

(3) Present Land Use

The land in the Study Area (11,000 ha) is classified broadly into four land categories, forest, arable land, pasture land and others (urban district, roads and riversides). The total area of each category obtained by estimation through a field survey based on aerial-photography and SEAG's materials is summarized below:

Classification	Area (ha)	Land Use
Forest	2,800	Mountains above 250 m in elevation: 1,400 ha
Arable	4,600	Arable: 2,600 ha Fallow: 2,000 ha
Pasture	3,200	Lowland pasture: 2,800 ha
Urban, other	400	Urban district: 140 ha Other includes roads and riversides
Total	11,000	

Characteristics of each land category are as follows:

a) The forest is mostly found on the mountains above about 250 m in elevation, located in the southern part of the Area, and on slopes along the riversides, although small areas are seen on the boundaries of each field. This forest contributes to soil conservation as well as to fuel for families. Also, these woods are used as grazing pasture by peasants or tenant farmers.

b) The uplands at 150 m to 250 m in elevation, located in the central part of the Area, with relatively deep soil, is used as arable land. The eastern part (Mbocayaty) is especially used for sugarcane culture and the center (Barrero, Azul, Fatima and Pindoty) mostly for vegetables and fruit trees. With some farms having large arable areas, parts of the fields are used as fallow land through use as grazing pasture every two to three years, aiming at recovery of the soil fertility.

c) Low land areas in the north (Sol Naciente, Rory) and west (Ybaroty) are used as pasture land due to poor drainage and low soil capacity.

3.5 Agricultural Management

3.5.1 General

Half a century has passed since agriculture was begun in 1936 in the Study Area. As will be shown in section (2), crops such as cotton, sugarcane, vegetables and fruit are grown there. However, there have been a number of changes in the kinds of crops harvested, owing to the market, level of available farming technology and financial capacity. The following shows specific kinds of crops grown at different periods.

(a) Early stage:

Cotton and other crops for own consumption

(b) Late 1940s - 1950:

Crops were being diversified to lessen farming risks. The increasing number of available crops included cotton, corn, mandioca, tobacco, peanuts, wheat, tung oil and citrus fruit. Planting of onions and grapes was also encouraged.

(c) 1950s:

Increase in the crop area for onions and grapes; decrease for tobacco and tung oil.

(d) 1960s:

Increase in the crop area for potatoes and vegetables; decrease for cotton.

(e) 1970s:

Increase in the area for fruit (plums, mangoes, etc.) and sugarcane. Some farmers tried sericulture for a certain period, which was followed by the introduction of apiculture (raising bees for honey).

Currently, the majority of farmers raise cotton or sugarcane as cash crops, and cultivate corn, poroto and mandioca for their own consumption. Some advanced farmers are operating diversified farming operations, with fruit and vegetables as their main products.

3.5.2 Main Crops and Planted Area

Kinds of crops raised, and the planted area in the Study Area are shown below:

Crops	Area (ha)	Percentage (%)
Cotton	820	32.4
Sugarcane	255	10.1
Mandioca	450	17.8
Corn	355	14.1
Poroto	270	10.7
Others	15	0.6
Sub-total	2,165	85.7
Onion	55	2.1
Tomato	25	1.0
Melon	21	0.8
Green pepper	14	0.6
Pumpkin	15	0.6
Other vegetables	50	2.0
Sub-total	180	7.1
Citrus fruit	25	1.0
Grape	43	1.7
Plum	74	2.9
Other fruits	40	1.6
Sub-total	182	7.2
Total	2,527	100.0

It is noted in the table above that a large portion of the planted area (32%) is used for growing cotton. This is because the majority of

farmers raise cotton as a cash crop for its ease of cultivation and relatively stable market price. About 10% of the planted area is used for sugarcane for which cultivation has been encouraged by the Government in recent years.

Mandioca, corn and poroto are raised for the farmers' own consumption, accounting for 43% of the total. Similar to vegetables, grapes, plums and citrus fruit are raised by exemplary good farmers, accounting for about 0.7% of the total.

3.5.3 Cropping Pattern

(1) Cropping Pattern

The present cropping calendar in the Study Area is shown in the Fig. 3.12. and cropping situation of the main crops described as follow.

a) Sugarcane:

Budding cane seedlings in April and May are planted at a row width of 1.5 meters. The crop is harvested from August to November; it can be continuously harvested (ratooning) for the next ten years. Fertilizer (initial 250 kg and additional 180 kg) is used for an area of 1 hectare. Present yield of sugarcane is 60 to 80 tons per ha.

b) Cotton:

Harvest is from February to April. From September to October, seeds (about 70,000 seeds, or 33 kg per ha) are sown 25 cm apart at a row width of 1 meter. A total yield of 1,200 to 1,500 kg per ha can be obtained. Yield exceeding this amount cannot be expected for ordinary farmers as they do not use fertilizers.

c) Mandioca:

Seeds are sown from August to September, and gradual harvesting starts in October the following year. This is a very important crop for the farmers' own consumption, but very little fertilizer is used.

d) Corn and Poroto:

Poroto is often planted as a cash crop between corn seedlings. Seeds are sown from August to September; harvest continues from November to January or February the following year.

e) Tomato:

Some farmers raise tomatoes three times a year; they can be grown throughout the year. Seeds are sown during November-December, March-April or July-August, and require about six months to mature. Most of the varieties are "Nozomi". The seedling period requires about one month. Seedlings are transplanted once or raised in pots. About 20,000 seedlings per ha are planted 35 to 40 cm apart at a row width of 1 meter. Passages 80 cm in width are also needed. Poultry manure (initial 30 tons) and chemical fertilizer (1,200 kg initial and additional combined) are used. Pesticide is sprayed over the crop once a week to prevent damage from disease and insects. A yield of 20 kg per ha, or more with watering, can be expected.

f) Cucumber:

Can be raised three times a year. Seeds are sown directly in the ground 50 cm apart at a row width of 1 meter, with passages 1 - 1.5 meters in width. They can be raised in pots during the cold season. 20 ton/ha of poultry manure (initial) and 400 kg/ha of chemical fertilizer (initial and additional combined) are used. Pesticide is sprayed once a week to prevent damage from disease and insects. Present yield of cucumber is 25,000 kg per ha.

g) Green Pepper:

This crop has a lengthy cultivating period and can be harvested throughout the year. Most of the seeds are sown in December and some from March to April. They are raised as seedlings for about 40 days before being transplanted to the field 30 cm apart at a row width of 1 meter. 20 ton/ha of poultry manure (initial) and 400 kg/ha of chemical fertilizer (initial and additional combined) are used. Thorough spraying of pesticide is conducted to prevent damage from disease and insects.

h) Onion:

Seeds are sown in April, kept as seedlings for 45 days, and planted 15 cm apart at a row width of 0.5 meter. As fertilizer, 3,000 kg/ha of agricultural coal is applied to adjust soil acidity, followed by 600 kg of chemical fertilizer. Present yield is 10 ton per ha. This crop can be harvested from October to November. Onions require well-ventilated, dry storage.

i) Melon:

The variety is Japanese "Sun Rise". Seeds are sown from July to August for harvesting from November to December. They can be grown first as seedlings or planted directly in the field.

In the latter case, seeds are planted 1 meter apart at a row width of 2 meters. About 20 ton/ha of poultry manure is applied over the whole planted area, followed by 300 kg of chemical fertilizer (initial and additional combined). The main branches are top pruned, with four left; the grandchild vine extending from the child vine bears the fruit. Straw mulching must be done. Present yield is 1,500 kg per ha.

j) Grape:

The varieties include Niagara, Sapino and Muscats for processing, and Olympia and Kyoho for marketing as fresh fruit. Seeds sprout in late August, flower in September and bear fruit in mid-November for the early strains and from December to February for the late strains. Present yield is 8,000 to 20,000 kg per ha.

k) Plum:

The variety is Santa Rosa. Flowering can be quickened by spraying 2% solution of coal nitrogen, resulting in a harvesting period shortened by about one month. The crop is harvested from November to December. The drawback in raising this crop is instability, as it tends to bear fruit only every second year.

l) Citrus Fruit:

This group includes many varieties such as mandarin oranges, ponkan and naranja. Early strains flower in April, and others from July to August. The crops are harvested from June to August.

m) Mango:

The plant flowers in August and is harvested in December.

(2) Characteristics of Cultivating Conditions

The following describes the relationship between field elevation and shipment period of fruit and vegetables in the main producing districts in areas such as the Study Area, Asuncion and Iguazu area.

In the three districts mentioned above the weather conditions differ according to elevation and a variety of cultivating conditions can be found, especially for fruit and vegetables. They are as follows:

a) In the case of vegetables and fruit production in the Iguazu district with an elevation of 300 to 500 m;.

During the winter period (from June to August) there are 10 - 20 days of frost and damage is common during this period.

Therefore, it is difficult to grow fruit and vegetables during this period. Because of these adverse weather conditions they can only be cultivated during the spring and summer cropping seasons.

b) Around the Asuncion suburban area;

This area can be cultivated throughout the year, but the diurnal range is slight in the summer period; even at night temperatures ranges from 28 to 30°C. Therefore, this period is not for vegetable growing due to the easy occurrence of bearing or fruiting injury. Because of these weather conditions, Autumn to Spring is the best season for cropping.

c) Study Area;

A large part of the cropping area in the Study Area extends over an elevation ranging from 130 to 200 m. Therefore, the diurnal range is relatively wide (7 - 10°C) even in the summer season and there are only slight weather obstacles, with the exception of rainfall distribution.

3.5.4 Farming Type

Farming in the Study Area can be classified into seven types as shown below.

Type 1:	cotton + crops for own consumption + (vegetables or mangoes) + livestock for own consumption
Type 2:	sugarcane + crops for own consumption + livestock for own consumption
Type 3:	vegetables + miscellaneous crops
Type 4:	beef cattle + cotton + crops for own consumption
Type 5:	fruit + miscellaneous crops
Type 6:	vegetables + fruit
Type 7:	fruit + miscellaneous crops + apiculture

Note: 1) The miscellaneous crops in type 3, 5 and 7 include cotton, corn and poroto.

2) The crops for own consumption in type 1, 2 and 4, including mandioca, corn and poroto, are consumed by ordinary farmers. Livestock for own use include draft cattle (for land cultivation and load pulling), dairy cows, pigs, poultry, etc.

Types 3, 5, 6 and 7 above are often adopted by the exemplary good farmers, conducting diversified farming with fruit or vegetables as major crops combined with others. The most prevalent farming type is the combination of fruit and vegetables, contributing to the current stable farming operation. As a special case, apiculture is being practiced by

some farmers, which, combined with fruit and other miscellaneous crops, is attracting attention as a suitable farming type.

Types 1, 2 and 4 are often seen among ordinary farmers. Most of the farmers adopt farming methods similar to types 1 and 2, conducting single cropping of cotton or sugarcane as cash crops. Farmers with pastures land (type 4) raise beef cattle. Recently, some ordinary farmers have followed the exemplary good farmers, growing some vegetables and fruit as cash crops. These crops include onions, tomatoes and mangoes. All the ordinary farmers grow mandioca, poroto and corn and raise poultry and pigs so as to be self-sufficient in food.

The vegetable cropping and growing land in the Study Area is blessed with favorable weather conditions as compared with other districts. However, the rainfall is uneven throughout the year in the Study Area. Dry spells occur from June to September, and vegetable cropping is difficult during this period. Therefore, in October and November there is a concentration of cropping because of higher rainfall.

Shortage of water for agriculture during the dry spells is a major obstacle to the establishment of a year-round cultivation system in the Study Area.

3.5.5 Production Costs and Productivity

(1) Production Cost

Production costs of the main crops are estimated with the followinfg conditions:

(a) Production cost of fruit was analyzed based on the result of the farm management survey, and of vegetables on data of SEAG in La Colmena.

(b) 30 kg of cotton seed is used per ha; seed costs 2,000 G/kg. The cost of agricultural chemicals covers that of pesticide both for killing germs and insects. Cost of fertilizer is not appropriated, as the ordinary farmers do not use it for cotton raising.

(c) Sugarcane seeds are used 5 tons per ha; seed costs 20,000 G per kg. The expense for buying the seed is needed only for the initial year as sugarcane can be grown continuously for the following several years.

(d) The seed cost of tomatoes, cucumbers and melons is high because of the use of imported hybrid seeds. Seed potatoes

are imported from Argentina.

(e) The production of the grapes and plums comes from matured orchards that are several years old; therefore, the cost of seedlings is not appropriated.

(f) For crops requiring intensive farming, such as tomatoes, cucumbers, melons, grapes and plums, the cost of both fertilizer and pesticide is higher.

The summary of the production costs are as follows:

Unit: G

Item / Crops	Production Materials				Labor	Others	Total
	Seed	Chemical	Fertilizer	Others			
Cotton	16,000	32,000	-	39,000	136,600	-	223,600
Sugarcane	-	-	56,000	88,000	215,000	-	359,000
Mandioca	40,000	-	-	-	221,000	-	261,000
Mixed crops Maize & Poroto	1,920 10,000	12,000	-	-	107,000	-	130,920
Onion	44,000	14,000	84,000	26,000	212,000	-	380,000
Potato	120,000	44,000	192,000	-	21,000	13,000	560,000
Tomato	130,000	258,000	576,000	320,000	548,000	-	1,832,000
Green Paper	200,000	150,000	264,000	11,000	550,000	-	1,175,000
Cucumber	390,000	155,000	244,000	155,000	373,000	-	1,307,000
Melon	325,000	84,000	262,000	-	212,000	-	883,000
Cabage	65,000	72,000	244,000	-	250,000	-	631,000
Grape	-	133,000	315,000	186,000	320,000	Interest 175,000	1,129,000
Plum	-	53,600	303,000	90,000	214,000	Interest 135,000	795,600
Citurus/Mango	-	32,000	21,000	32,000	150,000	85,000	509,000

The total present agricultural production and production costs by crops is shown below:

Crop	Cropping Area (ha)	Yield (ton/ha)	Production (ton)	Production Cost (1,000G/ha)	Total Production Cost (1,000G)
Cotton	820	1.3	1,066	223.6	183,352
Sugarcane	255	70.0	17,850	359.0	91,545
Maize	355	1.2	426		
Poroto	270	0.8	216	130.9	46,477
Mandioca	450	18.0	8,100	261.0	117,450

to be continued

Crop	Cropping Area (ha)	Yield (ton/ha)	Production (ton)	Production Cost (1,000G/ha)	Total Production Cost (1,000G)
Miscellaneous crops	15	2.5	38	182.0	2,730
Grape	43	20.0	860	1,129.0	48,547
Plum	74	4.6	340	795.6	58,874
Citrus	25	5.0	125	509.0	16,542
Other fruit	40	3.0	120		
Onion	55	10.0	550	380.0	20,900
Tomato	25	20.0	500	1,832.0	45,800
Water melon	15	20.0	300	883.0	13,252
Melon	6	12.0	72	883.0	5,301
Green Pepper	14	10.0	140	1,175.0	16,450
Other vegetable	65	15.0	975	631.0	41,015
Total	2,527	-	31,678	-	708,237

(2) Productivity

The following shows the yield per ha of the principal crops in the Study Area as compared with high yield districts.

Unit: ton/ha

Crops	High Yield Districts		* Study Area A	(%)	B	(%)	National Average
1. Cotton	1.4	Itapua	1.3	93	1.4	100	1.2
Sugarcane	96.8	Concepcion	70.0	72	90.0	93	51.4
2. Vegetables							
Tomato	40.0	Asuncion area	20.0	50	35.0	88	29.7
Onion	17.0	"	10.0	59	15.5	89	7.3
Green pepper	25.0	"	10.0	40	17.0	88	-
Pumpkin	18.0	"	15.0	83	18.0	100	-
3. Fruits							
Grape	13.0	Independencia	13.0	100	20.0	153	10.0
Plum	4.0	Cordillera	4.6	115	5.0	125	3.5
Oranges	7.0	Itapua	5.0	71	6.0	86	5.0

* A = Average yield in the Study Area
B = High yield farmer in the Study Area
(%) = Ratio of the yield (High yield district = 100.0)
Source : (1) Farm-economy survey 1988, JICA
(2) Basic agricultural production material prices 1982, JICA
(3) Departamento de Censo y Estadisticas Agropecuarias

The productivity of the main crops in the Study Area is higher than the national average.

In the case of vegetable production, there are differences in yields between the Study Area and high yield farmers of the Asuncion suburban area. The main reason for the difference in yield should be pointed out.

The following factors are responsible:

a) Differences in the quantity of input of agricultural production materials, mainly fertilizers and pesticides.

b) Differences in the countermeasures for drought damage depending on the water supply.

c) Differences in utilization of agricultural facilities (vinyl houses, vinyl mulching) to compensate for weather conditions.

The Annex D Table D.2.3 shows the productivity of the main crops in the Study Area as compared with other regions according to earning rates. The productivity of the main crops in the Study Area is higher than the national average. The low production cost as compared with the yield per ha should be pointed out as the reason for high productivity. And the following factors should be dealt with to reduce production costs.

a) Vegetables and Fruit:

Reduction of marketing costs by the establishment of a marketing system by the agricultural cooperative.

b) Cotton and Sugarcane:

Around the Study Area there are large scale sugarcane and cotton processing factories, therefore, transporting cost can be reduced.

c) Because of low wages for the agricultural labor as compared with other regions, the percentage of labor cost is high (cotton and sugarcane: about 60%, vegetables and fruit: about 30%). However, in the Study Area low wages are supplemented by extra benefits to the laborers (e.g. individual plots of land for laborers to work for themselves).

d) High soil productivity when crops are suited to the land.

3.6 Agricultural Economy

3.6.1 General

As for the agricultural land, the Study Area is blessed with favorable factors, especially in terms of distribution and marketing. It

is ideally located in the vicinity of Asuncion City, the biggest market for agricultural consumption in the country, and Puerto de Villeta, an important port for export/import duties. On the other hand, further increase in the amount of agricultural products in this Area has been hampered because of the small scale of the cultivated land per farm household and lack of agricultural water throughout the year. It is for these reasons that farming of products with high added value and those requiring processing has been traditionally conducted in the Study Area. The main crops in the Area, cotton, sugarcane, fruit and vegetables, all have high profitability and cash convertibility even when grown on a small scale. Moreover, primary and secondary processing are possible.

Because of these favorable features of vegetable and fruit production, the government has designated the Study Area as a model intensive suburban agricultural area, and intends to introduce the system into other regions.

3.6.2 Farm Scale and Land Tenure

The total number of farm households is 405 in the Study Area, and the breakdown of individual company distribution is summarized as follows and in Fig. 3.13.

	Company	No. of Farm Households	(%)
1)	Ybaroty	53	13.1
2)	Yahapety	27	6.7
3)	Bocayaty	56	13.8
4)	Rory	30	7.4
5)	Fatima	34	8.4
6)	Potrero Alto	33	8.1
7)	Caaty-mi	46	11.4
8)	Pindoty	52	12.8
9)	Barrero Azul	40	9.9
10)	Sol Naciente	34	8.4
	Total	405	100.0

(*Source: Agricultural Farm Management Survey, 1988, JICA)

Over 64% of the total farm households are small-scale farms with a landholding area of under 20 ha.

The farmers who own between 10 and 20 ha amount to 345 out of the total farm households. At present, all agricultural land in the Area is private land owned by individuals or corporations. However, 344 farm households, or about 85% of the total farm households, have title deeds acquired by completing the land registration. Annex D TableD.1.13 shows the number of farm households by farm-scale in the Study Area.

3.6.3 Farm Household Economy

(1) Farm household income

The gross farm agricultural income, farm household income and living expenses by farming type are shown as follows:

Unit: G/year

Farming Type	Land Holding Area	Gross Farm Income	Production Cost	Net Income	Living Expenses
1. Cotton + self consumption crops	10 ha	1,400,000	790,000	610,000	36,000
2. Sugarcane + self-consumption crops	10 ha	1,200,000	230,000	970,000	500,000
3. Vegetable + miscellaneous crops	15 ha	2,400,000	850,000	1,550,000	1,080,000
4. Beef cattle + cotton	20 ha	1,840,000	800,000	1,040,000	840,000
5. Fruit + miscellaneous crops	20 ha	4,920,000	2,720,000	2,200,000	2,000,000
6. Vegetable + fruit	25 ha	7,440,000	3,800,000	3,640,000	1,600,000
7. Fruit + miscellaneous crops + apiculture	30 ha	8,586,000	5,206,000	3,380,000	2,480,000

Source: Based on a review of farm household economy investigation by JICA, 1988.

* Crops for self-consumption are maize, poroto and mandioca.

Looking at average area of land and gross farm income, income from mainly fruit or vegetables farmer of 20 to 30 ha is four to six times the income from cotton and sugarcane farmers of 10 ha. Although both are mainly farms, type 6 earn over three times the income of type 3. This difference in income is due to the land area, but the difference between production yield and cultivated intensity is bigger than that for the land area. The difference between production yield and planted rate is based on whether there are irrigation facilities.

(2) Regional farm household income condition

Figure 3.14 shows the differences in farm household incomes according to size of land holdings in the Study Area compared with other regions.

In the case of land holdings of less than 15 ha, the farm household incomes in the Study Area are smaller than in other regions.

Although the farming types (main crops are sugarcane and cotton) are similar to a nationwide scale, there is a difference in farm household incomes. The main reason for the difference in income is based on the planted area and the intensity of land use.

On the other hand, the land holding class from 20 to 30 ha (except farming type 4) in the Study Area is that of intensive farming of mainly fruit and vegetables. Production income is higher when compared with other regions which are mono-cultivated. In the case of land holdings of less than 10 ha (farming type 1 and 2) and farming type 4 the annual income is below the national minimum income level (1,432,000 G/year).

The average national monthly minimum wage for industry is 119,350 G, in the agricultural sector, the average wage is 66,900 G (2,676 G/per day). However, the minimum wage in the Study Area is lower, i.e. 1,700 - 2,000 G/per day.

3.6.4 Marketing of Agricultural Products

(1) Market

Most of the fruit and vegetables produced in the Study Area are shipped to the ABASTO market and consumed in the Asuncion metropolitan area. The population supplied with food by the ABASTO market is about 700,000. ABASTO is made up of producers, shipping dealers and wholesalers (about 180 in all), retailers (150), related dealers (100) and those who make purchases. Sales prices are determined by the limits.

After the primary processing at the factory, most of the cotton is shipped abroad, while sugarcane is processed to produce sugar or alcohol for domestic consumption.

(2) Distribution and Marketing

In the Study Area, marketing channels for the principal agricultural products such as fruit and vegetables are different from cotton and sugarcane; methods of collection and shipment of products also differ between members and non-members of the agricultural cooperative.

a) Members of Cooperative

The agricultural cooperative goes from one member farmer to another to gather their products, all of which, except grapes for processing, is sent to ABASTO by trucks provided by the cooperative. Both ABASTO and the cooperative charge the

farmer for distribution costs and handling expenses, the amount of which is set for each product. Similarly, the cooperative ships cotton to cotton mills.

The following breakdown shows the ratio of each distribution route to the total sales of products shipped via the cooperative.

- ABASTO : 50%
- Cooperative Asuncion sales points : 39%
- Cooperative headquarters : 11%

b) Non-member farmers

No definite systematic distribution systems have been established among farmers who are not members of the cooperatives. They commonly sell their products directly to brokers called ACOPIADOR. The broker goes as far as the front yard of a farmer to buy his products. Actual collection of products is done by truckers who bring them to a sugarcane factory or cotton mill.

The broker is also engaged in distribution and sales of fertilizer, pesticide and other agricultural production materials as well as financing. Farmers without their own viable distribution networks rely to a great degree on services offered by the brokers. However, brokers often demand higher handling fees for selling farmers' products than the government and tend to set the purchase prices less than the standard prices determined by the government.

(3) Problems in distribution

The Study Area has a collection and shipping center operated by Colmena City for agricultural products. However, it lacks adequate facilities for incoming trucks and storing products. These inconveniences make the non-members of cooperatives without reliable distribution networks dependent on the broker for collection and shipping of their products, causing the following problems:

- Loss in the marketing process due to underdeveloped distribution network.

- High distribution cost, eating up the profits from sales.

At the peak of harvesting, even the members of cooperatives suffer from lack of collection trucks provided by the cooperatives and have to ask the brokers for help, leading to the following problems:

- Worsened product quality due to inadequate storage facilities.

- Slow response to market situations due to inhability to maintain stable collection or shipping systems.

3.6.5 Price of Agricultural Products and Production Value

(1) Relationship between the price of agricultural products and market

At present, the government's price guarantee system is applied to the price of sugarcane, while the price compensation system is being enforced for cotton. Prices of both crops have shown an average increase of more than 30% over the past four years (1984 - 1987). The shift of producer's prices (1981 -1987) for major agricultural products harvested within the Area is shown in Annex D Fig. D.2.1 and present producer's prices is tabulated in Annex G Table G.3.6.

Although prices of fruit and vegetables over the same period registered an increase of 10 to 20%, they tend to fluctuate considerably throughout the year. This means that these products are susceptible to demand situations in the market, bringing the price down drastically when there are over-shipments. Figure 3.15 shows the relation between the amount of product arrivals to ABASTO and the wholesale prices throughout the year, on a monthly basis.

Table 3.16 shows the quantity and ratio of foreign as well as domestic products classified according to crops over the recent three years (1985 - 1987). The amount of imported products reaches its peak when levels of domestic supplies are low: from March to June for vegetables and from April to September for fruit. The prices are relatively higher in these periods owing to a shortage of domestic supplies. In the case of the Study Area, the shipping periods for fruit and vegetables are from October to January when more than 70% of the produced is shipped. February to September is the off-season. The off-season production of fruit and vegetables in the Study Area is the same as the domestic off-season, therefore, the Study Area is in an unfavorable situation for price setting.

The quantity of shipments of the main fruit and vegetables by individual region and shipment period are shown in Annex D Table D.2.1 and D.2.2.

(2) Total production value

The following shows the total production value in the Study Area calculated from the total agricultural production.

Crops	Production Value (1,000 G)
Cotton	266,500
Sugarcane	196,350
Miscellaneous crops	409,405
Vegetables	193,291
Fruit	265,330
Wine	151,830
Beef cattle	89,112
Others	16,831
Total	1,588,649

"Others" includes Royal jelly, etc.

3.6.6 Agricultural Processing

A winery operated by the cooperative is located within the Study Area, constituting a major agricultural processing facility. Production of wine is very important not in terms of the regional economy, accounting for 10% of the total agricultural production value of the Area, but also in terms of prestige as a place of outstanding wine known under the brand name of "La Colmenita".

(1) Winery Production

1) Demand and supply

Total domestic demand for wine is 13.0 million liters per year (1987). On the other hand, a total of 10.0 million liters of wine is produced domestically per year, therefore 25% of the total demand depends on imported wines. Domestic production of wine has grown at 2% per year for the last 10 years (1977 -1987). However, the importation of wine has risen 5% per year (Actividad Vitivinicola en el Paraguay, Centro de Vitivinicultores del Paraguay, 1988). The reason for increased wine imports is a shortage of domestic wine production.

2) Winery production in the Study Area

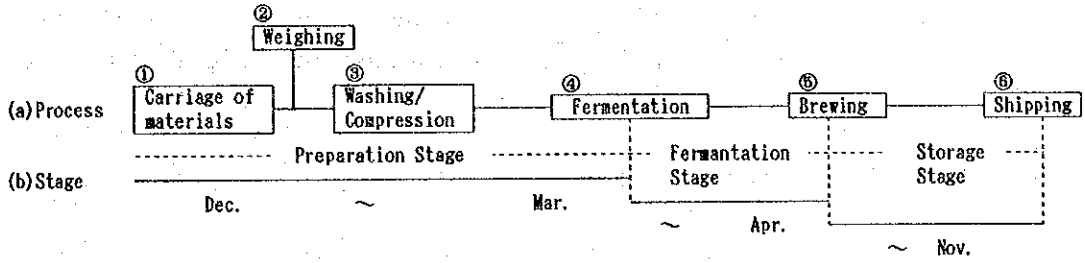
A total of 723,000 liters of wine were produced in the last year (1987/'88). The following shows the requirements for wine production materials.

Shortage of the production materials occurs in the area due to shipping of 40 to 50 % of wine production materials to market as a fruit in connection with the market peice.

Wine	Production of wine	Requirement of materials	Supply of materials
White	310,000 liter	215 ton	180 ton
Red	392,000	309	309
Total	723,000	524	489

3) Production process for wine, and its problem

The following shows the production process of wine and problems of fermentation.



Process	Problems
1) Carrying	- Shortening of production material.
2) Weighing	- Declined of the net yield.
3) Washing	- Shortening of washing water.
4) Fermentation	- Raising the fermentation temperature and thus making it difficult to maintain and improve product quality.
5) Brewing	- Tartaric occurs of wine

In particular, oxidation is quickened as the brewing temperature before the fermentation controlling reaches 30-33°C (max. 35°C), creating an environment where microorganisms can propagate more easily. As a result, the fermentation temperature becomes higher, making things difficult for the later fermentation control and storing (brewing) management. From now on, the following points must be attended to quality improvement and production expansion.

- Establishment of early shipment by shortening the brewing period.
- Lowering of the fermentation temperature and establishment of low-temperature fermentation technology.

- Removal of tartaric acid.

(2) Other processing facilities

The small cotton and rice mills have been set up by the agricultural cooperative in the Study Area. These are not functioned at present. Cotton and sugarcane produced within the Area are sent to a cotton mill and two sugar mills for processing. These factories, however, suffer from lack of raw materials.

At present, a juicing factory is under construction in the Area. In the plan, this factory will produce pineapple juice and in the future, canning of fruit and vegetables and production of soft drinks will be started.

3.6.7 Agricultural Supporting Services and Farmers' Organization

(1) Agricultural experiment, research and extension

1) Agricultural experiment and research

Experiment and research of agricultural products is being conducted mainly by National Agriculture Institute (IAN) and Regional Agriculture Research Center (CRIA), both of which are under the jurisdiction of the Department of Agriculture, Forestry Research and Propagation of MAG. In addition, major crops such as cotton, soy beans and wheat are being tested at seven places throughout the country.

The Study Area has an experimental field (0.5 ha) for grape growing. This is operated privately by the wine-brewing association. A group to study cultivation of fruit and vegetables has been set up within the agricultural cooperative. There are no government-level research centers. However, there is an experimental station run by IAN in Caacupe City, about 50 km northeast of the Study Area, where they conduct various experiments such as breeding, suitability tests for planting, and research on prevention of damage from disease and insects on cotton, sugarcane, corn, tomatoes, grapes and other fruit and vegetables.

2) Agricultural extension services

Department of agriculture and livestock extension service (SEAG) of MAG is responsible for spreading agricultural technology within the country. Currently, 136 SEAG offices are set up throughout the country, with 467 extension workers. For the Study Area, there is a SEAG La

Colmena office with six staffs engaged in spreading technology, and one assistant. The following list shows the responsibilities of these seven workers.

	Extension Workers		Number
a)	Agriculture	:	4
	- Field Crops	1	
	- Vegetables	1	
	- Fruit	1	
	- Cattle	1	
b)	Forestry instructor	:	1
c)	Education and lifestyle improvement instructor	:	1
d)	Assistant	:	1
	Total		7

The Area covered by the La Colmena office spreads over 31,000 ha, including the Study Area and the surrounding area. The extension services are being carried out through the twelve agricultural committees. The main activities are:

- Technical guidance for cultivation of crops (cotton, sugarcane, vegetables and fruit).
- Farm management and lifestyle guidance.
- Instruction on purchasing of products and production materials such as fertilizer and pesticide.

Right now, two jeeps and one motorcycle for transportation of stuffs and a set of measuring equipment are all that the office has, creating the following inconveniences:

- Lack of transportation vehicles.
- Lack of materials and equipment for spreading technology and scarcity of instruction tools (wireless transmission, telephone, video, etc.).
- Inadequate facilities for exhibitions and gatherings.

More and more farmers in the Study Area are expressing their desire to grow vegetables and fruit, shifting from the traditional crops such as cotton and sugarcane and pushing the trend toward diversification of products. This development has made it all the more important to have viable instruction systems on harvesting techniques, especially manuring management of vegetables and fruit, and an increase in the number of extension workers for this task.

(2) Farmers' Organizations

There are two farmers' organizations in the Study Area: the agricultural committee and the agricultural cooperative. These organizations are outlined below.

1) Committee

Committees are set up in each village (companias). At present, there are ten committees to which 208 farm households belong. Most of the committee members are farmers operating on a small-scale, making them vulnerable to social and economic conditions. By putting them in an organization, the committee intends to help those farmers to improve their productivity and living standards. The committee is operating under the instruction of the SEAG, whose main guidance includes the following:

- Joint shipment and marketing of agricultural products, mainly cotton and sugarcane
- Joint purchasing of fertilizer and pesticide
- Agricultural technical extension services for each committee

The committee system originated in the Integrated Rural Development Plan of Department of Paraguari, containing 80 committees with approx. 4,700 farm households (SEAG, 1986).

2) Agricultural Cooperative

The Study Area has the La Colmena agricultural industrial cooperative, which was established in 1948 with an aim to assist its members in their agricultural activities. With a present membership of 61, its main activities include the following:

- Collection, shipment and sales of products
- Financing
- Sales of production equipment
- Brewing and marketing of wine
- Purchasing of daily commodities
- Rental service of agricultural machines (tractors)

The following shows the total production and sales during 1986 - 1987. Vegetables, fruit and wine account for more than 90% of the total sales. The cooperative activities account for 49% of the entire production of the Study Area and play the important role in the Area.

Products	Output (quantity)	Sales (1,000G)	(%)
1) Vegetables & Fruit	1,300 ton	142,387	43.9
2) Wine	723,000 lit	158,849	49.0
3) Royal jelly	0.07 ton	10,343	3.2
4) Honey	4,258 lit	6,488	2.0
5) Miscellaneous crops	14 ton	4,229	1.3
6) Others	-	1,927	0.6
Total		324,223	100.0

Per capita annual income has shown a steady yearly increase, reaching approx. 4 million G on average (1986-1987). Other than giving mutual aid to its members, the main pillar of activities, the cooperative offers the following benefits to the members:

- Reliable and low-priced purchasing of such production materials as fertilizer and pesticide
- Minimization of distribution loss and obtaining market information
- Improvement of production technique through agricultural technology study circles

Since its establishment, La Colmena cooperative has been involved in various agricultural activities, focusing on the development of processing techniques for cotton and wine. Its stability and efficiency have placed the cooperative in the top rank of the nation's 40 cooperatives.

3.6.8 Agricultural Financing

There are two agricultural financial institutes in the Area: Bank of National Fomentation (BNF) and the Colmena Agricultural Industrial Cooperative. Their loan conditions and situations are shown below.

Item	B.N.F	Agricultural Cooperative
① Fund	-Government -B.C.P 91 % -Own fund(Deposit) -Foreign Institute 9 %	-Association of Japanese Agricultural Cooperative 21.8% -B.N.F 2.6% -Own Fund(Deposit) 75.6%
② Loan Condition	-Limited to La Colmena residents -Limited to land owners	Cooperative members
③ Interest (Aug. 1988)	-Short-term loan: 22.0 % (incl. handing charge) -Long-term loan : 32.0 % (incl. handing charge)	-Short-term loan: 22.0 % (incl. handing charge) -Long-term loan : 16.55 % (incl. handing charge)
④ Grace Period	Not available	1-2 years for long term loan
⑤ Loan Limited	4.5 millon G or 70 % of the farm management plan	80 % of the cooperative investiment
⑥ Loan Method	Three division method: period of planting, manuring and harvesting	Lump sum payment
⑦ Loan Objects	-Farm management -Living	-Farm management -Construction (limited to enlargement of vineyard)
⑧Total Loan Amount	280 millon G	230 millon G
⑨ Deposits	60 millon G	59 millon G
⑩Annual interest rate on deposit	16 - 17 %	11.0 %

In addition to financing by the above two institutes, brokers loan money to small-scale farmers whose main products include cotton and sugarcane. The farmers pay back what they owe with their crops. This system, however, has burdened some farmers with accumulated debts to the broker. They rely on the broker because most of them do not own their own land, making them unable to borrow money from BNF.

Outside the Study Area, there is Habilitation Agricultural Credit (CAH) established under the jurisdiction of MAG, whose sole purpose is to protect such small-scale farmers in line with the country's agricultural policies. CAH makes loans as well as technical guidance available to farmers who lack qualifications to borrow money from ordinary financial institutes, making preferential loans for such crops as cotton, sugarcane, soy beans, corn, wheat and rice. Right now, CAH plays an

important supporting role in the agricultural development projects being promoted throughout the country.

3.7 Water Use

The Project Area has many streams originated Tebicuary-Mi. However, water resources available is poor due to undurating topography and a small amount of dischage in the streams. Well water (shallow wells) is used for drinking and also water from the rivers is used for farming by a few farmers. The present situation is described in detail below.

3.7.1 Irrigation Water

The annual rainfall is indicated approx. 1,600 mm, but rainfall distribution is irregular and dry spells of over 20 days in a row occur several times a year. Therefore, Shallow-root plants, and especially plants of sandy soil areas has been suffered drought damage. At present, about ten superior farmers use pumps to irrigate even for small-scale in their farm land. Those without irrigation equipment haul water by cattle cart to irrigate their crops during seedling and transplantation periods.

Water sources include rivers (Tranquera, Rory, and Rory-Mi), springs and wells (two 80-m deep wells; others are shallow wells). All irrigation water, however, are used on a small scale with high running cost. Because of this, they are used only for fruit and vegetables with high profitability and only when urgent required. 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

Both crops show superior production volume and quality to others that are not irrigated.

3.7.2 Drinking Water

About half of the families have wells for private use, though there is a water works facility in the urban district (population: 2,300) of La Colmena. Almost all the farm households depend on their shallow wells for drinking water. Those without wells rely on water from rivers, springs, rainfall, etc. (rural water supply facilities will be described in 3.8.8).

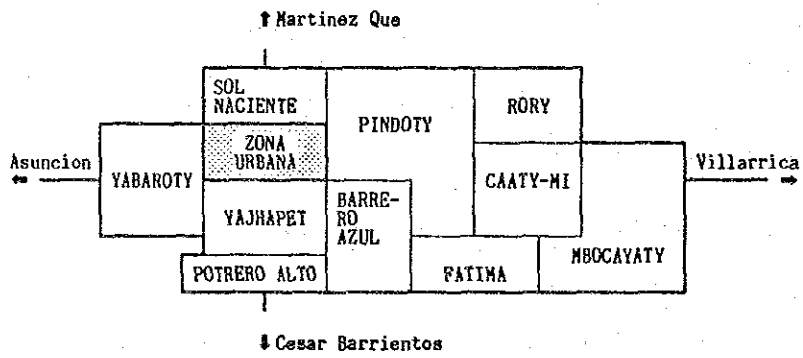
3.7.3 Others

A juice factory is being constructed in the eastern part of the La Colmena urban district. After completion, the factory will use water from Tranquera (expected water use: 45 liters per second) and intake weir is already constructed. With these, required water amount at the juice factory should be considered to formulate the water utilization plan in the Study Area.

3.8 Social Infrastructure

3.8.1 General

The Study Area has a densely populated urban areas in the center and develops rural areas scattered along the road. The latter is divided into following eleven administrative districts (Compania).



The population is equally spread over the urban and rural areas, however, the distribution of social capitals has unevenness greatly between the urban and rural areas. Although accumulation of social infrastructures at the urban areas in La Colmena is superior than that of average in the Department of Paraguari except for rate of road pavement. As for the rural areas, accumulation of social infrastructures is much different in comparison with the urban areas as same as the rural areas in the other cities of Department of Paraguari.

Table 3.1 shows present conditions of agricultural and social infrastructures at the each administrative district in the Area. The quality of such infrastructures is summarized in Table 3.2 based on the existing circumstances of such facilities in Paraguay.

Existing conditions and its problems on each facility are as follows;

3.8.2 Road Network

According to the information of the Department of Public Communications (MOPC), roads in Paraguay are divided into the following categories: main roads (TRONCAL), provincial roads (RURAL) and farm roads (SENDERO).

The main roads in the Area comprise Route 251, 805, 818 and 819. These main roads are linking the Study Areas with the major cities in the country (Asuncion, Coronel Oviedo, Villarrica, Stroessner, etc.). Only Route 251, connected to Route 1 via Acahay, is paved. Rate of pavement for the main road within the area is 33%.

The area has three provincial roads (818-1, 818-3 and 251-22) with a total length of 17.7 km. They run north-south without pavement. On the other hand, there are 39 farm roads with a total length of 61.3 km. They are not paved. Traffic volume for 12 hours at some of the major points is as follows: 158 cars and trucks at Route 251, 31 at Route 805, 245 at Route 818 and 52 at Route 819. The following describes the road types stated above:

- Main Roads

  Only Route 251 is paved. Other main roads have enough width but surfaces are bumpy and wooden bridges are narrow, obstructing the flow of traffic. Uneven road surfaces have been caused by inadequate drainage facilities, making it necessary to construct drain ditches when paving the roads, since these road is functioned for collecting and shipping of agricultural products and marketing in the Area. The narrow wooden bridges are the main obstacles for smooth flow of the traffic, and they should be improved with permanent ones.

- Provincial Roads

  Although right of way for the road is enough, effective width of these roads are only for 1.5 lanes in reality. Bumpy surface conditions seriously hamper the flow of traffic, transportation of agricultural products and daily necessities. In particular, the road extending from the urban district of La Colmena to Potrero Alto is so poorly maintained that it is not passable for cars. These poor road conditions can be corrected by improving road foundation, bridges and drainage facilities.

- Farm Roads

  Owing to the government settlement plan, there are enough right of way for farm roads, however, effective width of existing roads is at only about one lane. Many points (45%) are not

available for car traffic; impassability reaches 60% for the road stretching from east to west, making it very difficult to construct a network of farm roads within the area. These factors hamper car traffic are as follows:

- The road was originally passable, but made impassable because of erosion due to poor drainage of rain water.
- Rocks are exposed, making it very difficult to construct a road for car traffic.
- The road has been designed on the premise for cattle traffic, not for cars.

With these factors corrected, a viable agricultural road network can be constructed, to substantially improve the environment for both farming and farmer's living.

Following is the major items to be improved on the road network in the Area:

a) Strengthening main and provincial road functions (road pavement, bridges, cross drain, etc.).

b) Dissolution of impassable sections.

c) Improving foundation for farm roads.

d) Establishing farm road network.

3.8.3 Canals and Drains

The Study Area has no clearly defined canals for irrigation and/or drainage; the farmers depend on the three major streams flowing through the area for these functions. All the water needed for irrigation comes from streams and wells. Lack of well-developed drainage systems causes the rainwater to flow over roads, eroding surfaces and cultivated land. Roads are particularly vulnerable to flooding, making many points impassable during the rainy season.

Thus, it is all the more urgent to construct well-designed drainage systems for road and farm land protection. To promote the agriculture with technical irrigation, building up the systematic irrigation network and its related structures are indispensable.

The following points should be attended to:

a) Establishing irrigation networks.

b) Establishing drainage systems for farm land and road protection.

3.8.4 Medical Facilities

The urban area has one medical center. The center plays an important role in the community as a place for health improvement and medical care. One head doctor who specializes in pediatrics, one gynecologist, one dentist and five nurses are engaging their duty. The center has five beds and can accommodate in-patients. However, it is designed for initial examination and primary treatment, lacking facilities for treatment, oxygen inhalation, analyzing and dental treatment. Patients must be transferred to hospitals in Paraguari or Asuncion for serious treatment.

However, people in the area seem anxious for urgent improvement of the center's shortcomings, such as inadequate medical as well as communication facilities, poor road and ambulance conditions. To correct these drawbacks, the following points should be considered:

a) Review of the emergency medical system.

b) Establishment of emergency communication network.

c) Improvement of equipment for medical treatment.

d) Increase in the number of surgeons and interns as well as sicknesses that can be diagnosed.

3.8.5 Education

There are eight schools for primary education consisting two main schools, and six branch schools. All the students are within 5 km of these schools, however, the Fatima branch school offers only the first two years and the Potrero Alto branch school the first three years of education, forcing the students to walk long distances to receive higher education. The Fatima branch is now being renovated while the schools at Caaty-Mi and Potrero Alto are dilapidated from age. The only auxiliary facility available is the exercise ground of the main elementary school.

Although lower-grade primary education is available to almost habitants within the area, some students have to walk long distances to attend upper-grade classes. Moreover, lack of exercise facilities at middle high schools as well as branch schools are detrimental to effective education.

The following improvements are required:

a) Reconstruction of old facilities.

b) Availability of all the primary-level education at branch schools (eliminating the need for students to walk long distances to attend the class).

c) Enhancement of exercise facilities.

d) Improvement of lighting system in the classroom (especially at branch schools).

3.8.6 Electricity

370 households (80%) in the urban district and 90 families (22%) in the rural areas have facilities to receive electricity. Although the rate can be increased to 100% for the urban district and 50% for the farming areas, many farmers remain without electricity because of the cost involved (leading wire, electricity charge, etc.). Basic power networks are established for the whole Study Area, therefore, power supply to farmers should be considered centering on such areas as Mbocayaty, Ybaroty, and Potrero Alto. The capacity of a high-tension line for the basic power networks is 23 kv and voltage for family use is 220 v (50 Hz).

To summarize, the following improvements should be made:

a) Establishment of power networks within the Area.

b) Increased availability of electricity for rural area.

3.8.7 Communication

At the moment, telephones are installed at 100 places in the Area as a whole, but only one of them is located in the rural areas. The pay-phone is only one in ANTELCO at urban area. The switchboards will be made automatic and the lines will be increased to 200 within three years, according to the ANTELCO's long-term plan.

The scarcity of telephones (only one available) in the rural areas causes considerable inconvenience and problems in emergencies and in daily life. It is, therefore, necessary to install at each administrative division a pay-phone which is easily accessible to farmers. To summarize, improvement plans should include the following:

a) Early realization of automatic telephone switchboards and

increase in the number of lines.

b) Installation of pay-phones for agricultural administrative divisions.

c) Establishment of communication networks within the farming areas.

3.8.8 Rural Water Supply Facility

Water supply facilities are installed only in the urban area where 240 households, about half the total number, make use of them. The rest depend on private wells for drinking water. Potable water comes from two wells. Water is pumped up to the supply tower to be delivered to each family using gravity system. However, water is scarce during the dry season, necessitating rationing. In the rural areas, on the other hand, most of the drinking water is supplied by private wells. However, some farmers in the mountainous areas (especially Mbocayaty and Fatima) frequently have no wells and rely on streams for drinking and daily use water. Most of the private wells are about 10 meters deep with average water depth of 1.5 meters. Many dry up during the dry season. Water from a variety of sources such as rivers, streams and wells, all retains adequate quality for drinking. Per capita water consumption is 60 l/day in the urban district and 20 l/day in the rural areas.

Above mentioned, as existing potable water, development of stable water sources is under the pressure of necessity for getting of water use. Ensuring the water sources is essential for stable supply of drinking water to the rural area. However, because of the sparse population, it is very difficult to set up a centralized water supply system, making it necessary to construct a multiple number of facilities. It is also difficult to make use of groundwater for drinking purposes so streams are still relied upon. Rural water supply facilities to be established should be used not only for drinking but for miscellaneous agricultural use as well.

To summarize, the following improvements should be made:

a) Stable drinking water supply in the rural areas.

b) Development of new water sources for the urban area.

3.8.9 Processing of Sewage, Wastewater and Garbage

Sewers are almost nonexistent in the urban as well as rural areas. Most families dig holes inside their property to use as toilets; when

these become full, the contents are moved to other places. In the urban area, toilets are often fenced by brick walls while simple wooden fences are used to surround them in the rural areas.

Form	Brick	Wooden Fence	No Toilet
Urban Area	30%	70%	0%
Rural Area	5%	85%	10%

Most families use simple ditches within their properties to let wastewater flow. Some households in the urban area discharge the water directly into the river. Also, garbage treatment is perfomed by individual family in the rural areas and unlawful disposal of garbage is being practiced in the urban areas resulting seriously polluting of natural environment being occurred.

At the moment, individuals are solely responsible for processing of sewage, wastewater and garbage, but there have been no cases of environmental pollution because of that. On the other hand, from the hygienic view point (prevention of infection caused by disease-carrying parasites), it is desirable that toilets are enclosed by brick walls and preparation of dumping yard for garbage processing.

The following items should be enforced:

a) Installation of toilets and their improvement (use of bricks) in the rural area.

b) Increase in the number of brick-wall toilets.

c) 100% on property processing of wastewater (ditches, etc.).

d) Ensuring a dumping yard for urban areas.

3.8.10 Parks and Others

On the subject of public facilities, only the urban area has parks and soccer fields available to the general public; there are a few private soccer fields in the rural area. To improve community communication and for a healthy lifestyle of those living in rural areas, it is essential to set up parks with facilities for sports, such as soccer, basketball and volleyball. These parks are also necessary to nurture the next generation.

To summarize, the following items should be enforced:

a) Acquisition of land suitable for parks.

b) Construction of agricultural parks in each administrative division.

c) Nurturing of leader by promoting sports and other activities.

Table 3. 1 The Current Situation at Each Administrative Section

Administrative Section / Items	1. YBAROTY	2. YAJHAPE-TY	3. PINDOTY	4. RORY	5. CAATY-MI	6. MBOCAYA-TY	7. FATIMA	8. BARRERO AZUL	9. POTORERO ALTO	10. SOL NACIENTE	11. URBAN AREA	TOTAL
Area (ha)	2,940	640	1,380	720	890	1,480	1,140	700	380	390	340	11,000 ha
Population	340	175	360	190	295	335	215	260	210	220	2,310	4,910
Household	53	27	52	30	46	56	34	40	33	34	460	865
Av. Land Holding (ha)	55	20	25	20	15	25	35	15	10	10	-	25
Small Scale Farm	20	18	37	19	39	15	22	28	29	32	-	259
Rate of Organization (%)	53	74	60	97	63	43	71	88	46	76	-	66
Av. Income (10million G)	160	145	190	160	160	170	130	180	130	130	-	160
Farming pattern	I + E	M+ I	I	M + I	M + E	M	I + E	I + E	M + E	E + M	-	-
1. Diversion weir	−95△5	−95△5	−30△70	−80△20	−90△10	−100	−80△20	−40△60	−100	−100	−100	−80 △20
2. Reservoir	−95△5	−99△5	−60△40	−95△5	−100	−100	−90△10	−90△10	−100	−100	−100	−90 △10
3. Irrigation	−95△5	−95△5	−30△70	−80△20	−90△10	−100	−80△20	−40△60	−100	−100	−100	−80 △20
4. Drainage	−100	−100	−100	−100	−100	−100	−100	−100	−100	−100	−100	−100
5. Collection & shipping	−100	−100	−100	−100	−100	−100	−100	−100	−100	−100	◇100	−90 ◇10
6. Meeting place	−100	−100	−100	−100	−100	−100	−100	−100	−100	−100	●100	−90 ●10
7. Main road	◇40●60	−100	◇100	◇100	◇100	△100	−100	−100	−100	◇100	○40●60	△30◇35○5 ●30
8. Provincial road	−100	◇40○60	◇100	−100	−100	−100	△20◇80	△20◇80	△30◇70	−100	−100	△10 ◇85 ○5
9. Farm road	△85◇15	−100	△30◇70	◇100	△40◇60	△60◇40	△30◇70	△30◇70	△60◇40	△20◇80	−100	△40 ◇60
10. Electricity	−70○30	−10○90	−20○80	−40○60	−100	−100	−60○40	−30○70	−100	−20○80	◎100	−40 ○20 ◎40
11. Rural water supply	△30◇70	◇100	◇100	◇100	◇100	△30◇70	△30◇70	△20◇80	△30◇70	◇100	◎100	△5 ◇75 ◎20
12. Telecommunication	△100	△100	△99◇1	△100	△100	△100	△100	△100	△100	△100	△75◎25	△90 ◇0 ◎10
13. Medical care	△100	△100	△100	△100	△100	△100	△100	△100	△100	△100	◎100	△90 ◎10
14. Education	△100	△100	○100	△100	○100	○100	◇100	△100	◇100	△100	◎100	△35◇30○30◎5
15. Rural park	−100	−100	−100	−100	−100	−100	−100	−100	−100	−100	○100	−90 ○10
16. Garbage	△100	△100	△100	△100	△100	△100	△100	△100	△100	△100	△100	△100
17. Sewage	−20△80	△100	△80◇20	△100	△100	−20△80	−10△90	−10△90	−10△90	△100	△90○10	−5 △93 ○2

[note] Farming pattern : E=Extension farming M=Mono-colture farming I=Intensive farming

Level of quality: No facility= (−) Lowest = (△) Low = (◇) Medium= (○) Advanced= (◎) Supreme= (●)

Example : Improvement level (No facility) Improvement level (Lowest)

−95△5

Percentage of level Percentage of level

Table 3. 2 The Classification for the Quality of Improvement

Level / Method	Level of Improvement Quality					
	O. Zero (−)	I. Lowest (△)	II. Low (◇)	III. Medium (○)	IV. Advanced (◎)	V. Supreme (●)
1. Diversion weir	No facility	Directly	Diversion(small)	Diversion(medium)	Diversion(large)	Combine diversion
2. Reservoir	No facility	Natural	Pond(small)	Pond(medium)	Reservor(large)	Dam
3. Irrigation	No facility	Individual	Canal(small)	Canal(medium)	Canal(large)	Pumping system
4. Drainage	No facility	Natural	Open dich	Pipe drain (S)	Pipe drain (L)	Pumping system
5. Collection & shipping	No facility	Small	Medium	Large	Quality control	Active distribution
6. Meeting place	No facility	Small	Medium	Large	Multi-purpose	Total center
7. Main road	No facility	Bare (6.0m<)	Subgrade course	Sediment pavement	Small pavement	Asphalt pavement
8. Provincial road	No facility	Bare (2.0m<)	Bare (3.5m)	Subgrade (6.0m)	Sediment pavement	Small pavement
9. Farm road	No facility	Bare (2.0m<)	Bare (3.5m)	Subgrade (6.0m)	Sediment pavement	Small pavement
10. Electricity	No facility	Point	Private plant	Small network	Medium network	Power network
11. Rural water supply	No facility	Brook	Well	Private plant	Small network	Waterworks
12. Telecommunication	No facility	Use at urban	Point at rural	Small network	Medium network	Rural area net
13. Medical care	No facility	Vicinity	Traveling clinic	Clinic (small)	Clinic (mediun)	Hospital
14. Education	No facility	Head school	Branch(low class)	Branch(all class)	High school	College
15. Rural park	No facility	Bare (small)	Bare (medium)	Playing field	Multi-purpose	Rural park
16. Garbage	No facility	Individual	Public (small)	Puplic (medium)	Gathering	Total treatment
17. Sewage	No facility	Private toilet	Septic tank(pri.)	Privet plant	Small network	Sewerage

Table 3. 3 Present Road Condition

Type	Name	Length	Right of Way	Effective Width	Pavement	Sediment	Bare	Impassable	Cross		Household		Farm Land
									BR	CO	Direct	Undirect	Rate
		(km)	(m)	(m)	(km)	(km)	(km)	(km)	(plase)		(household)		%
(Main Road)													
A	251	5.5	15.9	6.2	5.5	-	-	-	3	-	7	4,500	45
A	805	2.8	29.1	8.0	-	1.0	1.8	-	-	-	32	380	90
A	818	12.3	16.3	3.7	-	-	12.3	-	4	5	60	1,560	95
A	819	2.8	15.8	3.9	-	-	2.8	-	-	3	15	2,150	90
	total	23.4			5.5	1.0	16.9	-	7	8	114	8,590	
(Provincial Road)													
B	818-01	5.2	9.0	3.0	-	-	5.2	1.0	1	2	33	68	100
B	818-03	4.6	7.5	3.0	-	-	4.6	1.0	1	2	20	58	100
C	251-22	5.8	12.0	6.2	-	-	5.8	2.5	2	4	51	580	100
	total	15.6			-	-	15.6	4.5	5	8	104	706	
(Farm Road)													
E	251-15	1.2	20.5	2.9	-	-	1.2	1.1	1	-	-	-	10
C	251-16	2.4	6.7	2.3	-	-	2.4	0.3	1	-	3	350	10
B	251-17	3.7	25.8	4.4	-	-	3.7	-	-	-	10	350	5
C	251-17-1	1.3	13.8	3.8	-	-	1.3	1.3	-	-	-	120	-
C	251-17-3	2.0	21.9	4.6	-	-	2.0	0.7	-	4	-	240	-
E	251-18	2.2	17.5	3.7	-	-	2.2	1.3	1	-	2	6	-
E	251-19	2.2	10.5	3.0	-	-	2.2	2.0	1	1	-	5	5
D	251-20	1.4	7.1	3.2	-	-	1.4	-	-	1	9	8	75
E	251-21	1.0	6.4	2.8	-	-	1.0	0.3	-	-	3	-	40
D	805-01	1.3	3.2	1.8	-	-	1.3	0.9	1	-	1	35	30
D	805-02	2.5	13.4	2.5	-	-	2.5	2.0	1	2	5	130	25
D	818-01-1	1.1	7.9	3.5	-	-	1.1	-	-	-	-	95	100
D	818-01-2	1.4	4.0	2.3	-	-	1.4	1.4	2	4	-	11	20
D	818-01-3	1.4	5.2	2.7	-	-	1.4	0.5	-	3	10	15	80
B	818-02	3.2	5.1	3.5	-	-	3.2	1.2	-	1	10	10	95
D	818-03-1	1.2	2.8	1.3	-	-	1.2	1.2	1	3	-	35	75
E	818-03-2	1.7	6.0	2.7	-	-	1.7	0.6	-	3	8	6	60
D	818-03-3	2.4	14.7	3.3	-	-	2.4	1.0	2	3	14	80	65
B	818-04	3.6	10.2	3.4	-	-	3.6	1.5	1	3	17	470	70
D	818-04-1	2.4	12.4	5.3	-	-	2.4	1.3	1	2	8	25	35
E	818-05	3.7	10.9	3.2	-	-	3.7	0.7	-	-	21	590	100
E	818-05-1	0.5	13.7	3.0	-	-	0.5	-	-	-	2	-	100
B	818-05-2	1.0	6.2	3.4	-	-	1.0	0.4	1	2	4	-	100
B	818-06	5.6	10.5	3.0	-	0.5	5.1	0.5	1	2	22	760	55
E	818-06-10	1.8	6.5	3.0	-	-	1.8	1.5	-	-	5	-	100
E	818-07	2.1	7.7	2.4	-	-	2.1	0.6	1	-	14	-	70
C	818-08	0.4	6.9	3.9	-	-	0.4	-	-	-	-	510	100
E	818-09	2.7	6.0	2.7	-	-	2.7	1.5	1	4	3	-	70
E	818-10	1.9	8.0	2.5	-	-	1.9	0.9	1	-	3	-	70
C	818-11	0.4	9.1	2.9	-	-	0.4	-	-	-	-	170	100
E	818-12	1.2	6.0	2.7	-	-	1.2	0.3	-	3	4	-	50
D	819-01	3.6	10.0	1.0	-	-	3.6	3.6	1	9	4	35	100
D	819-02	2.0	10.2	3.2	-	-	2.0	1.2	-	4	5	65	85
	total	66.5			-	0.5	66.0	29.8	19	43	187	4,011	
	TOTAL	105.5			5.5	1.5	98.5	34.3	26	51	405	13,307	

(note) BR=Bridge CO=conduit

Road Type : A=Trunk Road (Join Wide Area)
B=Connection Road I (Join Trunk Road)
C=Connection Road II (Join Outarea)
D=Connection Road III (Join Inside)
E=Simple Farm Road

Table 3. 4 Arrival Volume of Vegetable and Fruit

Unit : ton

	1986						1987					
	Domestic	%	Imports	%	Total	%	Domestic	%	Imports	%	Total	%
1.Vegetable												
Lettuce	848.9	100.0	0.0	0.0	848.9	100.0	907.0	100.0	0.0	0.0	907.0	100.0
Cabbege	3,605.1	98.8	42.3	1.2	3,647.4	100.0	4,134.0	99.9	3.0	0.1	4,137.0	100.0
Green Pepper	3,812.2	98.8	46.0	1.2	3,858.2	100.0	2,115.0	82.4	453.0	17.6	2,568.0	100.0
Tomato	15,378.5	97.8	350.7	2.2	15,729.2	100.0	16,096.0	86.4	2,534.0	13.6	18,630.0	100.0
Pumpkin	4,072.0	99.8	9.5	0.2	4,081.5	100.0	2,287.0	92.8	178.0	7.2	2,465.0	100.0
Onion	3,064.3	41.8	4,273.0	58.2	7,337.3	100.0	3,476.0	43.9	4,441.0	56.1	7,917.8	100.0
Mandioca	38,428.3	100.0	0.0	0.0	38,428.3	100.0	46,310.0	100.0	0.0	0.0	46,310.0	100.0
Potato	542.7	9.4	5,215.7	90.6	5,758.4	100.0	1,066.0	14.4	6,359.0	85.6	7,425.0	100.0
Carrot	2,540.2	80.7	608.1	19.3	3,148.3	100.0	2,941.0	75.5	952.0	24.5	3,893.0	100.0
Cauliflower	90.6	86.1	14.6	13.9	105.2	100.0	40.0	82.1	8.7	17.9	48.7	100.0
Poroto	233.3	100.0	0.0	0.0	233.3	100.0	317.1	100.0	0.0	0.0	317.1	100.0
Others	10,874.4	98.0	226.6	2.0	11,101.0	100.0	12,713.9	99.0	129.3	1.0	12,843.2	100.0
Sub-total	83,490.5	88.6	10,786.5	11.4	94,277.0	100.0	92,403.3	86.0	15,058.1	14.0	107,461.4	100.0
2.Fruits												
Naranja	7,683.0	49.3	7,904.1	50.7	15,587.1	100.0	10,033.0	59.7	6,777.0	40.3	16,810.0	100.0
Mandarina	1,351.3	87.4	194.5	12.6	1,545.8	100.0	935.0	97.5	24.0	2.5	959.0	100.0
Apple	4.5	0.7	646.8	99.3	651.3	100.0	11.0	1.8	596.0	98.2	607.0	100.0
Banana	9,690.4	96.8	318.8	3.2	10,009.2	100.0	12,079.0	99.3	84.0	0.7	12,163.0	100.0
Melon	2,159.8	98.2	38.6	1.8	2,198.4	100.0	2,001.0	98.5	30.0	1.5	2,031.0	100.0
Pineapple	3,256.5	96.6	115.4	3.4	3,371.9	100.0	4,205.0	96.3	161.0	3.7	4,366.0	100.0
Water Melon	6,444.1	99.9	3.5	0.1	6,447.6	100.0	6,492.0	100.0	1.0	0.0	6,493.0	100.0
Pulm	82.6	86.9	12.4	13.1	95.0	100.0	39.4	99.2	0.3	0.8	39.7	100.0
Grape	95.1	79.0	25.3	21.0	120.4	100.0	80.8	86.4	12.7	13.6	93.5	100.0
Others	1,902.5	90.5	199.2	9.5	2,101.7	100.0	953.8	84.9	170.0	15.1	1,123.8	100.0
Sub-total	32,669.8	77.5	9,458.6	22.5	42,128.4	100.0	36,830.0	82.4	7,856.0	17.6	44,686.0	100.0
T o t a l	116,160.3	85.2	20,245.1	14.8	136,405.4	100.0	129,233.3	84.9	22,914.1	15.1	152,147.4	100.0

Source : (1) INFORME ANUAL (1985,1986,1987,INGRESO), ABASTO
(2) Volumen General de Ingreso de Hortalizas y Frutas, 1982/1987, ABASTO

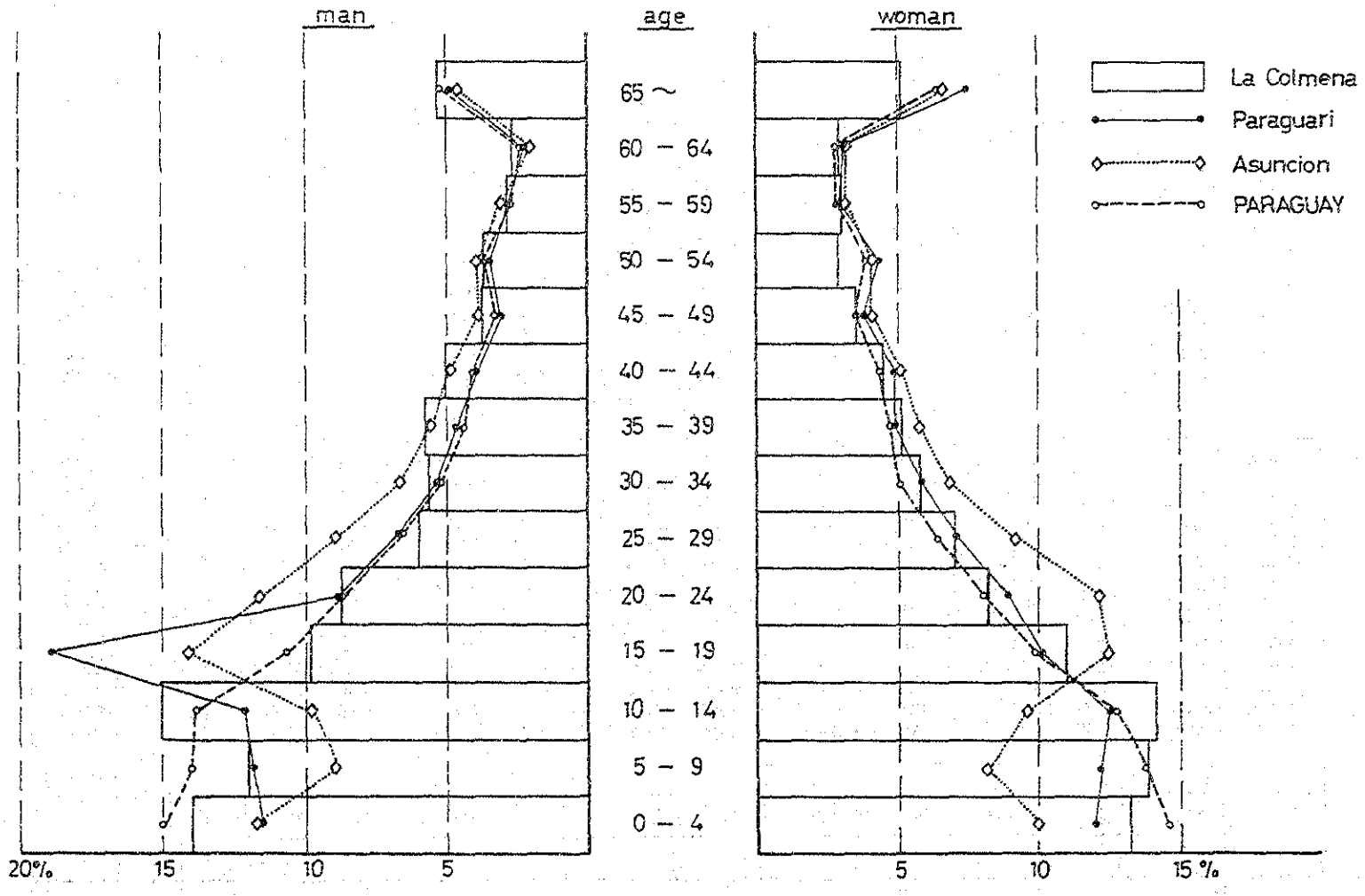


Fig. 3. 1 Population Components in the Study Area

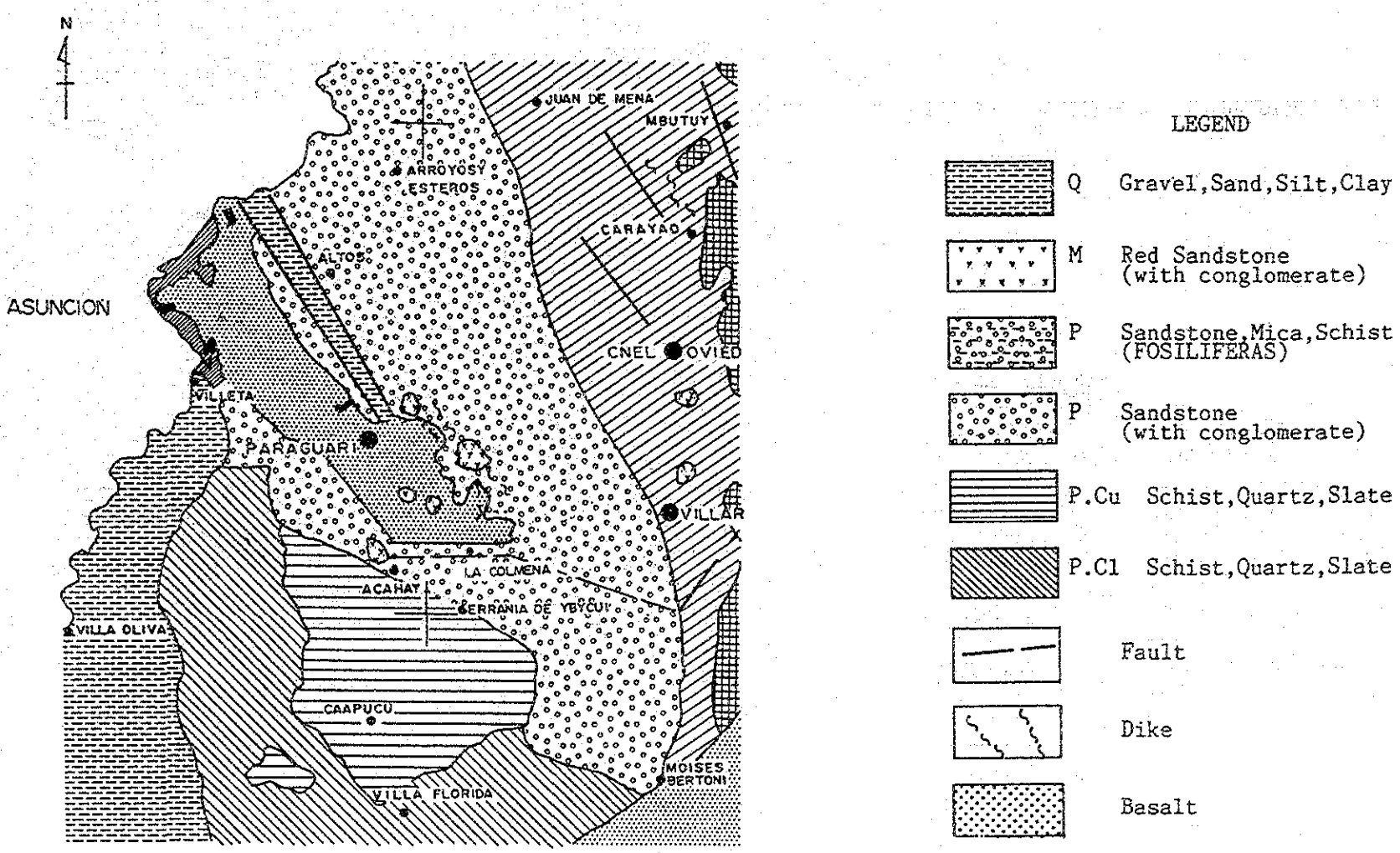
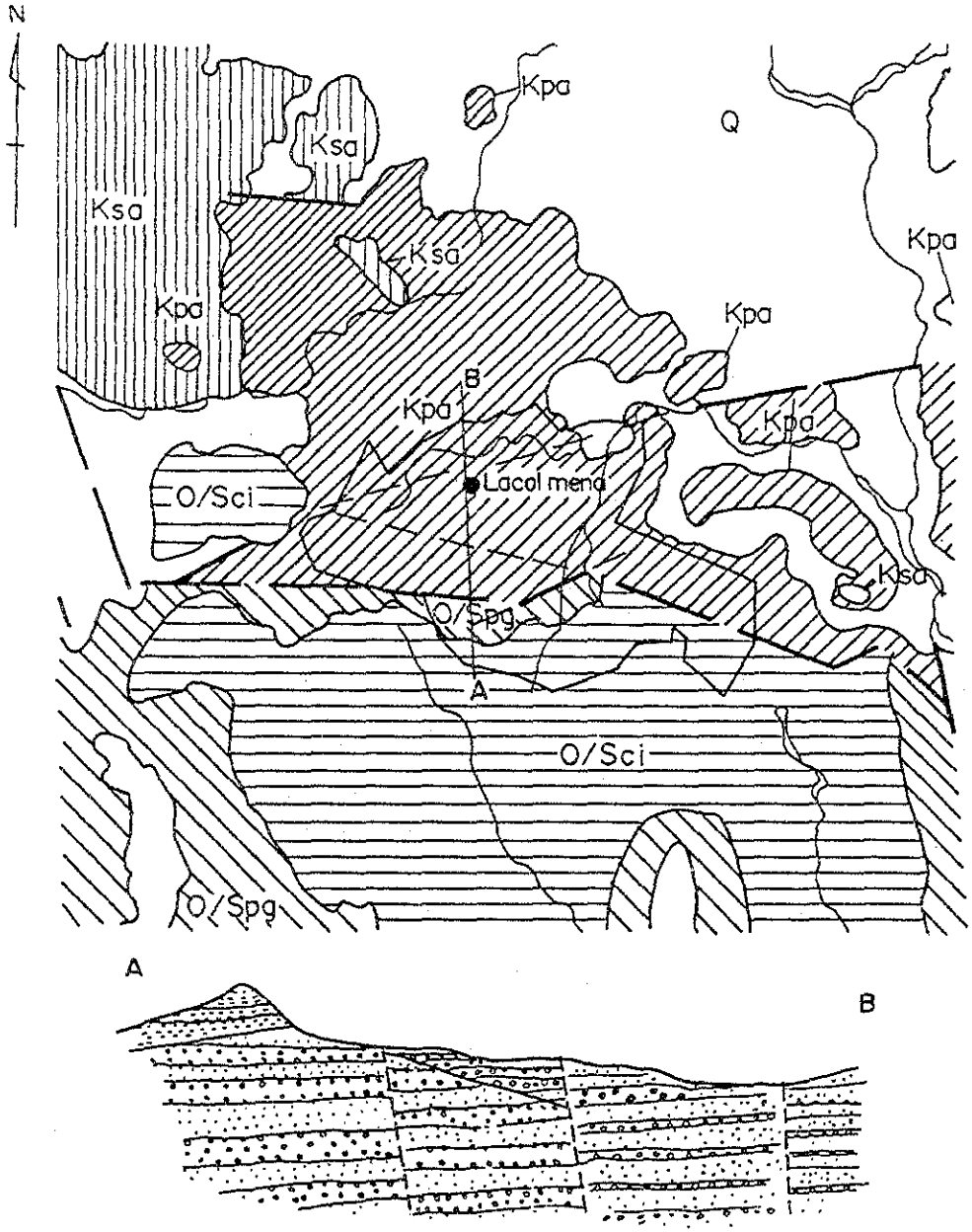


Fig. 3. 2 Geological Features in the Surrounding Area of La Colmena



LEGEND

Q	Quaternary Alluvium
Kpa	Conglomerate (with sandstone Mesozoic)
Ksa	Basalt(Mesozoic)
O/Scl	Sandstone (Paleozoic)
O/Spg	Conglomerate (Paleozoic)
	Fault

Fig. 3. 3 Geological Features in the Study Area

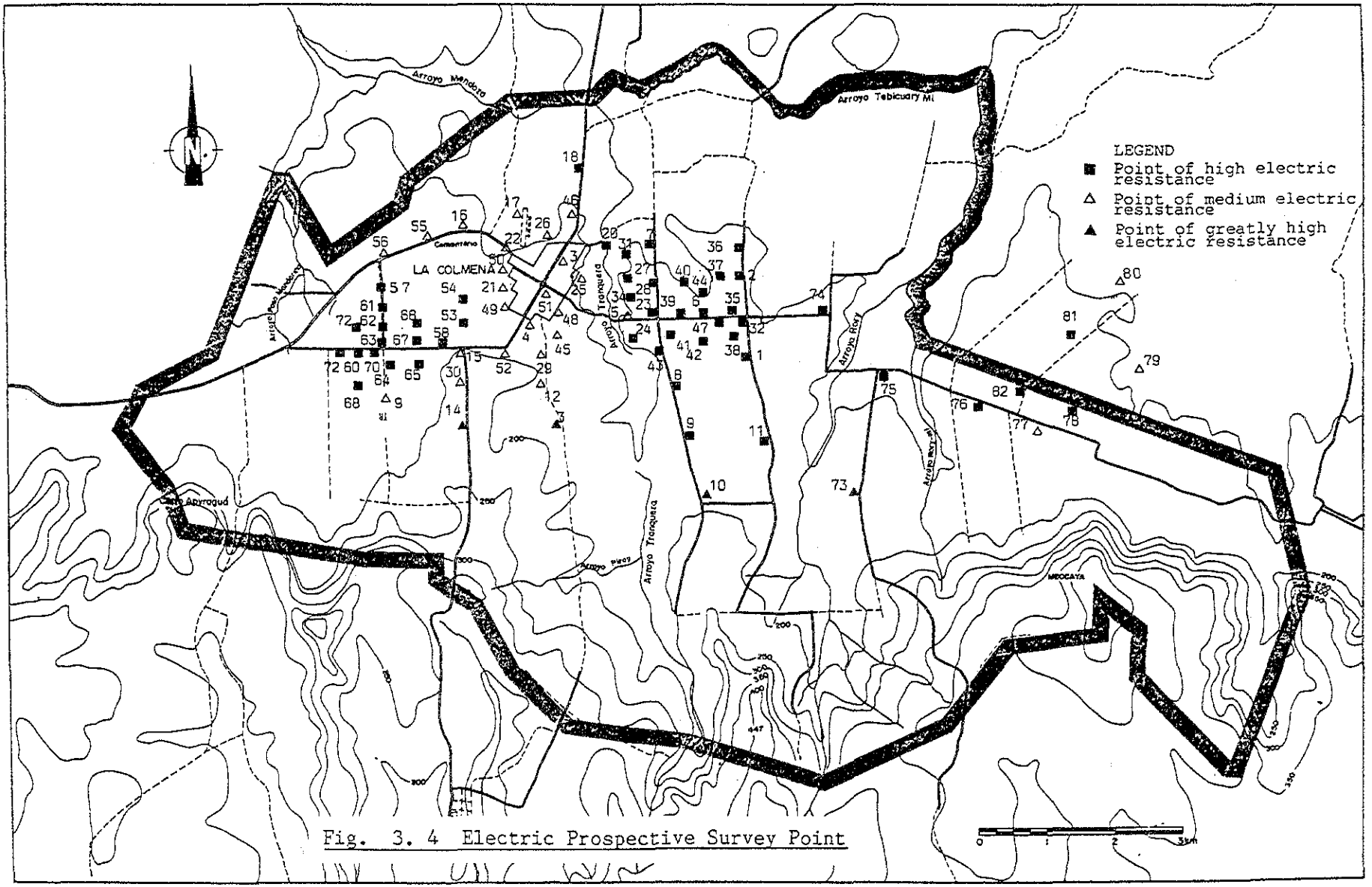


Fig. 3. 4 Electric Prospective Survey Point

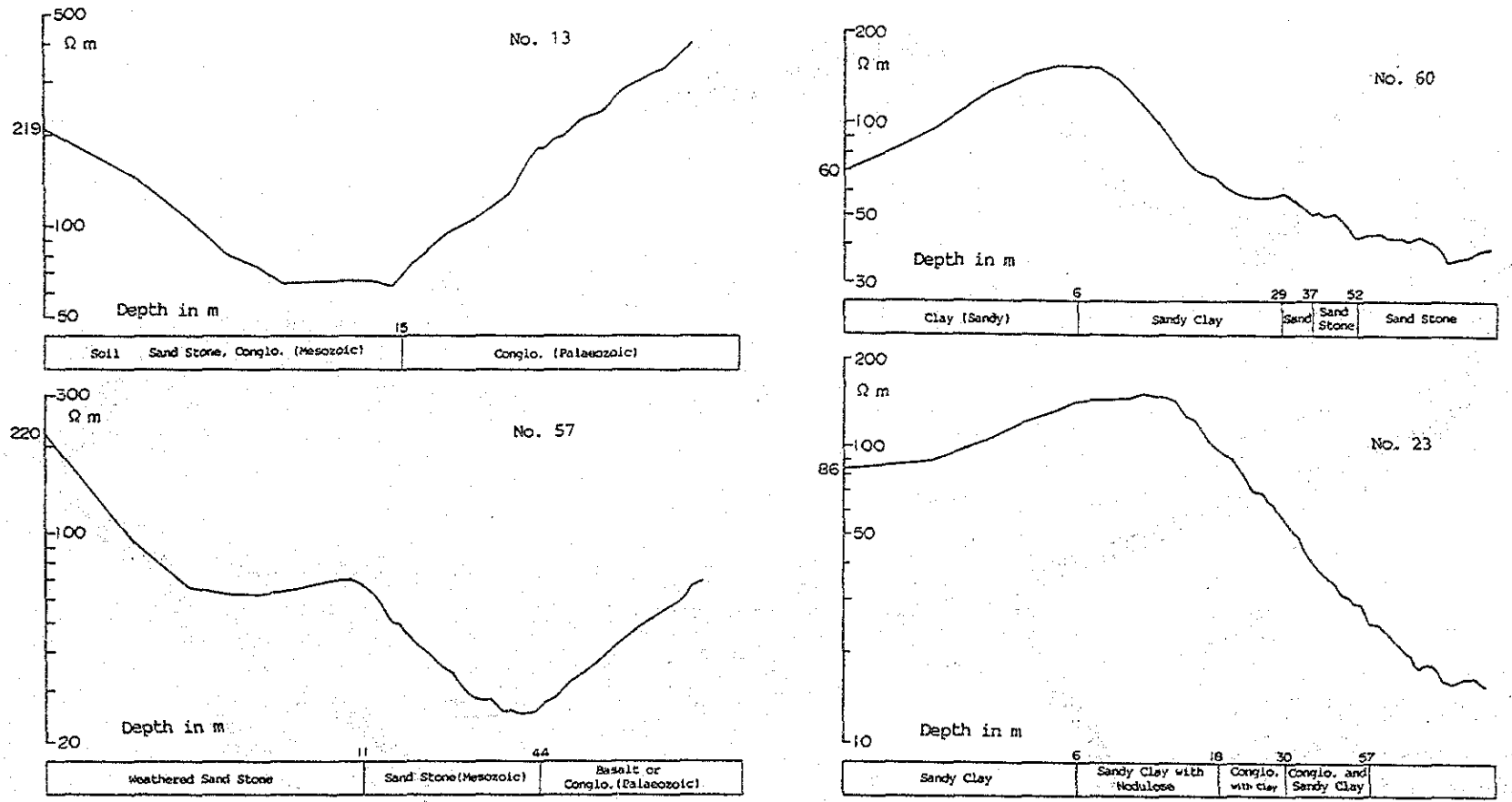
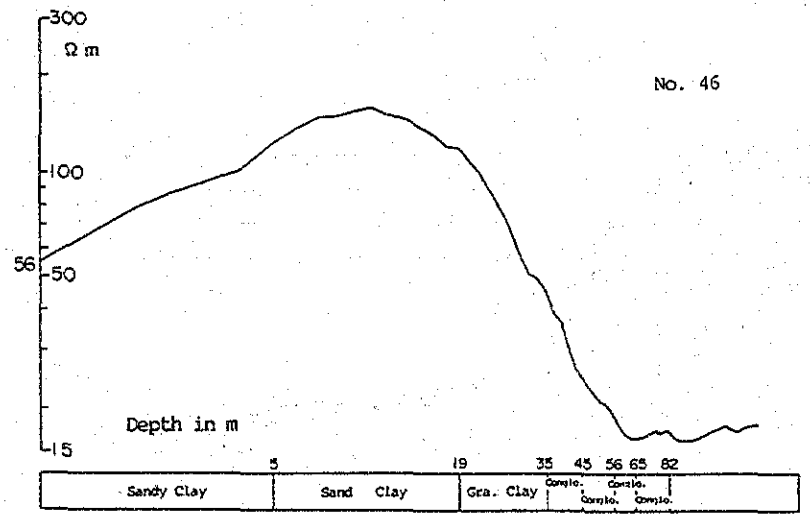
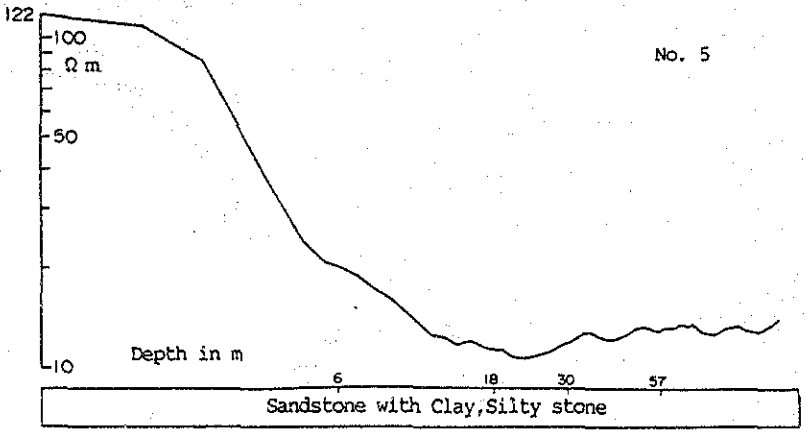
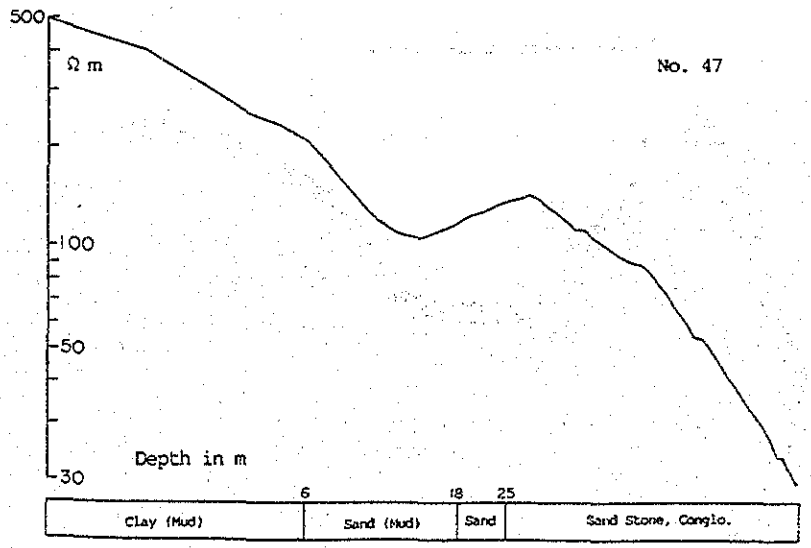


Fig. 3. 5 Key $\rho - \alpha$ (1)







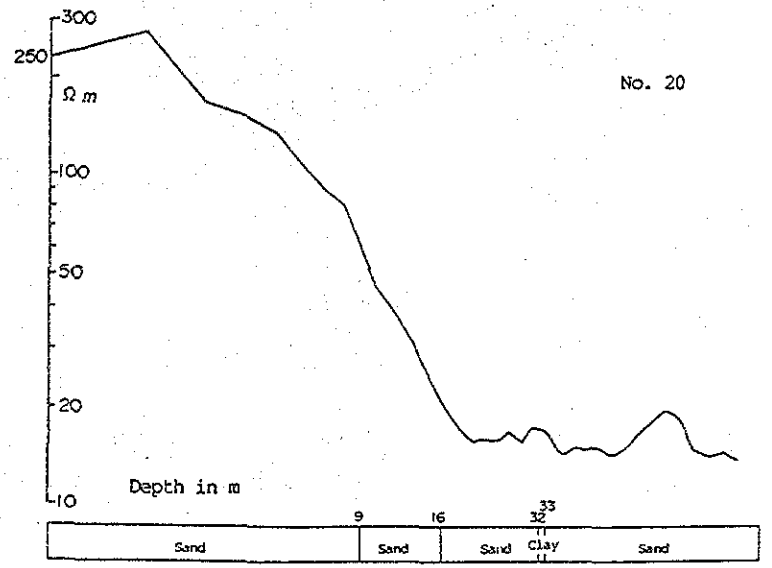


Fig. 3. 6 Key$\rho - \alpha$(2)

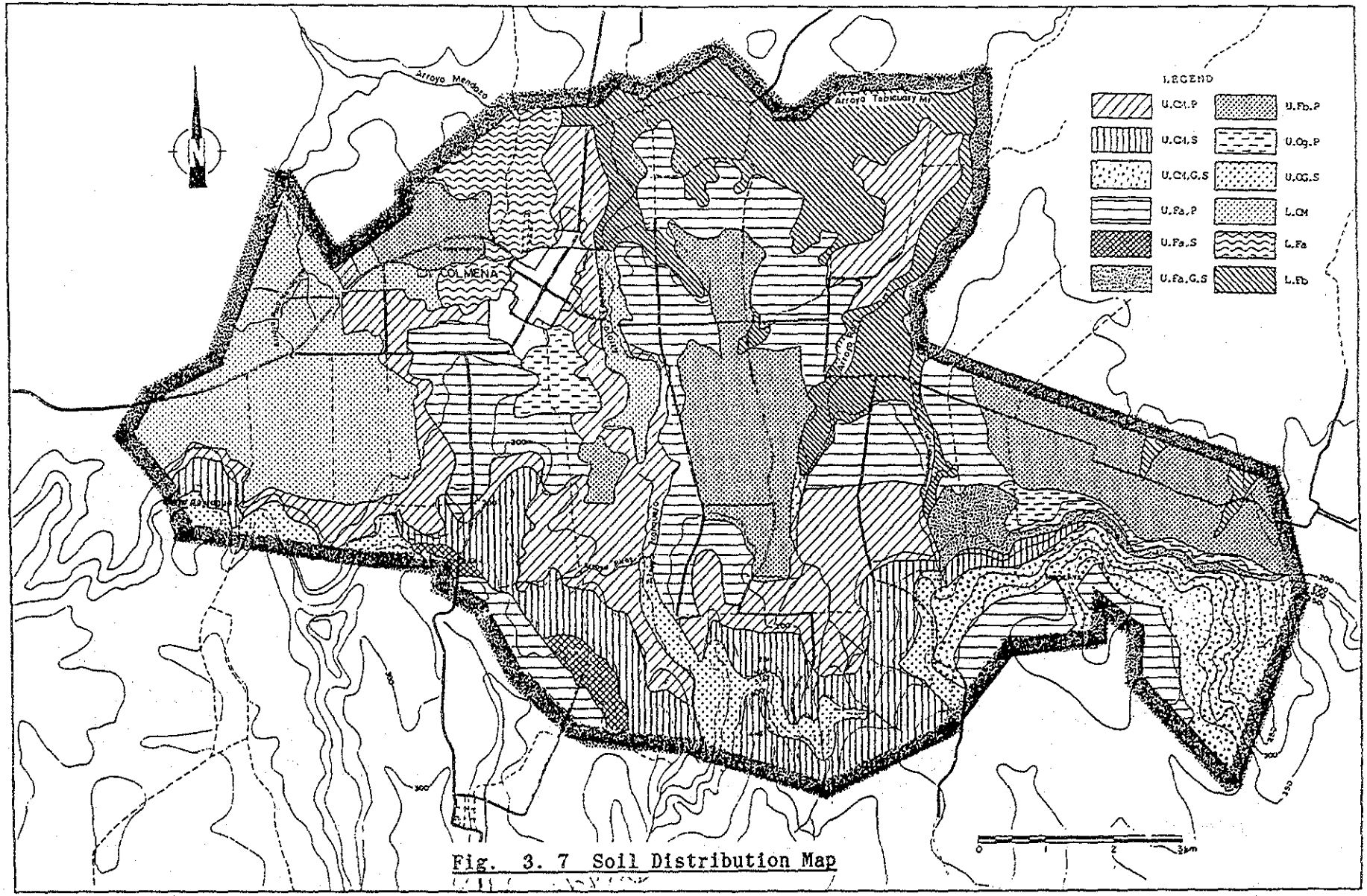


Fig. 3. 7 Soil Distribution Map

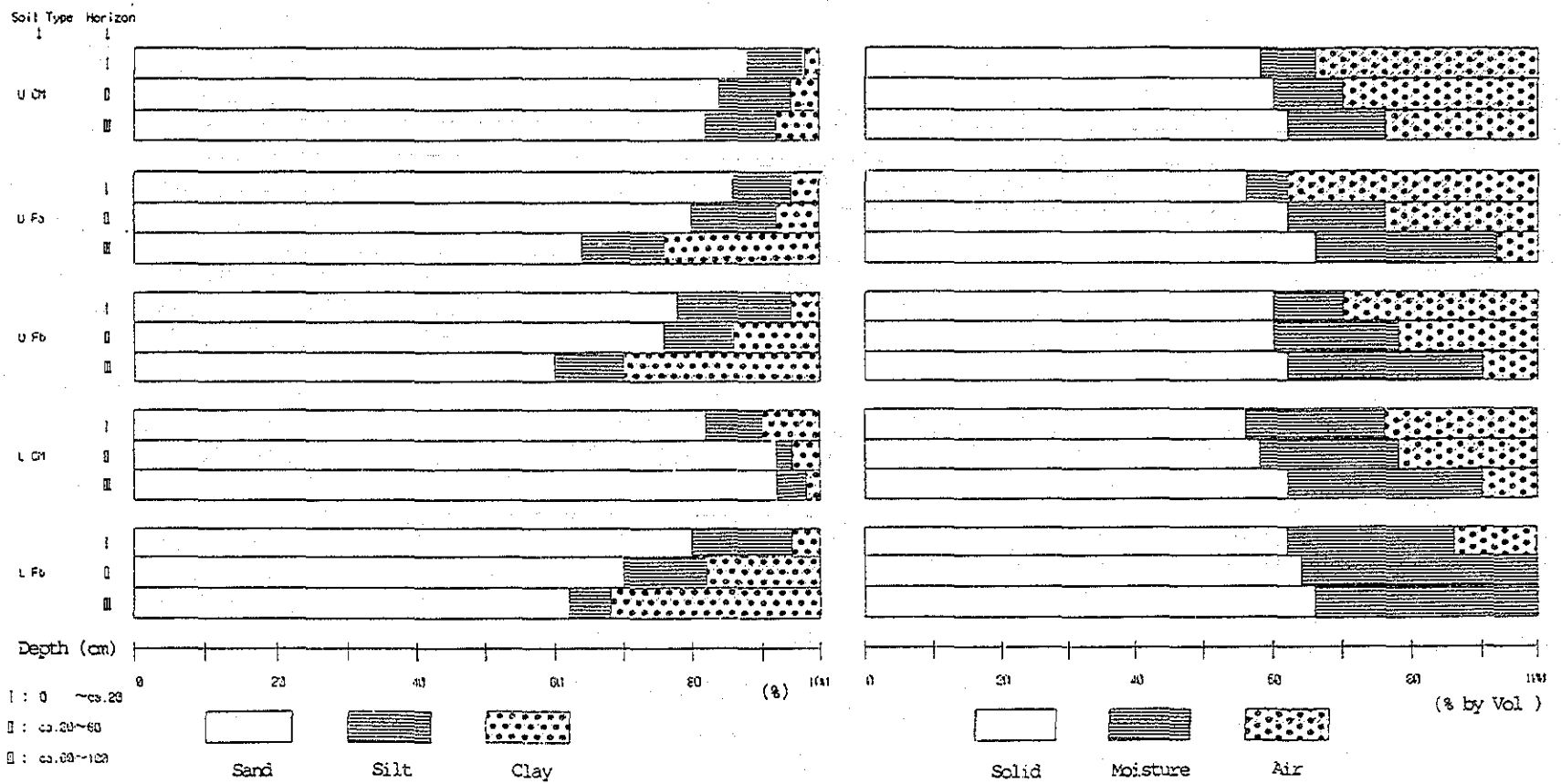


Fig. 3. 8 Distribution of Particle Size and Three Phases

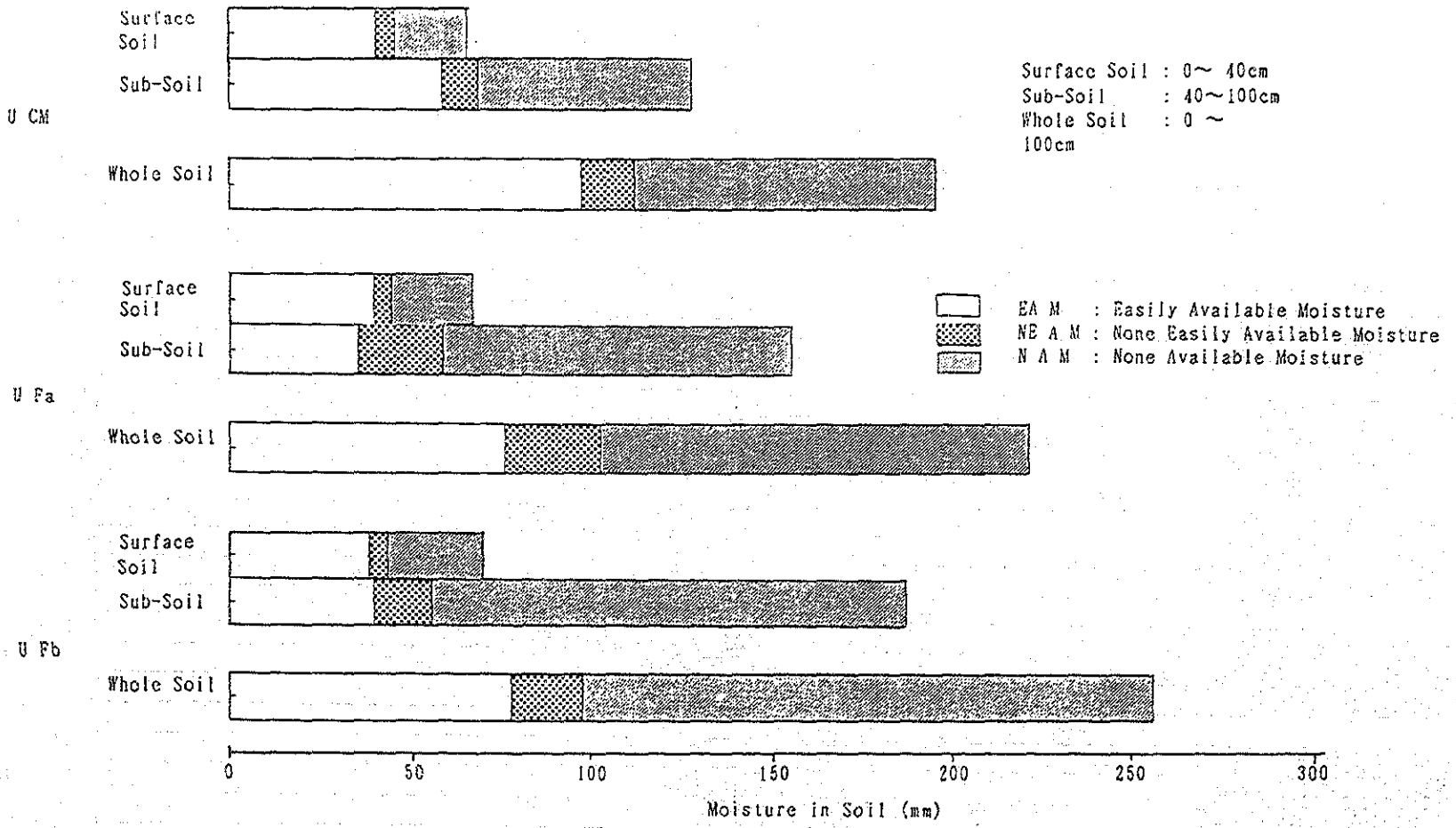


Fig. 3. 9 Soil Series vs. Moisture Holding Capacity

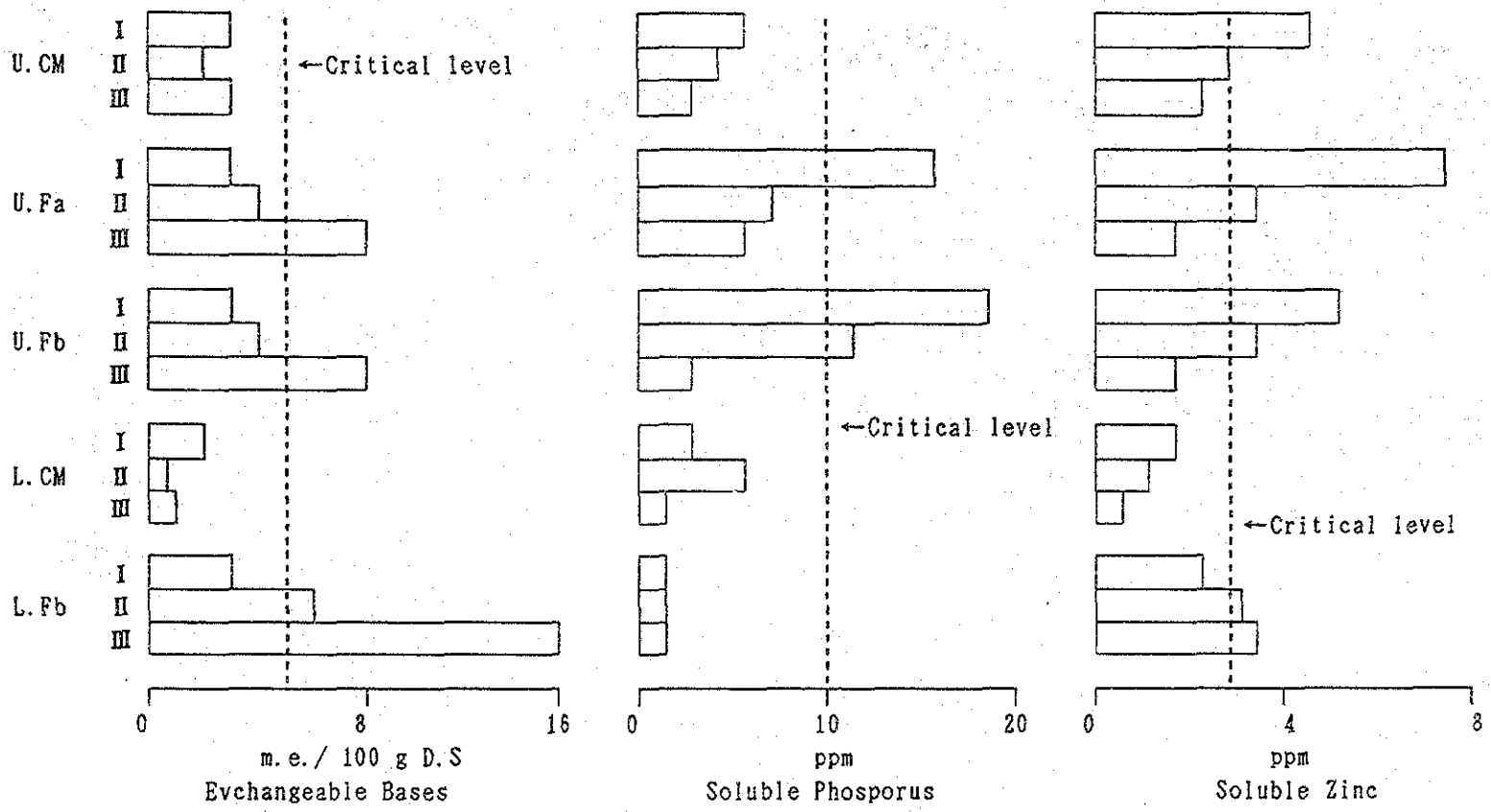


Fig. 3.10 Soil Series vs. Plan Nutritions Distribution in the Soil Layer

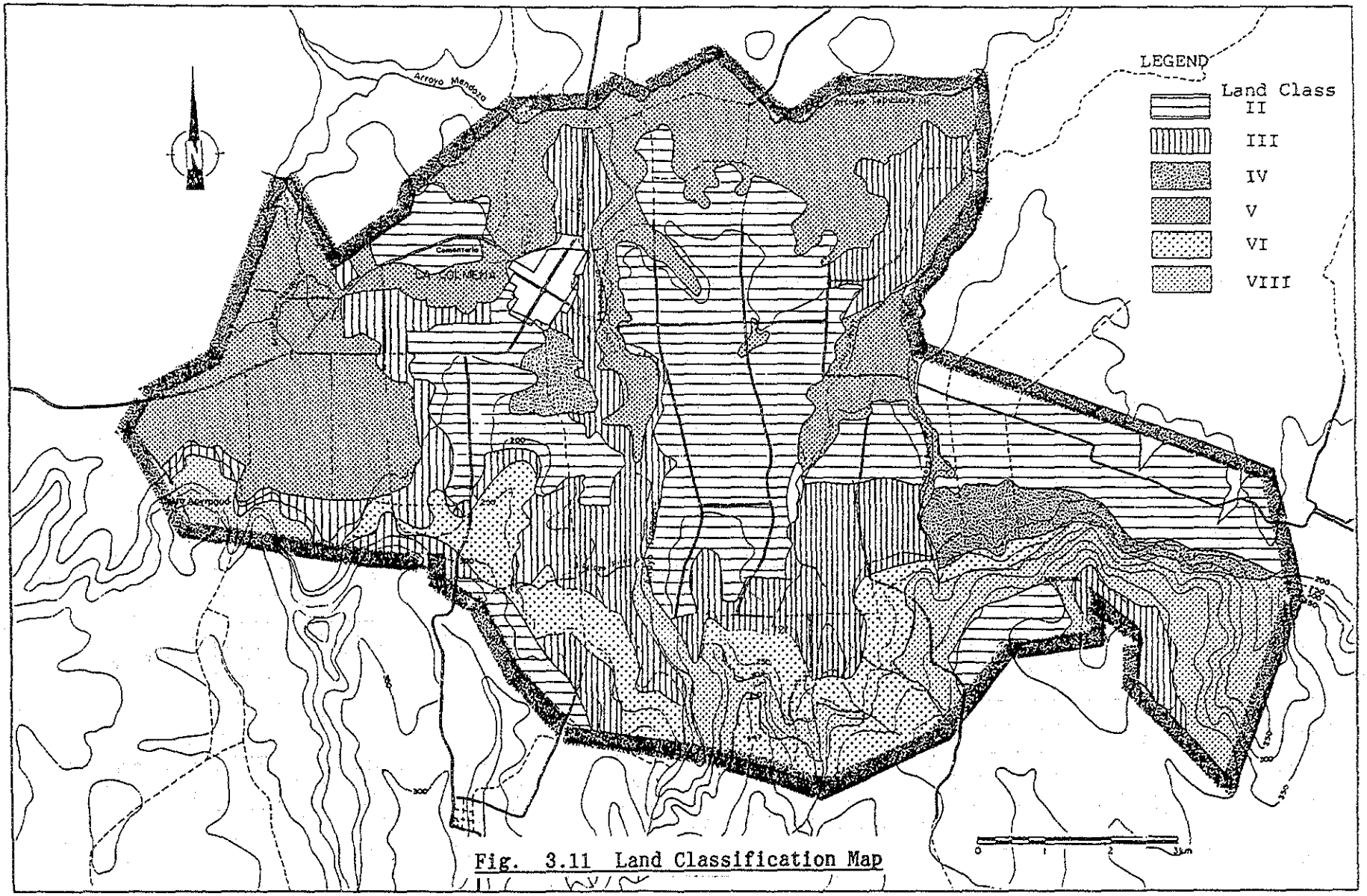
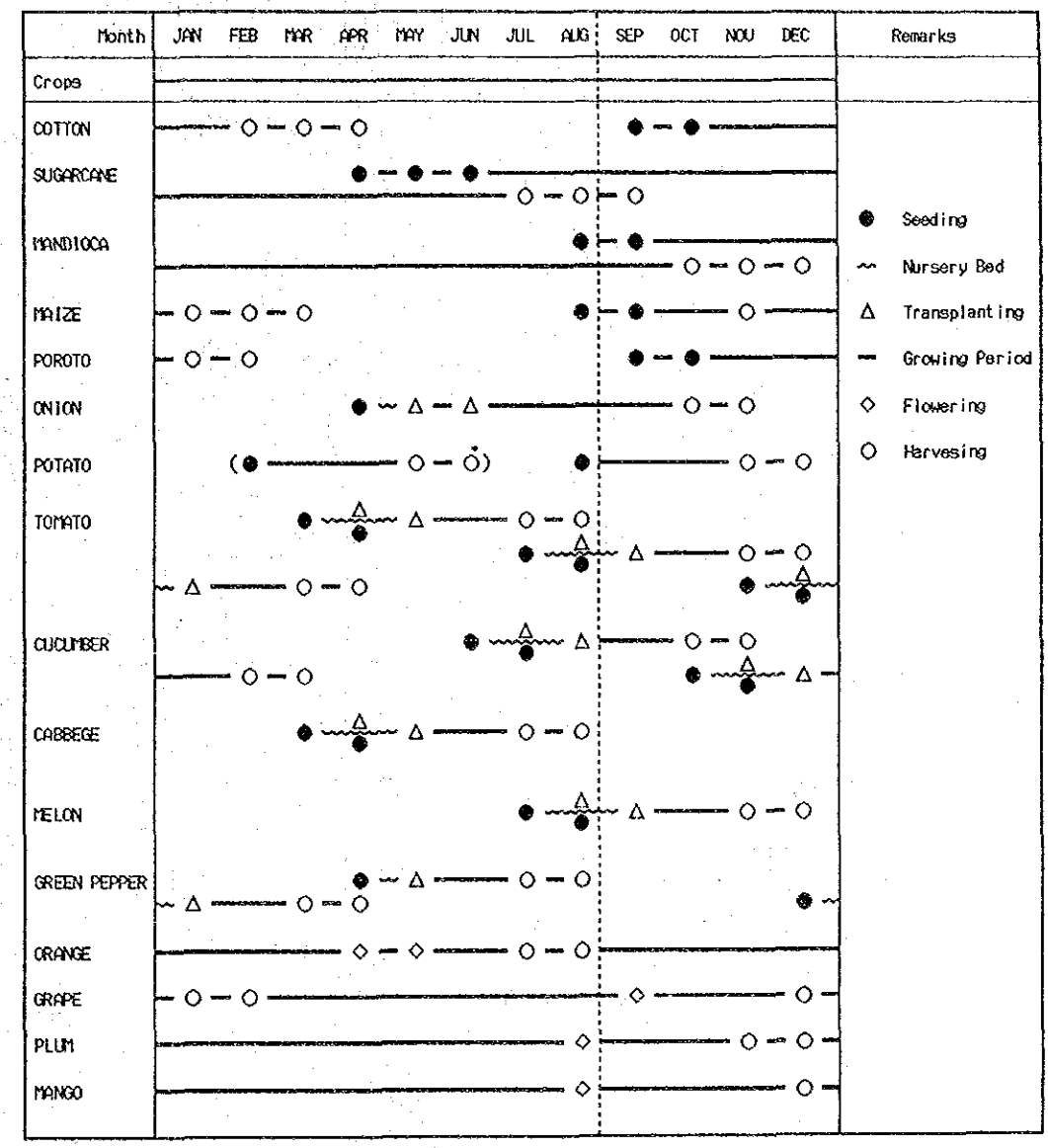


Fig. 3.11 Land Classification Map



Note : * The havest is less than that of the other period.

Fig. 3.12 Cropping Calendar of the Principal Crops

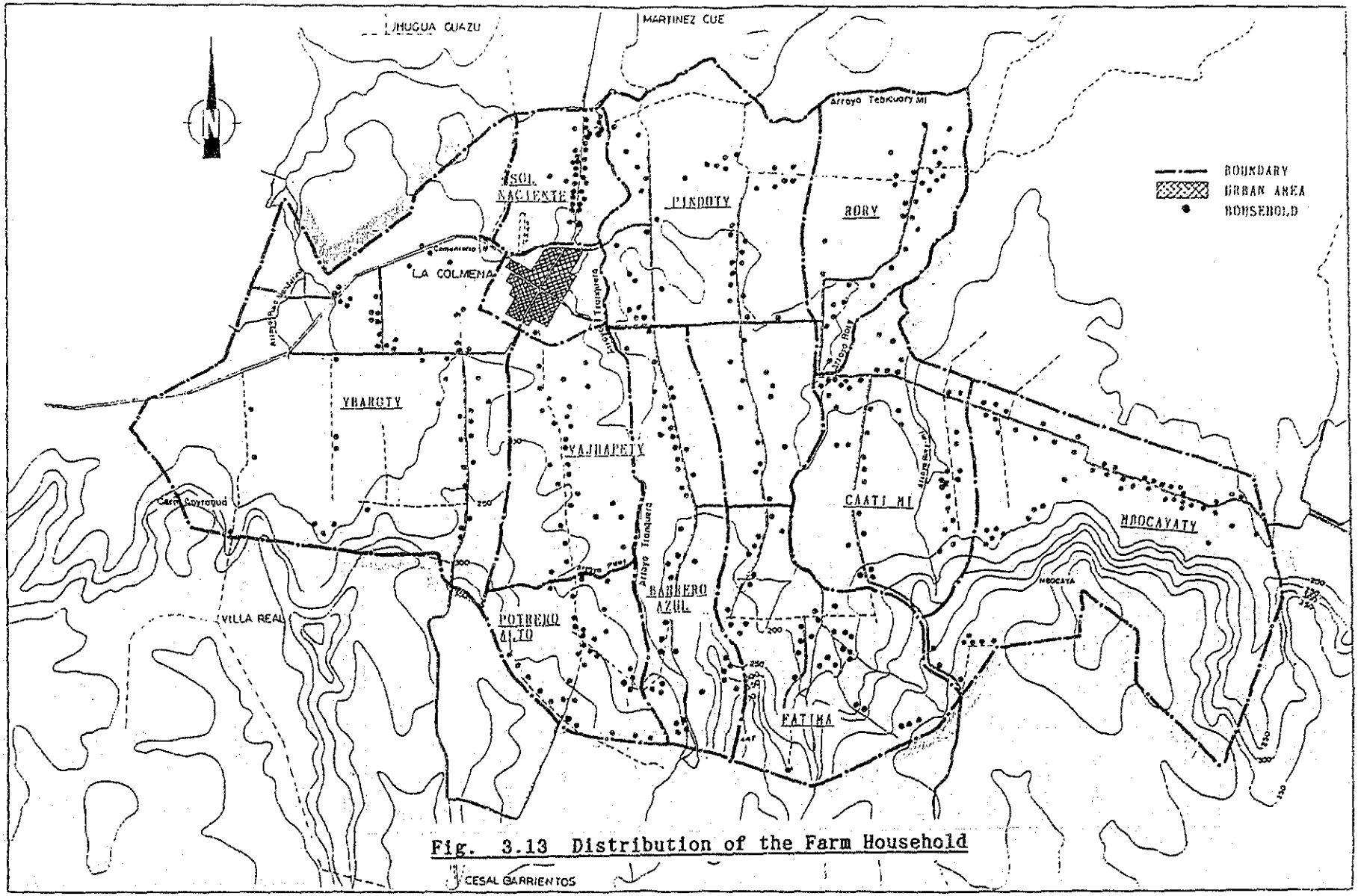
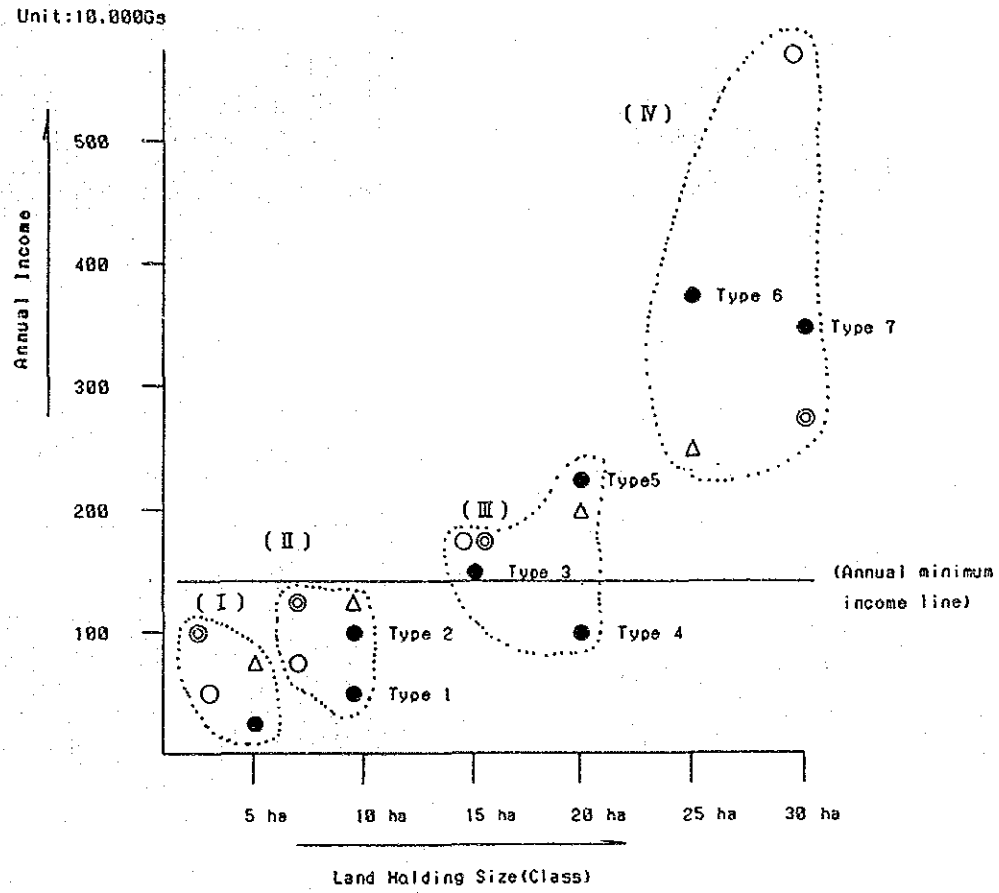


Fig. 3.13 Distribution of the Farm Household



Remarks :

● Study Area

○ A Districts: Ita, Quindy, Santa Rosa.

△ B Districts: Loreto, Itacurubi, Coronel Oviedo.

◎ C Districts: Cauazu, Consepcion, Cordilliera.

Type 1 to 7 means classification of the farming type in the Study Area

Surces: (1) Estudio del pqueno agricultor, 1977, USAID-MAG

(2) Proyecto de desrollo rural integrado del Dep. Paraguari, OEA-BID-PARAGUAY, 1980.

(3) Farm Management survey, 1988, JICA.

(4) Ministerio de Justicia y Trabajo, 1988.

Fig. 3.14 Comparison of the Farm Household Incomes

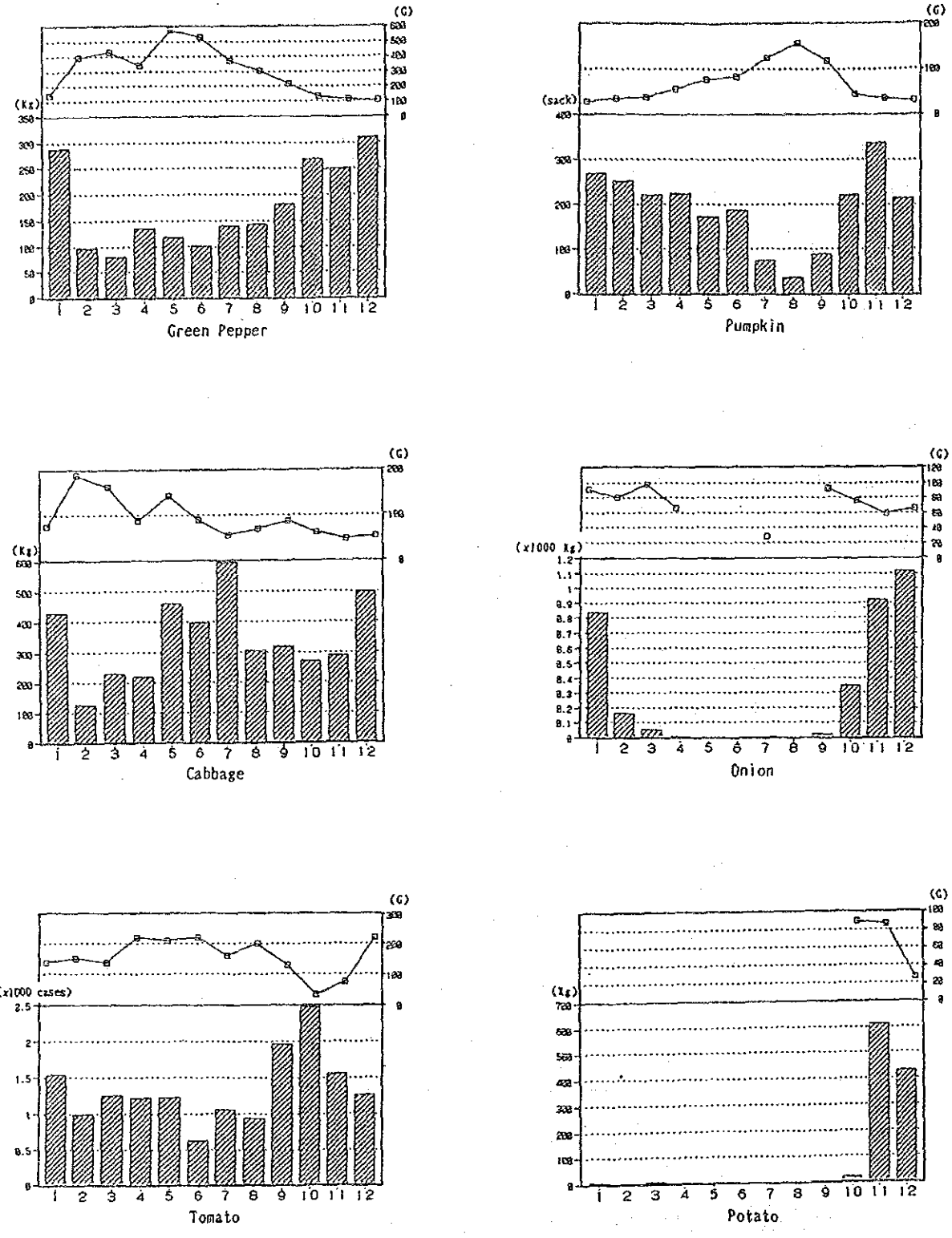


Fig. 3.15 Relation of the Arrival Volume and Whole Sales Price

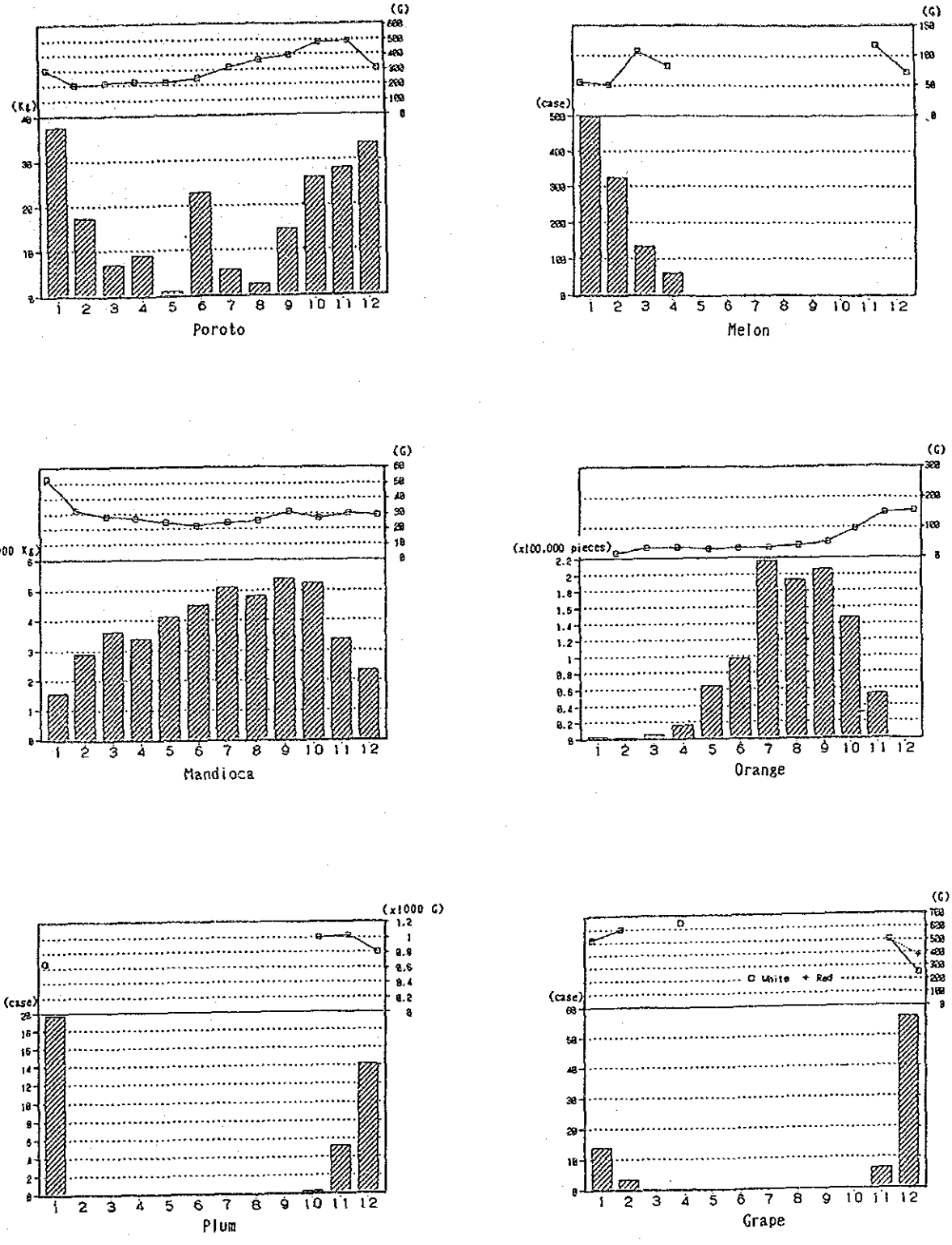


Fig. 3.15 Relation of the Arrival Volume and Whole Sales Price

CHAPTER 4 INTEGRATED RURAL INFRASTRUCTURE IMPROVEMENT PROJECT IN LA COLMENA

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4.1 Basic Concept

The integrated rural infrastructure improvement project aims at promoting the agriculture in the neighboring regions of the urban areas and increasing the farmers' income with an improvement of structure on agricultural production and facilitation of modernized farm management. At the same time, it also aims at activating the rural communities and accelerating the farmer's settlement in the rural areas through an improvement of rural living environments. An improvement plan proposed in the project will be verified through the present conditions in Paraguay taking the problems extracted from the study carried out in La Colmena and an improvement level to be established into account. Then, a model rural community containing a distinction of the rural areas located near urban areas will be constructed.

4.1.1 Approach to the Integrated Rural Infrastructure Improvement

The following table compares an index on major social capital in the Study Area, Paraguari districts and the nation as a whole:

	La Colmena			Paraguari		Paraguay	
	Area	Urban	Rural	Urban	Rural	Urban	Rural
1. Land holding	25ha	-	-	-	35ha	-	90.8ha
2. Farmer's income(1,000G)	1,600	-	-	-	1,600	-	1,800
3. Road pavement rate	35%	50%	33%	65%	38%	73%	37%
4. Diffusion of water works	26%	52%	0%	45%	0%	56%	3%
5. Diffusion of electricity	48%	80%	15%	57%	12%	83%	17%
6. Diffusion of Telephone	11%	22%	0%	15%	0%	42%	1%
7. School attendance rate	95%	99%	90%	96%	87%	97%	88%
8. Literacy rate	81%	85%	85%	82%	73%	82%	71%
9. Doctors per 1,000 hab.	0.6	1.3	0	1.7	0	1.7	0.2
10. Teachers per 1,000 hab.	6.3	7.8	4.8	9.6	5.4	8.3	5.1

From the table, it is pointed out that there is no extreme regional unevenness in the distribution of major social capital. However, building up of social infrastructures is slower in the rural areas than in the urban areas due to the scattered farm households. The projected areas will further be divided into 11 districts (Compania) on the basis of administrative boundaries, among which uneven distribution is more accentuated as shown in Table 3.1. Making a premise on conservation of natural environment in the area, uneven distribution of social infrastructures must be corrected as much as possible and projects

balanced among the concerned districts should be performed to improve the farmers' income level as well as their living environments.

The National Economic and Social Development Plan that is under way gives top priority to redressing the regional differential especially between the rural and the urban areas. In order to solve the differential, the government of Paraguay emphasizes the execution of the comprehensive rural development plan consisting of the elevation of farmers' income level, increase in agricultural production, enlargement of employment opportunities and improvement of living environment through an improvement and expansion of social infrastructure and structure of agricultural production.

To set up the improvement level of the project, the region as a whole should be united systematically to strengthen the deficiencies in social infrastructure in each district. Targets for the structuring of agricultural production as well as living standards to be furnished for model rural areas in the neighboring regions of the urban areas will be proposed.

4.1.2 Necessities of Improvement

Topography, soil fertility and farming scale in the project area are not superior to these conditions in the area along the Alto Parana River in the eastern part of Paraguay. Furthermore, Paraguay is surrounded by agricultural countries such as Brazil and Argentina. From these, it is concluded that the project area is at a disadvantage with respect to farming conditions. For the continued progress of the Area under the circumstance stated above, it is essential to create a comfortable rural community with increased farm household income by intensive utilization of farmland.

Problems of farm management and living environment in the project area, already pointed out in Chapter 3, are summarized below.

(1) Natural environment:

a) Mechanical farming with large-sized machines is unsuitable due to undulating topography, especially the sloping areas in the elevated lands.

b) Due to sandy soil in the arable land, the water holding capacity of the soil is poor, and damages from drought easily occur. Soil erosion also occurs easily.

c) It is difficult to forecast the drought season, except

November, because of the uneven distribution of rainfall.

d) Due to the heavy rainfall, erosion of the arable land and damages to road facilities easily occur.

e) Due to the small river basin, water available for the irrigation and other purposes is not sufficient within the projected area. Groundwater available for the project use is also scarce. With these circumstances, there are some places where drinking water cannot be ensured. It is difficult for the farmers themselves to provide irrigation facilities due to the undulating topography.

f) Low-land areas in the north part of the Area is always inundated since the riverbed slope of Tebicuary-Mi is gentle and causes poor drainage conditions.

(2) Farm management and farm household economy:

a) There are many farmers who cultivate cotton or sugarcane as a cash crop, and maize (inter cropping: poroto, bean) and cassava for self consumption. Each area is 1 to 2 ha. Moreover, they breed a few domestic animals (mainly dairy cows) to supplement their nutrition. Their net profit is estimated about 600,000 to 900,000 G per year. This income is low compared with labor in other industries (1,430,000 G per year on average).

b) Farmers are highly motivated for intensive agriculture, but this is not progressing because of the constraints of natural conditions.

(3) Institutions and organizations:

a) Due to the non-fullfillment of a debt to the B.N.F. or the landless, some farmers have taken loans from brokers. As a result, they are selling their products to the broker under unfavorable conditions.

b) Most of the farmers in the Area do not participate in cooperatives. Therefore, they are forced to use disadvantageous means of selling their products, purchasing materials, raising funds and so on.

c) Extension and supporting organizations need to be enhanced since prevailing technique for cultivation must be improved.

(4) Rural infrastructure:

a) Rural road networks are comparatively well ordered, but their functions are not fulfilled on account of many damaged parts and structural defects. In particular, the roads which run through the southern part (mountainous region) are impassable.

b) Groundwater is used for drinking water. In some areas, well water dries up in the drought period.

c) The electrical distribution system does not cover the whole Study Area.

d) Eight primary schools are established including branch schools, in the Area. Some of the branch schools are available only for the lower classes. As for the higher classes of primary school, the distance to attend school comes to over 5 km. Therefore, more schools are required.

e) A hospital serves the urban area, however, improvement of medical facilities, particularly emergency medical care facilities, is desirable.

f) Telephones serve almost all the urban area, but are nonexistent in the rural area. The communication system needs to be extended to the rural area.

g) La Colmena cooperative has a winery. The quality of the product will have to be improved since competition with the products of neighboring countries is serious.

h) Environmental pollution is a threat in the urban areas, because of inadequate garbage disposal facilities.

On the other hand, the advantages of the project area are as follows:

a) Asuncion, capital of Paraguay, is the biggest market in the country. Radical growth of demand in this market is expected. Asuncion is two hours by car from the Area.

b) Multiple farm management based on fruit and vegetables is already being undertaken by some farmers.

c) La Colmena Agricultural Cooperative fully fulfils its functions regarding marketing, processing, credit, etc. though members of the cooperative are few in number at present.

The early way to promote agriculture in the Area is to make full use of existing resources, facilities and organizations. Popularization of farming techniques created in the Area among the farmers will also contribute to promotion of regional agriculture. Although a change in the farmer's awareness is of prime importance for agricultural promotion, on the other hand, government action on this matter is also required. As a method to promote regional agriculture, there is a strong requirement for improvement of the agricultural and social infrastructure, such as water resources development, improvement of roads, etc., and evolution of

agricultural management with a form of enterprise by cooperative organization and supporting services for the popularization of farming techniques.

4.1.3 Possibilities for Development

Possibilities for development in the project area will be discussed in subsequent paragraphs in detail. The potential of the Area is summarized below:

a) Although water resources are scarce in the Area, stream flow of 64 l/sec with gravity system and 260 l/sec with pumping can be used in the drought period on the premise that water will be taken from over 180 m in elevation at three major streams in the Area. This amount of water is not sufficient for irrigation of the whole Study Area. However, if the water is used for the crop growing stage and/or cash crops, agricultural production in the Area will be improved in productivity and quality.

b) The national road to Asuncion has been paved. Existing branch roads such as provincial and farm roads will be fully functional with improvement in road structure, and related structures, and maintenance.

c) As stated in 4.1.1 (3), effectiveness of rural facilities will be emerge on strengthening.

d) A fruit juice factory is now under construction, therefore, introduction of fruit culture is favorable.

e) With respect to agricultural management and organizations, some farmers perform multiple farm management on the basis of farming on fruit and vegetables. This farm management will furnish the less advanced farmers with effective information and will contribute to acceleration of the project implementation.

f) There are sugar refineries near the Study Area and their marketing and distribution system is well developed. Therefore, the farmers who could not be converted to fruit growing instantly, owing to lack of funds and techniques, should concentrate on sugarcane farming to establish the concrete farm management.

To formulate the project, it is preferable to set up the abovementioned as an axis and/or starting point. Then, project planning will proceed to eliminate the hindrance factor of development and/or fill up the deficiencies in the infrastructure.

4.1.4 Basic Concept for Improvement

(1) Target and placement of the Project

The Project aims at taking measures to solve the problems of the living and agricultural environments in the Area, and also proposes a model rural community at the outskirts of Asuncion. Project planning will be carried out on the premise that the Project Area will be positioned as a multiple farming area with main products of fruit and vegetables.

The population of the Project Area is forecast to level off or increase only slightly. Farmers income in the target year, after completion of the Project, is projected to grow about 6% per annum.

(2) Basic concept of each field (outline)

a) Land Use

The Study Area still has virgin forest and wilderness. To conserve the natural environment, new land reclamation will not be undertaken. The development plan aims at intensive cultivation on existing farm land.

b) Agricultural development plan

The project should be planned as an integrated and consistent structure. In agricultural development, the following three plans will be established.

i) Water resources development

ii) Improvement of farm roads

iii) Strengthening and promotion of agricultural cooperative

In the development plan for water resources, intensive agricultural management will be proposed in terms of land and labor. Furthermore, irrigation using the stream flow in the Area will be introduced to increase the quality of agricultural products and stabilized cropping. Irrigation will be used for profitable cash crops since the available water is limited. The water supply plan is based on both drinking and irrigation water.

In the road improvement plan, review of the existing road network will be carried out because farm roads in the Area have to function as provincial and community roads. Then, improvement of the road structure and a maintenance program for the roads will be proposed. Improvement of roads in this Area will help reduce transportation costs and accelerate conversion to crops that have high marketability.

The agricultural cooperative plays an immeasurable role in disseminating farming techniques and information, in addition to its role in purchasing, marketing, processing and credit. This Area has a particularly high concentration of independent farmers and small-scale farmers. It seems that the organized activities of the cooperative have been effective in meeting the diversification in demand for agricultural products and in the commercialization of agricultural production. Consequently, farmers will be encouraged to join the cooperative. The plan will also call for improving the marketing and distribution system, new construction of collection and shipping facilities for fruit and vegetables, and improvement of winery facilities as measures to strengthen La Colmena Cooperative.

c) Rural infrastructure plan

In addition to the rural water supply and road improvements already mentioned, the following facilities will be proposed:

Electricity is already provided in part of the Area, where it has contributed to improve the farmer's living and agricultural management. Therefore, the extension of electricity to the area where no electricity is installed is desirable to accelerate the modernization of the living standard and agricultural management.

With prepardness an existing health center, the medical care system in the Study Area and its neighboring areas is established. In particular, provision of emergency medical care, oxygen supply and dental care are urgently required.

There is a lack of convenience of telephone services in the rural areas for emergency and daily use since only one telephone is available. Therefore, extension of telephone services is planned to improve the living and production environments.

O & M of facilities, distribution of irrigation water and

collection of water charges are important items for promoting the Project. These must be executed by the farmers themselves. In the plan, an O & M organization and schedule will be proposed on the basis of the facilities plan for the Project. Construction of an O & M center is planned in line with the proposed organization and schedule.

As a part of enhancing scheme for education, health, technology, and communication, a sub-center will be constructed for each committee. These sub-centers will provide a playground meeting hall and public telephone, and will contribute greatly to form a sense of community in the Area.

(3) Implementation program for the project

When the projects proposed in each field are implemented, those projects will be divided into two categories, depending on whether the execution is urgent or not and/or whether it is possible to undertake the project at an early stage or a preparation period is indispensable. Therefore, the projects will proceed in two stages taking the conditions stated above into consideration.

Initial Stage: Projects which have a higher priority can be undertaken at an early stage and will be effective in view of the direct and indirect benefit.

Future Stage : Projects which require adjustment with other projects and/or for which a preparation period is indispensable will also be required after developing the social and economic conditions of the Study Area in the near future.

4.2 Land Use Plan

4.2.1 Basic Concept for the Land Use Plan

The land use plan should be enforced according to the following policy that have been obtained as a result of the field study such as, topographic features, soil conditions, groundwater, water resources, farm management, etc.

a) The following areas should be left as they are: 1) mountainous areas with altitude 250 meters or more, because they are steep and play an important role in retaining water resources; 2) forestry hills, for farm land preservation.

b) The low land located in the southern and eastern part of the Area, including areas with poor drainage, is either sandy or clayish and will have little value as arable land even after extensive drainage improvement. For this reason, it is advisable to conduct drainage work on a limited scale to improve the value of land as a pasture for cattle.

c) The Study Area has 2,000 hectares of fallow land including sparsely wooded land. This form of land is necessary to recover soil fertility. These fallow land will be rotated with the existing farm land of 2,600 ha. Consequently, 4,600 ha of farm land will be utilized as the total farm land in the Area. For such reasons, the area of land to be used for farming should be left as it is.

Because of these conditions stated above, land use should remain the same as it is.

Classification	Area (ha)	Purposes
1. Forest		
- mountains	1,400	.Retention of water sources
- hills	1,400	.Supply of wood, firewood cattle grazing(the area can be developed for future use)
2. Arable land		
- cultivated land	2,600	
- fallows land	2,000	.Recovery of land productivity
3. Pasture		
- hills	400	
- low marshy land	2,800	.Poor drainage area 900 ha
4. Others	400	.Urban district,land used for roads, rivers, public facilities, etc.
Total	11,000	

4.2.2 Agricultural Land Use Plan

The way of the agricultural land utilization will be diversified with the execution of comprehensive rural infrastructure improvement plans, especially improvement of irrigation and farm roads. When irrigation facilities were installed at the farm land, the area of fruit and the ratio of vegetable cropping will be increased. Moreover, roads improvement will contribute to the shipping of agricultural products. These conditions will forward the conversion from cotton to sugarcane cultivation. Such changes will lead to intensive farming with more efficient use of land.

In the classes II and III of land classification described in 3.4.2, it is possible to grow a wide range of crops, such as vegetable, fruit, grass for grazing and trees. However, considering the occurrences

of drought, it is advisable to grow deep-rooted plants in the UFa-type soil and shallow-rooted plants in the UFb-type soil. The low-land (L) soil is limited to cultivation of paddy and grass for grazing, offering little possibility of introducing field crops in the Area even after extensive drainage work. To realize the stable and high yield of agricultural production, especially general field crops, vegetable and fruit, it is essential to give them proper nutrition. The following points should be considered for soil management.

1) Improvement of water retention ability:

- Continuous application of organic manure
- Application of mulch
- Introduction of green manure crops
- Improvement of irrigation facilities(especially for vegetable growing in U-CM, UFa soil).

2) Strengthening of nutrients supply:

- Deep land tilling (at least 30 cm deep, once in several years)
- Neutralization of acid in the soil (pH 6.0 - 6.5)
- Improvement in fertilization (application of N, P, K, Mg, B, Zn and their balance, more use of additional fertilization), application of 1)-a), 1-c) above.

4.2.3 Impact to the Natural Environment

To preserve the natural environment of the Area, new development for the existing forest is excluded as the objectives of the Study. In the water utilization plan, intake of droughty discharge scale is planned from the streams in the Area, however, river maintenance flow will be kept since such manner is limited in short period judging from the rainfall distribution in the Area. Therefore, it is concluded that impact to the natural environment of the Area due to execution of the Project exists within an extent of allowance.

4.3 Agricultural Production Plan

4.3.1 Basic Concept

With the implementation of the project, obstacle factors on the agricultural production will improve and elevate the conditions of the agricultural production in the projected area. The following basic concepts will be adopted to the production plan to increase the amount of the agricultural production and to improve the farmers' income levels.

1) The following points will be considered to hold the effective utilization of improved farming conditions for high productivity and stable farming: 1) soil property, 2) farming technique, 3) marketing trends, 4) farmer's intension.

2) For the plan designed to increase the agricultural production and farmers' income, it contains that expansion of the cropping area, multiple cropping and introducing the crops with high profitability.

3) Proper rotation systems should be established to maintain high yield and to avoid continuous cropping damages. Also, cares should be taken to prevent occurrence of seasonal labor peaks.

4.3.2 Proposed Farming Type

(1) Crops to be introduced

Selection of candidate crops for future introduction will be made based on the present major crops for the following reasons. For crops whose yield increase is planned will be selected among those that have strong market competitiveness and are domestically in short supply, i.e. imported amount is large.

1) Cotton and sugarcane

These are crops with long history of cultivation in the area and with firmly established growing techniques. Relatively high profits can be expected from growing them even on a small plot of land. Further, the government-set supporting prices are in force for these crops, whose expanded cultivation is being encouraged on a nationwide scale. In particular, the government is promoting campaigns to grow more sugarcane that can be used not only for sugar production but also as a material of fuel alcohol.

2) Fruit and vegetables

The Project Area holds high shares in the domestic market in the yield of fruit and vegetables, mainly pumpkins, onions and grapes, constituting the major production area in the country. The profitability of such fruit and vegetables in the area is higher than the national average. With improved irrigation and other conditions, whole-year production of such crops will be made possible, which in term will give the farmers and edge in setting the prices by supplying their products during the off-season period or making production adjustment suited to market situations. Also, effective enforcement of the plan will contribute to more stable farm management as direct competition with other production areas can be avoided.

(2) Farming types

In accordance with the implementation of the Project, the farming patterns are expected to be altered with the reasons stated below.

1) Profitability per unit area (ha) is high for all the mentioned introduction crops. However, it is more desirable to promote introduction of fruit and vegetables than cotton and sugarcane because the former is more profitable than the latter.

2) Vegetables are more susceptible to market price fluctuations than fruit. Therefore, more stable farm management can be realized by growing fruit, which is a perennial crop. For this reason, future farming will see an increase of diversified farming which combines fruit and vegetables with main emphasis placed on the former.

3) Large investments must be made to begin full-time fruit farming, and it takes long time before fruit trees become mature,necessitating pooling of farm funds. For this reason, gradual shift is expected from the present farming centered on the existing fruit growers to exclusive fruit growing.

4) Sugarcane has higher profitability than cotton, and, with improved road conditions, collection and shipment of the products will be made easier. Therefore, the farm land used for growing will be expanded in the future than present areas with poor road conditions.

5) Except those used for self-consumption, miscellaneous crops are expected to be replaced by vegetables, fruit and sugarcane with high cash values.

Type	Present	Proposed
1.	cotton + crops for self-consumption + livestock	cotton + vegetables + crops (self-use) sugarcane + vegetables + crops (self-use and livestock)
2.	sugarcane + crops for self-consumption + livestock	sugarcane + crops (self-use) + livestock
3.	vegetables + miscellaneous crops (self-use)	vegetables
4.	livestock + cotton	livestock + cotton + crops (self-use) livestock + sugarcane + crops (self-use)
5.	fruit + miscellaneous crops (self-use)	fruit
6.	vegetables + fruit	vegetables + fruit
7	fruit + miscellaneous crops + apiculture	fruit + apiculture