Specific water yield in the district around Asuncion (B. Aceval) as estimated based on amount of water extracted from the patiño layer in the past is 1 $m^3/h/m$. Rainfall patterns are also different in this district from those in central Chaco, with average annual precipitation of 1,400 mm and an average of 5-6 mm of rainfall per day during the summer spread fairly evenly throughout the season. Therefore irrigation here will be supplementary in nature, and density of well distribution and water management systems will be worked out in such a way as to enable agricultural activity to take place in the area.

3) Required construction under the irrigation plan

The specific construction projects that will need to be implemented in each of the agricultural development zones in order to carry out the irrigation plan are as shown in Table 7.2.5.10.

(1) Right bank of the Rio Paraguay

There are three separate zones in this district which, in order from north to south, have an agricultural land area of 11,600 ha, 5,400 ha, and 6,300 ha respectively.

a) Embankment to prevent flooding due to a rise in the level of the Rio Paraguay

The idea is to construct an embankment sufficient to counter a rise in water level for approximately fifteen non-excess probable years on the assumption that the arable land expected to be subject to flooding is not inhabited. This rise in level is projected to be 2.5 m; thus this embankment will have a freeboard of 0.5 m and a crest of 7 m. A standard section of this embankment is illustrated in fig. 7.2.5.1.

This embankment shall have compacted foundations 2 m in depth and run for a total length of 297 km. The construction work involved is as shown in Table 7.2.5.11.

b) Water transportation route from the main channel of the Rio Paraguay to the pumping site (see Table 7.2.5.12)

c) Electrical supply facilities (see Table 7.2.5.13)

d) Pumping station (see Table 7.2.5.14)

e) Drainage pumping station (see Table 7.2.5.15)

f) Main irrigation and drainage channels (see Table 7.2.5.16)

(2) Suburbs of Asuncion (B. Aceval)

The cost per 1 m^3/s of water yield was for the sake of comparison calculated for well diameters of 10", 6", and 4". Well depth has been set at 100 m; a submerged pump will be used, which will be positioned at a depth of 70 m.

At the farm end it is assumed irrigation will take the form of spraying, since the crops to be watered are fruit trees and vegetables.

As calculated from crop transpiration, one well of 10" diameter should theoretically be capable of irrigating an area of 20 ha. However, in reality it is not possible to keep a pump running 24 hours a day, and since irrigation in this district is meant to serve a supplementary role the plan will increase the area covered by each well by implementing a system of water management, e.g. intermittent irrigation when required, that prevents damage from drought. It is necessary to alleviate the expense of supplying water in this fashion so as to enable agricultural activity to take place in the area. Also, given the fact that the choice of distance between wells is limited by concerns about the lowering of the water table through pumping, it has been decided for the purposes of the present project that one 10"-diameter well should be drilled for every 100 ha.

(3) Northern Pozo Colorado and eastern part of the Mennonite settlements

Water will be taken from the main channel of the Rio Paraguay at La Victoria at a volume of flow of 50 m^3/s, then conveyed the approximately 170 km to a point on the west side of Pozo Colorado. At a point some 130 km from the intake site a volume of flow of 7.5 m^3/s will be diverted to the eastern part of the Mennonite settlements. Water will also be routed to the highest point in northern Pozo Colorado.

The water will be carried along its way as follows. A channel (with an elevation above sea level the same as or 1-2 m higher than the surface of the Rio Paraguay) will be excavated from La Victoria to a point 6.5 km away, where the no. 1 pumping station (with a rise of 10 m) will be located. The water will then be conveyed along a second channel 50 km in length (with a gradient of 1/5,000) to the no. 2 pumping station, which will raise up the water a further 20 m into a third channel again 50 km in length (and again with a gradient of 1/5,000). Then, at the no. 3 pumping station, the water will be lifted a further 20 m and travel down yet another channel for 10 km to the point on the west side of northern Pozo Colorado, where it will need to be raised an extra 7 m at the no. 5 pumping station so as to allow it to reach the highest point in the area.

Some alternative proposals for pumping sites were scrutinized involving routes along some of the tributaries of the lower Rio Paraguay (Riacho Yacarei — along the Rio Paraguay: 75 km, or 42 km "as the crow flies"; Riacho Gonzalvez — along the Rio Paraguay: 90 km, or 54 km "as the crow flies"; and Riacho San Carlos — along the Rio Paraguay: 96 km, or 63 km "as the crow flies"). However, none of these tributaries proved advantageous in terms of water quality, power supply, and other conditions, for which reason expenses were estimated on the assumption of a pumping site at La Victoria.

A sample diagram of the main water transportation construction projects that will be needed along the route from La Victoria on the Rio Paraguay to the northern part of Pozo Colorado is given in fig. 7.2.5.2.

a) Channel from the Rio Paraguay to the no. 1 pumping station

This water channel, which will be able to take in water at a volume of flow of 50 m3/s, will have a gradient of 1:5000 and run for a length of 6.5 km. It will have a cross-section of 100 m2 and displace 650,000 m3 of earth.

b) Electrical supply facilities

The electrical supply facilities will derive a step-down voltage of 138 KV from the 220 KV power transmission lines scheduled to go up between Vallemi and Filadelfia, supplying power to pumping stations nos. 1 through 5 with a voltage step-down of 3 KV at each. The general wiring scheme will be as shown in fig. 7.2.5.3, while Table 7.2.5.18 may be referred to for information on transmission line and transformer equipment size.

c) Pumping stations

Each pumping station will consist of the pump itself, a motor, the main piping, electrical equipment, and auxiliary machinery; other items to be considered are valves, a housing for the base of the pump, intake tanks, discharge pipes, discharge tanks, auxiliary piping, supplementary landing piers, and maintenance equipment.

See Table 7.2.5.19 for information on pumping station size.

d) Water channels between pumping stations

Even assuming a pipe diameter of 2 m and a speed of 4 m/s, it would take 40 steel or concrete pipes to carry 50 m^2/s of water; furthermore, over a distance of 50 km there would be a loss of head of 55 m, while concrete piping has a test pressure of

4 kg/cm² at the most, for which reason it would be difficult to use. Employing concrete pipes would mean reducing the distance between pumping stations so as to stay within allowable available pressure, and that in turn would necessitate increasing the number of pumping stations. In the case of steel a greater thickness of pipe would have to be used in order to enable the allowable internal pressure to withstand a 10 m lift in height and a 50 km distance, which would drive up the cost per unit length of pipe as well as the cost of transportation and foundations on which to place the pipeline. Either material would result in an increase in the cost of the piping itself as well as transportation and constructing foundations, and thus both are poorly suited for the job; moreover, such piping is not produced domestically in Paraguay. Estimates were therefore drawn up for an open-channel design. This employs a concrete waterway and has a gradient of 1:5,000; the standard channel cross-section adopted is as illustrated in fig. 7.2.5.4. The embankment will have the cross-section shown in fig. 7.2.5.5 and the surface excavation area that shown in fig. 7.2.5.6.

e) Waterways and structures (figs. 7.2.5.7-11)

If the plan takes concrete shape, waterways and associated structures will be designed following the implementation of further survey work as required. At the present stage the main waterways will all be considered equivalent for the purposes of estimating expenses.

f) Main and auxiliary irrigation channels, farm irrigation channels, and grading of the land

Main irrigation channels will be routed to match the topography of each region, and laid out such that each covers a minimum area of 1,000 ha.

Judging from the topography of the project area and the routing of main irrigation channels the most common type of block is 2,000 ha, so the amount of construction work involved as far as auxiliary irrigation channels are concerned has been worked out on this basis. The plan provides for standard auxiliary irrigation channels on the assumption of a 200 ha area divided into five blocks with water being supplied to each zone. (See fig. 7.2.5.10.)

As for the irrigation channels needed at the farm end, the following standard sizes were assumed for supply channels and auxiliary supply channels in working out the amount of construction required. (See fig. 7.2.5.11.)

Next, the grading of the land. Since the average gradient in the region ranges from about 1/3,400 (the eastern Mennonite zone) to 1/1,750 (the central part of northern Pozo Colorado), a design of 125 m^3 per hectare was used assuming a gradient of 1/2,000 and a width of 100 m for each terrace.

Unit costs were calculated as the sum of the cost of excavation and transportation.

4) Estimating construction expenses

(1) Unit construction costs

It is realistic to expect that construction costs in the Chaco region are generally going to be 50% more than in Asuncion and 30% more than in Concepcion, since all materials will have to be transported from Asuncion, and on-site expenses are higher than in Paraguay's major cities. The table takes the main unit costs for Asuncion and Concepcion and then increases them by the above percentages to obtain estimated unit costs for northern Lower Chaco. (See Table 7.2.5.22.)

(2) Construction expenses

Project construction expenses were estimated on the basis of the amount of construction work and unit construction costs calculated above. Tentative figures were worked out for irrigation plans for the suburbs of Asuncion on the right bank of the Rio Paraguay, and for Pozo Colorado and the eastern part of the Mennonite settlements.

In the case of pumping and drainage stations these criteria were followed. The total cost of machinery and equipment was calculated based on obtainable data, since, when water is divided evenly among several pumps under identical planning conditions, this figure is roughly proportionate to the total volume of water pumped regardless of the number of pumps, as long as there is no change in volume. The ratio of total cost of machinery and equipment to total expenditure on station construction was set at 1:2 in accordance with past figures from projects in Japan.

7.2.6 The drainage plan

A drainage plan was drawn up for agricultural areas in the five districts of northern Pozo Colorado, the eastern part of the Mennonite settlements, the southern part of the Mennonite settlements, the suburbs of Asuncion, and the right bank of the Rio Paraguay.

1) Drainage discharge volume at the farm level

Drainage channel size at the farm level was determined such as to allow drainage on the assumption of a hydrological balance on the farm with an allowable groundwater depth of 1.0 m and two days of 24-hour rainfall such as might occur once in two excess probable years.

Hydrological balance is expressed by the formula Qs = Rf + Sc + Si - Dn, in which:

Qs = volume of water to be drained from the farm drainage channel
Rf = nutritional content of groundwater on the farm (amount of rainfall, volume of water for eluviation, etc.)
Sc = amount of seepage from irrigation channels
Si = water entering the farm from outside
Dn =natural drainage discharge volume

(1) Northern Pozo Colorado and the eastern and southern Mennonite settlements

In Pozo Colorado the amount of 24-hour rainfall that might occur once in two excess probable years is 110 mm (UNDP: Proyecto de Desarrollo de Chaco — Par/75/002 - April 1980). The soil of northern Pozo Colorado consists of clay loam. The rate of penetration of levee irrigation water in this district is believed to be 25-30% (FAO Irrigation Drainage Paper No. 38). It has also been established that 20% of the volume of water supplied to farms here needs to be drained off for the purposes of salt eluviation in order to maintain the saline balance of the soil (FAO, op. cit.).

Crop transpiration during the summer in this region is 6.1 mm a day (see Table 7.2.5.8).
Rf = 0.3 (6.1 mm/day + 55 mm/day) + 0.2 x 6.1 mm/day = 19.6 mm/day

The variable Sc may be set at zero since the channels will be of concrete, while Dn may be ignored. Therefore Qs = Rf = 19.6 mm/day. This is equivalent to a water volume of approximately 2.3 litres/s/ha, and since it will be necessary to maintain a depth of 1.0 m if irrigation channels are to be constructed by machine, an ample cross-section will be ensured by the excavation width of the equipment. On the assumption of a drainage channel of a length of 100 m per hectare with an excavated width at the base of 0.5 m,

a depth of 1.0 m, and lateral dimensions of 1:1, the volume of earth displaced would be 150 m^3/ha.

(2) Suburbs of Asuncion

The amount of 24-hour rainfall that might occur once in two excess probable years in this region is 99 mm (Asuncion: UNDP — Proyecto de Desarrollo del Chaco Paraguay — PAR/75/002 - April 1980), while the transpiration rate for vegetables scheduled for summer cultivation is 5.1 mm a day. Applying the same criteria as for northern Pozo Colorado:

Rf = 0.3 (5.1 mm/day + 50 mm/day) + 0.2 x 5.1 mm/day = 17.6 mm/day (= 2 litres/s/ha)

Qs = Rf = 17.6 mm/day

Drainage channels will be of roughly the same dimensions as in northern Pozo Colorado.

(3) Right bank of the Rio Paraguay

No data is available on 24-hour probable rainfall in this region, but since observed monthly precipitation patterns in the summer resemble those of Asuncion, a rainfall of 99 mm can be postulated as in the preceding section on the suburbs of Asuncion as the 24-hour rainfall that might occur once in two excess probable years; farm water requirements are assumed to be 10 mm/day (see 7.2.5 "The irrigation plan"). The required drainage displacement volume can then be worked out on the same criteria as in the preceding sections as follows:

Rf = 0.3 (10 mm/day + 50 mm/day) + 0.2 x 10 mm/day = 20 mm/day (= 2.3 litres/s/ha)

Qs = Rf = 20 mm/day (= 2.3 litres/s/ha)

Drainage channel dimensions will be roughly the same as those in Pozo Colorado given above.

2) Water catchment, primary and secondary drainage channels and main drainage channels

Water catchment drainage channels will be laid out on farms in units of 100 ha. Secondary drainage channels will collect the water from ten such units, while these in turn will flow into four branch channels; since there are seven separate districts in the eastern part of the Mennonite settlements channel levels will differ depending on the size and configuration

of each district. This holds true for the other regions as well. The dimensions for each type of drainage channel are as shown in Table 7.2.6.1.

The drainage system in the eastern and southern parts of the Mennonite settlements will be on a similar scale to that in northern Pozo Colorado described above. The topography of the area around Asuncion should allow direct drainage into natural drainage channels at the catchment drainage channel level.

Water from primary drainage channels will be discharged into rivers via main drainage channels. The routing of the main drainage channels in each district was worked out on the basis of topographical maps.

3) Amount and cost of drainage construction

The amount of construction work required to set up this drainage-channel network is as shown in Tables 7.2.6.4-7.2.6.5. These figures were obtained by applying amount of construction per 10,000 ha proportionately to the area to be drained in each region.

4) Area of agricultural land that will require drainage even without irrigation

If it is decided not to establish irrigation facilities, it is still advisable that drainage channels be constructed as required in accordance with the topographical features of the region. The condition of the land undergoes changes when agricultural development is undertaken and natural vegetation is altered, even if only rainwater is used. An increase occurs in both the amount of evaporation from the ground and transpiration from the crops being grown on the land in which agricultural development has taken place, and there is a greater risk of salt damage in areas with a high water table. Given that the average gradient in the region is 1/5,000, it is advisable that drainage facilities be established in those parts of the regions subject to agricultural development with a gradient of less than 1/5,000. This criterion was applied at the planning stage. North-south cross-sections of the northern part of Pozo Colorado and eastern and southern parts of the Mennonite settlements were taken at 5 km intervals, and those areas with a gradient of less than 1/5,000 were identified as needing drainage. (Most rivers in the region flow from west to east.) Table 7.2.6.6 gives the area of land that will require drainage even without irrigation.

Table 7.2.6.6: Area of land that will require installation of drainage facilities even without irrigation

Agricultural development region	Total area (ha)	Area of districts requiring drainage (ha)	Percentage of total area of ordinary cropland + orchard areas	Area of districts requiring drainage facilities (ha)
Northern Pozo Colorado	76,000	47,000	33.4	15,700
Eastern Mennonite zone	185,000	123,000	16.6	20,500
Southern Mennonite zone	68,000	11,000	38.2	4,200

N.B.: 1) The area of those districts requiring drainage was obtained from maps with a scale of 1:250,000.

2) The percentage of total area of ordinary cropland + orchard areas was taken from the land use plan.

5) Assessment of the irrigation and drainage plan (Table 7.2.6.7)

An assessment was implemented based on estimated irrigation and drainage construction costs for five agricultural development planning districts, which were selected due to the suitability of their natural conditions, especially in terms of soil characteristics and pattern of flooding. There would appear to be considerable range in construction costs due to uncertainties in the estimated amount of construction and price of materials and equipment, but the estimates provide reasonable ballpark figures. (See Table 7.2.6.5.)

(1) Right bank of the Rio Paraguay

The area of agricultural land in this region that could be drained naturally is estimated to be approximately 2,000 ha in the north and 1,300 ha in the south. In the rest of the area measures would need to be taken to prevent flooding from the Rio Paraguay and provide adequate drainage in order to maintain productivity at a stable level. For this reason it would be necessary to build dykes, drainage channels, and mechanized drainage facilities. The cost for all this as averaged out for the whole of the right bank district is estimated to be US$13,600 per hectare of farmland, plus US$7,000 per hectare for irrigation and drainage facilities. This gives a total of US$20,600 per hectare of farmland, a figure that is completely unfeasible when considered in terms of likely agricultural conditions in the region at present.

(2) Suburbs of Asuncion

Water-supply facilities have been estimated at a smaller size than might theoretically be considered necessary, since irrigation in this region serves a purely supplementary role, while the volume of groundwater available for pumping is limited. Pumping of groundwater will make it necessary to improve water management and increase efficiency, which means some form of localized irrigation on farms such as drip

irrigation or spraying. However, at market prices the materials needed to construct the required facilities would cost several thousand dollars per hectare of farmland. In reality improvements will have to made as agricultural production rises and stabilizes with a steady supply of water and farms gradually gain economic leeway. If the agriculture of this region, which is today dominated by sugar cane, is to become more diversified and modern, then the current balance will need to be overturned. The profitability of continuing sugar production in Paraguay should be re-examined in the light of deteriorating manufacturing facilities and declining sugar-cane productivity as a result of disease, as well as the effects of the Mercado Comun del Sur on sugar production in Paraguay. Therefore irrigation using immediately-available groundwater, albeit in limited quantities, is a realistic possibility for promoting agricultural redevelopment in this region, and drainage facilities will be constructed over time as conditions require.

(3) Northern Pozo Colorado, eastern and southern part of the Mennonite settlements

The only feasible source of water for irrigation in these three areas is the Rio Paraguay, with a projected potential supply capacity of about 50 m3/s. It will not possible to irrigate the whole region with this amount of water; therefore the southern part and part of the eastern part of the Mennonite settlements have been excluded. The cost of pumping 50 m3/s of water to northern Pozo Colorado and the eastern part of the Mennonite settlements is estimated to be about US¥11,500 per hectare of farmland. For levee irrigation the cost of irrigation facilities on the farm would be US¥2,400 a hectare, while the cost of water-supply facilities to irrigate both these areas would be somewhat under US¥14,000 per hectare. Once such other expenses as equipment depreciation, maintenance and management of irrigation facilities, and power to run the pumps are factored in, it can be concluded that an irrigation and drainage programme is beyond the realm of possibility both economically and financially under current local agricultural conditions.

Moreover, the establishment of drainage facilities to prevent deterioration of agricultural land through salt damage would be an essential precondition to the implementation of an irrigation programme. This would entail expenditure of approximately US¥1,600 per hectare of farmland.

The estimated costs of constructing drainage facilities in areas in these three regions that would require drainage even in the absence of irrigation are given in Table 7.2.6.8.

7.2.7 The rural infrastructure plan

1) Basic policy

The objective of this plan is the installation of social infrastructure in communities inhabited by the farming population which is to utilize the production base provided under the present general development programme. As a rule the benefits of social capital investment are inevitably enjoyed first by urban regions with their concentrated populations, while farming areas find themselves constantly a step or two behind. The present plan therefore aims in so far as possible to eliminate differences in infrastructure standards between urban and rural areas.

The living environment of agricultural communities needs as much as possible to strike a balance between man and nature. Hence this infrastructure plan envisages a pleasant living environment in which much of the natural-growth forest in the surrounding areas will be preserved.

The implementation of the agricultural and livestock farming development programme will boost production of farm goods and thus stimulate the local economy, and at the same time population will grow. Existing social infrastructure will first be used to deal with this increase in population, and in cases in which established facilities no longer prove adequate they will be expanded or supplemented. In districts with no existing social infrastructure new infrastructure is to be installed.

Farmers and their families already dwelling in the project area are to be given first priority under the settlement plan, but, given such considerations as land distribution, land use planning, and so forth, it is inconceivable that they should be able to undertake agricultural production activities on the same site as before. Thus the existing farm population will also be resettled, and the social infrastructure programme is to benefit all farm households settling in the project area.

The types of social infrastructure to be covered by the rural infrastructure plan comprise domestic water supply, health and medical service facilities, communication facilities, electricity, and educational facilities. These are to be installed in the areas of settlement defined under the settlement plan.

Until now installation of social infrastructure has generally languished behind the pace of economic development, with agricultural activity going on while the living environment has remained neglected. This plan thus calls for work on social infrastructure to proceed in step with the development of the production base. One point to be especially kept in mind

is that the natural environment of the Chaco region is an extremely harsh one for people to live in, and the rural infrastructure plan based on the settlement plan must be drawn up in such a way as to guarantee the farming population the minimum conditions for a settled existence.

The type of agricultural activity to take place in livestock farming development planning districts is specialized beef production under the management of current ranch proprietors. Since these proprietors have already installed housing, electricity, domestic water supply, communication links, and other facilities on an individual basis at their own initiative, no social infrastructure is to be included in the plan for these districts. In the fields of education and health and medical services use will be made of existing facilities.

2) The rural infrastructure plan

The rural infrastructure plan was formulated after determining number of households and size of population for each agricultural development planning district and livestock farming development planning district on the basis of their respective settlement plans. Below are given the number of farmers to be settled in the project area and resulting increase in population.

The settlement plan calls for the settlement of (i) 640 farm households in the south of the Mennonite settlements, (ii) 1,360 households in the east of the Mennonite settlements, (iii) 630 households in northern Pozo Colorado, (iv) 390 households in the suburbs of Asuncion, and (v) 2,260 households in livestock farming development planning districts, for a total increase of 1,291 farm households over the current agricultural population of the project area as a whole. Each district will see a population increase of 1,581, 5,776, 2,687, -403, and 658 respectively. Figures on current and planned population in each district are given in Table 7.2.7.1. These have been computed as follows:

(i) Current population

- For the non-indigenous population of the southern and eastern parts of the Mennonite settlements and northern Pozo Colorado, the number of farm households in each district was multiplied by number of persons per household in the survey area (3.25 persons) and increased by 30%.
- The indigenous population was calculated by multiplying number of households in each district by number of persons per household (5 persons).
- The population in the suburbs of Asuncion was determined by questioning etc.
- The population of livestock farming development planning districts was calculated without a 30% increase.

(ii) Planned population

- For the southern and eastern parts of the Mennonite settlements and northern Pozo Colorado, the number of non-indigenous households to be settled in each district was multiplied by 3.25 persons, to which was then added the indigenous population increased by 50%.
- The population in the suburbs of Asuncion was calculated as the current population minus number of households moving out of the district multiplied by 3.25 persons.
- For livestock farming development planning districts, the number of non-indigenous households to be settled was multiplied by 3.25 persons, to which was then added the indigenous population increased by 20%.

(1) Patterns of settlement

The most sensible arrangement from the viewpoint of keeping down the cost of installing social infrastructure is to concentrate the population in centralized communities, since the construction of roads in the project area under the plan will enable farmers to commute to their farms, while they and their families will enjoy a more pleasant living environment.

However, some medium-sized and small (independent) farms are to raise dairy cattle under the farm-management plan. The most important aspect of dairy farming is the daily milking and care of the cows. This means these farmers will need to reside on the land they have been assigned. Living right on the farm also has its advantages for other forms of agriculture as far as taking care of the land is concerned. Again, while the indigenous population will at first work on a cooperative basis, the plan calls for individuals ultimately to be given the right to farm their own land; hence it would make more sense for each family to dwell on its own farm. Therefore households operating small- to medium-sized farms as well as indigenous peoples will live in non-centralized communities.

3) Installing social infrastructure

The current state of the social infrastructure of each region (medical, educational, and communications facilities) is outlined in Table 7.2.7.2, while location of facilities is shown in fig. 7.2.7.1. In light of this, social infrastructure will be installed in each of the regions as described below. This infrastructure is tailored to the increase in population in each district.

(1) Medical facilities

The survey area has one regional central hospital, five central clinics, and 15 ordinary

clinics. Paraguay has 1.7 doctors, 5.6 nurses, and 14.23 hospital beds per 10,000 people. Health and Welfare Ministry standards call for central clinics for every 2,000 to 20,000 people and ordinary clinics for populations of less than 2,000, and prescribe a floor area of approximately 290-520 m2 for the former and 80-125 m^2 for the latter.

(i) Southern part of the Mennonite settlements

This district currently has a population of 1,727, and the increase in agricultural population through new settlement will be 1,581.

There is an existing clinic is located roughly in the centre of the district (Campo Aceval) at a distance of about 35 km from the furthest point away. No facilities are to be established in the north of the district, since there are two central clinics 15 km beyond its boundaries to the east and northeast, while the area is relatively limited in size. One clinic is to be constructed in the southeast of the district on the national highway from Pozo Colorado to General Burgues. Also, the existing facility in the central part of the region is to be renovated.

(ii) Eastern part of the Mennonite settlements

This district currently has a population of 1,227, and the increase in agricultural population through new settlement will be 5,776. The increased population will be as shown in Table 7.2.7.1.

The district is divided into three zones. There is presently a central clinic in the western part of the largest zone on National Highway 9 (M. Irala Fernandez). The two other zones are at a considerable distance from this facility in the northeast. Under the current project's road plan, these are to be connected to Highway 9 by a principal road running through the southeast of the largest zone. However, since the distance to the central clinic is about 110 km, three new facilities will be established, one approximately 20 km away from Highway 9, one about 50 km away, and one in the south of the largest zone. In addition, the existing central clinic will be renovated.

(iii) Northern Pozo Colorado

This district currently has a population of 594, and the increase in agricultural population through new settlement will be 2,687.

There are no existing medical facilities in this area. Two new facilities are to be set up in the eastern part of the district, one on Highway 9 and the other on the principal road that is to cut roughly across the centre of the district under the current project's road plan.

(iv) Suburbs of Asuncion

This district currently has a population of 13,769. The project calls for a population decrease of 403, since there are more farm households now than are envisioned under the plan.

No new medical facilities are to be constructed in the area since it already has a regional central hospital and a central clinic, and is close to Asuncion.

Clinics will be equipped with waiting rooms, medical offices, delivery rooms, nursing stations, resting rooms, and lavatories. They will have a building area of 125 m^2 and a lot area of 500 m^2.

It is advisable that there be one physician each in the southern and eastern part of the Mennonite settlements and in northern Pozo Colorado, and at least one nurse in each clinic.

The location of the new clinics is shown in fig. 7.2.7.2, while a floor plan appears in fig. 7.2.7.4. Required expenditures for each district are given in Table 7.2.7.3.

(2) Educational facilities

Paraguay's average primary school enrolment rate is 94%, while that for middle schools is 28%. There are 25 pupils per teacher in primary schools and 15 pupils per teacher in middle and high schools. Classroom area per pupil is 1.0 m^2 in rural districts and 1.2 m^2 in urban districts, while lot area is 10.000 m^2. The current plan envisions a primary school enrolment rate of 100% and a middle school enrolment rate of 30% with a classroom area per pupil of 1.2 m^2. School-age population has been calculated by working out the percentage of total population that is of school age for the whole country, then applying that percentage to the population of each planning district. The increase in school-age population, which figure is necessary to computing classroom area, has been calculated from the difference in population at the survey and project stages. Classroom area for new primary and middle schools will be set at 280 m2 per school so as to increase the number of schools and thus make them more convenient to get to for pupils, since the incoming farm population will live scattered throughout each district. No new high schools are to be built, but rather existing facilities will be used. An agricultural school will be established where persons who have completed compulsory education will receive training in the skills needed to promote the development of agriculture in the survey area.

(i) Southern part of the Mennonite settlements

In this district the primary-school-age population will increase by 237 and the middle-school-age population by 104, resulting in an increased enrolment of 237 and 31 respectively.

Existing educational facilities consist of seven primary schools situated in and around the district in such a way as to cover virtually the whole area except the north, and two middle schools in the southeast corner of the district, one within and one outside its boundaries. Therefore two primary schools will be established in the north of the district, along with one middle school in approximately its centre, since the two existing middle schools are both in the southeast. Furthermore, one of the primary schools to be built in the north will also be used as a middle school.

(ii) Eastern part of the Mennonite settlements

In this district the primary-school-age population will increase by 837 and the middle-school-age population by 383, resulting in an increased enrolment of 870 and 115 respectively.

As far as existing educational facilities go, there are four primary schools and one middle school in the extreme west of the largest of the three zones, along with one primary school just outside the southeast zone. For this reason nine primary schools and three middle schools will be set up in such a way as to cover virtually the whole district excepting the extreme west of the largest zone.

(iii) Northern Pozo Colorado

In this district the primary-school-age population will increase by 403 and the middle-school-age population by 177, resulting in an increased enrolment of 403 and 53 respectively.

Currently there is just a single primary school near Highway 9 at the western end of the zone. Consequently four new primary schools will be established such as to cover most of the district except its western end, along with a middle school in the centre of the region.

(iv) Suburbs of Asuncion

In this district the primary-school-age population will decrease by 60 and the middle-school-age population by 27 due to relocation in other districts.

This zone and the surrounding areas have 13 primary schools, four middle schools, and one private agricultural high school. No new educational facilities will be set up as there is to be a drop in enrolment.

The location of the new educational facilities is shown in fig. 7.2.7.2, while a floor plan appears in fig. 7.2.7.4. Required expenditures on educational facilities in each district are given in Table 7.2.7.4.

There is just one agricultural school in the survey area, a private agricultural training school in Cerrito on the outskirts of Asuncion. The industry of the survey area consists almost exclusively of agriculture and livestock farming, except for iron production in Villa Hayes and sugar production in Benjamin Aceval just outside Asuncion. Thus for now the most effective way to foster economic growth in the region is to promote agricultural production. To this end it is essential to educate young people in the agricultural skills they will need in the future. Hence an agricultural school is to be established in northern Pozo Colorado in which to train the next generation of farmers.

Students who have completed compulsory education will be eligible for enrolment at this institution, which will be organized as a boarding school.

The school will offer two programmes, agriculture and animal husbandry, which students may select in accordance with their particular goals. The agriculture programme is to cover (i) agriculture in general, (ii) cultivation of vegetables, (iii) cultivation of fruit, (iv) forestry, and (v) grain production. The animal husbandry programme is to cover (i) small livestock (chickens, pigs, sheep, goats, etc.), (ii) beekeeping, (iii) large livestock (beef and dairy cattle), (iv) dairy products, and (v) pasturage and feed crops.

Each programme will have an enrolment of 75 for a total school enrolment of 150. The location of the school is shown in fig. 7.2.7.5, while required expenditures are listed in Table 7.2.7.5 thereof.

(3) Communication facilities

Microwave communication involves creating a wireless link between the base station (telefono urbano) and the user (telefono rural) via a relay station, but expansion is difficult as the base stations currently in use are located in some of the telefono urbano base stations in Asuncion. Telefono urbano, which involves a wireless link between the

base station and the relay station followed by a cable link between the relay station and the end-user, is the most common form of network in Paraguay. Under the present project a telefono-urbano-type system will be adopted for communications. According to the plan, existing facilities in Loma Plata connected to Asuncion's central exchange will be expanded, and from there wireless links will be established with each of the project districts utilizing existing relay stations. There is an average of one telephone for every eighteen households in the survey area, but almost all these telephones are located in the suburbs of Asuncion, while the other districts have a total of just seven public telephones. Therefore public telephones will be installed in each of the settlement districts.

(i) Southern part of the Mennonite settlements

There is a telefono rural just outside the district in the southwest, along with a private facility making use of a telefono rural in Campo Aceval. And that is it as far as existing telephone links are concerned. For this reason public telephones will be installed in a total of three locations in the north, centre, and southeast of the district. In addition 24 lines will be reserved for the use of each relay station in the future.

(ii) Eastern part of the Mennonite settlements

There is a telefono rural on Highway 9 about 15 km southeast of this district (Fortin Salazar), but nothing in the way of communication facilities in the district itself. Public telephones will be set up in a total of five locations, the northwest, centre, east, and south of the largest of the three zones into which the district is divided, and the centre of the eastern zone. At the same time 24 lines will be reserved for the use of each in the future.

(iii) Northern Pozo Colorado

There is a telefono rural on Highway 9 about 10 km north-northwest of this district (Fortin Salazar), but no existing communication facilities in the district itself. Public telephones will be installed in two locations, one in the west and one in the east. Again 24 lines will be reserved for the use of each in the future.

(iv) Suburbs of Asuncion

There is a telefono urbano in Villa Hayes with a cable link to Benjamin Aceval. Since the existing facilities are in usable condition, and there are more farm households in the area now than are envisioned under the plan, no new communication facilities are to be established in this district.

The location of these communication facilities is shown in fig. 7.2.7.6, while required expenditures for each district are given in Table 7.2.7.6.

(4) Electricity

Paraguay's vast generating capacity ensures that it has more than ample electricity, and nearby existing generating facilities will be used to supply power to all districts in order to facilitate future upkeep and maintenance.

(i) Southern part of the Mennonite settlements

A 220 KV power line from Vallemi in Departamento Concepcion to Loma Plata in the Mennonite settlements is scheduled to come into use by 1995, and this will pass close by this district. The plan calls for a 220 KV transmission line from Loma Plata to northern Pozo Colorado following Highway 9 to the western end of the district; along the way 66 KV will be diverted to the centre of the district, then 23 KV will run from there, branching into 220 V power lines at intervals of two kilometres. Farm households moving into the area will draw their electricity supply from this network.

(ii) Eastern part of the Mennonite settlements

The 220 KV transmission line running from Loma Plata to northern Pozo Colorado will supply 23 KV of power to the northern and southern parts of the largest of the zones in the district, and 66 KV to the eastern part of that zone; 23 KV will then be routed from the latter to the eastern and southern zones, branching into 220 V power lines at intervals of two kilometres. Farm households moving into the area will draw their electricity supply from this network.

(iii) Northern Pozo Colorado

A 220 KV power line will be routed from Loma Plata along Highway 9 to the western end of this district, and from there 66 KV will run to the centre of the district and then branch into 220 V power lines at intervals of two kilometres. Farm households moving into the area will draw their electricity supply from this network.

(iv) Suburbs of Asuncion

A 23 KV line will be routed from existing facilities, branching into 220 V power lines at intervals of two kilometres. Farm households moving into the area will draw their electricity supply from this network.

The planned power supply network for each district is illustrated in fig. 7.2.7.7, while project scale and required expenditures are shown in Table 7.2.7.7.

(5) Domestic water supply

In most of the southern and eastern Mennonite settlements, northern Pozo Colorado, and suburbs of Asuncion, groundwater displays high salinity, while river water is unstable in terms of flow, discharge rate, and quality, and is said to produce salt damage when stored. Thus rainwater becomes the only option. Currently rain falling on houses is directed through gutters into tanks for storage, and this technique is the best-suited to the survey area.

The first thing that will be required of the settlement plan is to provide drinking water to the farming population as a minimum condition for leading a settled existence as described in the section on basic policy on rural infrastructure. Therefore a water supply programme will be prepared for small-scale farm zones in the southern and eastern parts of the Mennonite settlements and the northern Pozo Colorado district. The sources of supply for drinking water are to be rainwater stored in underground tanks, public tajamar, and well water from river-terraces. Water supply for medium-sized farm households is covered under agricultural facilities and is thus excluded from this aspect of the plan. Similarly, indigenous people engaged in small-scale part-time farming in livestock farming development planning districts will not be dealt with under this aspect of the plan, since they are already settled in scattered groups with secure supplies of drinking water, and they are to use rainwater under the housing plan. The suburbs of Asuncion is also not to be included, because part of the area has exploitable sources of groundwater, and the public water company is currently in the planning stages of a water-supply project. Costs are as shown in Table 7.2.7.8.

(6) Housing

Ideally, housing is constructed by the individual in accordance with what he can afford. However, small-scale farmers under the present project simply do not have the money, and the most they could manage when they first settle on the land would be to put up temporary shanties. Therefore the plan calls for the government to build housing by the time the settlers arrive, with farmers to repay the cost over the long term. A total of 3,680 homes are to go up, 2,140 for indigenous small-scale farmers, and 1,540 for independent small-scale farmers. Costs are as shown in Table 7.2.7.9.

(7) Miscellaneous

The settlement plan involves relocating people from both the survey area and throughout the country, and settlers will have to be guaranteed conditions allowing them to lead a stable existence. Installing social infrastructure in areas of settlement would be pointless unless it enabled beneficiaries to enjoy higher standards of living than they did in their

previous homes. From the point of view of securing human resources, the government will need to expand the scope of programmes designed to help inhabitants deal with the harsh living environment of the Chaco region. Social infrastructure is basically a question of social capital, and needs to be approached with social rather than economic considerations in mind. In this sense installing such infrastructure is something the national government will have to be responsible for. Therefore this type of infrastructure will not be covered under the present plan, and no project assessment will be made.

Fig. 7.2.7.2. Location of new medical and educational facilities

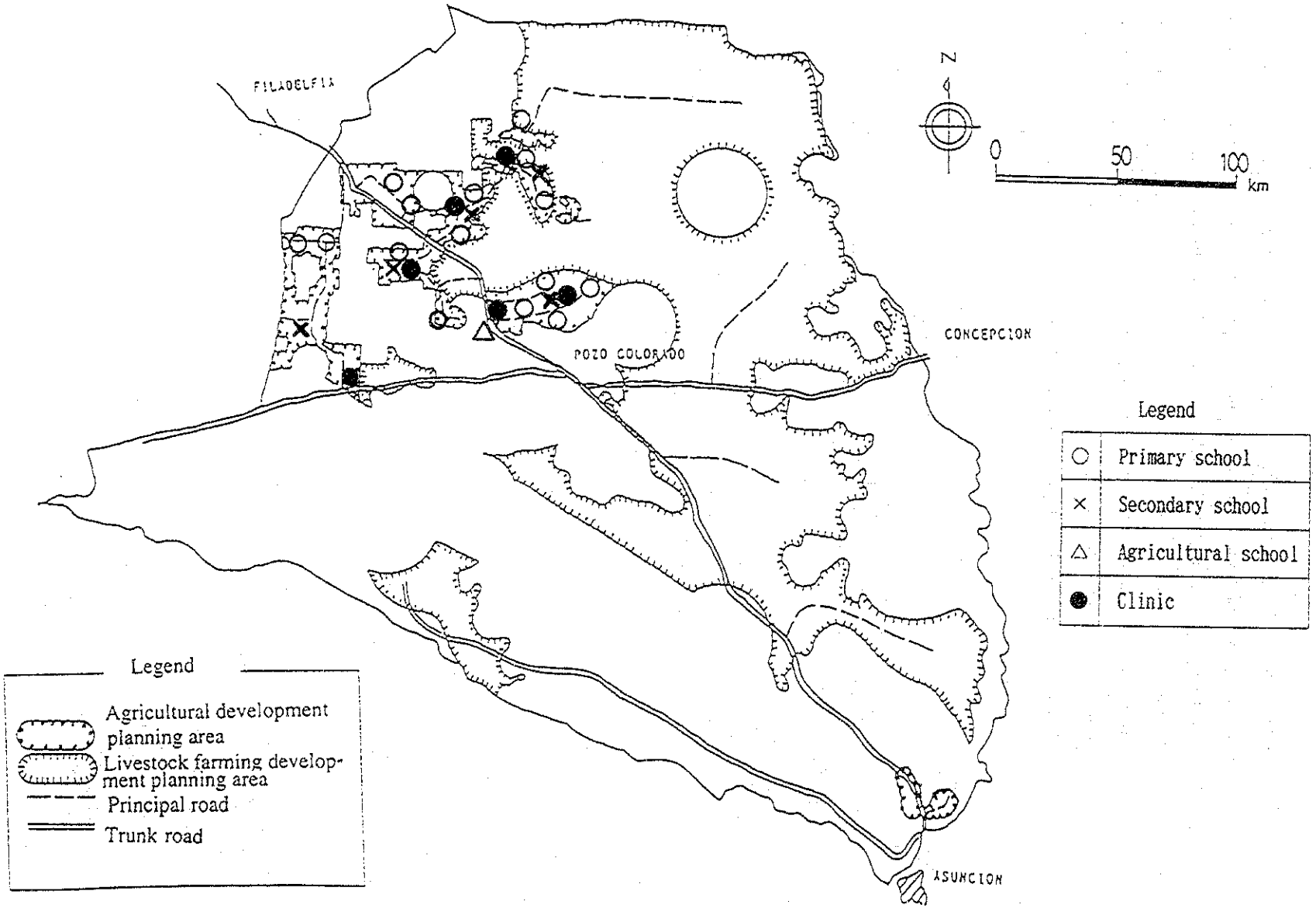


Fig. 7.2.7.6 Location of communication facilities

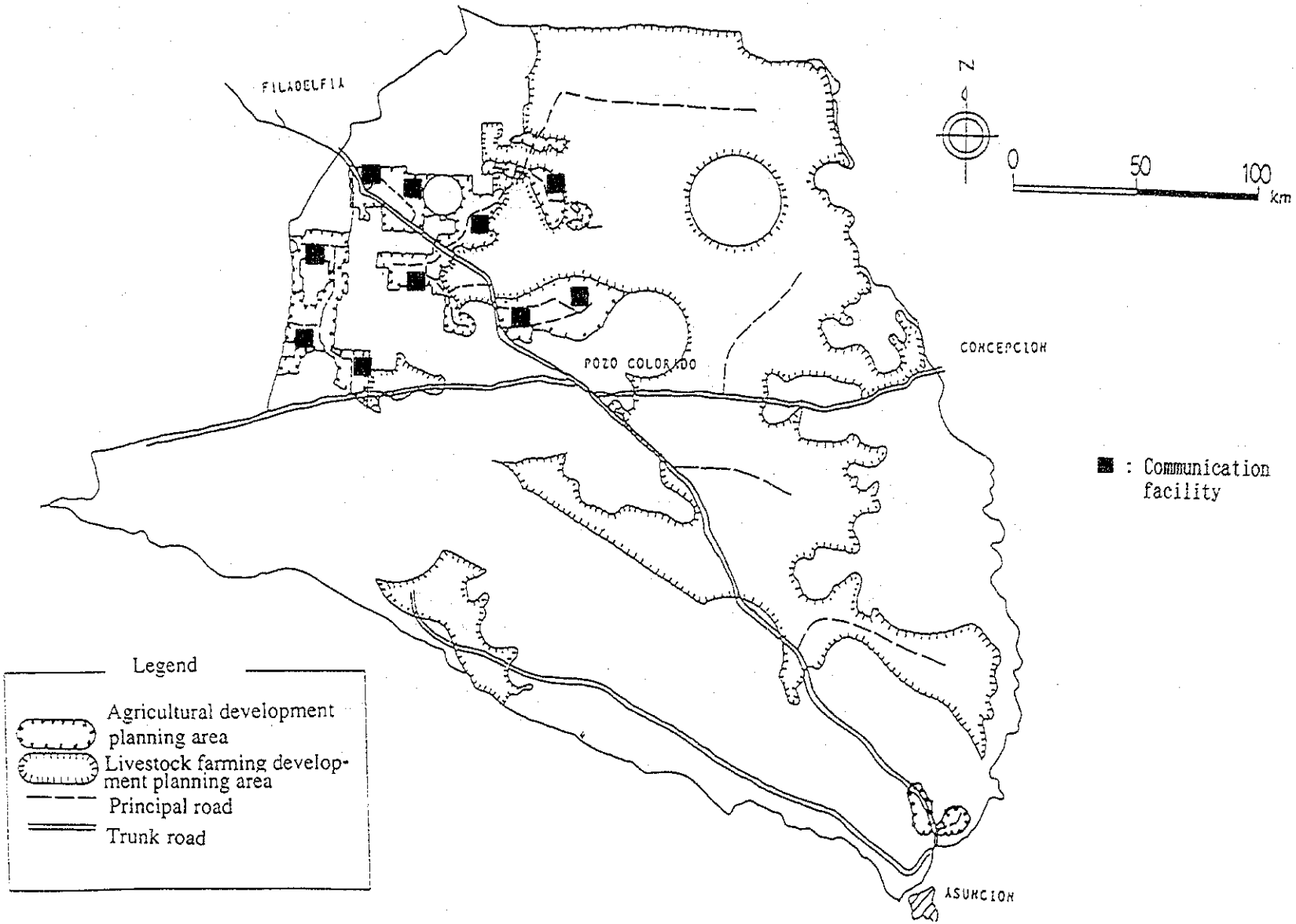
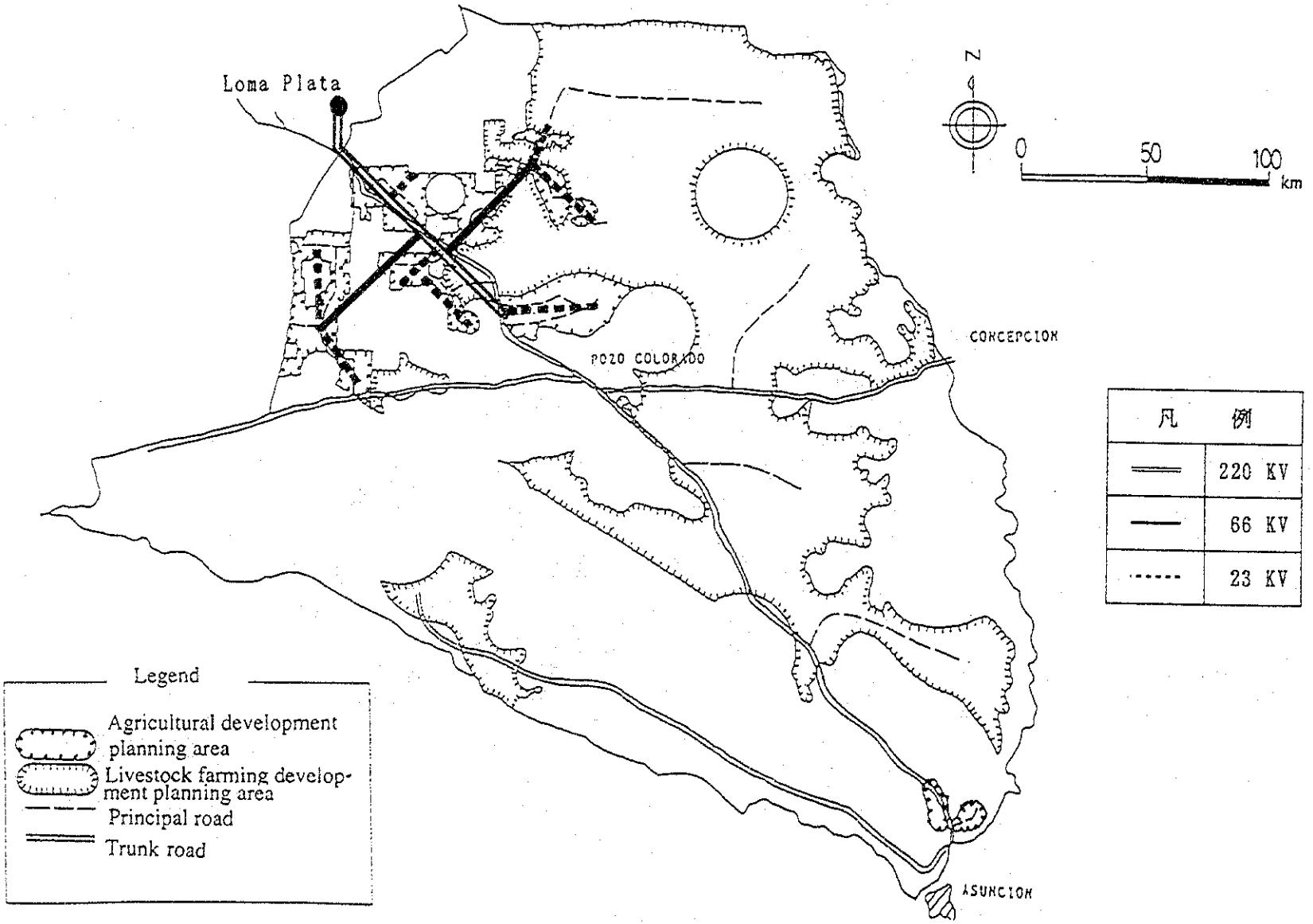


Fig. 7.2.7.7 Power supply network of agricultural communities



7.2.8 The farmland conservation plan

Paraguay is making a serious effort to raise the level of awareness about the need for soil conservation on agricultural land in all parts of the country. Even so, many areas suffer from soil loss due to the continuation of long-standing practices such as uncontrolled exploitation of the land, repeated cultivation of a single crop, and overuse of machinery. Furthermore, forests are being cut down indiscriminately as demand for timber rises, while planting of trees is rare and shelterbelts are still few and far between.

The low-lying parts of the survey area, which are flat, serve mostly as natural grasslands for grazing, and do not display soil loss.

Erosion caused by strong winds during winter is to be observed on ploughed land in the semi-arid districts of the west and north of the area. The environment undergoes changes when forests are cut down to make way for farmland, and in certain locations where water resources have been improperly handled salt accumulation has resulted accompanied by deterioration of the soil.

Thus farmland conservation under this project is to fall into two parts, a shelterbelt programme, and prevention of salt accumulation.

1) Shelterbelts

Eighty percent of the winds in the project area throughout the year blow from the north or northeast. Winds are strong between May and November, and during the winter from July to September in particular the predominant wind direction is north. Rainfall, by contrast, is extremely scarce during these months as compared to the rest of the year. According to research by the Chaco Central Experimental Station soil is picked up at a wind speed of 7 m, while a maximum wind speed of 10.9 m/sec has been recorded in the Loma Plata district of the Mennonite settlements.

Conditions being such, shelterbelts are to be planted on ordinary cropland, fodder cropland, orchard areas, and improved grasslands in agricultural development planning districts as it is so important that erosion be prevented in these areas.

Every effort will be made to use the 25% or more of forest left intact under the provisions of the draft Forest Resources Act as shelterbelts, and where forests on shelterbelt land are sparse trees will be planted in order to increase their effectiveness in blocking the wind.

(1) Shelterbelt location and orientation

(i) Vicinity of farms — Primary shelterbelts are to be set up in an east-west direction, with secondary shelterbelts running north-south.

(ii) On farms — Shelterbelts are to be set up in an east-west direction at intervals of no more than 200 m.

(2) Spacing of shelterbelts

The Chaco Central Experimental Station has established 20 H (H = tree height in metres) as the standard effective shelterbelt range, so this figure will be adopted as the maximum spacing between belts in the present project. It is also to be recommended that windbreak effectiveness be boosted further once agricultural activity gets underway through the planting of additional shelterbelts on farms between those already existing.

(3) Width of shelterbelts

The wider a shelterbelt the more effective it will be in blocking the wind. Shelterbelts on farms will need to be at least three to five rows wide, while those in surrounding areas will be as wide as circumstances permit. It will also be necessary to allow some leeway in the width of each belt for when it is renewed.

(4) Species of tree to be used for shelterbelts

The Forestry Bureau of the Ministry of Agriculture and Livestock is currently conducting comparative testing on seven species of tree well adapted to the project area at a shelterbelt experimental farm it has set up in the Mennonite settlements. The results are eagerly awaited. For now grevilea (Grebilea robusta), long planted by farmers in the project area around homes and along roadways to block the wind, is considered to be a prime candidate.

The species of tree to be used in a shelterbelt should:

(i) Have a sturdy trunk.

(ii) Be dense at the crown, with branches growing from low down.

(iii) Produce thick foliage during the windy part of the year.

(iv) Grow rapidly.

(v) Have deep roots.

(vi) Be adapted to the climate of the region.

(vii) Be resistant to disease and insects.

(viii) Not be an intermediate host for diseases and insects harmful to crops.

Where several species of trees with different heights and rates of growth are to combined

in order to provide greater protection from the wind, these will be selected in accordance with their individual characteristics.

(5) Estimated cost

The estimated cost of the shelterbelt programme (that portion to be funded from government subsidies) is US$6,187,000. A breakdown of expenses appears in Table 7.2.8.1.

2) Preventing salt accumulation

In areas with a high risk of salt accumulation adequate drainage will be provided, while measures will be taken to prevent the water table on farmland from rising through capillary action. The water table will as a rule be maintained at a level of 0.8-1 m below the ground.

(i) A drainage programme will be implemented in agricultural development planning districts so as to improve drainage.

(ii) Field techniques will be used for drainage at the farm level.

In addition, wells are to be dug in development planning districts in order to monitor the level of the water table and groundwater quality on an ongoing basis. This will require an estimated expenditure of US$52,000. A breakdown of costs appears in Table 7.2.8.1.

Supplementary note

The key to minimizing salt damage is eliminating the cause of salt accumulation in soil, eluviation of salts that have accumulated, and prevention of flooding.
(In addition, the basic principles of conditioning soil are (i) improving drainage, (ii) lowering the water table, (iii) desalinization, (iv) neutralization of soluble salts through the introduction of chemical substances, and (v) improving soil permeability. In conditioning soil it is normally essential to use these techniques in combination, and any measures need to be tailored to actual soil characteristics as well as concentration, distribution, and types of accumulated salts.)

a) Of these measures against salt damage, eluviation of accumulated salts requires large quantities of irrigation water.

b) The drainage and farmland conservation plans urge that the greatest of caution be exercised to prevent flooding, and it is essential that the measures recommended there be properly implemented.

c) The cause of salt accumulation in soil refers to the process whereby salts dissolved in groundwater and soil through the evapotranspiration of soil moisture rise to the topsoil or ground surface through capillary action, resulting in salt accumulation. In semi-arid regions such as the northwest of the area covered by the present development project adequate care will need to be taken to eliminate salt accumulation by providing drainage.

7.2.9 Environmental conservation measures

1) Environmental concerns addressed in defining the geographical scope of the development project

As has already been mentioned in Section 7.1 "The land use plan", the following types of districts have been excluded from the geographical scope of the project due to environmental concerns:

(i) Areas designated as national parks; (ii) environmental conservation zones; (iii) historical sites and other areas designated as cultural-heritage protection zones; (iv) areas subject to constant flooding and rivers and lakes; (v) the Mennonite settlements; and (vi) reserves for indigenous peoples around the Mennonite settlements.

The land use plan envisages 50 m buffer zones (environmental protection zones) around excluded districts and rivers and lakes. Buffer zones of an appropriate size will be established after detailed analysis of local conditions when actual zoning takes place with the implementation of feasibility studies etc. (Designation of buffer-zone forests as protected woodlands would be advisable.)

2) Environmental conservation measures relating to natural site conditions in the project area

(1) Environmental conservation measures under the land use plan based on the Forest Resources Act

It has been decided as the result of consultations with the Paraguayans to apply the provisions of the draft Forest Resources Act, which is currently under deliberation in the legislature, to the present development project.

The present Forests Act prescribes the orderly exploitation of forest resources from the point of view of such concerns as land conservation and nutritional content of water sources, but it has not been strictly implemented. For this reason the law has been amended as the Forest Resources Act, which beefs up regulations and restrictions in an

effort to protect forests, and encourages the establishment of shelterbelts. Discussion is also underway at both the national and regional level on the organization of forest management in Paraguay.

The land use plan under the present development project calls for 25% of the project area minus public lands and rivers and lakes to be preserved as forests and shelterbelts in accordance with Article 49 of the draft Forest Resources Act; at the same time, natural-growth forest in natural-grassland districts will be left as grassland forest (shelter woods etc.).

Note: Forest Resources Act (draft), Article 49

Twenty-five percent of the area of natural forest on land holdings of an area of 20 ha or more in rural districts shall be preserved intact. Should the owner of the land not possess an area of forest equivalent to this minimum percentage, he shall plant an area of forest equal to 25% of the area he possesses in accordance with current regulations."

(2) Forest management and environmental concerns under the project

Article 6 of the draft Forest Resources Act classifies forests into "protected forests" and "productive forests", subdividing "protected forests" into "forests whose exploitation is forbidden" and "forests whose exploitation is restricted". Article 49 defines a category "forests to be preserved", which covers the 25% of forest to be left undeveloped in the project area. A description is given below of how woodlands in the project area that fall in the categories of "protected forests" and "forests to be preserved" under the Forest Resources Act are to be managed.

(a) Forests whose exploitation is forbidden

Exploitation is forbidden of forests in the project area which are:

(i) located within areas designated as national parks;
(ii) located within areas designated as natural or environmental conservation zones;
(iii) located on wetlands of international importance as waterbird habitats;
(iv) any other type of forest the exploitation of which is prohibited by the Paraguayan government.

These types of forest have for the sake of conserving the environment already been excluded from the scope of the development project under Section 7.1 "The land use plan". In the case of forests located on wetlands of international importance as

waterbird habitats, reconfirmation will be needed of the geographical relationship between districts excluded from the project (areas subject to constant flooding etc.) and protected areas designated under the Ramsar Treaty when Paraguay becomes a signatory.

Considering the importance of these non-exploitable forests for the conservation of the environment, it is to be recommended that the state take charge of their management.

(b) Forests whose exploitation is restricted (protected woodlands)
Certain types of forests growing in areas to be developed will for the sake of conserving the environment be excluded from the bounds of those areas and subject to protection when actual zoning takes place with the implementation of feasibility studies etc. (This includes the buffer zones referred to in 1) above.)

The types of forests to be subject to such protection are those that serve the broad interests of society by performing an important environmental role, such as (i) supplying nutrients to the water supply, (ii) preventing soil runoff, (iii) preventing soil erosion, (iv) stopping soil from blowing away, (v) protecting against damage from gales, flooding, drought, or fog, (vi) protecting against fire, (vii) protecting fish species, (viii) contributing to public health, or (ix) acting as the scenic backdrop for a well-known tourist attraction or historical site.

It is also recommended that forests whose exploitation is restricted be officially designated protected woodlands by the government and subject to appropriate conservation measures. It is advised that protected woodlands be managed by local governments (or the state).

(c) Forests to be preserved under Article 49 of the Act
Forests whose exploitation is forbidden" have been excluded from the geographical scope of the development programme under the land use plan; "forests whose exploitation is restricted" are to be excluded at the stage feasibility studies etc. are conducted and subject to protective measures. The following types of forests in the development area fall in the category of "forests to be preserved" as defined under Article 49 of the Forest Resources Act:

(i) shelterbelts or grassland forests essential to individual agricultural communities;
(ii) shelterbelts or grassland forests on individual farms;

(iii) forests serving as a source of firewood for individual agricultural communities;
(iv) forests serving as a source of firewood for individual farms.

Forests falling into category (i) above, including key shelterbelts of especial importance to the community in terms of preserving the environment, are suitable candidates for official designation as protected woodlands.

Local governments or administrative bodies organized within each farm community can take charge of managing forests in categories (i) and (iii), which concern the whole community, while the farmers themselves may be given responsibility for looking after forests in categories (ii) and (iv), as these are located on individual farms.

Moreover, the state may as necessary provide direction and advice on shelterbelt management to the above bodies or individuals.

This, then, is the form that forest management will have to take in order to conserve the environment in cases in which the development project affects protected forests as defined under Article 6 and forests to be preserved as defined under Article 49 of the Forest Resources Act.

Finally, before the project is launched it will be necessary for the Paraguayans to decide who will be in charge of managing which section of forest, as well as put in place legislation.

(3) Environmental concerns addressed under the farm-management plan

a) This aspect of the project centres on livestock farming, as this is best suited to natural site conditions in the project area.

b) The livestock farming plan defines the number of animals to be kept so as to minimize impact on the ecosystem.

c) The crop production plan basically envisions a form of farming combining growing of crops with breeding of livestock. It identifies varieties of crops and types of agriculture suited to conditions in the area subject to development. Measures prescribed includes rotating croplands and pasturage, and preventing wind erosion through the planting of winter crops.

(4) Environmental concerns addressed under the settlement plan

Care has been exercised in drawing up the settlement plan to restrict the number of households to a level that is in balance with land productivity in the development area.

(5) Basic policy on community infrastructure

The living environment of agricultural communities needs as much as possible to strike a balance between man and nature. Hence the infrastructure plan of the present development project envisages a pleasant living environment in which much of the natural-growth forest in the surrounding areas will be preserved.

(6) Soil conservation measures

The following soil conservation measures have been identified under the development programme, and these will need to be kept in mind both in implementing the various plans and managing agricultural production:

(i) As a way to prevent salt damage, the water table should be kept at least 0.8-1 m below the surface of the ground in ordinary croplands, fodder croplands, orchard areas, and improved grasslands, where natural drainage is difficult. The necessary drainage measures are to be implemented under the drainage and farmland conservation plans.

(ii) Shelterbelts are to be planted in and around farms under the farmland conservation plan in order to control wind erosion and evapotranspiration of soil moisture caused by winds.

(iii) As noted in the section on farmland reclamation, the slash-and-burn method is not to be employed in preparing land for farming. Rather, the greatest of care is to be taken to preserve the topsoil; for instance, in order to prevent damage to topsoil during removal of trees and shrubs roots extracted from the ground should be left to dry in the open air for several days and any soil attached to them shaken off before they are disposed off.

Furthermore, once reclamation work is complete the farmland should be made as level as possible by smoothing out any uneven areas so as to minimize evapotranspiration of soil moisture.

(iv) Under the crop production plan an effort is to be made to alleviate evapotranspiration of soil moisture and maintain and enhance the fertility of the land by improving the soil's physical and chemical composition through the application of manure generated

by livestock on the farm. To this end a six-year pattern of rotation is to be adopted on ordinary and fodder cropland on which short-term crops are grown, with fields cultivated in one year being utilized as improved grasslands for the next five years.

(v) One measure against wind erosion included under the crop production plan is the planting of sorghum as a winter crop.

(7) Environmental concerns addressed under other aspects of the project

a) Agricultural road plan

In principle a road network is to be established by repairing and upgrading existing roads, and construction of new roads is to be kept to the bare minimum for environmental reasons.

b) Fodder production plan

(i) Dry grasslands are to be subject to improvement due to their low productivity, but wet grasslands are to be used as they are without modification out of concern for impact on the environment.

(ii) The least possible amount of nitrogenous fertilizer is to be applied to fodder cropland, while livestock manure alone, not chemical fertilizer, is to be used on natural and improved grasslands. In this way it is hoped to reduce impact on the ecosystem.

(iii) Ecologically-sound methods of controlling insects harmful to fodder crops will be devised in place of the use of chemical pesticides, such as releasing insects that eat such pests and artificial breeding of sterile females.

c) Livestock farming plan

Improved and natural grasslands are to be fenced off into small fields in order to prevent overgrazing, with livestock being rotated in accordance with the state of grass growth in different areas.

d) Experimental research and agricultural assistance programmes

(i) The Grasslands and Fodder Crops Division of the Chaco Animal Husbandry Experimental Station is to take up a new field of study: basic research on the ecology of natural grasslands and forests, and related experimental work on environmentally-sound, sustainable forms of grazing.

(ii) Similarly, it is to undertake basic experiments on the ecologically-sound methods of grassland development outlined in the current plan.

(iii) The Agricultural Training Centre is to educate farmers about the importance of conserving the natural environment and equip them with the knowledge and skills they will need to practise "sustainable farming".

(iv) The Agricultural Training Centre's Training Farm will demonstrate environmentally-sound farming methods and techniques.

7.3 AGRICULTURE AND LIVESTOCK FARMING PLAN

7.3.1 Crop cultivation plan

1) Selection of appropriate crops

(1) Farm crops

a) Guideline for selection

The following three categories were considered as candidates for the selection of appropriate crops: (1) crops currently cultivated in Paraguay; (2) crops successfully cultivated there in the past; and (3) crops found to be promising in the study area from data (Tables 7.3.1 to 3).

Each crop was selected with consideration given to the following factors (of those described in Table 7.3.1 to 3); (1) total points; (2) cultivating condition (especially drought resistance, temperature aptitude); and (3) economic condition (especially marketability).

b) Selection of crops

The studies of individual crops are as follows.

(a) Short term field crops

Selected crops - (for export) cotton, peanuts
(for domestic use) sorghum
(for self-consumption) cassava, poroto

(i) Cotton

Cotton is selected as one of the appropriate crops. It usually likes high temperature and abundant sunshine, and is thus fit for the natural environment of the study area. In the study area, it has been successfully cultivated as a main farm crop in the Mennonite settlements, and its cultivation technology has been developed.

(ii) Peanuts

Peanuts are suited to temperate zones and in well-drained soil which has strong drought resistance, and they are fit for the environment of the study area. Also, although peanut oil collected in the study area is now used only for household consumption, it can be used as an oil crop for export. Thus, it is selected as a suitable crop.

(iii) Sorghum

Sorghum is a fodder crop cultivated most commonly in the study area. Having drought resistance, temperature aptitude, etc., it is suited for the the study area and its dry matter yield is high. There are soiling and seed varieties and both are used for silage, hay, and livestock farming. Its cultivation has been successful so far, and so it is considered to be a main fodder crop in dairy and beef cattle farming.

In addition to sorghum, such millets as Cameroon grass, Sudan grass, and Johnson grass are considered promising as fodder crops.

(iv) Wheat

Wheat is not selected in the plan. It is not suited for the study area given the natural conditions, though it is a representative winter crop in Paraguay that is fond of cool temperatures and is commonly cultivated in the eastern region. Its profitability and marketability are not so good and little value can be added, either.

(v) Oats

Oats are not selected in the plan. Oats have less drought resistance than other wheat varieties and are cultivated only in part of the study area for green manure in winter. Also, sorghum is considered to be a main winter crop for silage. Oat yield is smaller than that of sorghum.

(vi) Cassava, poroto

Both of these are used for household crops in the settlements in the plan. They are currently cultivated mainly for home consumption and have little marketability, though they are generally suited to the study area.

(b) Short term oil crops

Selected crops are sunflower, sesame, safflower, and castor beans.

(i) Sunflowers

Sunflowers are selected because of an expected increase in their export as an oil crop. They are suited to the environment of the study areas, given their fondness for high temperatures and dry weather, and they have been successfully cultivated in the Mennonite settlements.

(ii) Sesame

Sesame is selected because of its marketability. It is suited to the study area given its drought resistance and fondness for high temperature. It is currently cultivated in parts of the region.

(iii) Safflower

Safflower is selected because it is considered to be advantageous as an oil crop with its high linoleic content from the viewpoint of marketability. It is suited to the study area given its drought resistance and temperature aptitude. It is currently cultivated in some parts.

(iv) Castor beans

Castor beans have been selected in the plan for the following reasons. They are suited to the study area given their strong drought resistance, they are an important crop next to cotton, peanuts, and sorghum in the Mennonite settlements, and they have been successfully cultivated as as an oil crop. Also, besides their added value as an oil crop, they are sometimes cultivated in fields for wind erosion prevention.

(v) Rape seed

Rape seed is not selected for the following reasons. It has little suitability for the study area given its weak drought resistance, smaller temperature aptitude, etc. From the viewpoint of marketability, it may not be so advantageous unless it can be produced at low cost because of competition with other countries.

(c) Short term craft crops

Besides the above-mentioned field crops, the following are said to be promising as materials in the study area. Rosella (export fiber crop and fruit jam), kenaf (fiber crop), cumin (spice crop), basil (spice crop), oregano (spice crop) and marigold (foodstuff dyes). Some have been cultivated in Paraguay in the past. Of these, marigold is promising given its high total points and marketability. But it is left out of consideration for the plan because its cultivation system cannot be certified as of now. Rosella (as a fiber crop) and oregano are not selected because of their low profitability and marketability, though their total points are high.

(d) Vegetables

From the viewpoint of total points and cultivation aptitude, the following seven varieties are selected: watermelons, melons, tomatoes, cabbages, garlic, asparagus,

and cucumbers. In selecting these, it was borne in mind that their domestic production cannot keep up with the increase in demand and that the effort to increase their self-sufficiency rates is desirable.

For their production, a diversification of varieties and the prevention of seasonal overproduction through the utilization of regional differences and the improvement of cultivation techniques need to be taken into consideration. For the diversification of varieties, however, the domestic seed production of vegetables needs to be considered, as well, based on experimental research in the vegetable sector.

(e) Fruit trees

In total eight fruit trees have been selected. They are citrus fruits (sweet orange, mandarins, and grapefruit), macadamia nuts, bananas, papaya, pineapples, and mangoes. For the production of these, as in the vegetable sector, the diversification of varieties and the prevention of seasonal overproduction by the utilization of regional differences and the improvement of cultivation techniques need to be considered.

From the standpoint of marketability, however, they are disadvantageous in terms of material supply and access to markets because of competition from Brazil, though domestic demand for citrus fruit juice is expected to increase. Further, for the introduction of macadamia nuts, their cultivation technology etc. needs to be taken fully into account, since their cropping has only been done in a limited area in the country.

(f) Perennial craft crops

The selected crop is jojoba.

(i) Sugarcane

Sugarcane is suited to the study area because of its strong drought resistance and fondness for high temperature. Currently it is cultivated over a large area to supply materials for the sugar refinery in Benjamin Aceval. But it is not selected in the plan for the following reasons. It is not so useful as a material for sugar manufacturing from the viewpoint of marketability. It is not so promising for use as an alcohol material in terms of profitability, since its transportation to the factory located in the eastern region is costly. Further, it is disadvantageous in terms of marketability via MERCOSUR, and there is a problem of disease.

(ii) Jojoba

Jojoba is selected as one of the appropriate crops for the following reasons. It is a perennial shrub suited to zones with high temperatures and a dry climate, and the respective natural environments of its place of origin and the study area are similar. In terms of marketability, it seems to be very promising because about 50% of the wax in the seed has wide industrial use, for example, as a lubricant. It is also possible to be used as livestock fodder, since the seed contains protein (about 30%). As for jojoba, however, the cultivation technology, etc. for its introduction must be taken into sufficient consideration, because it has not been cultivated very much before in these areas, as in the case of macadamia nuts.

(iii) Other perennial craft crops

Other perennial craft crops (stevia, ramio, guayule Hevea brasilienis, peppermint, annatto tree and coffee) will be considered in accordance with the progress of experimental research on cultivation, processing conditions, etc.; thus they will not be introduced at this time. As for mulberry, it cannot be included in the plan now because there are problems of processing and other facilities in the country, though its total points are high.

Aleurites cordata and mate (though excluded from Table 7.3.1.3) are both traditional crops cultivated since olden times in the eastern region of Paraguay, as well as being perennial crops suited ecologically to the eastern region but not targetted for the study. Since their markets are limited, they should be given special treatment as traditional crops in the east for the time being, so as to prevent their competition. Thus they are out of consideration for selection. Aleurites cordata is usually cultivated in covered soil and highly useful as an eastern crop capable of preventing soil losses, if its marketability is satisfied. Further, as for mate, its capability of soil loss prevention is higher than those of other ordinary crops, though not as high as Aleurites cordata (it is also highly suited to the eastern region where the optimum amount of rainfall can be assured to restore tree vigor because stem leaves are targetted).

Though not included in the crops to be studied as of now, abundant growth of karanday mulberry (Copernicia alba) exists in the study area. It is reported that C.alba is a plant that secretes a thin layer of wax materials to its leaves to prevent water evaporation, a characteristic of the plants in dry regions, and its wax is close to that of carnauba (Copernicia cerifera) in Brazil in quality. Research on the use of this plant's resources may be significant.

2) Cultivation plan

(1) Basic scheme

For the cultivation plan, cultivation and cropping systems were considered. That is, a cultivation standard was clarified for each of the above-mentioned crops selected for cultivation in the agricultural development scheme areas, their cultivation systems were decided and their cropping systems dependent upon farming types were also decided. The basic scheme of the plan is as follows.

a) Meeting the development objectives

How to meet the development objective is taken into account in the cultivation plan. There are five objectives in the integrated development plan. They are (1) self-sufficiency in the national food supply, (2) an increase in exports of agricultural products, (3) creation and expansion of employment opportunities, (4) support for small farmers and landless farmers, and (5) securing stable standard of living for the farming population.

As for the self-sufficiency of the national food supply, it still seems that imports are more advantageous, because the rate of seasonal dependence on imports is big, especially for fruit and vegetables, while the qualities of domestic products are not necessarily good.

These problems would be dealt with by the utilization of cultivation methods and post-harvesting technology. Efforts should be made to increase exports and to stabilize farming management by selecting and effectively cultivating cotton, the main export produce of Paraguay, peanuts, the main produce of the study area, and oil crops that have been successfully cultivated in the past.

The cultivation of some of the crops will need employed workers, which in turn will lead to the creation and expansion of employment opportunities.

Small and landless farmers are usually considered to be poor in both funds and technology. Therefore, the kind of crops that can be cultivated even in such conditions is included in the plan.

b) Soil fertility maintenance measures

In the Mennonite settlements (the only place in the study area where agricultural development projects have been put into practice), cultivation has long been carried out without using fertilizers. As a result, the soil has increasingly been losing its

fertility, forming one of the causes of unstable yield. Also, since strong winds blow, particularly in winter, cultivated lands (in the case of bare land) are at the risk of erosion. Therefore, as for the fields to be developed by the integrated development plan, priority is given to the maintenance and improvement of the soil. Along these lines, measures to protect farmland, the creation of windbreaks, the planting of winter crops to prevent wind erosion, the introduction of green manure crops, the practice of effective crop rotation, and others should be considered.

c) Rotation of fields and grasslands

In fields where short-term field crops are cultivated,rotation with improved grasslands should be carried out with a view to attaining continuous agriculture. Efforts should also be made to improve soil fertility by physically and chemically improving the soil, developing a deep and wide root system for pastures, using its rhizosphere life forms and applying organic materials made of livestock waste.

d) Diversification of crops and systemization of combined crops

The diversification of crops is an essential part of the development strategy, so as to increase exports in the integrated development plan.

For the systemization of cultivation by combining crops, it goes without saying that crops such as cotton, peanuts and so on, successfully cultivated at present and in the past, are used while new crops applicable to the study area which have cultivation systems should also be introduced.

Each crop is selected as described in other sections, considering such factors as the natural condition of the study area, the current situation of cultivation, marketability, and so on. For the agricultural development scheme zones (four zones), a cropping system is set up by combining crops considering a difference in site conditions and examining the specific cultivation types of seeding, fertilizer application, harvesting, etc.

(2) Cultivation standard and system for each crop

a) Short-term field crops

(a) Cotton

As for varieties to be used, Reba P 288 (Linea 100), a main variety in the study area, and Reba P 279, the existing main variety, are selected in accordance with market trends. The breaking, ploughing, and preparing of the soil are carried out about a month before seeding and weed killers are applied before germination.

The seeding is operated at 25kg/ha by a machine (seeding machine) from September to October. During cultivation, weeding operations are carried out six times (four times with machine work by cultivator and twice with manual work) and insecticides are applied six times (by sprayer). According to the result of experimental research in the Mennonite settlements, it is not necessary to apply fertilizers and the soil should be improved by secondarily cropping sorghum and rotating with grassland. Before harvesting, chemicals are used to get leaves to fall, and the harvesting is operated by cotton combine from February to March. Basic yields should be set at 1,800g/ha, because the improvement of productivity can beexpected from further experimental research.

The above is the case when cultivation is mechanically operated. In the case of a small-scale cultivation, however, the harvesting of all the work is manual. Also, when the area size of cultivation is less than 1ha, seeding and insecticide application are done manually.

In addition, cotton whose fibres are stained with color (yellow, brown, etc.) is a problem to be tackled from the viewpoint of marketability, etc., and thus it is necessary to keep a watch over the results of future experimental research and market trends.

(b) Peanuts

The varieties to be used are Español, Virginia, Star, etc., and each is decided in accordance with market trends. The cultivation system includes the pre-germination application of weed killers after the breaking, ploughing, and preparation of the land and before seeding. The seeding is carried out at 60kg/ha mechanically (by seeding machine) from September to October. During cultivation, weeding operations are done six times (four times with mechanical work by cultivator and twice with manual work) and the spraying of insecticides and fungicides (by sprayer) are operated three and four times respectively. A peanut combine is used before harvesting and the harvesting is carried out from February to March. Basic yields are 1,800/ha, because productivity can be expected to be improved by further experimental research.

(c) Sorghum

Sorghum is cultivated to prevent wind erosion in winter as a secondary crop to cotton or peanuts. The varieties are selected from Fredy (for silage and pasture), Sileca 1844 (for silage), etc. according to their purpose. After harvesting cotton

and peanuts, the tilling and preparing of the land is carried out from March to April and seeding is operated at 10kg/ha from April to May. Sorghum is cultivated as livestock fodder and green manure,and so management operation including the application of fertilizers, etc., is not necessary. Ploughing is done after a necessary amount for fodder has been harvested in July. Immediately after this, land preparation is carried out for the cultivation of cotton and peanuts.

Sorghum is cultivated to provide green manure of many varieties. Its effects are generally summed up as follows. (1) Maintenance and improvement of the aggregated structure of the soil; (2) increase in the water holding capacity of the soil; (3) promotion of the propagation of useful microbes by soil organic matter; (4) increase in the fertilizing effect of chemical fertilizers by soil organic matter; (5) an increase in the effect of phosphoric acid by combining intermediate decomposed materials (humic acid, organic acid, saccharide, etc.) with iron, aluminum, etc.; (6) improvement of subsoil and increase in cultivating depth by deep-rooting green manure crop; and (7) though it is known that Leguminosae green manure crop is effective in the fertilization of soil by nitrogen fixation, sorghum is appropriate in the case of a combination between agriculture and livestock farming, since it is used as fodder for livestock.

(d) Cassava

Cassava is cultivated by farmers in the settlements for home use. There are many varieties and a selection is made of them in accordance with needs. The cutting of seedlings is done at the rate of 20,000 pieces/ha in August and fertilizers are not given. Disease control is carried out when needed, keeping watch over the level of generation of disease and insect damage. Weeding operation is carried out manually as the need arises, also keeping watch over the growth of weeds. Harvesting is done at 16t/ha from April to June the following year.

(e) Poroto

Poroto is cultivated by the farmers in the settlements for home use, as in the case of cassava. The varieties to be used are selected frm the existing ones based on their purpose. Seeding is done at the rate of 10kg/ha in January and disease control and weeding work are operated when necessary. Harvesting is carried out at 1,200kg/ha from April to May.

b) Short-term oil crops

(a) Sunflowers

Appropriate varieties are selected from those developed in the U.S, etc. Seeding is operated at the rate of 10kg/ha by machine, and fertilizers are given to the area at 100kg/ha. Management work includes weeding (twice and by machine), insecticide spraying (twice), and manual thinning (once). Harvesting is done from January to February and yields are expected to be around 1,800g/ha. Further, since the sunflower is a capitulum and has a high plant height, collapse is said to be the biggest problem for cultivation. In the study area, however, it is not cultivated in winter when strong winds blow. It is a fast growing crop and absorbs much nutrition, thus the reduction of stems and leaves should be considered besides the usual application of fertilizers.

(b) Sesame

The variety to be selected should be the white sesame, because it is used for the extraction of oil. It is also necessary to select one whose capsule is non-dehiscent, because harvesting is operated by machine. Seeding is done at the rate of 3kg/ha in October. Management work includes manual weeding (twice) and insecticide spraying (twice) without the application of fertilizers. Harvesting is carried out from January to February and yields are expected at around 600kg/ha.

(c) Safflower

The variety to be used should be Alcaidia which is said to be suitable for oil extraction in various parts of the world. Seeding is done at the amount of 14kg/ha from April to May. Although fungicide spraying (twice) and weeding (by machine and manually once each) during cultivation, the use of insecticide depends on the appearance of insects. Harvesting is mechanically operated from September to October (600kg/ha).

A safflower is an important crop in terms of the effective use of agricultural land and the maintenance of soil under the condition that not many winter crops exist, since it is cultivated in winter, unlike other oil crops.

(d) Castor beans

The variety to be selected should be Lynn, which has been successfully cultivated in the study area and can be cultivated as an annual crop. Seeding is carried out at the rate of 10kg/ha by machine from December to January. Management work includes weeding (once by machine and once manually), but the application of

fertilizers and disease control are not operated. Harvesting is done manually at the rate of 800kg/ha from May to June.

As described in the study results, castor beans are essentially a perennial crop, and in the study area a dwarf variety is cultivated as an annual crop, considering its convenience of harvesting. This method is followed in this case, as well.

c) Vegetables

(a) Watermelons

Varieties are divided into those whose fruit form is round (Crimson, Sweet, etc.) and those whose fruit form is long and narrow (Charleston, Gray, Congo, etc.). The varieties to be used are selected from these in accordance with market preferences. Seeding is carried out at the rate of 1kg/ha in August, directly spraying seeds in the field given chemical fertilizers at the amount of 50kg/ha. Management work includes weeding/ridging (done manually, twice) and the spraying of insecticides and fungicides (once respectively by mist sprayer). Harvesting is operated at the rate of 15t/ha from November to January.

(c) Tomatoes

Varieties to be adopted are Santa Cruz, Principe Gigante, and others whose growing periods are in the summertime. In this case, as in the above-mentioned case of vegetables, the seedlings are produced by farmers themselves and are regularly planted by 2.7m 0.9m in fertilized fields. Management work includes manual weeding together with ridging (twice) and the spraying of insecticides (three times) and fungicides (twice) by mist sprayer. It is also necessary to erect struts and pick buds. Harvesting is done at the rate of 80t/ha from February to April.

(d) Cucumbers

Varieties are to be selected from suitable existing specimens. The growing of seedlings is done by farmers themselves in June and they are regularly planted at 1.8m x 0.4m in fields with compound fertilizers applied at the rate of 100kg/ha. Management work includes weeding (once) and spraying of insecticides and fungicides by mist sprayer (once each). Harvesting is done at the amount of 3t/ha from October to December.

(e) Cabbages

Varieties are selected from Master, Naniwa, Chumbio AG-70, etc. The rearing of

seedlings is carried out by farmers themselves in November and they are planted regularly by 70cm x 35cm in the field given fertilizers 400kg/ha in January (about 40,000 stumps/ha). Management work includes manual weeding (twice) and the spraying of insecticides (once by mist sprayer). Harvesting is done at 4t/ha from April to May.

(f) Garlic

Varieties are selected from Quinteria, Cazador, Shanghai, and others. Producing farmers plant bulbs they buy from a seed supply centre in fields given fertilizers at the rate of 10kg/ha around May. Management work includes weeding (once) and harvesting is done at the amount of 1,900kg/ha in November.

(g) Asparagus

Asparagus is a perennial crop unlike other vegetables, and once it is cultivated, it can be harvested for 15 to 20 years. Varieties are selected from the existing ones, such as Mary Washington, considering their suitability to the areas, and are cultivated as green asparagus. In the first year, the rearing of seedlings is done by each farmer from February to March, they are regularly planted at 1.2m x 0.4m from April to May (about 2,000 stumps/ha) and then, weeding is operated three times, the addition of fertilizers twice and the spraying of fungicides once. The first harvesting is done from October to December the following year, and in the first few years overharvesting should be avoided. Yields should be maintained around 4t/ha after production is stabilized.

d) Fruit trees

(a) Sweet oranges

Varieties are selected from existing ones, such as Valencia, considering their suitability to the areas. The farmers buy grafts from a seed supply centre and plant them at 7m x 7m in the prepared field from July to August (200 pieces/ha). In this case, the basic amount of fertilizers should be 200kg/ha. After that, weeding is done twice, the spraying of fungicides once and tree forming is operated from March to April the following year. Up to the fourth year after planting, management work is carried out and the first fructification usually appears in the fifth year. After the fructification, the addition of fertilizers, weeding and the spraying of fungicides are operated once, twice and twice respectively every year, in addition to tree forming and pruning works from March to April and harvesting from July to September. Yields amount to about 10t/ha and an economic tree age should be around 30.

(b) Bananas

Varieties are selected from Nanica, Congo, Montecristo, etc. Absorbing buds are planted regularly by 4m x 4m (625 pieces/ha) from September to February. After that, weeding (twice) and supplementary planting are carried out when needed, harvesting is started from January the following year and up to about 30t/ha is harvested by July. From August to December, management work includes the spraying of fungicides (once) and the cutting of side buds (once). These should be repeated every year until the fifth year, which is an economic year.

(c) Pineapples

Pineapple plants become dry and die after fruits are harvested, unlike other ordinary fruit trees. Varieties to be used are to be selected from Cayena Lisa, Perola, etc. Absorbing buds are planted regularly at 0.36m x 1m (27,000 pieces/ ha) in fields given fertilizers at the rate of 200kg/ha from August to September. For one year after that, weeding (a total of three times: once by machine and twice manually), the addition of fertilizers (once) and the spraying of fungicides (once) are carried out as management work. Harvesting is done from December to February amounts to about 20t/ha.

(d) Mangoes

Varieties are to be selected from Comun, Haden, Sensation, etc. The farmers buy grafts from a seed supply centre and plant them regularly at 10m x 10m (100 pieces/ha) in fields given fertilizers at the rate of 300kg/ha from January to May. Management work includes the application of fertilizers (twice), weeding (twice) and the spraying of insecticides (twice), and the first fructification appears in about the fourth year after planting. Harvesting is carried out from October to May the following year and yields are expected to amount to 15t/ha. The management work is as described above and an economic tree age is about 20 years.

(e) Papaya

Varieties are to be selected from Solo, Sunrise solo, Taifon, etc. The farmers breed seedlings themselves and plant them regularly at 3m x 3m (1,100pieces) from February to May. Management work includes the application of fertilizers (twice), weeding (twice) and the spraying of insecticides (twice). Yields are expected to be around 10t/ha for some years starting from the second year. An economic plant age is 5 years.

(f) Macadamia nuts

Varieties are selected out of hybrids (344, 508, 660, B-8, B-11, etc.) among Integrifolia species themselves or between Integrifolia species and Tetraphylla species. The farmers buy grafts from a seed supply centre and plant them regularly at 8m x 8m (150 pieces/ha) from October to December. Fertilizers are given twice, weeding is carried out three times and fungicides are sprayed twice as part of management work until June of the following year. Thereafter tree forming is operated from July to August. After the first fructification which usually comes in the fifth year, the management work includes harvesting done from January to May, tree forming and pruning operations from June to August, the application of fertilizers (three times), weeding (three times) and the spraying of insecticides (three times), all carried out in the periods other than the above. Macadamia nut plants are hard to graft because of their poor survival rate, and therefore the grafts bought by the farmers are considered to be expensive.

e) Perennial craft crops

Jojoba is selected as a perennial craft crop. Since the optimum amount of rainfall for cultivation is considered to be from 300 to 1,000mm, it should be cultivated in the eastern and southern parts of the Mennonite settlements, judging from the level of rainfall in the agricultural development plan areas. Jojoba has been cultivated in Nueva Asuncion province. But much is unknown about its cultivation in the study area and therefore it is technically and financially difficult for farmers to select fine varieties, to spray seeds and to breed seedlings. Also, it takes about three years to identify sexes, because stumps are different between males and females. Thus, as in the case of macadamia nuts, the rearing of seedlings should be done at a seed supply centre while the farmers buy them and plant them. As for the actual planting, it is necessary to mix male stumps with female ones at a certain rate. Further, since it is globally a new crop, the improvement of cultivation techniques is needed in accordance with progress in future experimental research on cultivation, varieties, etc.

(3) Cropping system for each farming type (fig.7.3.1.7)

Although each farming type in the agricultural development areas is described in 7.3.2 Farming plan 1, the cropping systems by type are as follows. These were selected considering the present level of cultivation techniques. Thus, it is desirable that the improvement of cultivation methods and cropping systems will be carried out in future when fertilizer-applied cultivation is found to be effective in the Mennonite settlements and the surrounding areas, for example, and in accordance with the progress of future

experimental research. The types of animal husbandry development plan areas are described in other sections. Figures below each crop indicate the area size of cultivation and land utilization.

a) Northern part of Pozo Colorado, eastern and southern parts of the Mennonite settlements

(a) Groups provided with technology for producing agricultural products for export

(i) Peanuts + cotton + sorghum + dairy farming

In this type peanuts and cotton are selected as short-term field crops. These two crops have been successfully cultivated in the three areas in the vicinity of the Mennonite settlements for a long time and they have been identified as being suited to the natural environment there. But the result of cultivation tests in the settlements shows that cultivation with no fertilizers is better at present, thus no fertilizer should be applied to the short-term crops.

Peanuts and cotton are cultivated at the rate of 45ha each. Also, an effort should be made to realize the effective utilization of agricultural lands, the preservation of soil in winter, and the improvement of soil fertility as green manure by cultivating sorghum in the same field in winter. Sorghum is basically used as fodder for dairy cows. But all the amounts harvested in 90ha are not necessary from the viewpoint of the needed feeding heads. Therefore, the heads gained in 36ha are used as fodder and the remaining 54ha is ploughed.

As for cropping systems, the works for peanuts and cotton are carried out about the same time. That is, the ploughing and preparation of land are done from August to September and theharvesting from February to March for both. The work for sorghum is started from April immediately after these are harvested and the field is ploughed after the area used for fodder amounting to 10ha is harvested in July without carrying out any management work. Soon after this, the cultivation of peanuts and cotton are started. For these, the fields are changed every year so as to prevent damage caused by nematodo and continuous cropping.

(ii) Short-term oil crops (sunflower, sesame, safflower and castor beans) + dairy farming

Short-term oil crops are selected from sunflowers, sesame, castor beans and safflower and cultivated. These crops are important from the standpoint of the

diversification of crops, though the history of cultivating these is generally shorter than cotton and peanuts in the study area.

The cropping system for this type is the same as in the case of (i) except when short-term oil crops are cultivated as summer crops. For sunflower and sesame, the land is ploughed and prepared in September, seeds are sprayed in October, and harvesting are carried out from January to February. In the case of castor beans, the period of the cultivation is later than that for these two crops, starting from November and lasting until June. Therefore, it can be thought that the cropping of sorghum as a winter crop would be delayed. In actuality, however, a lag in cultivation time is not such a big problem, because the whole period of castor bean cultivation can be advanced depending on the condition of rainfall, and sorghum is usually cultivated as green manure crop. In the case of safflower, it is cultivated in winter, unlike the above three crops, land ploughing and preparation are done in March, and harvesting is carried out from September to October. For this, green manure crops are cultivated in summertime when needed. Further, no specific crops are cultivated in summer every year for this type either. It is rather desirable that the fields are changed every year, for example, by cultivating different crops at 45ha each.

(iii) Perennial craft crop (jojoba) + dairy farming

The only agricultural crop to be used is jojoba, which is a perennial crop with a cropping system the same as its cultivation system.

(iv) Dairy farming

This type is described in the livestock farming plan.

(b) Group provided with technology to satisfy the demand of the domestic market

Farmers have had techniques to enable independent farming from the outset, and thus the type of cotton, fruit trees, dairy farming, and small-medium scale livestock farming is selected to increase the composite effect. By manually picking cotton at the time of harvesting, machine expenses can be reduced and quality can be improved. As for fruit trees, citrus fruits or macadamia nut plants should be used. Further, for small and medium scale livestock farming,sheep or goats which are widely raised in the study area are selected.

For this system, sorghum is cultivated as a secondary crop to cotton and the land is alternately used as fields and as grassland. As for fruit trees, as mentioned

above, citrus fruits (sweet oranges, grapefruit, and mandarins) and macadamia nuts are selected. Citrus fruits have been successfully cultivated in these areas and thus various kinds of problems can be tackled. Also they have the advantage that there are not many fluctuations in crop prospects even though the amount of rainfall may change, because they are perennial. In the case of macadamia nuts, however, they have never been cultivated in the study area, though much attention has been paid to them in Paraguay recently. Therefore, the technical aspect of their cultivation and other factors should be studied, including the selection of varieties.

(i) Cotton + sorghum + fruit tree + dairy farming + small and medium-scale livestock farming (sheep)

Sorghum is cultivated as a crop secondary to cotton, as in the above type. In this type, however, all the sorghum is utilized as livestock fodder. Fruit trees are selected from citrus fruits (sweet oranges, grapefruit, and mandarins) or macadamia nuts. In cases when the cultivation of citrus fruits is started in the first year, its planting carried out from July to August comes at about the same time as the harvesting of sorghum and the ploughing and preparation of land for cotton. In the case of citrus trees after their fructification in the fifth year, harvesting is carried out in about the same season as those for cotton and sorghum.

As for macadamia nuts, the preparation of land and the ploughing and preparation of land for cotton are done in about the same season, because planting work in the first year is carried out about three months later than that for citrus trees. The harvesting of macadamia nuts is done from January to April, thus during this period cotton should be harvested.

(ii) Cotton + sorghum + fruit tree + dairy farming + small and medium-scale livestock farming (goats)

The only difference between this type and (i) is that goats are used for livestock farming. All the other aspects of its cropping system are the same as (i).

(c) Group without the technology to satisfy the demand of the domestic market

Initially the work of this group will be carried out just as a side job, but it will be changed to full time in the future. The crops to be used are exactly the same as (b), including cotton, fruit trees (citrus fruits or macadamia nuts), dairy farming, and small-medium scale livestock farming (sheep or goats). Although it is imagined

that the farmers lack the technology and funds necessary to realize independence farming and do not possess techniques to meet the demand of domestic market, cotton is a traditional crop in Paraguay and thus management can somehow be possible if it is on a small scale. For this type, it is possible to realize the same scale as (b) in the tenth year. This can be done, for example, in the following manner. Initially sorghum is cultivated, because its cultivation system is relatively easy. Then, while raising this crop, efforts should be made to disseminate technology through training, etc., to stably provide wages to the workers, to gradually plant fruit trees and finally to include animal husbandry. In this case, sorghum is cultivated as a second crop to cotton, as well, and the land is alternately utilized as fields and grassland.

(d) Groups of indigenous people

(i) Cotton + small-medium scale livestock farming + apiculture

This type only needs a small area. Even at the time of cotton harvesting which usually needs the largest number of workers, it can be done by each farming household if it is small in scale. This in turn creates surplus workers and they will be able to work for the other farms to gain income. Cotton is the only agricultural crop to be selected and its cropping system is the same as its cultivation system. The ploughing and preparation of land are done by machine while the other works are done manually.

b) Zone in the suburbs of Asuncion

(a) Group provided with technology to meet the demand of the domestic market

In this case, there are two types (fruit trees + vegetables and fruit trees + dairy farming), because the combination of vegetables and dairy farming is impossible in small-size farms. From the viewpoint of the current cultivation situations, the former including vegetables which needs the supply of water should be carried out in irrigated areas and the latter should be carried out in non-irrigated areas, though an irrigation system is expected to be introduced to this area.

(i) Fruit trees + dairy farming

The fruit trees to be cultivated should be selected from tropical varieties (bananas, pineapples, mangoes, and papaya). Their cropping systems depend on the selected fruit trees. Land preparation and planting for bananas and pineapples are carried out after June and for mangoes and papaya after November. In the case of these tropical fruits, the periods for harvesting are generally long.

(ii) Fruit trees + vegetables

As in the case of (1), the fruit trees to be cultivated are selected from four tropical varieties. The vegetables are selected from watermelons, melons, tomatoes, cucumbers, garlic and asparagus. Of these vegetables, asparagus is a perennial crop and thus the other vegetables should not be cultivated in the fields for this. The seedling breeding for many of these vegetables should be carried out by the farmers themselves. Although various combinations are possible, if bananas, watermelons, and cabbages are selected, for example, the land preparations for bananas and watermelons are done in the same period in the year when bananas are planted.

(b) Indigenous group

Citrus fruits are selected for the cultivation of fruit trees.

(i) Fruit trees

c) Appropriate areas for livestock farming

In the livestock farming development plan areas, the type of full-time beef cattle farming for large-scale farmers (5,000ha and 2,000ha) and small-medium scale livestock farming including apiculture (10ha) should be added to the above-mentioned types. Its details are described in the livestock farming plan.

(4) Rotation of fields and alternating system between fields and grasslands

As mentioned above, efforts should be made to increase land fertility and improve soil preservation by rotating crops with types incorporating short-term crops. Further, by using the land for fields and grasslands in alternation, improving the physical properties of the soil and using livestock manure to improve soil fertility, as described in the basic plan, cropping should be stabilized and agriculture should be continuously developed.

In the case of the type of short-term crop (90ha in the field) + dairy farming (45ha in the grassland, etc.), the improved grassland of the total grassland, etc. amounts to 36ha and one sixth of this should be renewed every six years. Therefore, in 6ha to be renewed of improved grassland, short-term crops are planted the following year and the field 6ha for short-term crops should be used as improved grassland in the following year. In this manner, the sites should be moved around for improved grasslands. The same can be said of the case of short-term crops (field 9ha) + dairy farming and small-medium size livestock farming (grassland, etc., 27ha). The improved grassland amounts to 9ha of the grassland, etc. and one sixth of them (1.5ha) is renewed every six years. Thus, the sites are rotated for improved grassland and fields by 1.5ha, as well.

Fig. 7.3.1.7 Cropping system for each farming type

Type	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.
Cotton + Peanut + Sorghum + Dairy farming	Ploughing,Preparation Spraying seed Management work Harvesting (Cotton)												Plough,Preparation Spreyingseed (Cotton)				
	Ploughing,Preparation Spraying seed Management work Harvesting (Peanut)												Plough,Preparation Spreyingseed (Peanuts)				
								Plough,Preparation Management work (Green sorghum)									
									Spreyingseed Harvesting,Ploughing								
Short-time oil crop Sorghum + Dairy farming	Plough,Preparation Spraying Management work Harvesting EXP.(Sunflowers)												Plough,Preparation Spreyingseed (Sunflowers)				
								Plough,Preparation Management work ES (Green sorghum)									
									Spreyingseed Harvesting,Ploughing								
Cotton + Sorghum + Fruit tree + Dairy + Small-medium size livestok	Ploughing,Preparation Spraying seed Management work Harvesting (Cotton)												Plough,Preparation Spreyingseed (Cotton)				
									Plough,Preparation Management work (Green sorghum)								
	(Sweetorenges)												Spreyingseed Harvesting,Ploughing				
	Harvesting Management work													Harvesting Management work			
Fruittrees + Vegitable													Plough,Preparation Spreyingseed Management work (Watermelon)				
								Plough,Preparation Management EXP.(Cabbages)									Harvesting
	EXP.(Bnana)								Spraying seed		Harvesting						
	Harvesting Management work								Harvesting					Management work			

Note: for types which have only one farming crop (dairy + perennial craft crop, cotton + small-medium size livestock farming + apiculture, fruit trees + dairy farming, fruit trees + small-medium livestock farming) and those which have only livestock farming (dairy farming, full time beef cattle farming, small-medium size livestock farming + apiculture), please refer to their respective cultivation systems and livestock farming plans.

7.3.2 Fodder crop production plan

1) Basic direction of plan

Fodder crops are cultivated as fodder for dairy cattle mainly in the Mennonite settlements and their environs in the study area (Table 7.3.2.2). Due to the harsh natural conditions (soil, climate, etc.), the kinds of crops are limited and not many leguminosae plants (alfalfa, clover, etc.) are cultivated there except in experimentation stations. Sorghum (Sorghum bicolor) is the most important of the fodder crops cultivated in these areas. The fodder crop production plan is made in accordance with the following basic directions.

(i) The cultivation of fodder crops should be planned in the agricultural development plan areas to provide cattle with green and stored fodder in dairy farming and also, in the livestock farming development plan areas, to supply supplementary fodder to cattle in beef cattle farming.

(ii) The ploughing of land and moving the surface of land should be done carefully, and efforts should be made to reduce the effect of wind erosion in the agricultural development plan areas, because the soil tends to be damaged by wind erosion there. Currently, an unploughed cultivation system for field crops is being tested in some experimentation research institutes and thus there is a possibility of its introduction in the future. As in the case of ordinary fields, the rotational system between fields and grasslands should be planned in the fodder fields so as to maintain soil fertility.

(iii) Sorghum should be selected as a crop to be cultivated considering the natural conditions, cropping seasons, cultivation costs, productivity, etc., and its cultivation should be planned based on the division between a summer crop and a secondary crop in the ordinary fields. For sorghum, there are two cultivation types: green cultivation for silage and seed production for providing materials to be mixed in the fodder. Since sorghum for harvesting seeds is considered in the cultivation field, the cultivation for providing green and mixed fodder is considered here in this plan.

(iv) Besides green for dairy cattle, the use of hay and silage can be considered as a method to provide sorghum as stored fodder in winter when the productivity of the grassland declines. Considering the expenses for machines and equipment needed for fodder adjusting and storage, however, its utilization as silage is advantageous, and so this should be planned.

2) Cultivation plan for sorghum

(1) Establishment and management of sorghum fields

The establishment of fodder fields in the agricultural development areas should be carried out in the same way as for normal fields. When a field is newly established, shrubs are felled by bulldozers and chains in the season of little rain, such basic work as the removal of roots, illuviation, burning, ploughing, and so on should be finished during the dry season and the seeds should be sprayed in the rainy season. The basic working system for summer crops from establishment to harvesting is described in figs.7.3.2.1 to 7.3.2.2.

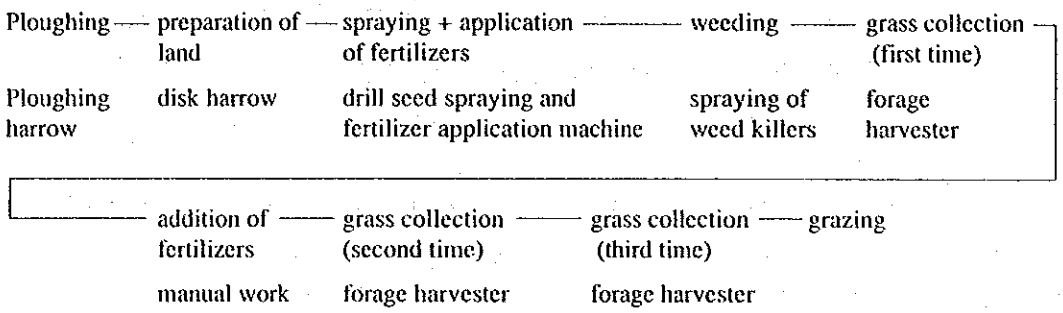


Fig. 7.3.2.1 Summer crop sorghum cultivation and management work system

In the case of secondary cropping, the cultivation and management system is as follows.

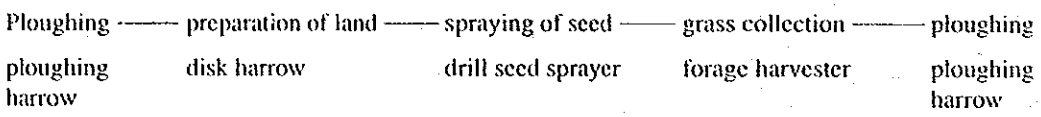


Fig.7.3.2.2 Secondary crop sorghum cultivation and management work

(2) Area size of establishment by region and amount of fodder utilization

The cultivation of green sorghum should be planned on the basis of a division between summer and secondary crops. The nutrient content of sorghum to be used is described in Table 7.3.2.2 and the production and utilization levels of sorghum by area and farming type are shown in Table 7.3.2.3 and 7.3.2.4

(i) Targetted yields

The targetted yields for summer sorghum are set at 60t/ha (first time:40t/ha, second time:20t/ha, and third time:10t/ha). That for secondary crops is set at 10t/ha each time. The utilization rate of sorghum is 70%.

(ii) Utilization method

Summer sorghum is due to be used as silage adjustment and grazing for beef cattle and dairy cattle in addition to green fodder for dairy cattle. Summer sorghum will be used as green for dairy cattle and for ploughing. Summer sorghum is ploughed as green manure after it is harvested once.

(3) Outline of cultivation and management

The outline of summer crops and secondary crops and cultivation and management work by season are described in the Tables 7.3.2.5 and 7.3.2.3 .

(i) Variety introduction

Sorghum is divided into two types: one is for harvesting green and the other for harvesting seeds. Both should be adopted, since the former has a larger amount of dry material production and the latter has a larger amount of protein. As for introduced varieties, in addition to Fredy, Alex Chaco, and Sileca 1844 currently cultivated in the study area, Pastizal, Seda, Ag-2002, AG-2005-E, BR-64R, Dekalb SX-121 (varieties for green harvesting), Bermejo, Pionner are used in view of such factors as yield, nutrition value, cropping period, falling and disease resistance, and so on. Experimental research is now being made on the yields of new varieties, disease and falling resistance, nutrient content, etc., at PRONIEGA, IAN, and the Central Research Stations in Chaco. Thus, depending on the results of this research, it is possible to introduce new fixed varieties and hybrids.

(ii) Land preparation and seed spraying After ploughing with a harrower, a disk harrow is operated and the land is prepared in early November. Since soil acidity in the development areas is within the level appropriate for sorghum cultivation, it is not necessary to introduce soil improving materials for adjusting the acid level for the time being. The seeds should be sprayed immediately after the preparation of the land so as to prevent wind erosion. Seed spraying for summer sorghum should be carried out during the two months from November to December and for secondary crops it should be in March. The seed spraying should be done by drilling based on a spacing of 70cm. The amount of the seeds to be sprayed is from 7kg to 9kg/ha. In the case of Chaco, the amount of seeds to be sprayed increases 30% from those in the eastern regions for the reason that germination rates decline due to high temperatures, and that harsh drought in the seed spraying season and damage due to wild birds are great. Fertilizers are given at the same time as when the seeds are sprayed (urea 100kg/ha, ingredient quantity N: 46kg/ha). The total quantity of urea amounts to 200kg/ha. But since decomposition and dissolution often occur due to high temperature and

rainfall, the addition of fertilizers should be carried out. For secondary sorghum, the application of fertilizers is not needed.

(iii) Disease and insect control, fertilization management

Although diseases such as Oidium and damage by insects are reported in the sorghum cultivated lands for harvesting seeds in the study area, it is not so important when it is used for harvesting green. Thus, disease and insect control is not operated for the time being. On the other hand, since research on the biological control of insect pests using their natural enemies is now being carried out at IAN of MAG and at the agricultural department of Asuncion National University, its application may be possible in the future, depending on the results of the research. This is a densely planted and fast growing crop, and therefore weeding during cultivation is not planned. But insecticides may need to be sprayed, because there is a possibility that the germination and growth of sorghum decline and weeds grow when there is no rainfall for a long time after the seed spraying. The spraying of Atrazina, etc., should be considered before germination and those of Picloran, Bromoxymil, etc., after germination. The addition of fertilizers is carried out manually after the first harvesting (urea 100kg/ha). Just as in forage and ordinary fields, efforts should be made for fields and grassland and to prevent the decline in the fertility of soil.

(4) Harvesting

In the case of summer crops, the first harvesting is done 90 to 100 days after the seeds are sprayed and the second harvesting 50 to 60 days after the first. When a further 50 days have passed, the third harvesting is carried out. Then (depending on the growth of new buds) grazing is done about 60 days after the third harvesting in order to prevent the poisoning of cyanogen acid that is abundantly included in browses. Grasses are cut at the height of 15 to 20cm from the land surface by a forage harvester towed by a tractor of about 80Hp and collected. In the case of secondary crops, the first harvesting is carried out 90 days after the seeds are sprayed, whereafter it is ploughed as green manure.

(5) Adjustment and utilization

When used as green forage for dairy farming, they are carried to the cowshed directly after cutting and are fed to the dairy cattle. When stored as supplementary forage for beef cattle, however, harvested sorghum is trampled and compacted by a tractor, accumulated in a bunker, or such like, covered with black vinyl sheet, adjusted as silage and stored. An example of fodder analysis of sorghum silage in the Chaco region is shown in Table 7.3.2.7.

7.3.3 Livestock farming plan

1) Basic direction for livestock improvement and propagation plan

1,730 head of cattle are raised in the study area. But their rearing forms are rather extensive; cows and bulls are raised together in large paddocks whose size ranges from several hundred to several thousand hectares, and in many ranches, livestock improvement is carried out without any mating plans. Therefore, there is a limit to the dissemination of artificial insemination technology.

Under these circumstances, the improvement of livestock raising and management and the building of public livestock breeding farms are a must for the livestock improvement and propagation plan so as to improve livestock effectively.

As for beef cattle, the improvement is based on mating between European species including "Ganado Criollo" (the existing species introduced from Europe and accustomed to the climatic conditions of Paraguay) and the Brahman and Nelore species of zebu. The resource preservation of the Criollo is another factor to be considered. Resources in the study area are abundant and thus the propagation of beef cattle and the targetted number of cattle can be easily achieved.

As for dairy cattle, an improvement plan is being carried out in the Mennonite settlements. An effort is being made to produce hybrids hardy to hot conditions, by mating Holland and Brown Swiss European species with Brahman zebu species. The introduction of stud cattle and fine semen from abroad is considered.

However, the propagation of dairy cattle will be difficult. Although many dairy cattle are raised in the Mennonite settlements in the study area, the decision has been made that this place should be excluded from the areas targetted to be developed in the integrated development plan. In the study area, not many have been tried except in the Mennonite settlements. Thus, breeding stock will have to be introduced from outside the development plan target area in order to aim for propagation. The cooperation of the Mennonite settlers in propagation will be indispensable.

For sheep and goats, there are hardly any pure breeds in the study area at present, while there are no stock breeding farms that are planning improvements in any systematic way. Thus, there is a plan to make the PRONIEGA Chaco testing station a centre for improvement efforts. The propagation of sheep and goats will be easily achieved, because resources are abundant in the study area.

As for apiculture, the improvement plan is based on the mating between African species (Apis mellifera adansonii) and Italian ones (Apis mellifera liqustica).

Targetted for improvement by the plan are beef cattle, dairy cattle, sheep, goats and honey bees. Other livestock including pigs, birds, etc., depend on natural propagation.

(1) Livestock improvement plan

a) Beef cattle

All economic factors should be taken into account for the selection of beef cattle. Of the economic factors the main ones are (1) breeding potential, (2) lactation ability, (3) weight gaining speed and fodder demand rate, (4) longevity, and (5) beef productivity. In addition to these factors, suitability to the climatic conditions of the study area should be considered. Generally a crossing technology is utilized for commercial beef production. The improvements of breeding potential, vitality, fertility, weight gaining speed, heat resistance, and disease resistance can be expected by utilizing a heterosis crossing. The use of this technology is included in this plan to carry out the improvement project for commercial production except for stud cattle production. In Paraguay, in order to breed cattle having excellent disease and heat resistance, Nelore and Brahman of zebu species have been introduced, and these zebu species have been crossed with European ones including Criollo. In the study area, many Criollo, Nelore, Brahman, Hereford, and others have been raised, and mating is due to be based on a two-breed crossbreeding rotation system to realize a heterosis effect (see fig. 7.3.3.1).

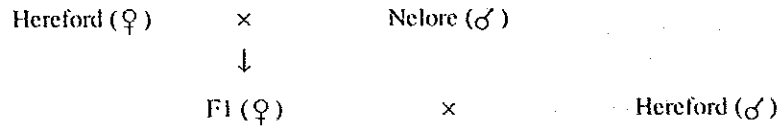


Fig. 7.3.3.1 Two-breed crossbreeding rotation system

The heterosis effect is maintained at only 67% by mating based on the two-breed crossbreeding rotation system (calculated on the basis of the finding that the heterosis effect is proportional to heterosity - this finding is the result of a crossing experiment carried out at Fort Robinson experimentation station in the USA). Therefore, the adoption of a three-breed crossbreeding rotation system is considered in order to expand the heterosis effect up to 87% in future (fig. 7.3.3.2).

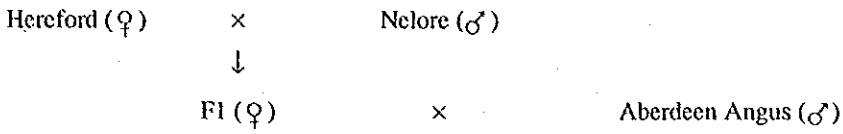


Fig. 7.3.3.2 Three-breed crossbreeding rotation system

Stud male cattle to be used for rotation crossing should have the same ability as those used for reproducing pure ones.

Further, as a result of long selection efforts, it has been found better to incorporate the selection of the fittest Criollo in the plan in order to protect the hereditary resources of it existing in Paraguay and suited to the climatic conditions there.

The improvement of beef cattle can be speeded up by introducing artificial insemination and fertilized egg transplantation techniques. Already in some farms, improvement efforts have been carried out using these techniques and thus the introduction of fertilized egg transplantation technology should be included in the plan. But there is a limit to the full-scale introduction of these techniques, given the beef cattle raising conditions in the study area. Therefore, artificial insemination should be carried out for about 20% of the parent cattle and the natural mating method should be used for the rest. Although stud livestock farms are responsible for supplying frozen semen and stud male cattle, the supply from some breeders should be planned. Fertilized egg transplanting technology has been brought from Japan and already applied here, but still in the study area only a few breeders have adopted this for producing stud livestock. Thus, it is not adopted as a general technique in this plan.

Feasible figures should be targeted for the production plan in connection with the propagation and breeding of beef cattle considering the current technical level. The figures set on the basis of the achievements so far are shown in Table 7.3.3.1 and lifetime production cycles of beef propagation cattle in Table 7.3.3.3. Many of these figures can be realized by the improvement of rearing management rather than the improvement of the livestock itself.

b) Dairy cattle

Many dairy cattle are raised in the Mennonite settlements in the study area. But the production level is not so high due to the high temperatures and thus the Criollo is also used for producing milk. The Mennonite settlements are excluded from the

integrated development plan. This means that there are only a few dairy cattle in this area which could be a basis for improvement efforts. Thus, the improvement of dairy cattle should start with the selection of varieties introduced from outside the development plan target area. Holland types have been brought from Uruguay recently and are being used as a basis for improvement. This example can be put to good use in the plan. In the plan, Holland, Brown Swiss, etc. are used as base cattle. The improvement is carried out by mating between heat resistant Brahman and zebu species. The technology to be used is artificial insemination. In this case, it will be difficult to adapt improved pure European types to the region since the settlers who will be the carriers of development are not sufficiently well-versed in the husbandry management of dairy cattle. Thus, consideration will first of all be given to let the settlers undertake husbandry management of hybrid dairy cattle which suit the local environment, whereafter improvement will gradually be promoted.

Planned figures in connection with the production and reproducing capability of dairy cattle are shown in Table 7.3.3.2. The lifetime producing cycles of dairy cattle are described in Table 7.3.3.4.

c) Small-medium scale livestock farm

Sheep and goats are selected for small farms and bees for indigenous farmers. These types of livestock are widely raised in the study area. As for sheep and goats, however, no improvement target has been set and no fine stud livestock have yet been selected. Sheep and goats are raised mainly for home consumption and therefore, they are not so big. The supply of fine stud varieties is a must for making them bigger. According to the plan, stud varieties will be introduced from the outside. Also, ranches will be established for producing stud varieties. For this, the PRONIEGA Chaco Testing Station will be responsible.

(i) Sheep

As for Chaco hybrids, Romney Marsh, Hampshire Down (for wool and mutton production), and Santa Ines (for mutton production) can be recommended as the mainstay for improvement. Although Corridale and Merino are considered especially for producing wool, long-haired varieties are not recommended for Chaco, because there are many thorny shrubs.

(ii) Goats

The improvement of existing varieties should be carried out utilizing Sannen (dairy and meat) or Anglo Nubian.

(iii) Apiculture

Basically Italian and African hybrids are used. But since numerous wild bees live in the study area, the breeders there catch them, store them in Langstroth type hives and try to improve varieties by utilizing queen bees introduced from Europe. Thus, this system is adopted in the plan.

Planned production figures for sheep, goats, and bees are shown in Tables 7.3.3.3, 7.3.3.4, and 7.3.3.5, respectively.

The lifetime production cycles of sheep are described in Table 7.3.3.5.

(2) Livestock propagation plan

As mentioned earlier, the propagation of beef cattle, dairy cattle, sheep, goats and bees should be included in the plan. The selection of these are based on the following reasons.

(i) Beef cattle are the basis for stock breeding in the study areas and are the most suited to their natural environments.

(ii) The introduction of herbivorous livestock is essential to the utilization of the vast grasslands in the study area.

(iii) Beef cattle, dairy cattle, and apicultural products can be expected to meet the increasing domestic demand for foods and even to be used for export.

(iv) As a mainstay for the development plan, there is a measure to deal with the situations of small farmers and tenant farmers. Sheep and goats are best suited to these farmers, because they can be raised without large areas.

(v) Sheep and goats are suited to the farming type consisting of small and indigenous farmers without adequate funds, for the reason that their propagation is possible within a relatively short period of time and the turnover rate of capital investments is fast.

(vi) Sheep and goats are useful for eliminating weeds and are thus useful as grassland management livestock, as well.

(vii) Goat milk is currently used by the indigenous people for home consumption and thus is useful for increasing their nutrient intake.

(viii) As for honey bees, melliferous plants are abundant in the study area and have been successfully raised by the indigenous people.

The number of currently raised livestock in the development plan areas is decided by setting the grazing capacity for each area divided on the basis of the current land utilization level and calculating grazing capacity indices. The results of grazing capacity

calculated by this method are shown in Table 7.3.3.6. The figures that result from the calculation of the numbers of livestock currently raised according to area using these grazing capacity indices are described in Table 7.3.3.7. Livestock propagation should be planned on the basis of these figures.

The planned number of raised livestock is calculated on the basis of the necessary nutrient amount and the supplyable amount of fodder; its procedure is described in fig. 7.3.3.6.

A comparison between the planned number calculated in the above manner and the present situation is shown for each development plan area and stock variety in Table 7.3.3.8. According to this, for beef cattle it will be increased by 1.7 times, for sheep by 2.9, for goats by 4.1, and for bees by 8.7.

There are two methods conceivable for livestock propagation. One is home propagation and the other is that introduced from outside. The home propagation system is adopted for beef cattle in the plan, because their resources exist to a certain extent in the planned areas. For large scale beef cattle farming, however, methods brought in from abroad are added to the home method when necessary. It is expected that the planned number will be achieved 5 to 6 years after the settlement. As described above, only a few dairy cattle are raised in the development plan areas. Therefore, propagation should be carried out using methods from outside. Since it takes 5 to 6 years to achieve the planned raising size by introducing heifers amounting to about half of the planned number, this technology is included in the plan.

For the small and medium farmers in the development plan areas, the home propagation system should be adopted to increase the number of livestock.

The livestock propagation plans for each area are shown in Table 7.3.3.9. Also, the propagation plans according to beef cattle and dairy cattle farming types are described in Tables 7.3.3.10 to 7.3.3.14.

2) Basic direction for livestock raising and management plan

First and foremost, it is necessary to improve the livestock husbandry management so as to increase the productivity of animal products in the study area. The problems currently facing the raising management are as follows. Reproductive rates are low due to a fodder shortages in winter, accident rates are high for calves, a long time is needed for husbandry, and the probability of catching diseases is high. Thus, husbandry management with

importance placed on securing fodder in wintertime should be planned.

It is hard to carry out husbandry management fully because the paddocks are so big. Therefore, the establishment of facilities should be planned in order to improve propagation and fully carry out sanitary management by dividing the paddock into small parts.

Since composite farming with agriculture is aimed at in the agricultural development areas, consideration should be given to a balance in the distribution of labour. Thus, a production system by machine should be incorporated in the plan up to a certain point. In dairy farming, a semi-intensive system will be utilized for supplying fodder.

The sanitary management of livestock is very difficult in the study area due to natural conditions and geographical location. Thus, it is necessary to establish facilities which make sanitary management easy and to create a system by which administrative assistance can be given for dealing with diseases.

Small and medium scale livestock are due to be raised by tenant and indigenous farmers and an intensive husbandry management will be used. In particular, the sanitary management for sheep is the most important.

(1) Raising management for each type of livestock

a) Beef cattle

In the study area, there are only a few cases where improved grassland is established for beef cattle farming and the husbandry environment has been improved. If grazing is done on natural grasslands all through the year, production improvement is impossible because of the shortage of fodder in winter. Husbandry management is planned considering the following factors.

(i) The husbandry environment should be improved by introducing improved grasslands and forage fields to beef cattle farming. This will lead to an improvement in propagation rates, and a decline in accident rates for calves will lead to a production improvement. Efforts should be made to improve the success of mating and to reduce the accident rates for calves by providing more nutrients to cows during the period of reproduction (30 days before delivery and 60 days after delivery).

(ii) Delivery is carried out on the grasslands. The reproduction period should be set just before spring. Cattle nearing delivery should be grazed on land near the farming station where a watch house or similar facility exists.

(iii) It is necessary to divide a paddock into small parts so as to improve the efficiency of mating and management work. If this is done, the cattle groups can be grazed in divisions of (1) dry cows, (2) dairy cows, (3) recently weaned calves, (4) breeding and fattening cows, and (5) stud bulls. Nutrition management should be fully carried out especially for (2) and (4). When the number of paddocks is small or the number of cow groups is small, the above division may not be possible. In this case, it is possible to place (1) and (4) under the same management.

(iv) A corral should be set up in order to carry out livestock hygiene measures adequately. Alongside the corral, squeeze shoot, and chemical provision facilities should be set up and thus the work for maintaining livestock hygiene and artificial insemination can be done smoothly.

The annual husbandry management plan for beef cattle is shown in fig. 7.3.3.7.

b) Dairy cattle

Cases where dairy cattle are raised through intensive methods including the establishment of improved grasslands, the introduction of fodder crops such as sorghum, and the supply of thick and heavy forages can be found in the Mennonite settlements. The husbandry management for dairy cattle follows these cases in the Mennonite settlements.

For dairy farming, two types of composite farming with fields and specialized dairy farming are planned. The husbandry management plan for dairy cattle should be made considering the following factors.

(i) As in the case of beef cattle, efforts should be made to improve reproduction and raw milk production by creating a fodder production foundation establishing improved grasslands and forage fields.

(ii) In composite farming, a husbandry management plan should be made giving consideration to the distribution of labour with field crops. The important part of husbandry management for dairy cows is the daily milking work. The plan aims at founding a conservation type of dairy farming through grazing all through the year. When milk is taken in the morning and in the evening, the cows are collected in the paddock; after milking they are grazed. Therefore, the cow group to be milked is grazed near the station while dry cows and breeding cows are grazed in an area far from the station. The milking is done manually for up to 10 cows

while for over 60 cows it is done by milking machines. The milking period is generally eight months while the dry period is three months.

(iii) Mating for dairy cattle is done by artificial insemination in principle. At the time of milking every day, cows on heat are identified and mating is carried out. Deliveries are carried out on grazing land all through the year.

(iv) The breeding cows for renewal are raised on adjusted powder milk for about two months after the first milk is given after delivery. Bullocks and cows other than those for renewal are usually sold 10 days after delivery.

The annual husbandry management plan for dairy cattle is shown in fig. 7.3.3.8.

c) Sheep and goats

Sheep and goats are raised in combination with field crops and apiculture. A husbandry management plan should be based on the following factors keeping in mind the distribution of labour.

(i) Both sheep and goats are raised while grazing on natural and improved grasslands. Mating is based on natural crossing. Delivery for sheep is allowed once a year and for goats twice a year. For sheep, one ram is provided per 30 ewes, and for goats one male per 25 females. Castration is carried out immediately after weaning.

(ii) For both sheep and goats, the improvement of productivity depends on the growth rates of lambs and goat kids after delivery. Therefore, efforts should be made to provide more nutrients to mother ewes and goats, to carry out full hygiene management and protect newborns from wild dogs and other wild animals. The introduction of improved grasslands should be planned to improve nutrient intake and the elimination of parasites should be done as part of hygiene measures.

(iii) Sheep and goat houses should be set up at the station to protect the newborns from wild dogs, etc. Sheep and goats are due to be raised by small-scale farmers. Accidents can be reduced by collecting them at the station in the evening after grazing and maintaining a strict night watch.

(iv) Wool trimming for sheep is done just before spring, and dirty hair cutting and pruning are done in the summertime.

The annual husbandry management plan for sheep is shown in fig. 7.3.3.9.

d) Apiculture

The breeding density for bees is limited by law. At present, the standard density is 20 swarms in a radius of 2.5km.But small-scale farmers are allowed to breed up to 24 swarms. The breeding swarm density should be planned around this standard.

The standard number of swarms at one site is ten and hives are set up. Although melliferous plants are abundant, because development is lagging behind it is expected that they will decrease and their distribution will fluctuate as development advances in future. Therefore, according to the plan, a new type of breeding (fodder changing) will be considered, though at present a fixed site breeding system is used. It is possible to collect honey intensively by setting up hives in the ranches particularly during the honey discharging period. In this case, the introduction of a fodder changing system can be considered.

Annual honey collecting times are three, from September to October, in December, and in March respectively. Queen bees should be renewed every year and an Italian variety from Europe will be used.

(2) Fodder supply plan

Livestock planned for propagation are all herbivorous animals (beef cattle, dairy cattle, sheep, and goats) excluding honey bees. They are due to be raised using self-supplied forage as much as possible to reduce production costs. Fortunately, in the study area natural grasslands are abundant and thus the environment is suited to the raising of these herbivorous types of livestock.

The problem, however, besides the low productivity of the natural grasslands, is the fact that there is a seasonal fluctuation in production and that a number of animals are kept at the lowest productive wild grass site each season. When making a fodder supply plan, it is important first of all to solve this problem by tying up with grasslands and fodder crop fields. This signals a need to secure nutrients for livestock in winter. It is important that the nutrient supply quota should be balanced throughout the year.

The following methods can be adopted in order to balance the supply of fodder. (1) Some parts of grazing areas are left as non-grazing sites and when a shortage of forage occurs these sites are used; (2) improved grasslands are established and dry grass and silage are stored; and (3) in seasons when there is a shortage of forage, thick and heavy fodder, agricultural side-products, etc. are given to the livestock as alternative fodder.

Based on these, a fodder supply plan should be made. Also, the following factors should be taken into account when making the plan.

(i) To calculate the necessary amount of nutrients for each type of livestock, the US NRC standard should be used because there is no appropriate nutrition standard in Paraguay.

(ii) Considering the summer heat and the livestock types that graze all year round, 30% more nutrients should be added to standard TDN quotas.

(iii) The establishment of improved grasslands should be planned so as to compensate for nutrient shortages in winter, but their area should be kept to 20 to 30% of the area of the available land, in view of production costs.

(iv) Fodder adjustment should be simplified as much as possible in view of its cost and labour distribution; grasses are not due to be used as hay or silage and the provision of live grasses should be made in principle. Spare paddocks should be set up to be used during the winter and dry seasons.

(v) In seed sowing fields, some sorghum cultivated as green manure secondary to cotton and peanuts should be used as materials for silage adjustment.

(vi) As for sorghum introduced as a forage crop, it is used as silage and greens. Sorghum should be supplied when there is a shortage of grasses during the winter and dry seasons.

(vii) In dairy farming, about one third of the annual requirement of TDN for dairy cows is supplied by concentrated forage.

Group compositions (100 head/group) based on reproductive performance, productivity, and other factors for each type of livestock described earlier are shown in Tables 7.3.3.15 to 7.3.3.18. The results made by calculating annual requirements of TDN from standard nutrient levels for each type of livestock (on the basis of parous cows, 100 head for dairy farming and 100 adults for other livestock) are shown in Tables 7.3.3.19 to 7.3.3.22.

Further, forage production plans according to each farming type are made by estimating the usable TDN quantity from the fields in the fodder supply plan and fodder production; results estimating the supply and demand of forage are detailed in the section on the livestock farming plan.

3) Basic direction for the livestock farming plan

The livestock farming plan is broadly divided into two types; one is a settlement plan for agricultural development plan areas, using the type of composite farming with agriculture; the other is an improvement of existing ranches in the livestock farming development plan areas.

In the former type, small and medium scale livestock including dairy cattle, sheep, goats, and bees are raised with the aim of dispersing the danger of agricultural production caused by unstable climatic conditions. The performers of this integrated plan are tenant and indigenous farmers (small-scale farming) and farmers with technology (medium- to large-scale farming).

The latter type is for large-scale specialized farming with an integrated beef cattle breeding and fattening system. Efforts should be made to increase productivity by establishing facilities and grasslands for farmers already engaged in beef cattle farming in the study plan areas. Other necessary facilities and equipment should be provided as well.

As for the labour force, in the case of composite farming,consideration should be given to the balance with crop fields and labour should be employed when necessary.

Collective utilization of facilities shared with crop fields can be considered in order to avoid overinvestment in facilities, equipment, and machines. In the case of small-scale farmers, collective use of facilities by four households should be planned.

As for land utilization in composite farming between livestock farming and agriculture, a complementary system can be planned. For example, some green manure crops cultivated secondary to usual field crops are used as self-supplied fodder.

(1) Beef cattle

For beef cattle, there is a plan to create large-scale farming with an integrated breeding and fattening system in the livestock development plan areas. Farmers with 300ha or more are targetted by this plan. There are two model types; one is the case where both the area of land and the size of livestock husbandry are expanded ("size expansion type"); the other is where the husbandry size is expanded while the land size is kept unchanged ("facility establishing type"). As for the former type, there is a plan to expand beef cattle farms of about 1,200ha to those of 2,000ha with an integrated breeding and fattening system (600 reproducing cows). Meanwhile, for the latter type, there is a plan to create farms of 5,000ha, said to be the optimum size for beef cattle farming utilizing the natural grasslands in the Chaco region, with an integrated breeding and fattening system (1,500 reproducing cows).

These farming sizes have been decided on the basis of the following factors. (1) Five to six years are needed for beef cattle propagation mainly using the home propagation method; (2) an intensive farming system should be established to a certain extent by

introducing grasslands and forage crops rather than using existing natural grasslands; and (3) as for beef cattle farming, the size of about 5,000ha should be targetted as a model in terms of profitability. As far as profitability is concerned, a beef cattle fattening system can be considered by supplying concentrated fodder. In this plan, however, such a system is not included for the following reasons.

(i) There is no established evaluation of cows fattened by fodder grains in Paraguay.
(ii) The beef cattle fattening zone is located in the eastern region of Paraguay where many improved grasslands and forage crops exist.
(iii) The cultivation zone for grains (materials for concentrated fodder) is located in the eastern region and Chaco is not suited for a formula fodder producing factory.

a) Outline of farm management plan

An outline of the farm management plan, involving farming forms, the number of livestock, land utilization, agricultural facilities and agricultural machines for two types are shown in Tables 7.3.3.23 and 7.3.3.24. As for the beef cattle integrated breeding and fattening system due to be introduced in the livestock farming development plan areas, the current situation and the plan are compared. The current figures are estimated on the basis of ranch studies. The number of livestock to be bred has been decided by setting the fertility of current land utilization.

b) Forage supply and demand plan

Based on the fodder supply plan in the livestock husbandry management plan, detailed fodder supply plan cases have been made (per 100 mature beef cows), and from the necessary TDN quantity a balance has been made between a fodder producing plan and a fodder demand plan.

The forage supply and demand plan is described in Tables 7.3.3.25 and 7.3.3.26.

c) Labour plan

In cattle farming, the work which needs most manpower is livestock management. To economize on livestock management work, there is a plan to divide paddocks into small parts and to set up corrals. At present, a herdsman can manage up to 500 head of cattle. This is expected to increase to 800 head per herdsman.

A monthly working plan has been made by estimating the annual working hours needed for livestock management and those for forage production. Two types of working plan are shown in Tables 7.3.3.27 and 7.3.3.28.

As a result, it is found that if each household can provide 2.5 working hands, a farm with 600 head of cattle (the integrated beef cattle breeding and fattening system) can provide necessary manpower themselves, except for fence repairing, while in a farm with 1,500 head of cattle, about four labourers need to be employed.

The total employment is 260 workers per year for a farm with 500 head of cattle and 500 per year for a farm with 1,500.

d) Facility plan

Beef cattle are grazed all year round and the investment in the establishment of fences is the largest of all facilities for ranches. The fences are composed of wooden pillars (length 2 to 2.2cm, height from the ground 1.4m, depth below the ground 0.8m) with a spacing of 5 to 8m, four stages of round wire, and three stays for one span.

The water supply facilities adopt a pipe system. Water stored in the tajamar is lifted to the tank by windmills, and from the tank it is supplied to a concrete tank set up on each paddock via a vinyl chloride tank.

A corral essential to the shipping of livestock, a hygiene management facility structured of wood and a weighing machine, a treatment house, a medicine supply facility, an inoculation house, an artificial insemination house, getting on and off facilities, and others should be provided.

Besides these, a machine warehouse, a watchtower, a material storehouse, and a silo should be set up. A model plan of a field is shown in figs. 7.3.3.10 and 7.3.3.11.

e) Farm appliances introduction plan

A set of tractors and working machines should be introduced for sorghum cultivation, sorghum silage adjustment, natural grassland establishment, the management of improved grasslands, tajamar reservoirs, and the management of working roads.

f) Farm management balance plan

The current farm management balance has been calculated using current farm management technology indices, etc. As a result, it has been found that agricultural income rates are 29% for a farming scale of 5,000ha (a beef cattle breeding and fattening farm) and 21% for the size of 1,200ha (Table 7.3.3.29).

Also, animal produce sales and farming costs have been roughly estimated based on

the forage supply and demand plan, the livestock husbandry management plan, the livestock improvement plan, and others. As shown in Table 7.3.3.30, animal produce sales were calculated on the basis of animal produce production levels on the scale of 100 cows of reproducing age. The farming costs were calculated on the basis of planning factors, since detailed cases were non-existent except for rough figures of BNF in Loma Plata in the Mennonite settlements. Thus, the incomes shown in Table 7.3.3.31 can be gained from livestock farming. Income levels tend to increase when the scale expands. The same thing can result if farms with 600 head of cattle (using an integrated breeding and fattening system) expand by 34.6% and that of 1,500 head by 37.6%.

(2) Dairy farming

The creation of farming in combination with field crops and of specialized dairy farming in the agricultural development plan areas is due to be promoted. Dairy farming is highly profitable and thus it should be incorporated in measures to deal with the problems of small farming. There is a plan to create a total of six types. These are specialized farming with 100 parous cows, composite farming of 80 head of cattle and agriculture, that of 60 head of cattle and agriculture, and that of 10 head of cattle and agriculture (the other two types are composite farming with small-medium livestock).

The above farming scales have been decided for the following reasons. (1) Cases in the Mennonite settlements were considered. (2) Reference was made to the incomes of farmers in the eastern settlements. (3) For composite farming with agriculture, the distribution of manpower was taken into account. (4) Milking was planned for manual operation in the case of small-scale farming.

a) Outline of farm management plan

Outlines of farm management type, the number of breeding livestock, agricultural facilities and agricultural appliances for each type are shown in Tables 7.3.3.32 and 7.3.3.37.

b) Fodder supply and demand plan

The fodder supply and demand plan should be made in the same way as for beef cattle farming. Fodder supply and demand plans corresponding to each farming scale are shown in Tables 7.3.3.38 to 7.3.3.43.

c) Work plan

In the case of dairy farming, milking work is added to a livestock management. This

milking work needs much manpower. In the usual husbandry management of grazing etc. the number of parous cows managed by one person is 200, and the time needed to milk one cow is ten minutes according to the plan. Also, manual milking is carried out on the scale of 10 cows while a milking machine is used in the case of a scale of over 60 cows. For dairy farming, a husbandry management system by grazing cows all the year around is adopted and the plan has been made giving consideration to the distribution of labour with field crops.

Based on these conditions, the working hours needed for livestock management, forage production, and so on were estimated and a monthly working schedule was made. The working schedules for each type are shown in Tables 7.3.3.44 to 7.3.3.49.

As a result, it has been found that farms with over 60 parous cows need to employ seasonal workers.

Estimates of requisite manpower by size are as follows. If each household can provide 2.5 workers, dairy cattle farming with 60 parous cows combined with agriculture needs 260 workers a year, while farming sizes of 80 and 100 need 300 a year. In the case of farms with 10 parous cows combined with agriculture, a plan should be made so that they can provide necessary workers themselves without employing others for dairy farming.

d) Facility plan

The livestock farming facilities in dairy farming are the same as for beef cattle farming, including fences and a water supply system. Since there is milking work for dairy farming, facilities for this should be built. If the farm size is more than 60 parous cows, the introduction of a milker and a bulk cooler should be planned.

Besides these, the establishment of a material house, a watch house, a machinery storehouse, a silo, a paddock, and others needs to be planned.

A model plan of fields for each type is shown in the figs. 7.3.3.12. to 7.3.3.16.

e) Agricultural machine introduction plan

As in the case of beef cattle farming, the introduction of tractors and other machinery necessary for forage crop cultivation, grassland management, livestock management and other works should be planned. For the actual introduction, overinvestment needs to be avoided. For farm combined with agriculture, joint utilization with

agriculture should be planned, and for a small-scale farm with 10 parous cows jointutilization by up to four households should be considered.

f) Farm management balance plan

As in the case of the beef cattle farming, based on the husbandry management plan, the livestock improvement plan, and others, animal produce sales and costs were estimated. As shown in Table 7.3.3.50, an estimate of profits gained from the animal produce sales was calculated on the basis of the production level per 100 parous cows. The farming costs were estimated by adding up necessary factors just as for beef cattle farming. Thus, agricultural income can be gained as shown in Table 7.3.3.51. Income rates by type are 39.4% for a specialized dairy farm with a scale of 100 parous cows, 39.5% for a farm with 80 head of cattle combined with agriculture, and 35.3% for a farm with 60 head of cattle combined with agriculture. The breakdown of small-scale farms with 10 head of cattle combined with agriculture is as follows. (1) 37.5% for dairy farming + small-medium scale livestock (40 sheep) + field crop farming, (2) 38.5% for dairy farming + small-medium scale livestock (30 goats) + field crop farming and (3) 48.6% for dairy farming + fruit trees. The profitability of dairy farming differs from type to type. This is because all the types excluding specialized dairy farming are composite farming combined with agriculture and thus consideration was given to aggregate income by taking into account labour distribution, facility investment distribution, and so on.

(3) Sheep and goats

Sheep and goats are due to be raised in combination with field crops in the agricultural development plan areas, as well as being raised on a small scale by indigenous people in the livestock farming development plan areas. They are also due to be raised in combination with dairy farming and apiculture. According to the plan, there are three types of farming in the agricultural development plan areas. They consist of composite farming on the scale of 40 mature ewes, 10 parous cows, and agriculture, that of 30 goats, 10 parous cows, and agriculture, and that of 15 sheep, 5 swarms of bees, and agriculture (by indigenous people). As part of the measures to deal with the problems of indigenous people in the livestock farming development plan areas, the creation of composite farming on the scale of 20 sheep and 7 swarms of bees should be incorporated into the plan. In total there are four types for raising sheep and goats.

a) Outline of farm management plan

Outlines of farm management forms, livestock numbers, land utilization, agricultural facilities, and agricultural machinery for each type are shown in Tables 7.3.3.52 to 7.3.3.53 (for farming combined with dairy farming, refer to (2) "Dairy farming").

b) Fodder supply and demand plan

The fodder supply and demand plan is made in the same way as for beef cattle farming.

c) Work plan

For both sheep and goats, 150 animals should be managed by one person. Basically, small- to medium-scale farms should provide workers themselves. Since it takes a long time to stabilize farm management by small independent type farmers, surplus workers should be provided to them. In the farming of the third type (carried out mainly by indigenous people) workers may be generated.

The working plans for the types of 15 sheep + 5 swarms of honey bees and 20 sheep + 7 swarms of honey bees are shown in Tables 7.3.3.54 to 7.3.3.55.

d) Facility plan

Grazing facilities for sheep and goats are composed of fences and water supply facilities. The fences should be structured of 8m wooden sticks, 5 stage round wires, with four stays in one span. At night, sheep and goats are kept in their stables at stations with recreation areas.

e) Agricultural machinery introduction plan

As for small-medium scale livestock farming combined with dairy farming, machines should be introduced for the facility management of tajamar reservoirs and the like, as well as general work. They can be jointly used by farmers for forage production, grassland management, livestock management, and road construction. For small-scale farming done by indigenous people, small type machines are due to be introduced, but large machines will not be introduced.

f) Farm management balance plan

As in the case of beef cattle farming, based on the forage management plan, the livestock improvement plan, and others, rough estimates of animal produce sales and farm management costs were calculated. As for the animal produce sales profits, the calculation was made on the basis of the amount of produce per 100 animals, as indicated in Tables 7.3.3.56 and 7.3.3.57. As for the farming costs, the calculation was done by adding up each expense. The result is shown in Table 7.3.3.58. Income rates by type are 37.5% for composite farming between 40 sheep, agriculture, and dairy farming (also shown in the section on dairy farming) and 38.5% for composite farming between 30 goats, agriculture, and dairy farming. On the other hand, it is

52.0% for composite farming between 15 sheep, agriculture, and dairy farming in the agricultural development plan areas (done mainly by indigenous people). An income rate of 54.6% is expected to be gained by composite farming between 20 sheep and apiculture in the livestock farming development plan areas carried out for the betterment of the indigenous people. These differences in income levels result from the fact that profitability is extremely high for apiculture because of low capital investments, while this is comparatively high for dairy farming as well. The profitability for small-scale sheep and goat farming is somewhat low.

(4) Apiculture

Honey bees are due to be raised in sizes from 5 to 7 swarms by the indigenous people in the agricultural development plan and livestock farming development plan areas.

As for the work plan for apiculture, the annual working hours needed for the management of one swarm should be kept at around 50 hours.

As mentioned earlier, farming should be carried out in combination with field crops and small-medium scale livestock. As described in the section on the husbandry plan, two types of husbandry by using fixed sites and changing forages should be planned, because the husbandry density becomes very high and the number of melliferous plants will decline due to development.

Honey bees are due to be bred in the improved hives of the Langstroth type. Tools such as a honey separator, cotton cloth, a smoking machine, hive tools, a honey knife, a nest foundation, and so on are also needed and thus expenses are due to be allocated for these tools.

There are honey and pollen as products and their productions are planned at 60kg for honey and 2kg for pollen per one swarm.

Capital investments are not so high because bee breeding needs few tools and the costs for materials and labour are small. Therefore, in the farm management balance, its profitability is shown as being very high.

Fig. 7.3.3.6 Procedure for calculating the number of livestock to be bred

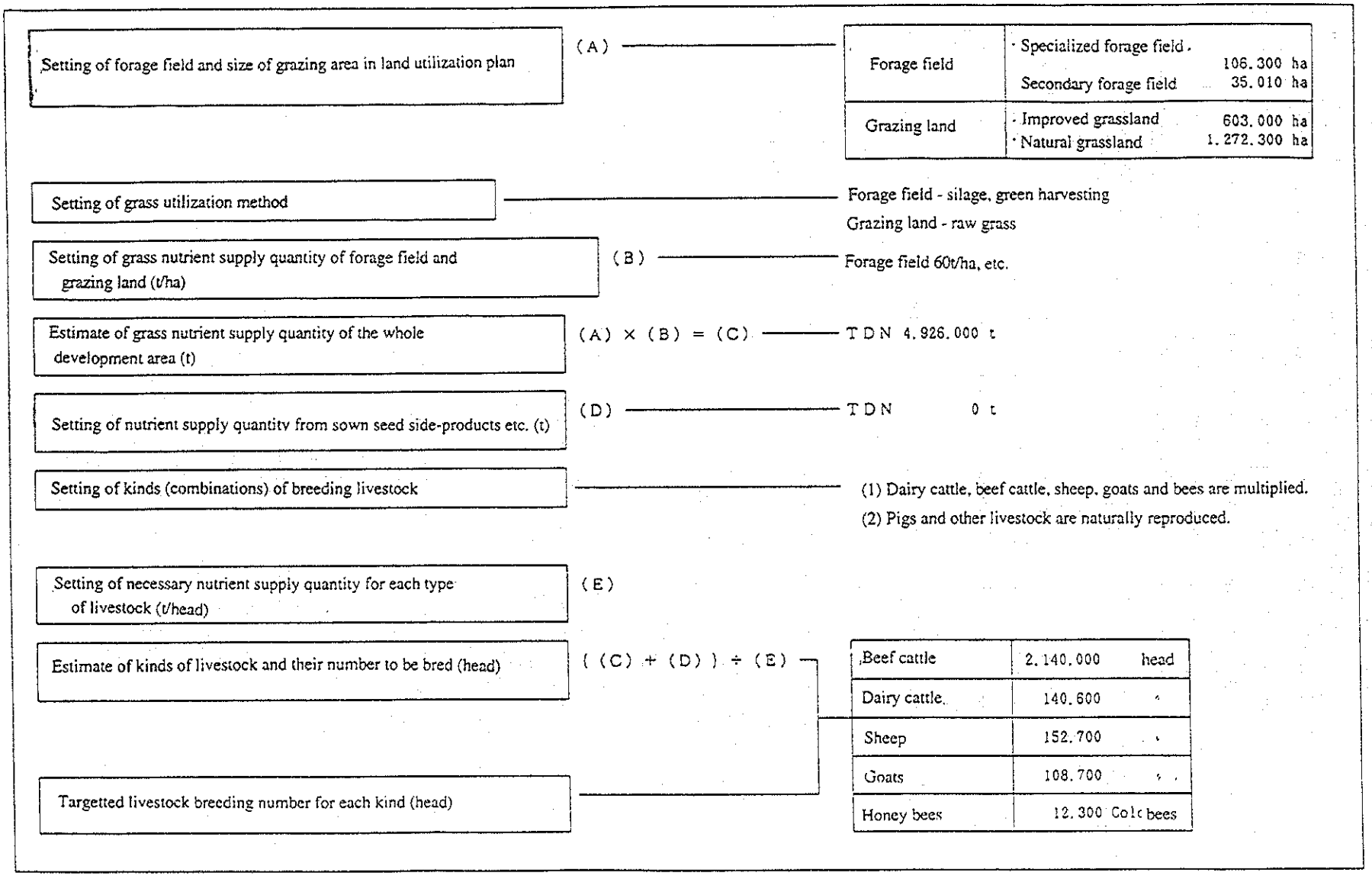


Table 7.3.3.8 Current situation and plan of the number of live stock

unit: number of heads and swarms

Kind	Suburbs of Asuncion				Northern Pozo Colorado				Southern Mennonite settlements				Eastern Mennonite settlements			
	Current situation		Plan		Current situation		Plan		Current situation		Plan		Current situation		Plan	
	Total	Mature females	Total	Mature females	Total	Mature females	Total	Mature females	Total	Mature females	Total	Mature females	Total	Mature females	Total	Mature females
Beef cattle	4,886	1,563			10,143	3,245			11,189	3,580			38,754	12,401		
Dairy cattle			1,241	900			21,375	15,500			22,615	16,400			75,845	55,000
Sheep	182	81			378	169	18,335	8,200	417	186	18,447	8,250	1,443	645	33,651	15,050
Goats	87	16			180	33	28,176	5,250	199	37	28,981	5,400	689	128	51,523	9,600
Bees	2				17		400		15		350		41		750	

unit: number of heads and swarms

Kind	Livestock farming plan area				Sum of other areas				Whole of Department Pst.Hayes			
	Current situation		Plan		Current situation		Plan		Current situation		Plan	
	Total	Mature females	Total	Mature females	Total	Mature females	Total	Mature females	Total	Mature females	Total	Mature females
Beef cattle	366,567	213,301	1,887,842	638,000	999,055	319,697	999,055	319,697	1,730,594	553,787	2,886,897	957,697
Dairy cattle											121,076	87,800
Sheep	24,820	11,100	73,340	32,800	37,200	16,637	37,200	16,637	64,439	28,818	180,973	80,937
Goats	11,849	2,200			17,760	3,309	17,760	3,309	30,764	5,723	126,440	23,559
Bees	582		11,480		944		944		1,600		13,924	0

Note 1: Figures for beef cattle, sheep and goats are based on 1991 census of agriculture and forestry

Note 2: Figures for bees are based on 1990 estimate by the Ministry of Agriculture and Livestock

Note 3: Figures for other regions were calculated on the assumption that no increase would occur.

Note 4: The number of mature females versus total numbers of sheep and goats in the Current situation used the ratios of the corresponding numbers in Plan.

Table 7.3.3.9 Livestock multiplication plan by region(1)

Name of area	Kind \ Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Remarks
Suberbs of Asuncion	Beef cattle	1,563	1,563	1,563	1,563	1,563	1,563										
	Dairy cattle							135	496	646	782	875	900	900	900	900	
	sheep	81	81	81	81	81	81										
	goats	16	16	16	16	16	16										
	Bees	2	2	2	2	2	2										
Northern Poz Colorado	Beef cattle	3,245	3,245	3,245	3,245	3,245	3,245	3,245									
	Dairy cattle								2,015	4,689	7,866	11,470	13,330	14,531	15,229	15,500	
	sheep	169	169	169	169	169	169	169	1,025	3,075	5,125	7,175	8,200	8,200	8,200	8,200	
	goats	33	33	33	33	33	33	33	656	1,969	3,281	4,594	5,250	5,250	5,250	5,250	
	Bees	17	17	17	17	17	17	17	100	200	300	400	400	400	400	400	
Southern Menn. settlements	Beef cattle	3,580	3,580	3,580	3,580	3,580	3,580	3,580	3,580	3,580	3,580	3,580	3,580				
	Dairy cattle													2,132	4,961	8,323	
	sheep	186	186	186	186	186	186	186	186	186	186	186	186	1,031	3,094	5,156	
	goats	37	37	37	37	37	37	37	37	37	37	37	37	675	2,025	3,375	
	Bees	15	15	15	15	15	15	15	15	15	15	15	15	88	175	263	
Easter Menn. settlements	Beef cattle	12,401	12,401	12,401	12,401	12,401	12,401	12,401	12,401	12,401	12,401	12,401	12,401	12,401	12,401	12,401	
	Dairy cattle																
	sheep	645	645	645	645	645	645	645	645	645	645	645	645	645	645	645	
	goats	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	
	Bees	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	
Livestock farmin development plan areas	Beef cattle	213,301	213,301	213,301	213,301	213,301	213,301	213,301	232,400	255,300	280,400	306,300	332,600	359,400	393,800	430,300	
	Dairy cattle																
	sheep	11,100	11,100	11,100	11,100	11,100	11,100	11,100	11,471	12,990	14,509	16,208	17,574	19,201	20,829	22,456	
	goats	2,200	2,200	2,200	2,200	2,200	2,200	2,200									
	Bees	582	582	582	582	582	582	582	943	1,706	2,469	3,232	4,020	4,838	5,655	6,472	
Other areas	Beef cattle	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	
	Dairy cattle																
	sheep	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	
	goats	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	
	Bees	944	944	944	944	944	944	944	944	944	944	944	944	944	944	944	
Entire study area	Beef cattle	553,787	553,787	553,787	553,787	553,787	553,787	571,323	590,978	616,078	641,978	668,278	695,078	725,898	762,398	800,198	
	Dairy cattle	0	0	0	0	0	0	135	2,511	5,335	8,648	12,345	14,230	17,563	21,090	24,723	
	sheep	28,818	28,818	28,818	28,818	28,818	28,818	29,108	31,483	35,052	38,801	42,217	44,869	47,342	51,032	54,695	
	goats	5,723	5,723	5,723	5,723	5,723	5,723	5,707	4,130	5,443	6,755	8,068	8,724	9,362	10,712	12,062	
	Bees	1,601	1,601	1,601	1,601	1,601	1,601	1,599	2,043	2,906	3,769	4,632	5,420	6,311	7,215	8,120	

Note: Numbers of mature females for beef cattle, dairy cattle, sheep and goats. Number of swarms for bees

Table 7.3.3.9 Livestock multiplication plan by region(2)

Name of area	Kind \ Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Remarks
Suberbs of Asuncion	Beef cattle																	
	Dairy cattle	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	900	
	sheep																	
	goats																	
	Bees																	
Northern Poz Colorado	Beef cattle																	
	Dairy cattle	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	
	sheep	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	8,200	
	goats	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	5,250	
	Bees	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	
Southern Menn. settlements	Beef cattle																	
	Dairy cattle	12,136	14,104	15,375	16,113	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	
	sheep	7,219	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	
	goats	4,725	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	
	Bees	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	
Easter Menn. settlements	Beef cattle	12,401																
	Dairy cattle		5,720	13,310	22,330	32,560	43,560	48,840	52,250	54,230	55,000	55,000	55,000	55,000	55,000	55,000	55,000	
	sheep	645	1,505	4,515	7,525	10,535	13,545	15,050	15,050	15,050	15,050	15,050	15,050	15,050	15,050	15,050	15,050	
	goats	128	960	2,880	4,800	6,720	8,640	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	
	Bees	41	150	300	450	600	750	750	750	750	750	750	750	750	750	750	750	
Livestock farmin development plan areas	Beef cattle	468,100	506,300	544,600	582,800	607,000	628,200	634,200	637,200	638,000	638,000	638,000	638,000	638,000	638,000	638,000	638,000	
	Dairy cattle																	
	sheep	24,057	25,576	27,095	28,614	30,133	31,652	32,800	32,800	32,800	32,800	32,800	32,800	32,800	32,800	32,800	32,800	
	goats																	
	Bees	7,264	8,027	8,790	9,552	10,315	11,078	11,480	11,480	11,480	11,480	11,480	11,480	11,480	11,480	11,480	11,480	
Other areas	Beef cattle	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	319,697	
	Dairy cattle																	
	sheep	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	16,637	
	goats	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309	
	Bees	944	944	944	944	944	944	944	944	944	944	944	944	944	944	944	944	
Entire study area	Beef cattle	838,398	864,297	902,497	926,697	947,897	953,897	956,897	957,697	957,697	957,697	957,697	957,697	957,697	957,697	957,697	957,697	
	Dairy cattle	28,536	36,224	45,085	54,843	65,360	76,360	81,640	85,050	87,030	87,800	87,800	87,800	87,800	87,800	87,800	87,800	
	sheep	56,758	60,168	64,697	69,226	73,755	78,284	80,937	80,937	80,937	80,937	80,937	80,937	80,937	80,937	80,937	80,937	
	goats	13,412	14,919	16,839	18,759	20,679	22,599	23,559	23,559	23,559	23,559	23,559	23,559	23,559	23,559	23,559	23,559	
	Bees	8,999	9,871	10,784	11,696	12,609	13,522	13,924	13,924	13,924	13,924	13,924	13,924	13,924	13,924	13,924	13,924	

Note: Numbers of mature females for beef cattle, dairy cattle, sheep and goats. Number of swarms for bees

7.3.4 Farm management plan

1) Farm management type

(1) Basic direction

The creation of types should be based on a combination between agriculture and livestock farming to disperse risks. Also, consideration must be given to such factors as the cultivation of wind erosion crops in winter, the diversification of export farm produce and human resources, and so on.

(2) Farm management type

a) Agriculture development plan area

(a) The eastern and southern parts of the Mennonite settlements and the northern part of Pozo Colorado

A) Types for group with technology for producing export farm products

(i) Peanuts + cotton + sorghum + dairy farming

(ii) Short-term oil crops + sorghum + dairy farming

(iii) Perennial craft crops + dairy farming

(iv) Dairy farming

B) Types for group with technology capable of meeting the demand of the domestic market

(i) Cotton + sorghum + fruit trees + dairy farming + small-medium livestock farming (sheep) (full-time from the beginning)

(ii) Cotton + sorghum + fruit trees + dairy farming + small-medium livestock farming (goats) (full-time from the beginning)

C) Types for group without technology capable of meeting the demand of the domestic market

(i) Cotton + sorghum + fruit trees + dairy farming + small-medium livestock farming (sheep) (full-time from half-way)

(ii) Cotton + sorghum + fruit trees + dairy farming + small-medium livestock farming (goats) (full-time from half-way)

D) Type for indigenous group

(i) Cotton + small-medium livestock farming + apiculture

(b) Suburbs of Asuncion

A) Types for group with technology capable of meeting the demand of domestic market

(i) Fruit trees + dairy farming

(ii) Fruit trees + vegetables

B) Type for indigenous group

(i) Fruit trees

b) Livestock farming development plan area

(i) Full time beef cattle farming (large scale)

(ii) Full time beef cattle farming (smaller than (1))

(iii) Small-medium livestock farming + apiculture

2) Farm management plan

(1) Basic direction

A technical examination of cultivation systems for each farm management type was carried out and a cropping system was created for each. The farming plan clarifies the number of family members, manpower, residences, facilities, land utilization, gross income, farming costs, agricultural income, etc., and shows the situation of each type. Usually the progress of the farming type and the process to stabilization are clarified by showing the yearly situation. In this case, however, the balance of the year when the land utilization plan for distributed lands and the development utilization of the distributed lands are completed is shown. The economic aspects of the farm management, such as financing, details of farm management, and so on are shown in section 7.4.4 Agriculture credit plan.

Basic direction for making the farm management plan

(i) For each farm management type in the farm management plan, efforts should be made to increase profits by giving consideration to the effective distribution of human resources and manpower.

(ii) For the large scale farming type, conservation efforts should be made by introducing machines so that the advantages of scale can be realized.

(2) Precondition for making a balance sheet for the year when land development is completed.

a) Number of family members

The average number of members per family is 3.3 according to the 1991 Agriculture

and Livestock Farming Census. This is common to all types except that for indigenous people.

10,192 / 3,273 = 3.2 persons/household
Number of families

b) Number of workers

The number of workers per family is 2.5 according to the 1991 Agriculture and Livestock Farming Census. As in the case of the number of family members, this is common to all types except that for indigenous people.

10,192	-	(1,552 + 460)	= 8,180
Farming population		Number of children below 12	Working population in the study area farming household

8,180 / 3,273 = 2.5 persons/household
Number of farming households

c) Method for calculating perennial crops

The costs of land preparation, seedlings, and others are only needed in the first year when planting is carried out, and no profits are gained until the first year when harvesting is made. Under this situation, the value gained by dividing the husbandry costs (sum total of production costs until products sales exceed the production cost) by product life (decided for each crop) is calculated as a mature orchard cost and made part of the production costs of the stabilized year, as is done in Japan.

d) Method for calculating working hours and labour costs

On the condition that annual working hours per head are 2,400 (daily working hours 8/head, annual working days 300), labour costs can be calculated in the following way. Hours gained by subtracting family working hours 6,000 (2,400 hours, 2.5 persons) from annual total working hours divided by 8 (daily working hours), and the result is multiplied by daily wages.

e) Basis for deciding area distribution according to type of farmer

Type of farmer	Distributed area size (ha)	Current land ownership size	Planned farm management size (small, medium, large)	Method for setting
(5)	10	0	small	Decided from a targetted income level (1 million Gs.) and the fact hat most of farm work is done manually.
(3) (4)	60	less than 20 ha	small	Decided from cases in the eastern region (settlements and income) and argetted income (planned farming scale is medium).
(2)	200	20 ha ~ 300 ha	medium	Decided from cases in the Mennonite settlements and targetted income.
(1)	2,000 5,000	more than 300 ha	large	Decided as a model of livestock farming.

Note: Types of farmers are the following five groups.

(1) Those who can achieve development themselves and continue farming with production technology and capital for agriculture and livestock farming.

(2) Those who are provided with agricultural technology necessary to produce export products by modern methods andwith initial capital.

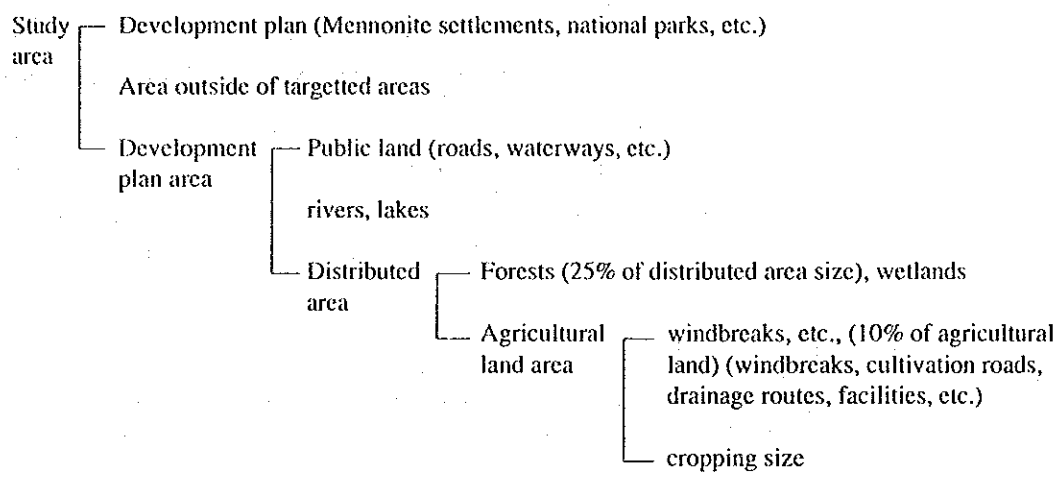
(3) Those who are provided with agricultural technology capable of meeting the demand of the domestic market.

(4) Those who are not provided with agricultural technology capable of meeting the demand of the domestic market.

(5) Indigenous people

f) Distributed area and cropping size

The relationship between distributed area and cropping size is as follows.



g) Utilization plan for distributed land

(a) Area size for crop cultivation

In the case of short-term crops, the whole area is used for cultivation from the first year. For perennial crops, a plan must be made in the following way. Planting is carried out on one third of the area scheduled to be planted every year and all the planting will be completed in the third year. If a planting area is 9ha or 4.5ha, the entire area should be planted from the first year excluding the farmers who have side jobs.

(b) Area for livestock farming

Although grasslands (grassland and forage fields) are used for livestock farming, the entire area set for husbandry is not utilized from the start, because livestock are due to be propagated. According to the distributed land utilization plan, about half of the entire area is used in the first year, all are used in the fifth year and during those years, a certain size is going to be added gradually.

h) Targetted farm income

(a) Group having technology to produce export farm products

The income targetted for this group is 30 million Gs. This results from a comparison with a Japanese settlement of the same area in the eastern region of Paraguay.

(b) Group with technology capable of satisfying the demand on the domestic market

Targetted income is 10 million Gs. This is based on the current income level of farmers in the suburbs of Asuncion where this group will settle.

* Income from sugarcane

22,000G/t (purchase price of sugar factory) -14,046Gs./t (production cost) = 7,954Gs (Income/t) 7,954Gs 60t/ha (average harvest) 10.9ha (average cropping area) = 5,201,916Gs.

This will become about 7 million Gs if 1 to 2 million Gs from home-grown vegetable sales are added (data are taken from the 1991 Agriculture and Livestock Census, Ministry of Agriculture and Livestock, interviews, and so on).

(c) Indigenous group

Target income is 1 million Gs. based on the results of interviews, the survey on indigenous people's preferences, etc.

(3) Farm management plan for each farm management type

As farm management plans for each farm management type, the table for distributed land utilization plans for each region and farmer and a table on the balance of development stabilized year are provided. Figures below each crop indicate cropping area (utilization area).

a) The northern part of Pozo Colorado, the eastern and southern parts of the Mennonite settlements

(a) Group having technology to produce export farm products

(i) Peanuts + cotton + sorghum + dairy farming

45ha 45ha (90ha) 45ha

distributed land utilization plan - Table 7.3.4.1

balance of development stabilized year - Table 7.3.4.2

(ii) Short-term oil crops (sunflowers, sesame, safflower, and castor beans) + sorghum + dairy farming

90ha

(90ha) 45ha

distributed land utilization plan - Table 7.3.4.3

balance of development stabilized year - Table 7.3.4.4

(iii) Perennial craft crop (jojoba) + dairy farming

45ha 94.5ha

distributed land utilization plan - Table 7.3.4.5

balance of development stabilized year - Table 7.3.4.6

(iv) Dairy farming

128ha

distributed land utilization plan - Table 7.3.4.7

balance of development stabilized year - Table 7.3.4.8

For details refer to the livestock farming plan.

(b) Group having technology capable of meeting the demand of the domestic market

(i) Cotton + sorghum + fruit trees + dairy farming + small-medium livestock

9ha (9ha) 4.5ha 9ha 18ha farming (sheep)

distributed land utilization plan - Table 7.3.4.9

balance of development stabilized year - Table 7.3.4.10

(ii) Cotton + sorghum + fruit trees + dairy farming + small-medium livestock

9ha (9ha) 4.5ha 9ha 18ha farming (goats)

distributed land utilization plan - Table 7.3.4.11

balance of development stabilized year - Table 7.3.4.12

(c) Group without technology capable of meeting the demand of the domestic market

(i) Cotton + sorghum + fruit trees + dairy farming + small-medium livestock

9ha (9ha) 4.5ha 9ha 18ha farming (sheep)

distributed land utilization plan - Table 7.3.4.13

balance of development stabilized year - Table 7.3.4.14

(ii) Cotton + sorghum + fruit trees + dairy farming + small-medium livestock

9ha (9ha) 9ha 18ha farming (goats)

distributed land utilization plan - Table 7.3.4.15

balance of development stabilized year - Table 7.3.4.16

(d) Indigenous group

(i) Cotton + small-medium livestock farming (sheep) + apiculture

0.9ha 6.3ha 5 groups

distributed land utilization plan - Table 7.3.4.17

balance of development stabilized year - Table 7.3.4.18

b) Suburbs of Asuncion

(a) Group having technology capable of meeting the demand of the domestic market

(i) Fruit trees + dairy farming

9ha 18ha

distributed land utilization plan - Table 7.3.4.19

balance of development stabilized year - Table 7.3.4.20

(ii) Fruit trees + vegetables

9ha 0.9ha

distributed land utilization plan - Table 7.3.4.21

balance of development stabilized year - Table 7.3.4.22

(b) Indigenous group

(i) Fruit trees

0.9ha

distributed land utilization plan - Table 7.3.4.23

balance of development stabilized year - Table 7.3.4.24

c) Livestock farming development plan area

In the livestock farming development plan area, a total of three farm management types are planned; two beef cattle specialized farm management types for large scale farmers and one combining small-medium livestock husbandry and apiculture for the indigenous people. The details of these types are described in the livestock farming plan.

Table 7.3.4.25 Comprehensive table for farming types (1/4)
Agricultural development plan area (1)

Note: Balance is calculated on the basis of stable farming years

Classification of settlers	Group capable of producing export farm products			
Farming type	Peanuts + cotton + sorghum + dairy farming	Short-term oil crops+sorghum+dairy farming	Perennial craft crops + dairy farming Dairy farming	Dairy farming
Number of family members	3.2	3.2	3.2	3.2
Number of family workers	2.5	2.5	2.5	2.5
Employed labour force	temporary (400/day), full time (0)	temporary (400/day), full time (0)	temporary (800/day), full time (1)	temporary (300/day), full time (0)
Land area size	200ha	200ha	200ha	200ha
Cultivation area size	peanuts (45ha), cotton (45ha), sorghum (90ha), grasslands (45ha), etc.	short-term oil crop (90ha), sorghum (90ha), grasslands (45ha), etc.	perennial craft crop(45ha), grasslands (94.5ha), etc.	grasslands (115ha), etc.
Number of livestock	parous cows 60, breeding cows 17, calves 6	parous cows 60, breeding cows 17, calves 6	parous cows 80, breeding cows 34, calves 7	parous cows 100, breeding cows 29, calves 9
Farming balance (US$1,000)	Gross income (77), (agriculture 37, livestock 39) Farming costs (51), (agriculture 26, livestock 25) Farm income (26), (agriculture 12, livestock 14)	Gross income (64), (agriculture 25, livestock 39) Farming costs (43), (agriculture 17, livestock 25) Farm income (22), (agriculture 8, livestock 14)	Gross income (106), (agriculture 54, livestock 52) Farming costs (56), (agriculture 25, livestock 31) Farming income (49), (agriculture 29, livestock 20)	Gross income (65), (agriculture , livestock 65) Farming costs (39), (agriculture , livestock 39) Farm income (26), (agriculture , livestock (26)
Machines to be used	Tractor, disk plough, disk harrow, wagon, seeding machine, broadcaster, digging machine, sterilizer, pumping machine, forage harvester, rotary cutter, electric generator, roller, fence tensioner, truck, cotton combine, peanut combine	Tractor, disk plough, disk harrow, wagon, seeding machine, broadcaster, digging machine, sterilizer, pumping machine, forage harvester, rotary cutter, electric generator, roller, fence tensioner, truck	Tractor, disk plough, disk harrow, wagon, seeding machine, broadcaster, digging machine, sterilizer, pumping machine, forage harvester, rotary cutter, electric generator, roller, fence tensioner, truck	Tractor, disk plough, disk harrow, wagon, seeding machine, broadcaster, digging machine, sterilizer, pumping machine, forage harvester, rotary cutter, electric generator, roller, fence tensioner, truck
Facilities	Watch house, farm tools, material warehouse, storage house, milking house, collar, fence, milker, bulk cooler, tajamar reservoirs, drinking pool, silo, windmill, water pipe, rainwater storage tank, ground tank	Watch house, farm tools, material warehouse, storage house, milking house, collar, fence, milker, bulk cooler, tajamar reservoirs, drinking pool, silo, windmill, water pipe, rainwater storage tank, ground tank	Watch house, farm tools, material warehouse, storage house, milking house, collar, fence, milker, bulk cooler, tajamar reservoirs, drinking pool, silo, windmill, water pipe, rainwater storage tank, ground tank	Watch house, farm tools, material warehouse, milking house, collar, fence, milker, bulk cooler, tajamar reservoir, drinking pool, silo, windmill, water pipe, rainwater storage tank, ground tank
Area targetted for development plan and number of settling households	eastern Mennonite settlements 100, southern Mennonite settlements 100, subtotal 300	eastern Mennonite settlements, 100 southern Mennonite settlements, 100 northern Pozo Colorado 100, subtotal 300	eastern Mennonite settlements, 20 southern Mennonite settlements, 10 northern Pozo Colorado,100 subtotal 30	eastern Mennonite settlements, 350 subtotal 350
Remarks	(1) Sorghum is cultivated as a secondary crop. (2) Combines are leased.	(1) Balance of short-term crops is based on that of sunflowers. (2) Short-term oil crops = sunflower, sesame, safflower and castor beans.	(1) Perennial craft crop = jojoba	