reproduction is approximately 38% or 2,923 cattle. (See Table 4.8.7.) Paraguay is adopting a breeding style to graze cows in huge natural grasslands throughout the year. There is some limit to the diffusion and expansion of AI (artificial insemination). It is estimated that more than 80% is reproduced by NS (natural service).

There are approximately 5,000 cattle of the pure variety which will become the bearers of improvement in the study area. It is generally said that approximately 5% of the total reproducing female cows is required as breeding stocks. There are 680,000 multiparous cows in the study area are as shown in Table 4.8.7. Percentage of the pure variety is less than 1%. Thus, the number of breeding stocks is substantially insufficient.

There is no data which show the number of breeders and their supply ability in Paraguay. However, there are 154 breeders associated with the Asociacion Rural del Paraguay in the whole Paraguay and 25 breeders in the study area.

(b) Selection of varieties and crossbreeding system

The major breeding stocks in Paraguay are Criollo, Nelore, Brahman, Santa Gertrudis, Hereford, Angus, Brown Swiss, Charolais, Chianina, Simmental, Gervieh, etc.

In Paraguay, crossbreeding is generally conducted between the European variety and Brahman or Nelore, and between Criollo and Nelore or Brahman. This is the result of the two breed crossbreeding rotation system aiming at the heterosis effect.

In the Comprehensive Report II of the "Livestock Improvement Plan in Paraguay" (JICA, 1985), Mr. Matsukawa who was in charge of breeding stocks proposed adoption of the three breed crossbreeding rotation system which bears a maximum of 87% of the heterosis effect in future as the two breed crossbreeding rotation system maintains only 67% of the heterosis effect.

In the case of dairy cows, the European-strain Holland and Jersey are crossbred with Brahman or Nelore to produce a variety with an anti-heat feature. In the Mennonite settlements in the study area, the diffusion rate of AI of the dairy cows is high. In the case of Loma Plata, the diffusion rate of AI including dairy cows has reached to 30%.

d) Productivity of beef cattle and prices

According to management efficiency indices of beef cattle production in Paraguay, on average, the reproduction rate is 50%, shipment rate is 12%, dressed carcass yielding percentage is 50%, the age at shipment is 3-4 years old, weight at shipment is 400 kg, and the age for reproduction is 2.5-3 years old.

In general, beef cattle are bred by grazing them in a large natural grasslands of 500 ha throughout the year.

In June-August in winter when the growth of grass stops, the absolute quantity of grass becomes insufficient. As the protein content in the fodder lowers, the weight of the cows decreases and the morbidity rate increases due to malnutrition. Thus, production efficiency of beef cattle is extremely poor. There are few stock farms which give condensed fodder and dried grasses to cows during the winter time when fodder becomes insufficient. Therefore, the daily weight gain until shipment is 0.2-0.25 kg and it takes four years until cows are fattened.

Due to malnutrition during the winter time, the reproduction cycle of female cows enters a state of hibernation and no estrus. When nutrition is improved from spring through summer, estrus returns and mating becomes possible. Thus, delivery takes place every two years, resulting in a low reproduction rate.

Sales price of beef cattle in the market has been on anincreasing trend in recent years (fig. 4.8.1). The number of bullocks, male cows, and female cows shipped to market, the total weight, average weight, and the average price per 1 kg of meat are shown in Table 4.8.12.

e) Diseases of cow

As for the sanitation of livestock in Paraguay, two organizations, SENACSA (Institute for Prevention of Infectious Diseases of Livestock) and LIDIAV (Livestock Sanitation Centre of the Ministry of Agriculture and Livestock) are in charge of preventing and diagnosing diseases. As for the division of functions between the two organizations, SENACSA is in charge of eradicating infectious diseases designated by law while LIDIAV is in charge of diagnosing, preventing or improving all disease other than legal infectious diseases.

It is said that Paraguay has almost all kind of diseases of cow except a few such as cattle plague and bovine contagious pleuropneumonia.

SENACSA designated foot and mouth disease of cow, brucellosis, rabies, and tuberculosis as legal infectious diseases, and is making efforts to establish a structure to control these diseases. It is also reviewing infectious anemia of horse, cholera of pig, New Castle disease of chicken, and tick control which are currently handled by LIDIAV as projects to be undertaken by SENACSA.

f) Dairy farming

According to the 1991 census, the number of farmers breeding dairy cows was 142,253 households. The number of cattle bred was 517,430. Among them, the number of milked cows was 320,136 and the daily output of milk was 116,000 liters.

The major varieties of dairy cows are Holstein, Brown Swiss, Criollo, and hybrids which are also beef cattle. In recent years, the number of F1 dairy cows, which was created by crossbreeding Holstein with Brahman and has the anti-heat feature, is increasing.

g) Apiculture

According to the 1956 Census on Agriculture and Livestock Farming, more than 60,000 swarms of honeybees had been kept then. In 1970, they were reduced to 5,000 swarms. The reason for the decline of apiculture in this country is an invasion of African bees from Brazil. Subsequently, with technological cooperation from Japan and Switzerland and cooperation from the American Peace Corps, apiculture has been promoted again. At present, it has been restored up to 20,000 swarms.

The major varieties are a crossbred variety of the African variety (Apis mellifera adansonii) and the Italian variety (A. m. ligustica). The Langstroth standard beehive is most popularly diffused. 90% of beehives in the country are of this type.

The sources of honey are the flowers and trees in forests. The cultivated honey sources are limited to oil crops and eucalyptus in the eastern region. The bees are cultured all on fixed lands; rotation apiculture is not conducted. Therefore, the annual honey output per swarm is 20-80 kg, having a great difference depending on the locations. According to a survey by the Ministry of Agriculture and Livestock, honey output in 1990 was 820 t (according to the 1991 census on Agriculture and Livestock Farming, it was 244 t). Besides this, 1.5 tons of royal jelly were produced.

h) Other livestock

The minor domestic animals for which the number bred is increasing in recent years

are pigs and chickens. While the number of pigs bred has been stagnant over the last two years, it showed a growth rate of 16-20% per year during 1985-1988. Pigs are mainly bred in the eastern region. The major producing provinces include Alto Parana, Itapua, Caaguazu and San Pedro. Production of chickens for both meat and eggs is mainly conducted in Departamento Central.

Many sheep and goats are bred in Departamento Presidente Hayes in the study area. The reason why there are many of them bred in the study area are because they are bred for the purpose of managing the vast grassland (to remove weeds and shrubs), for the purpose of allowing cash income for the indigenous people and landless farmers, and for the purpose of getting milk for self-consumption.

(2) Livestock farming in the study area

The study area forms a large beef cattle production area in Paraguay by utilizing the vast natural grassland. 22.7% of the number of cows bred in the country is bred in Departamento Presidente Hayes. The development plan in the study area cannot be considered without developing strategy using beef cattle.

As for livestock farming other than beef cattle in the Departamento, pigs and chickens occupy 1-2% share of the national total, and sheep and goats occupy 18% and 30% shares, respectively.

It is not exaggeration to say that the major part of the output of agricultural and livestock farming is derived from livestock farming. Among livestock farming, production of beef cattle occupies the major part.

a) Productivity of beef cattle and dairy cows

(a) Beef cattle

The field survey was conducted through interviews on reproduction and fattening management efficiency indices with regard to livestock productivity. The figures for indices in the study area, the Mennonite settlements, and the eastern region are as shown in Table 4.8.18. The subjects of survey were mainly stock farms where livestock was managed relatively well. However, there were some stock farms where management was poor, resulting in a high accident rate of calves.

Let's look at the productivity of reproductive cows from this survey:

(i) The average durable years are in the range of 8-11 years. The cows are bred for 10 years on average.

(ii) The interval of delivery is from 13 months to 24 months, manifesting a large difference by stock farm. In general, two deliveries per year are possible in the eastern region, and one delivery per year is possible in the Chaco region. The average interval of delivery in the study area is 15-16 months. Similarly, the reproduction rate is 50-90%, manifesting a large difference by stock farm.

(iii) The accident rate of calves and growing cows have large difference by stock farm, ranging from 1.5-45%. At stock farm where the accident rate is 45%, the lowest rate in the past was 20%. There are many miscarriage due to the fact that such reproductive diseases as campirobacteriosis bovina and trichomoniasis of reproductive cows prevail. The accident rate of calves is also high due to poor management after delivery. The result of survey shows that the accident of calves often takes place up to the weaning period, and that after they enter the growing and fattening period, accidents are reduced.

(iv) The first mating of the reproductive cow is conducted at the age of 18-36 months and between the weight of 290-360 kg, but this also manifests a large difference by stock farm. In the Chaco region, the first mating can be conducted earlier. The cows which are given condensed fodder during the growing period or are grazed in improved grassland can be mated at the age of two. The target weight at first mating is 300 kg.

(v) The calves are weaned at 7-8 months. There is not much difference by stock farm. However, there is much difference in weight at the time of weaning. When a calf is bred in a normal natural grassland, the weight reaches to 150-160 kg. When supplement fodder such as condensed fodder are given, the weight will exceed 200 kg.

Next, let's look at the productivity of growing and fattening cows:

(i) The growing and fattening period is 14-48 months after weaning with a large difference by stock farm. By growing in natural fields alone, growing and fattening requires four years. In stock farms where cows are grazed in improved grasslands or are given condensed fodder, cows are shipped 1.5 or 2 years after weaning.

(ii) The weight at shipment is over 400 kg except in one stock farm in the eastern region.

(iii) The daily gain during the growing and fattening period is 0.2-0.8 kg, manifesting a large difference depending on the stock farm. This is because fodder and environmental conditions are different depending on the respective stock farms.

(iv) Accidents during the growing and fattening period are few unless any disease takes place. They were in the range of 1-2%.

(v) It was difficult to assess the dressing percentage because cows are shipped to market. However, it was approximately 50% for bullocks.

(b) Dairy cows

The productivity of dairy cows in the study area is as shown in Table 4.8.19.

The productivity of dairy cows in Paraguay is low. With dairy cows which was crossbred between European variety such as Holland and the zebu varieties such as Brahman, the productive period is 8 -10 years. The first mating of the growing female cow is conducted at 15-16 months when the weight is 300-320 kg. The weight of the multiparous cow is 450-500 kg. The interval of delivery is 12-15 months. The annual milk output is 2,500-3,000 kg. These figures are obtained from improved dairy cows in the Mennonite settlements. The productivity is remarkably low when the farmer is milking the Criollo type of cow.

b) Production costs of dairy and beef cattle

While we tried to assess the production costs of dairy and beef cattle through interviews with farmers, it was difficult. According to the 1991 survey data by the Livestock Farming Fund, the beef cattle production costs in the study area is as shown in Table 4.8.20.

According to the survey data of the Loma Plata stock farm of BNF (Banco National de Foment), the profitability of dairy farming and beef cattle production in Loma Plata is as shown in Table 4.8.21. In dairy farming, the fixed costs, machine costs and condensed fodder costs occupy great weight among the farming costs. In beef cattle farming, the weight of fixed costs, machine costs, and interest payments is large.

c) Sanitation of livestock

It is difficult to secure sanitation of livestock in the study area because of its geographical conditions. In other words, as the area is surrounded by the Rio

Paraguay to the east and the Rio Pilcomayo to the southwest, the topography is flat, and drainage is thus poor. Also, since roads are not well developed, sanitation programs cannot be promoted in inland areas. Paraguay has signed a livestock disease prevention agreement with neighbouring Argentina, but since livestock frequently go in and out of the periphery of the Rio Pilcomayo, the agreement is often violated.

On the other hand, more than 20% of the number of cattle bred in Paraguay are bred in the study area. The area serves as a base for the supply of meat to the capital city of Asuncion. It also serves as a base for the supply of young cows to cow fattening areas in the provinces of Concepcion, San Pedro, and Caaguazu in the eastern region.

Therefore, it is difficult to eradicate foot and mouth disease in Departamento Presidente Hayes as well as in Departamento Ñeembucu in the eastern region. Therefore, a sanitation program is important in the study area from the economic viewpoint.

The study area is contaminated by legal infectious diseases such as foot and mouth disease, brucellosis, and rabies, as well as infectious anemia of horse. In addition, the problem of intestinal parasites is great.

As a sanitation program in stock farm, it is necessary (i) to install coral (?), (ii) to make the grazing area small to facilitate easier supervision, (iii) to conduct vaccination, (iv) to develop improved grasslands and thoroughly supervise the nutritional status of livestock, etc. The government is also required to render guidance and supervision so that these sanitation programs would be implemented.

d) Facilities in stock farms

(a) Facilities of beef cattle stock farms

(i) Fences

Fences are a facility for which large investments must be made in stock farms in Paraguay. For the main posts in the Chaco region, very hard trees such as quebracho, caranda, labon, palo rosa and algarrobo are used. The size of one grazing field is 500-600 ha, or 1,000 ha, depending on the stock farm as the size of stock farms in the Chaco region is large. In stock farm where improved grassland is developed, there are cases where grazing fields of 50-100 ha are made. The general structure of fence is composed of main posts (length: 2 m, the part on the ground: 1.4 m, the part in underground: 0.6-0.8 m) stuck in a

span of 5-8m, round steel wires (17/15) attached in three to five steps, three-four stays in one span (at an interval of 1.2-2.0 m). The tensioning is conducted at every 100-300 m.

(ii) Corrals

The corral is a facility essential for shipment of cows, sanitation management, and livestock management. The corral is usually made of wood such as quebracho in the same manner as the fence. It also has a weight meter, treatment frame, medical bath, vaccination centre, artificial insemination, riding facility, etc.

(iii) Drinking water facility

The tamajar is a drinking water facility made in consideration of natural conditions of the Chaco region. The tamajar is made by an excavator. The excavated soil is piled up along the sides of the tamajar, and a water tank (Australian-type) is installed. The tamajar may be used as a drinking fountain as it is. However, water is usually pumped to the water tank by a windmill, and the water tank supplies water to supply tanks installed at the respective grazing fields through PVC pipes (1 1/4ø).

(iv) Other facilities

In the study area, beef cattle are grazed throughout the year. Some breeders have cow sheds. However, the majority of stock farms do not have cow sheds. Buildings in stock farms include warehouses, hay storage, agricultural machine storage, material storage, housing units, etc. Since electricity has not been introduced to the study area except in the Mennonite settlements, large stock farms have their own electricity generating facility.

(b) Facilities in dairy farms

Dairy farms have milking facilities in addition to those of beef cattle farms. In the case of the Mennonite settlements, simple milking sheds are built to milk manually in the case of less than 20 cows. If the size reaches 20-30 cows, bucket milkers are introduced. In farming that exceeds 100 cows, there are cases where milking parlors have been introduced. Farmers who produce more than 500 liters of milk per day are introducing bulk coolers.

e) Apiculture

A survey on apiculture was conducted mainly with small-scale apiculture farmers

among the indigenous people in the La Herencia area, in the periphery of the Mennonite settlements, through interviews on the number of breeding swarms, melliferous plants, nectar producing period, breeding technology, production figures, etc. Concerning areas where apiculture may be potentially introduced in future, the varieties and distribution of grasses and trees which grow on slightly high lands and marsh zones in the area which are considered promising were confirmed through field surveys of mainly the peripheries of the Mennonite settlements, the Campo Aceval settlement, peripheries of Pozo Colorado. As a result of these field surveys, the following points were clarified:

(i) In the habitats of the indigenous people in the study area, apiculture has been diffused to some extent, and more than 800 swarms of honeybees are bred in the periphery of La Herencia alone. In the periphery of the Mennonite settlements, several hundreds of swarms are bred.

(ii) The farmers surveyed collect honey four times during the nectar producing period from September through April and produce more than 70 kg of honey per swarm. This output is twice the national average. The honey collected in the study area is of good quality, with a light amber color and a good flavor.

(iii) The honeybees are all bred on fixed land; the site is not transferred at all.

(iv) Varieties of superior melliferous plants such as algarrobo and green olive are distributed in relative abundance, mainly in locations which are not always inundated on slightly high lands within the study area. On the other hand, in marshes, water grasses such as water hyacinth and palms serve as major melliferous plants. Melliferous plants in marshes mostly bear flowers throughout the year.

(v) As crossbreeding with the African bee (Apis mellifera adansonii) has progressed, gregarization and violence have increased, making swarm management difficult.

(vi) Numerous wild swarms of bees inhabit the area. Local apiculturists catch these wild swarms, accommodate them in Langstroth beehives, an are introducing the European strain of queen bee and improving the variety.

(vii) As a result of the survey, it was confirmed that all of the beehives are of the improved Langstroth variety.

(viii) A JICA-sponsored mini-apiculture project is now being implemented.

It is planned that in the project mentioned in (viii), an experimental bee swarm will be bred in the grassland testing station of PRONIEGA in Pozo Colorado and collect basic data on apiculture in the Chaco region. Even if a swarm of bees is introduced within this year, the result of testing will be available only after next year. It is difficult to use the basic data of the mini-project for this survey.

(3) Survey of unit price of products and production materials and equipment

The indices of investment into basic facilities, agricultural facilities, machines and cows for livestock farming in 1992 at the Chortizer Agricultural Cooperative in the Mennonite settlements are as shown in Table 4.8.22.

When we surveyed the unit prices of products and production materials and equipment from another angle, they were as shown in Table 4.8.23.

4) Outline of stock farms surveyed and result of interviews with stock farm owners concerning Chaco Development

A total of twelve stock farms were surveyed. In connection with the areas of grasslands and fodder crops, labour in stock farm, farming area, productivity of beef cattle, sales of livestock products, facilities, farming machines, livestock management, development of grasslands, utilization management, etc. were surveyed.

When three stock farm owners were asked their opinions on the Chaco Development during survey of stock farm, they had the following opinions:

(1) How do you like to develop your land in future?

(i) The stock farms in Chaco are large-scale roughly managed farms. The farmers must think of making beef cattle management easier by making farming small scale to improve productivity;

(ii) they wish to improve forest and natural grassland-mixed areas to improve productivity;

(iii) they wish to expand production of own-made fodder by introducing superior grasses and fodder crops; and

(iv) development of stock farm should not be carried out in a hurry. Taking grassland development as an example, trees must be left to prevent coldness or heat for cows. Development must be carried out in such a way not to lose surface soil. The varieties

of grass to be introduced must be decided in consideration of current vegetation. It is important to carry out development by paying full attention to the above points.

(2) How the lower Chaco region should be developed.

(i) It is necessary to develop the infrastructure of the respective stock farms;

(ii) it is necessary to reinforce the testing and research organization in order to develop livestock farming in this area;

(iii) it is necessary to reinforce stock farms which carry out selection of breeding cows;

(iv) development should be based on dairy farming in the Central Chaco and beef cattle farming in lower Chaco;

(v) it is necessary to develop such infrastructure as roads and electricity in future in areas where agriculture and livestock farming are carried out. There is a need to establish a school for cowboys as there is none currently;

(vi) it is necessary to develop roads as soon as possible as their development is delayed;

(vii) a religious organization is trying to improve the lifestyle of indigenous people. It is said that the organization has acquired land of 10,000 ha for their settlement. This kind of program is considered to be the first step of developing the Chaco region;

(viii) the water volume of the Rio Pilcomayo has decreased. The number of wild animals which used to inhabit has also decreased. Development in consideration of environment is needed;

(ix) it would be helpful for stock farm owners if a settlement is established in Chaco and commodities are supplied from the settlement as a base. At present, they have to go to the Mennonite settlements or Asuncion just to buy bricks; and

(x) there are fewer schools in Chaco. Especially, there is no school for the children of cowboys to go to. In the periphery of Pozo Colorado, there is only one American mission school on the way to General Diaz (40 km from Pozo Colorado).

(3) Problems in managing stock farms

(i) It is difficult to control water in Chaco. Either excessive or less water is no good. The balance of water is bad in Chaco;

(ii) the groundwater cannot be used because the salt concentration is high. The usable water is less;

(iii) since there are many marshes, there are many parasites and disease-causing germs. The livestock sanitation costs are incurred;

(iv) at present, cows and bulls, calves and heifers cows are grazed all together in a large farm. Therefore, the improvement of cows is lagging behind. Since the farm is too large, investment in new fencing is required.

(v) high costs are incurred for weeding. When the father started farming, the whole field was grassland. Now, it has many shrubs harmful to livestock and a huge amount of costs are required to get rid of them. The entry of weeds is related to a decrease of water volume in the Rio Pilcomayo.

(4) Securing labour

(i) There is no problem in securing labour. This farm is not hiring Indios at all. The labour is procured from Concepcion in the form of part-time employment. When an Indio is hired, there is a problem of marriage. Also, if one Indio is hired, we have to look after his large family;

(ii) at present, we are hiring many Indios. The problem in hiring an Indio is that, if one is hired, we have to look after his 10 family members. Since there is a plan to place them in a settlement, if it is realized, we may dismiss them once and then re-employ them. There is no problem in securing labour.

(5) What should be the future of agriculture in Paraguay?

(i) In order to keep up with MERCOSUR, we have to produce quality meat. For this purpose, the conventional breeding method is not good. In order to improve meat, it is essential to develop improved grasslands and fodder fields, etc.;

(ii) Chaco produces a variety of products. But because of lack of water, output is unstable. It may be better to improve productivity with crops suitable to local features such as agriculture in the eastern region and livestock farming in the western region;

(iii) since impact from MERCOSUR is expected, there would be no need to grant subsidies, but the protection of producers is necessary. In Brazil and Argentina, seasonal fluctuation is large. In Paraguay, quality improvement is necessary.

Paraguay has less taxes and smaller production costs. However, manpower is more expensive than in Brazil.

(6) Do you have a plan to divide or lease your land?

(i) Since our farming size is too large, I am planning to transfer half of the farm to my sister and her husband next year.

4.9 TESTING, RESEARCH, AND AGRICULTURAL SUPPORT

4.9.1 Testing and research

1) Contents of study

The survey through interview and exchange of opinions were conducted to assess the status of consolidation of facilities and contents of testing and research at testing and research organizations related with agriculture and livestock farming in the study area and challenges and future plans of testing and research in the Chaco region by organizations related to testing and research of the Paraguayan Government so as to use them as the basis of formulating the Plan.

2) Results of study

The testing and research structure concerning agriculture and livestock farming in Paraguay is administratively supervised by the Agricultural Research Bureau and the Livestock Research Bureau of the Ministry of Agriculture and Livestock. However, in terms of organizational structure, the respective testing and research organizations belong to different ministries and agencies, and the country as a whole do not have a unilateral structure.

As testing and research structures in the field husbandry division, there are the Department of Agriculture of the University of Asuncion, National Institute of Agriculture (IAN), the Regional Agricultural Research Centre (CRIA), the newly established Chaco Central Experiment Station (EECC) as national organizations. The private organizations include the Integrated Agriculture Institute of Paraguay (CETAPAR) sponsored by JICA (Japan) and the testing organization attached to the Mennonite settlements. While these organizations are well developed with foreign assistance, they are unevenly located in the eastern region where agriculture is more advanced.

In the study area, there had been only the Chaco Central Agricultural and Livestock Farming Service (SAP) established by three agricultural cooperatives in the Mennonite settlements. There had been no national organization until recently. In 1992, the aforementioned Central Chaco Experiment Station (REECC) was newly established and made a big progress in the testing and research structure (for the structures of the respective organizations, see figs. 4.9.1-5).

The Central Chaco Experiment Station (EECC) is located in the Mennonite settlements, and completed the construction of Phase 1 facilities in 1992 with a donation by the German aid agency (GTZ) and now belongs to the Ministry of Agriculture and Livestock. It has

advanced facilities as a testing and research organization. It has a Phase 2 development plan and there is a plan to manage the research structure with experts dispatched from Germany for the time being.

The Paraguayan Government is positioning EECC as the central organization for agricultural testing and research not only in existing agricultural areas such as the Mennonite settlements, but also in the whole Chaco region. The direction of testing and research at the Station is to conduct testing and research closely associated with the region by assessing and analyzing the problems faced by agriculture in the region and adopting the intention of producers in the Mennonite settlements, etc. on the basis of establishing an agricultural production system having continuity on the assumption that the natural environment in the Chaco region will be maintained and preserved. The basic research themes raised for the time being are as follows:

(i) Development of a farming method suitable to the soil and water in the region (prevention of wind damage, maintenance of water in the field, prevention of salt damage, etc.)

(ii) Establishment of a land utilization method suitable to the condition of the dry area (maintenance of soil fertility, introduction of green fertilizers to prevent dryness in winter time, rotational cultivation for the purpose of stabilizing the cropping season.)

(iii) Introduction and development of substitute crops for existing major crops (Introduction of highly profitable crops in place of cotton and peanuts, aptitude testing, etc.)

(iv) Introduction of grasses and fodder crops and improvement of the productivity of grasslands (Introduction of new varieties of grass and new fodder crops, increase of output through improvement of cultivation technology, improvement of grazing power of the grassland, etc.)

(v) Development of the utilization of forest and farming lands such as agro-forestry (effective placement of forest and farming land and rotational utilization)

On the other hand, as for the testing and research structure related with the livestock farming, there are three testing stations which belong to the National Planning Department of the Livestock Technology Research and Diffusion (PRONIEGA) as national organizations, the livestock testing station of the Livestock Fund (FG), and the Institute for Prevention of Livestock Diseases (SENACSA). As private organizations, there are the livestock division

of the aforementioned Integrated Agricultural Institute of Paraguay (CETAPAR) and the livestock division of the Chaco Central Agricultural and Livestock Services (SAP). The country as a whole has a testing and research structure in this division weaker than the field husbandry division.

In the study area, there is the Chaco Livestock Experiment Station of PRONIEGA in Pozo Colorado. PRONIEGA is an organization which was established in 1969 with U.S. assistance with the objectives to conduct testing and research, develop technology, introduce overseas technology, train technicians, and diffuse technology to producers. Subsequently, Japanese experts are also dispatched under technological assistance scheme. It has made a number of achievements in testing and research so far. Its organizational structure is shown in Table 4.9.1. level of facilities is not necessarily sufficient for a testing and research organization, including those of the Chaco Experiment Station.

4.9.2 Support for Agriculture

1) Contents of the study

A survey was conducted to assess the contents of a variety of systems related to agriculture and livestock farming in Paraguay, the state of implementation of programs to support agriculture in the study area, and the state of consolidation of related facilities.

In order to use as a base material in drafting the agricultural support plan, survey through interviews and exchange of opinions were also conducted concerning directions of government policies concerning support to agriculture and problems in the Chaco region and its future directions.

2) Results of study

(1) Diffusion of agricultural technology

Diffusion of agricultural technology in Paraguay is under the supervision of the Diffusion Bureau (SEAG) of the Ministry of Agriculture and Livestock. As for its organizational structure, regional coordination offices (Coordinaciones Regionales) are located in seven regions in the country. In addition, supervisory offices (Supervision Zonal) are established in 18 areas at the Departamento level which supervise approximately 140 local diffusion centres (Agencias Locales).

Organizational structure is as shown in fig. 4.9.6. This diffusion organization has a total of approximately 570 personnel. Among them, diffusion workers who are directly engaged in diffusion activities are approximately 410 people.

Responsibility of SEAG includes not only the field husbandry division, but also the livestock farming division. However, the actual targets of diffusion activities are mainly small- and medium-scale farmers in the field husbandry division as livestock farming has been conventionally operated by large-scale farmers and there has been less need for them to depend on public organizations for the diffusion of technology. Therefore, most of the diffusion workers are in charge of field husbandry division. These workers are specialized in the respective crops. Therefore, the contents of their guidance are often limited to the area of cultivation technology of the respective crops. aforementioned National Planing Department of the Livestock Technology Research and Diffusion (PRONIEGA) is originally supposed to have the role of diffusing technology. However, due to a shortage of manpower, that role is hardly functioning at present.

SEAG's guidance is conducted mainly by mobile guidance. Due to fact that the number of diffusion workers is few, that they don't have mobility, and that farmers are not well prepared to accept guidance, it seems difficult for diffusion workers to conduct effective diffusion activities. In recent years, small- and medium-scale farmers are increasingly breeding livestock and are having increasing demand for guidance on livestock farming technology. Thus, guidance is given with cooperation of other organizations such as the Institute of Prevention of Livestock Diseases (SENACSA) in some areas.

The aforementioned diffusion structure of SEAG is organized mainly in the eastern region where farming is advanced. In the Chaco region which is the study area, the regional coordination office and the supervision office are not yet established. local diffusion centres are established only at two places; Benjamin Aceval in the suburbs of Asuncion and Campo Aceval adjacent to the Mennonite settlements (two workers). The greatest reason for this is that agricultural development in the Chaco region is lagging behind. In addition, the Mennonite settlements, which serve as the main body of the production area, have their own technological service organization (SAP) organized mainly by agricultural cooperatives, so that their dependence on the public diffusion structure has been little. This fact is deemed to be one reason for the delay in the establishment of SEAG's structure.

(2) Farmers' organizations

As for farmers' organizations in Paraguay, autonomous production organizations have been organized in Japanese and German migrants' settlements with the concurrent objective to form a settlement community from a relatively early stage. However, there has been no political initiative to organize general farmers. Rather, there was a period when a policy was adopted to suppress such organizations. Thus, there have been very

few organizations except that some were organized as a voluntary activity of religious organizations.

However, since the Law concerning Establishment of Unions (Law No. 349) was enacted in 1972, organization of agricultural cooperatives has been positioned as one of the major policies of the government, together with the agricultural reform system, with recognition that organizing farmers would form the basis of sound development of agriculture. preferential policies have been also promoted including preference to the import/export quota and guarantee of customs duty reduction or exemption for agricultural cooperatives. Thus, the government is positioning agricultural cooperatives as preferential organization in agricultural policy, and the Agricultural Cooperative Bureau (GC) of the Ministry of Agriculture and Livestock is taking initiative to organize them.

In addition, the Agricultural Diffusion Bureau (SEAG) and financial institution such as the Agricultural Credit Association (CAH) are also promoting organization of agricultural cooperative as part of diffusion activities or organizing the structure to receive agricultural financing. The Institute of Rural Welfare (IBR) is also promoting establishment of agricultural cooperatives as the condition to stabilize farming in the settlement.

However, the organization of agricultural cooperatives is not necessarily going on smoothly. As of 1992, the number of cooperatives related with agriculture and livestock farming and agricultural product processing is only 130 organizations with the number of members being approximately 36,000 people. While the organization rate of farmers are slightly higher in Departamento Itapua and Alto Parana in the eastern region where agriculture is advanced, it is only around 12% at the national level.

Among the present agricultural cooperatives, there are large-scale ones which combined the local community and production organization such as the Colonias Unidas, agricultural cooperatives in Departamento Itapua in the eastern region which has more than 3,000 members, and the three agricultural cooperatives in the Mennonite settlements. However, majority of agricultural cooperatives are small-scale with less than 100 members.

In the Chaco region including the study area, there are only a few organizations including the three agricultural cooperatives in the Mennonite settlements, an agricultural cooperative of sugarcane farmers in Benjamin Aceval in the suburbs of Asuncion, and another one being currently established in the Campo Aceval Settlement in the

neighbourhood of the Mennonite settlements. In the whole area, 18 settlements were organized by the Institute of Rural Welfare (IBR) in the past. However, those settlements have poor farming management as a whole, and no agricultural cooperative is yet formed.

On the other hand, there are approximately 20,000 indigenous people inhabiting in the study area and majority of them are serving as agricultural labourers or are engaged in self-sustaining farming. The Institute of Indigenous People (INDI) is in charge of improvement of their welfare and economy including settlement and farming development, and is promoting a program mainly focused on forming the community. The private organizations including religious organizations are also making efforts to organize them. However, due to their ethnic characteristics and difference of living customs, organization is delayed. However, in the indigenous habitats within the Mennonite settlements, six cooperative organizations (ASCIMs) have been formed under the support of the Mennonite settlements and are conducting modern agricultural production activities.

Other types of farmers' organizations include the Association of Farmland Owners (ARP) composed of large-scale livestock farmers and the Credit Users Association (AUCA) organized by the Agricultural Credit Association (CAH).

(3) Agricultural credit

There are three public financing organizations related to agriculture and livestock farming in Paraguay: the National Bank for Industrial Development (BNF), Agricultural Credit Association (CAH) and the Livestock Farming Fund (FG). Besides these, some leading agricultural cooperatives may loan their own funds or sub-loan funds obtained from other sources. The Institute of Rural Welfare (IBR) may finance initial fund to settlers with a long-term low interest rate (rate: 10-20% for a period of approximately five years). There are private organizations such as a savings and credit cooperative which include some organizations by farmers.

Among the three public organizations, the National Bank of Industrial Development (BNF) is the organization which is in charge of financing industrial development as a whole in the country. It loans its own fund and also conducts a two-step loan by receiving loans from international financial organizations or foreign assistance. Concerning the agricultural and livestock farming sector, it provides general loans to farmers and finance agricultural projects by the government.

The major kinds of finance by BNF are as follows;

* Short-term fund for production of crops or farming (own funds: financing period of less than one year, interest rate: 26%)
* Long-term funds for specific governmental projects (funds from international organizations: Financing period of five years, interest rate: 28%)
* Long-term funds mainly for improving farmers' facilities (sub-financing funds from OECF, etc.: financing period six years, interest rate: 28%)

In most cases, the land owned by farmers is secured as collateral for loans. In the case of settled farmers, the title deeds to the land issued by the Institute of Rural Welfare is secured as collateral.

The Agricultural Credit Association (CAH) is a financial organization under the supervision of the Ministry of Agriculture and Livestock and provides funds for small- and medium-scale farmers who are ineligible to borrow from BNF, etc. As the condition for loans, farmers are required to join the Credit Users Association (AUCA). The types of loan offered by the Credit Association include short-term loans for the purchase of materials, employed labour, sales expenses, etc. by respective crops by year, and long-term loan for farming investment such as purchase of machines, construction of facilities, purchase of livestock, development of farming land, etc. The loan interest rate is slightly more favorable than that of BNF financing. The collateral condition is the same as that of IBR.

The Livestock Fund (FG) is an organization established with the objective of financing corporations and producers connected with livestock farming. It is jointly managed by the National Central Bank (BCP) and the Asociacion Rural del Paraguay (ARP) which is an organization of livestock farmers under the supervision of BCP. This organization undertakes loan activities as well as having its own testing and research facility, developing livestock farming technology, and verifying its economics. The Chaco region which is the study area is designated as a priority area and approximately 40% of outstanding loans are given to farmers in this area. The types of FG loan are short-term loans within one to two years for breeding and raising livestock, and long-term loan within four years for purchase of breeding cows and construction of facilities, etc. The interest rate is at the same level with that of BNF. While these organizations conduct financing activities, they also provide farmers with management guidance concerning utilization of funds.

(4) Other forms of support to agriculture

a) Supply of seeds for farming

Concerning supply of seeds for farming in Paraguay, the National Seeds Service (SENASE) is established with the objective to increase production of strategic crops for export through supply of superior seeds, save foreign exchange through domestic production of seeds, and provide farmers with support to production technology to improve productivity. This organization is supplying seeds of beans, peanuts, rice, corn and wheat which are the major crops in Paraguay as well as green beans, safflower, green peas, and vegetables. As shown in fig. 4.9.7, it has a seeds inspection facility in its headquarters at San Lorenzo and a storage warehouse in Departamento Misiones in the southeastern region. It consigns the production of seeds to farmers and seed producers and select them, and also import them from overseas to supply to farmers. The production figures of major seeds in 1991 are at the levels of 1,900 t of cotton, 16,000 t of beans, 14,500 t of wheat, and 113 t of corns. Production of seeds of peanuts and rice is very few.

At present, it does not have sufficient supply capacity against the nationwide demand of seeds. However, according to the "Plan to Strengthen Production of Major Crops" under technological assistance from Japan, it is reinforcing tie-ups with testing and research organizations concerning procurement of original seeds and development of inspection, selection and storage facilities.

The leading agricultural cooperatives such as the ones in the Mennonite settlements are organizing their own seeds production and supply structures, and are importing seeds directly from overseas. Majority of seeds for fodder grasses are currently depending on import by private importers.

b) Sanitation and disease prevention of livestock and supply of breeding stock

Paraguay is a place where many infectious disease of livestock including hand and mouth disease are taking place. Concerning the sanitation of livestock, there are the Institute of Prevention of Livestock Diseases (SENACSA) which is in charge of preventing legal infectious diseases and the Livestock Sanitation Centre (LIDIAV) of the Ministry of Agriculture and Livestock which is in charge of general diseases of livestock.

The organizational structure of SENACSA has 124 facilities such as regional research centres, local disease prevention centres, and service stations under the supervision of the seven regional coordination offices throughout the country. There

are 34 facilities in the Chaco region including the study area. Its responsibilities include guidance on infectious diseases, vaccination, diagnosis and guidance on treatment when the disease takes place, inspection, disposal and mobile supervision of sick livestock, etc.

The Chaco region is an important livestock farming area which breeds 30% of the total heads of livestock in the country. Since it is facing the border with Argentina, it is designated as an important area in terms of disease prevention and sanitation. However, as the land is vast and the traffic network is not well developed, disease prevention is difficult.

The reproduction and variety improvement of livestock are mainly based on natural mating by breeding cows as beef cows, which are the major livestock, are bred by natural grazing. The artificial insemination is limited to some of dairy cows.

As a public organization to supply breeding cows, there are the Balerito Breeding Stock Farm of the Department of Livestock Development Planning of the Livestock Bureau of the Ministry of Agriculture and Livestock (PRODEGA) and the Livestock Artificial Insemination Centre (AI Centre) which is a sub-organization of PRODEGA. The supply of breeding cows by these public organizations is only around 600 per year. The majority of breeding cows are supplied by 154 private breeders in the country. Among them, there are 25 breeders in the Chaco region. Supply of semen for artificial insemination by the AI Centre is only around 40,000 tubes per year. The supply capacity of breeding cows and semen in the country as a whole is not sufficient. This is also one factor of the delay in livestock improvement.

4.10 REGIONAL DEVELOPMENT

1) Contents of study

Materials were collected and interviews were conducted with related organizations concerning social infrastructure, settlement, small-scale farmers and indigenous people which are required to draft the rural development plan (social infrastructure) and the settlement plan. The field survey was conducted in the study area to assess the status of these aspects, status of development of social infrastructure in the study area and its peripheral areas which are estimated to be suitable for farming land, and judge their aptitude as settlement areas. This survey was consigned to the Institute Paraguay del Indigena (INDI). The basic policy to formulate the rural development plan and settlement plan was discussed with the Paraguayan counterpart.

2) Result of study in the study area

(1) Social infrastructure

The social infrastructure of Paraguay adopts a pattern in which agricultural development follows industrial development. Since the study area has harsh natural and traffic conditions, i.e. (i) The gap of precipitation is large, (ii) The irrigation water is insufficient, (iii) The soils are inferior, (iv) The water for living is insufficient, (v) The salt concentration of groundwater is high, (vi) Since the topography is flat, drainage is poor in many areas, (vii) It is far away from the marketplace, etc., agricultural development and social infrastructure are very backward except in the suburbs of the Mennonite settlements located in the central Chaco region.

(i) As for medical centres, there are one public regional central hospital that supervises the medical services in the area, five central clinics under it, and 15 sub-clinics under them, totaling 21 facilities (3.9% of the national total). In addition, there are three private clinics. The medical facilities are narrow, and are extremely old; The medical facilities and medicine are insufficient. The number of medical doctors and nurses is also low. The number of public medical facilities is shown in Table 4.10.1. Their locations are shown in for fig. 4.10.1.

(ii) As for the schooling system, there are 14 kindergartens (12.3% of the national total), 102 primary schools (2.3% of the national total), 16 junior high schools (2% of the national total), and 11 senior high schools (1.9% of the national total). The educational facilities are extremely old, and for educational equipment, teaching aids, and the number of teachers are insufficient. The number of teachers by school and the number of students are shown in Table 4.10.2.

(iii) As for for communication facilities, a cable communication facility is installed only in the suburbs of Asuncion. Other areas use microwave communication which is becoming the mainstay in recent years. There are seven wireless stations. In addition, the military and some farmers have radio communication facilities. The number of users are a total of 705 in eight areas. Since there are only seven communication facilities in the vast area, the scattered residents have an extreme inconvenience. The locations of communication facilities are as shown in fig. 4.10.2.

(iv) The only electrified areas are the suburbs of Asuncion and the Mennonite settlements, which generate and transmit their own electricity. The number of households which are electrified is 4,418 households in six areas (1% of the national average) with a distribution network of 51,585,000 kWh (2% of the national average). The inhabitants scattered around the study area except some farmers who have their own power generators are forced to have inconvenience. The electrification network of the study area and its peripheries is as shown in fig. 4.10.3.

(v) The number of households having piped water is 742 households in three areas (1.4% of the national average). The per capita water supply is 80-150 l. The locations of piped water installation are as shown in fig. 4.10.4.

(vi) 20 units of public housing were constructed in Villa Hayes (in 1990). The average housing area is approximately 50 m2 per unit.

(2) Settlement

The settlement activities in Paraguay are being conducted by the Institute of Rural Welfare (IBR) which was established on the basis of the Law concerning Establishment of the Institute of Rural Welfare (enacted on March 29, 1963). The major objectives of IBR is to gradually abolish large and small farmlands and replace them into a fair system of land ownership and utilization, reform the agricultural structure of the country through rational means of solution, and effectively let the rural population participate in the economic and social progress of the country. As the means to solve these, IBR is to distribute land fairly, give financing, protect appropriate organizations of production and merchandising, guarantee their freedom and dignity, and fully support rural producers in order to achieve economic stability which is the basis of social welfare. IBR is conducting settlement activities on the basis of the Law concerning Establishment of the Institute of Rural Welfare and the Farmland Law.

There are 18 settlements (2.6% of the national total) in the study area. Their land areas

are 1,094,124 ha (12.5% of the national total). The number of lots are 3,016 (1.9% of the national total) and the average allotment area is 355 ha per lot. The allotment area per household is approximately 10 times of the average national allotment area reflecting the natural conditions. Since existing settlements except some of them in the suburbs of Asuncion and in the vicinity of the Mennonite settlements have harsh natural and traffic conditions, there are many farmers who leave farming or transfer to other areas, and some of them are not remaining the form of the settlement. The land area per settlement and the number of lots are as shown in Table 4.10.10. The locations of settlements are as shown in fig. 4.10.6.

(3) Human resources

a) Farmers

The management bodies of agriculture and livestock farming in Paraguay are generally positioned as follows:

(i) Self-consumption farming: to cultivate cassava, poroto beans, corn, etc. mainly for self-consumption and keep small and medium-sized livestock such as chicken and pigs. This is the traditional farming of farm owners group of less than 10 ha who occupy the majority of agricultural and livestock farmers.

(ii) Full-time monoculture: large-scale monoculture cultivation of beans and wheat through utilization of machines, and most of the farms are cultivated. Many of the farmers are settlers from overseas. The size of 50-1,000 ha.

(iii) Concurrent management of field husbandry and livestock farming (including diary farming): ranging from nearly self-consumption to mainly livestock farming. This has been noted as the new form. The size: 20-1,000 ha.

(iv) Estancias (large-scale stock farms): the traditional grazing livestock farming based on the natural grazing form. The so-called "Hacienda" (in Latin America after the 17th century, combination of large land ownership and Indio labour supplied cereals and meat to sustain the regional economy). Size: more than 1,000 ha.

The total number of farming households in Paraguay, according to the 1991 Agricultural and Livestock Farming Census, is 307,221 households. Among them, the number of small-scale farmers is 247,616 households (approximately 81%). In addition, the number of landless farmers is 7,962 households (approximately 3%).

The total land area owned is 23,818,000 ha. Of these, the land area owned by small-scale farmers is 1,469,000 ha (approximately 6.2%, average: approximately 6 ha per household).

The small-scale farmer in Paraguay is defined as follows: (i) the annual income is less than US$2,000, (ii) the income must be also obtained from agriculture and livestock farming; (iii) the land area owned is less than 20 ha; and (iv) they do not have the technology to produce crops that can be marketed. Therefore, this plan will adopt the above-mentioned definition.

The total number of farming households in the study area (excluding the Mennonite settlements) is 3,484 households. Of these, the number of small-scale farmers are 955 households (27%). Landless farmers comprise 211 households (6%). The total land area owned is 6,710,000 ha. The land area owned by small-scale farmers is 5,556 ha (approximately 0.08%, average: 6.0 ha per household). Small-scale farmers have difficulty in becoming self-reliant as full-time farmers due to the harsh natural and social conditions and lack of technology. Most of them are part-time farmers who also work as seasonal agricultural, factory and construction workers.

In the Phase 2 survey, a questionnaire survey was conducted to assess the status of small-scale farmers who are resident of the study area and a small-scale farmers in adjacent areas who are potential human resources as candidate settlers. The area of survey were the suburbs of Asuncion, the settlement along the Rio Pilcomayo and the Departamentos de San Pedro and Concepcion along the east coast of the Rio Paraguay. The number of subject farmers was 20 (for the items of survey and the results of survey, refer to 1.10 in Chapter 1 of the Appendix).

b) Indigenous people

According to the Articles of Incorporation of the indigenous people' Community executed in December 1981 and the new Constitution enacted on June 22, 1992, it is stipulated that the Government recognizes the existence of indigenous people, gives lands to them free of charge, guarantees their right to participate in social, economic, political, and cultural activities in the country, and prevent decrease of their population, destruction of their living environment, economic exploitation of them, and loss of their culture.

The number of indigenous people' population in the study area is approximately 20,000 (51.9% of the national total, approximately 4,000 households) composed of

seven ethnic groups in 93 locations. Their birth rate is 3.4% (same as the national average). Most of their habitats are roadless undeveloped interiors. Thus, they are forced to have uncultural lives. As their living and medical conditions are extremely inferior, the mortality rate of infants below the age of two is as high as 26.6% (the national average is 5%).

Most of the indigenous people speak their own language and have culture and customs different from those of the general people, have difficulty in maintaining exchange, social and economic harmony with other ethic groups.

The number of communities (According to the Articles of Incorporation of the Indigenous Communities, Law No. 904/82, the community is defined as a group of family who has a common culture, language and living environment) within the study area are 26. Among them, eight communities own a land area of 46,959 ha. Most of them cultivate crops for their own consumption and keeping some livestock. The land area per community is as shown in Table 4.10.15. The locations of communities and habitats are as shown in fig. 4.10.7. The locations of communities which own lands are as shown in fig. 4.10.7.

As a result of a survey on awareness of indigenous people (Estudio de intenciones y espectativas de la poblacion Indigena del departamento de Presidente Hayes 1991: JICA), 85% of the indigenous people are engaged in agriculture and livestock farming. However, their technological level is extremely inferior to that of other small-scale farmers. Approximately 90% of them wish to live in theircurrent habitats and approximately 90% of them wish to be engaged in occupation related to agriculture and livestock farming.

The outline of the survey on awareness of indigenous people is as follows:

(a) Survey of awareness of the indigenous people

Since there are approximately 20,000 indigenous people living in the study area, how the indigenous people should participate in the agricultural development plan is an issue. Therefore, it is important to assess the status and intention of the indigenous people. While the survey on the status of the Indios in Paraguay conducted under the United Nations assistance in 1981 (Censo y Estudio de la Poblacion Indigena del Paraguay: INDI) is the latest material, it hardly surveyed the life, culture, intentions, etc. of indigenous people. The indigenous people are said to have unique society, mostly living in roadless undeveloped interiors, have

the language of their own ethnic group, and unique culture and customs. Therefore, the survey on the status of Indios within the study area was conducted by consigning it to the Instituto Paraguayo del Indigena (INDI) which is the governmental organization in charge of the affairs of Indios.

(A) Subjects of survey

In the study area, there are seven ethnic groups which form many villages throughout the area. Therefore, from the estimated population and habitats, a total of 135 families (number of family members: 677 persons) from 27 areas, i.e. 8 families from Angaite (3 areas), 75 families from Lengua (10 areas), 11 families from Maka (4 areas), 16 families from Nivakle (5 areas), 9 families from Sanapana (2 areas), 6 families from Toba Maskoy (2 areas), and 10 families from Toba Qom (1 area)were selected. In addition, the chiefs of 13 villages (El Eatribo, Sombrero Piri, Makathlawaiya, PTO. Colon, Pozo Amarillo, Armonia, Quenkuket, Llamakaset, Coop. Hope, Loma Pyta, Casanillo, Cerrito, and Samaria) were interviewed on their general intentions. The ethnic groups subject to the survey and their areas are as shown in Table 4.10.16. The locations of survey are as shown in fig. 4.10.7. The survey form is as shown in Table 4.10.17.

B) Results of survey

The major results of survey are as follows:

(i) The number of family members is a maximum of eight and a minimum of three, and an average of 5.

(ii) The villages which own lands are only three (11.1%).

(iii) The languages always used are: Lengua: 27.9%, Spanish: 21.8%, Guarani: 21.0%, Nivakle: 9.3%, Maka: 6.1%, Toba Qom: 4.2%, Sanapana: 4.0%, Toba Maskoy: 3.9%, Angaite: 1.8%. Those who cannot read nor speak Spanish occupy 58.6% of the total.

(iv) The major occupations are agriculture (30.9%), agricultural labourer (18.7%), textile-related (16.3%), apiculture (12.2%), livestock farming (7.3), agriculture and livestock farming (6.5%), and transportation (3.3%). Other occupations include cultivation of fruits and vegetables, teachers, log cutters and employees of the agricultural cooperative. (v) The families having toilet occupy 76.5% (concrete: 4.2%, ground dug: 72.3%). The families having no toilet occupy 23.5%.

(vi) The sources of drinking and living water are the tamajar (37.0%), well (23.7%), rainwater (23.0%), lake (8.2%), river (5.9%), and spring (2.2%).

(vii) The villages which have medical doctor, nurses, beds and nurse aids are 11.1%, 29.6%, 25.9%, and 51.9%, respectively. The villages having no medical doctor has an average distance of 102 km to a place where a doctor is available.

(viii) The number of families which lost their children represents 34.8%. The number of children died is 75. Those below 5 years old are 69 (92%). The major causes of death are unknown (68.4%), dehydration (9.2%), diarrhea (7.9%), respiratory diseases (5.3%), and measles (2.6%). Other causes include liver diseases, infectious diseases and tetanus.

(ix) The materials for housing: For the wall, palm (45.5%), animal skin (31.4%), bricks (13.2%), timber (6.6%), and tent (1.7%). For the roof, tin-plate (27.7%), palm (26.9%), straws (25.4%), slate (13.1%), and tiles (6.2%). As for the number of rooms, one room is 6.7%, two rooms 24.2%, and more than three rooms 9.1%.

(x) As for the number of years living in the same habitat, more than 10 years is 47.7%, 4-10 years is 33.9%, 2-4 years 13.8%, and less than two years 4.6%. The families who wish to live in the same habitat occupy 90.2% with those who do not wish so representing 9.8%.

(xi) The annual income per family is 771,000 Gs. for agriculture, 714,300 Gs. for a labourers, 254,700 Gs. for handicrafts, 254,200 Gs. for apiculturist, 181,500 Gs. for hunters, and 120,000 Gs. for fishers.

(xii) The average area of cultivation by crop is 2.13 ha for cotton, 0.38 ha for corn, 0.29 ha for cassava, 0.27 ha for peanuts, 0.25 ha for sorghum, 0.22 ha for poroto, 0.22 ha for watermelons, and 0.1 ha for castor beans.

(xiii) The occupation desired in a future are 72.3% for agriculture, 7.9% for a driver (tractor), 6.9% for apiculturist, 5.9% for teacher, 4% for livestock farming, and 3% for handicraft making.

(xiv) Problems in life (wish) are transportation (38.7%), hospital (20.4%), drinking water (16.9%), electricity (10.9%), school (7.1%), entertainment facility (3.6%), meeting place (2.4%), etc.

(xv) Problems in farming are funds (18%), farming diffusion (17.7%), farmland (16.4%), machines (11.9%), water for farming (10.3%), farming testing (7.8%), transportation (7.7%), seeds (7.3%), salt content (2.9%), etc.

(xvi) The matters necessary for improving a life are a land ownership (17.4%), support for farming technology (10.3%), farming finance and support for farming machines (8.8%), procurement of job (8.3%), establishment of hospital, etc. (5.8%), support for foods, seeds, farming tools, etc. (5.4%), improvement of labour conditions (5.0%), improvement of labour

conditions (5.0%), overall assistance (4.5%), support for housing (3.3%), support for education (2.9%), support for handicraft making (2.5%), etc.

(xvii) Among the 13 areas, those which received assistance are seven areas. The contents of assistance received are technology (31.3%), funds (25%), machine, cows, and horses (12.5%, respectively), and industry (6.2%).

c) Unemployment

The Farmland Law stipulates that those who are older than 18 year and who are engaged in agriculture and livestock farming, and have the will to do so, regardless of their nationality, can become a settlers in agriculture and a livestock farming. From this provision, there is a possibility to take a unemployed workers who have the will to be engaged in agriculture and livestock farming into this plan. The number of labourers in Paraguay as of 1991 was 1,412,000. Since the unemployment rate is 7%, the number of unemployed is approximately 98,800 persons.

Therefore, a farmers, indigenous people in the study area, small-scale farmers, landless farmers and unemployed throughout the country are considered as a potential human resources for development.

(4) Land ownership

The Farmland Law and the new constitution enacted on June 22, 1992 stipulate the promotion of fair distribution and ownership of land, restraint of the large farmland system, development of small and medium-sized farmlands, consolidation of a variety of support to farmers, and reform of the agricultural structure.

The total number of farmers in the study area is 4,215 households with the land area owned being 7,008,000 ha. The number of landless farmers is 211 households (approximately 5%). The number of small-scale farmers (with the land area of less than 20 ha is 977 households (approximately 23%). The number of farmers who own more than 1,000 ha is only 884 households (21%, 0.9% of the national total) among a farmers in the study area, but they own 93.5% of the lands within the study area. The ratio of farmers who own a large land area is high compared to the national average.

4.11 FACILITY PLANS AND DESIGN CALCULATION

1) Contents of study

The survey through interviews and material collection were conducted by visiting mainly people related with agricultural processing in the Mennonite settlements, industry-related people in the peripheries of the study area, local farmers, and related bureaus of the Ministry of Agriculture and Livestock concerning the status of development of agriculture-related facilities and agricultural processing facilities, status of production and their management and operation.

On the basis of the installation plans of testing and research and agricultural support facilities and agricultural processing facilities, reference design drawings were obtained from the related bureaus of the Ministry of Agriculture and Livestock, and precautions in design and design conditions were asked. The interviews were conducted with construction-related people to assess the approximate project expenses of these facilities.

2) Results of study

(1) Status of agriculture-related facilities

(i) Seed supply facilities

In the Mennonite settlements, the Central Chaco Agricultural and Livestock Farming Service (SAP), the agricultural research and diffusion organization in the settlement, produces seeds through contracted producers, and supplies them to farmers through agricultural cooperatives. Other farmers purchase the quantity of seeds necessary for the planting season from brokers who buy their crops.

(ii) Fertilizers supply facilities

Since farmers in study area do not generally use fertilizers, there is no fertilizer supply facility.

(iii) Agricultural machine facilities

In the Mennonite settlements, individual farmers generally own agricultural machines, but some cooperatives adopts the method of joint utilization.

(2) Status of agricultural product processing facilities

The agricultural product processing facilities in the study area exist in Villa Hayes and Benjamin Aceval in the southern part of the area and the Mennonite settlements in the northern part of the area. The agricultural product processors in the southern part of the area are a sugar refinery and small-scale alcohol factory. In the Mennonite settlements

in the northern part, milk and dairy products processing, cotton, oil squeezing, and fodder mixing factories are concentrated.

(i) The dairy product processing industry in Paraguay developed later than in neighbouring countries. Production by cooperatives in the Mennonita settlements was put on the right track in the 1980's and built up to the present basis. Among the total outputs of dairy products in Paraguay, production by cooperatives in the whole country represents 70%. The milk produced is mostly consumed in the form of milk. The ratio of processed products like cheese is low.

(ii) Cotton processing industry

The cotton processing industry in Paraguay has been growing by approximately 20% every year. In 1990, production exceeded 800,000 tons (???). There are 48 cotton processing factories in the country (1990). The processing capacity per hour is 268 tons. Since cotton processing factories continuously operate during the harvesting season in a concentrated manner, the number of operating days per year remain around half a year.

(iii) Oil squeezing industry

There are 31 major oil squeezing factories in Paraguay. They are located in the eastern region and in the suburbs of Asuncion. The major raw materials are beans and cotton seeds, followed by coco (a kind of palm naturally grown in Paraguay). Squeezing oil from peanuts is very little. The daily production capacity is 4,600 tons for beans and 4,000 tons for cotton seeds. The output is said to be generally 50-60% of production capacity.

(iv) Meat industry

The number of cows slaughtered in Paraguay for export amounts to 500,000 per year. The meat industry occupies an important position among export industries. There are approximately 100 slaughter houses in the country. Most of them are small-scale facilities for the domestic market. The facilities for slaughtering cows for export are called packers. They conduct consistent works from slaughtering, cutting, freezing to packing. There are 10 packers in the country. The packers who have a license to export to Europe are only four. The large-scale meat processing plant has geographical constraints and needs to satisfy a number of conditions. Therefore, they are concentrated along with the Rio Paraguay in Asuncion.

(3) Status of agricultural product processing facilities in the Mennonite settlements

The agricultural product processing facilities managed by agricultural cooperatives are concentrated in the Mennonite settlements. The outline of facilities by the respective agricultural cooperatives is described as follows:

a) Loma Plata Agricultural Cooperatives

(i) Milk and dairy product factory

The Loma Plata Agricultural Cooperative has 1,000 dairy farmers and collects 40,000 tons of milk per year. The factory was constructed in 1955 mainly to produce cheese. Its size was expanded in 1987 to start manufacture and sales of LL milk. The current factory was subsequently expanded to have a processing capacity of 70,000 tons per year. The factory is made of bricks with tiles plated in the interior, and is a sanitary facility. The production capacity of the factory is as follows:

* LL milk		150,000 l/day (capacity)
		90,000 l/day (operation)
* Sterilized milk (good for three days)		40,000 l/day (capacity)
	Winter:	18,000 l/day (operation)
	Summer:	30,000 l/day (operation)
* Yogurt		3,000 l/day
* Cheese		7,000 l/day
* Condensed milk		1,500 l/day

(ii) Cotton processing factory

The cotton processing factory was established in 1952 and was expanded in 1980. The factory's capacity is 18,000 tons. However, the recent figure of acceptance remains to be approximately 6,400 tons. The factory starts its operation during the harvest season in February and operates continuously until raw materials are depleted. Usually, operation is completed in August, whereupon the factory is closed. The factory facilities are composed of a material warehouse, cotton processing site, product warehouse, and by-product warehouse. The percentage of the warehouse is large. The structure of the facility is of tingrade.

(iii) Mixed fodder factory

The factory was built in 1990 with finance from BNF. There are seven silos using existing facilities; they can store up to 3,000 tons. The manufacturing capacity is 10 tons per hour. It can run seven hours a day and 260 days per year, and can produce 18,000 tons per year. The Loma Plata Agricultural Cooperative has a

plan to supply mixed fodder not only to dairy farmers under its jurisdiction, but also to other farmers in peripheral areas in future. The raw materials for fodder are sorghum (90%) and others (such as corn, cotton seed grounds, 10%).

(iv) Oil squeezing factory

The factory was set up for squeezing oil from peanuts and cotton seeds. The factory has three squeezing machines. The capacity is 45 tons/hour with one squeezer and seven tons per hour with two squeezers. The daily manufacturing capacity is 5,000 liters with peanuts and 1,500 liters with cotton seeds with an annual capacity of approximately 1,200 tons. However, production figure remains to be 400 tons. The products are all consumed within its jurisdiction.

(v) Other agricultural product processing

The peanut shelling factory has a capacity of 6 tons per hour and is processing 100 tons per day. The products are exported to Europe as material for snacks via Asuncion. In addition, there is the palo santo essence extracting factory. The products are exported to Europe and the U.S.A. as material for cosmetics.

b) Neuland Agricultural Cooperative

(i) Mixed fodder factory

The factory was built in 1981 for self-consumption within the jurisdiction of the Neuland Agricultural Cooperative. The factory has one cutter, one mixer, and five silos (1,250 tons). The processing capacity is 1 ton per hour. The production of 1,500 tons is possible in a year. The current output remains to be 700 tons per year.

(ii) Oil squeezing factory

At present, 94% of peanuts are shipped as nuts and the remainder is squeezed for oil for consumption within the jurisdiction. The factory has two units of oil squeezers made in 1950. The manufacturing capacity is 400 liters per day and 500 tons per year.

c) Fernheim Agricultural Cooperative

(i) Milk and dairy product factory

This factory was built in 1940 under joint investment with the Fernheim Agricultural Cooperative. Subsequently in 1982, its size was expanded. The LL milk is not produced here. The milk processing capacity is 50,000 liters per day. At present, the factory is allegedly operating beyond its capacity. There is a plan to expand the facility to produce 100,000 liters. When it is completed, it will have a capacity three times as much as the current capacity. Percentage of processed

products such as cheese is higher than that of the factory in the Loma Plata Agricultural Cooperative.

* Sterilized milk (good for three days)	35,000 l/day
* Yogurt	10,000 l/day
* Cheese	25,000 l/day
* Condensed milk	1,000 l/day

(ii) Cotton processing factory

The cotton processing factory started its operation in 1948. Its size was expanded in 1983 through 1984. The capacity of the factory is 6,250 tons per year, but the size of the current production remains to be half of it.

(iii) Oil squeezing factory

The capacity is 2 tons/hour with peanuts and 1 ton with cotton seeds. It produces only for consumption within the jurisdiction. Therefore, it operates only for one month in a year.

(4) Facility Plan (Construction Plan)

a) Major structures

In Paraguay, the building are generally made of bricks. Even in the Chaco region, most of the buildings are made of bricks.

The frames are generally made of lapacho timber in the Chaco region. The insulating material is affixed on it and the roofing is made of zinc-plated steel sheet. Some facilities are roofed by tiles with Defera underneath.

The factories and warehouses have high ceiling. The buildings that need a large span uses assembling materials made of steel bars called "tingrade" as frames. The exterior is generally made of bricks, and zinc-plated steel sheet is used as roofing.

b) Natural conditions related with facility design and construction method

The Chaco region has more harsh natural environment than the southern and eastern regions. There is a need to design facilities by keeping the following points in mind:

First of all, heat-proof measure in summer is required. The exterior walls of the living room need sufficient insulation. The direct sunshine should not be exposed on the exterior wall of the living room. Usually, corridor-like eaves are made. The insulating material is always used as liner for roofing material.

Secondly, measure must be taken against strong wind. It is effective to make corridors around the building or plant windbreak trees around the site of the building. In patio-style design, the living quarters can be contained inside.

Thirdly, water measures are important. In the Chaco region, all the water necessary for living must depend on rainwater. The zinc-plated steel sheet which will not gather mosses is used as roofing material. The water tank with sufficient capacity is installed in underground.

c) Problems in construction

There are the following problems in construction:

First, all construction materials must be transported from Asuncion. When a facility will be constructed at a location away from National Highway No. 9, a huge amount of labour and funds are required as road conditions are poor.

Secondly, skilled labour must be secured from Asuncion as it is not available locally. Therefore, expenses for temporarily housing, etc. are incurred.

Thirdly, water for construction without salt content must be secured. Before starting construction, a tamajar must be made to reserve water. Therefore, a long construction period is required.

d) Calculation

In Paraguay, there is no fixed calculation criteria. The ordering organizations prepare drawings, get estimates from general contractors, check the contents of estimates and construction period, and then decide on general contractors. Therefore, the unit price of construction varies according to the construction project.

e) Construction unit costs

As mentioned above, estimate of construction costs in the Chaco region is extremely difficult. But it would be appropriate to estimate the costs of 1.5 times as much as that in Asuncion. The standard construction costs in Asuncion is 400,000 Gs. per m3 for office or housing made of brick and 300,000 per m3 for factory or warehouse made of tingrade. However, according to price indices reported by the Central Bank, construction costs have increased 14% since last year.

4.12 ECONOMY, MARKET DISTRIBUTION, AND PROJECT EVALUATION

1) Contents of study

The survey through interview and material collection were conducted by visiting mainly distribution organizations, agricultural finance organizations, and related bureaus of the Ministry of Agriculture and Livestock, and materials were collected concerning the review of distribution and status of demand and supply of agricultural and livestock products and assessment of business.

2) Results of study

(1) Economy and Trade

While the economic growth rate in Paraguay in 1991 decreased from the previous year due to stagnation in the agricultural sector, prices have stabilized and overseas debts have increased only slightly.

The trade balance in 1991 resulted in a deficit of approximately $500 million as the export of beans decreased due to the poor harvest caused by bad weather, manifesting the problem of the monocultural production structure.

(2) Agricultural credit

The governmental financial organizations which give credit to agricultural projects in the study area are the National Bank of Development (BNF), Livestock Fund (FG), and the Agricultural Credit Association (CAH). The outlines of these organizations are as follows:

a) BNF

This is a financial organization established in 1961. It has the largest size of funds and extends loans to all kinds of sectors. Especially, the agricultural sector occupies 79.4% of the total loan amount of 221,659 million Gs. with the subject land areas covering 800,000 ha. The two-step loan is introduced from OECF and its fund is reinforced. The loans to the study area are implemented through three branches (Loma Plata, San Lorenzo, and Concepcion) and the head office.

b) FG

This organization was established in 1969, under the direction of the Central Bank, and is extending loans to producers and corporations related to livestock farming. The major areas of loans are improvement of grasslands and introduction of superior quality cows. 40% of the total loan amount are extended to the Chaco region.

Besides, in the Chaco region, the model testing centre of 30,000 ha was established at the 620 km point of the National Highway No. 9 to verify testing of livestock development.

c) CAH

This is an affiliate organization of the Ministry of Agriculture and Livestock established in 1943. The objective of this financial organization is to support small-scale farmers who can be potentially self-reliant in terms of technology and organization, and give loans for their farming improvement by lowering collateral condition.

In addition to this, El Fondo de Desarrollo Campesino (FDC) was established in 1991 with MAG as the implementing body under cooperation of the Ministry of Finance, National Central Bank and other financial organizations with the objective to promote comprehensive range of rural development, give loans to small-scale producers, diffuse technology, and strengthen producers organizations. With a loan from El Fondo International de Desarrollo Agricola (FIDA), it started its activities by implementing projects to assist small-scale farmers in three Departamentos in the northeastern region in Paraguay.

(3) Distribution of agricultural products

a) Peanuts

The peanuts are exported in the form of nuts mainly for snacks. The ones squeezed for oil production are only for consumption in the Mennonite settlements. The export amount of peanuts from Paraguay is some 7,000 tons per year. 90% of them are produced in the Chaco region.

b) Cotton

The volume of cotton handled is huge. The leading distributors in Paraguay are exporting them and distribution routes have also been established. Europe is the main export destination. However, due to stagnation of international prices and lack of labour, the land area of cultivation is decreasing in the Chaco region.

c) Rice

The rice produced in Paraguay has no unified standard with crushed rice and impurities being mixed in them, and the quality is not constant. Pushed by imported foreign rice, consumption of domestic rice is not growing. There is a need to promote organization of producers and mills to unify the standard and improve the quality of rice in distribution.

d) Vegetables and fruits

These products used to be traded among individuals and the distribution mechanism had been extremely backward. However, construction of the central wholesale market by the World Bank finance and development of the distribution mechanism through technological cooperation by Japan have brought forth substantial improvement. In future, organization of producers is an urgent task.

(4) Distribution of livestock products

a) Beef

The distribution of meat in Paraguay is mainly for the domestic market. Chicken and pork are all for the domestic market. Only beef, which is produced in the greatest quantities, is exported by approximately 10 exporters (Frigorificos) who have freezing facilities and are inspected by foreign importers.

Of beef distribution, trading in live cows between producers and freezing corporations which have meat processing facilities takes three forms: (i) direct trading between producers and freezing corporations, (ii) that which goes through auction markets, and (iii) trading by brokers. In Paraguay as a whole trading through (i) and (ii) is divided almost fifty-fifty, covering more than 90% of the total. There are many large-scale beef cattle farmers in the study area, and most of the distribution is executed through (1).

Paraguay is in an advantageous position for exports, as countries with a high demand for beef include its neighbours such as Brazil, Chile, and Peru. However, as with other farming products the prices depend on international prices and so are not stable.

b) Milk

Milk production in the Chaco region has tripled in the last 10 years, becoming the most promising industry. Milk production in Paraguay is estimated to be around 200,000 tons per year. The Chaco region produces 20% of this. The majority of the milk marketed to general consumers is that processed by agricultural cooperatives in the Mennonite settlements in the Chaco region. A variety of dairy products are supplied to shops in urban areas.

(5) Distribution of forestry products

Forestry is not prospering in the study area. However, there are extremely unique industries on a worldwide level, such as the extraction of tannin from quebracho and the extraction of essence from palo santo. While these products are for export, the export volume is stagnant due to the existence of alternative substances.

(6) Export routes for livestock products

Most of the products from the study area are exported via Asuncion through National Highway No. 9 which bisects the area. Therefore, access to the highway is a most important point.

In future, the National Highway that connects Pozo Colorado (located in the centre of the study area) and Concepcion, which has potential to develop as a port for the export of agricultural products, will become an important route.

(7) Distribution of agricultural machinery

Paraguay does not have factories to produce large agricultural machinery. This is all purchased through importers. 17.5% of the import price is levied as customs duty and expenses.

CHAPTER 5

DEVELOPMENT POTENTIAL AND CONSTRAINTS ON DEVELOPMENT

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5.1 LAND RESOURCES

1) Development potential

The study area is sandwiched between the Rio Paraguay and the Rio Pilcomayo. While its soil fertility is inferior to that in the eastern region where acrisol is distributed, the northwestern region has a distribution of highly fertile xerosol and regosol.

The soils in the study area show the following features: while the pH of solonetz and planosol present strong alkalinity, other soils present minor alkalinity or neutrality to weak acidity. Substitute lime (CaO) is slight in regosol, but is contained in other soils to the appropriate extent. Substitute potassium (K2O) is contained relatively abundantly except in regosol. Substitute magnesia (MgO) is contained extremely abundantly. On the other hand, as concerns microelements, heat soluble boron (B) and soluble copper (Cu) are contained to an appropriate extent, while easily reducible manganese (Mn) and soluble zinc (Zn) show very low values. Thus, the area has a high development potential in terms of soils. Since the wetlands have mineral contents in the soil and the ecological advantages of the marsh, the potential for livestock farming development is high.

Therefore, if the land is utilized by taking advantage of the features of the natural conditions in the area, these land resources can be effectively utilized.

2) Constraints in development

75% of the total soil in the study area is occupied by solonetz, which is a saline soil, and is distributed from the central region to the southern region. Since the distribution area of solonetz is topographically very flat and highly viscous, it has poor drainage and harsh conditions.

In the Mennonite settlements located in the northern region of the study area, the problem of saline accumulation in the soil is caused, depending on the use and management of the land. Therefore, there is a need to pay thorough attention to the soil preservation here.

5.2 WATER RESOURCES

1) Water reserves

(1) Rio Paraguay

The annual total flow of the Rio Paraguay amounts to approximately 100 billion tons (at the Concepcion point). As the lowest flow even during the dry season is 1,500 m^3/s, this is a very promising water source for irrigation.

(2) Rainwater

Precipitation differs largely between the western and eastern regions of the study area. It is 1,300 mm per year in the eastern region and becomes 800 mm in the western region. The study area is divided into eight basins by classification of basins. The average precipitation along the whole basins including the outside areas is 970 mm per year. Precipitation is used for field crops as rainwater, and is a promising water source for the tamajar and potable water.

(3) Underground water

The cultivation volume of the patiño stratum distributed in the suburb of Asuncion is estimated to be 14-28 x 10^3 m^3/km^2. This can be considered to be the maximum underground water reserve that can be continuously pumped. While the actual pumpable water volume is less than this value, it can be used for potable water and irrigation through the deep wells.

2) Constrains in water resources

(1) Rivers in the area

Since the river water has much base contents, the risk of Na damage and the saline substance density damage is high, and it is not suitable for irrigation and potable water in terms of its quality.

(2) Rio Paraguay

While this river has no problem in terms of quality and reserve, it cannot be taken naturally as it flows on the lowland. It must be pumped.

(3) Rio Pilcomayo

Since this is a flooding river accompanying a huge amount of sand sediments, the river path is extremely unstable. As it also flows into the marsh in the upstream, the flow in the area is little. During the dry season, its salt density becomes high, making the water unusable. To utilize this river, it is necessary to execute the soil erosion preventive

program in Bolivia. As it is an international river and the river running along the national border, and has a problem of requiring an international agreement, it is difficult to incorporate this river into this Plan.

(4) Rain water

The annual precipitation is 800-1,300 mm. While it is a useful water source for field crops, the precipitation pattern is irregular by year. There is a need to pay attention to drought in conducting farming by using the rain water.

(5) Constantly inundated land

Since this is a very shallow plate pond, it is difficult to assess the amount of water usable. As the impact on the environment is also great, it is difficult to use it for irrigation.

(6) Underground water

The Chaco stratum has a series of sand strata as the aquifers and has abundant water reserve. However, it essentially has extremely high salt density. The water usable for agriculture and livestock farming and potable water is very limited. Its planned utilization is difficult.

The patiño aquifer distributed in the southernmost part of the study area has quality water and the usable aquifer is thick. However, it must be noted that, as the Chaco stratum is distributed in the periphery of the range of distribution of this stratum, the saline water in the Chaco stratum may be pumped as the water level drops due to the over pumping.

5.3 HUMAN RESOURCES

1) Development potential

The subjects for human resources include 3,484 households of farmers (among them, 955 small-scale farmers and 211 landless farmers) and approximately 4,000 households of indigenous people in the study area as well as small-scale farmers, children of small-scale farmers and landless farmers in the whole country including the Departamentos Concepcion and San Pedro on the eastern coast of Rio Paraguay outside the study area.

2) Constraints in development

The indigenous people form unique society, have different languages, and have difficulty in associating with other ethnic groups. They have low agricultural technology and have no capital power. Small-scale farmers and landless farmers have no funds and have low technology. The unemployed have almost no agricultural experience and nor funds.

Therefore, to introduce them into this plan, the support of the Paraguayan Government is required in terms of agricultural support such as agricultural diffusion, agricultural credit, and farmers' organization and improvement of the distribution mechanism, experiment, research and training, and securing market, etc.

5.4 AGRICULTURE

1) Development potential

(i) Since the weather conditions such as temperature and sunlight hours are good, many crops can be cultivated;

(ii) In the areas which are suitable for agricultural development, a certain width of land can be secured. Since the land is flat, the erosion by loss of soils is little; and

(iii) The soils of the land are xerosol and regosol and are highly fertile. The property of soil is suitable for the crop cultivation. As substitute potassium (K_2O) is relatively abundant and substitute manganese (MgO) is extremely abundant, the soil is advantageous for crop cultivation.

2) Constraints in development

(i) As precipitation is unstable, and changes greatly by year, the output becomes unstable in the case of the short-term crops;

(ii) When the use and management of water is inappropriate, the output may become unstable;

(iii) When the field is left bare during the winter time, it may be highly susceptible to the wind damage. However, there are few winter crops which would become the commercial crops;

(iv) The small-scale farmers and landless farmers who will become the bearers of development have little fund and technology;

(v) As the road conditions are poor, transportation of the products and materials for agricultural production is difficult; and

(vi) Since the domestic market is small, and the freight is expensive in the case of export as Paraguay is an inland country, it is difficult to select the crops except some limited crops. It is possible to produce only the high value added agricultural products.

5.5 LIVESTOCK FARMING

1) Development potential

(i) Since the marshes have water, the grasses are not dried by frost and do not die even during the winter time; (ii) Since the soil contains much mineral ingredients such as P and Na, the productivity of livestock is high; and (iii) the Chaco region has many grass and feed trees in the bean family and the supply of protein is leading to improvement of nutrition of livestock. Because of such an advantageous natural environment, the productivity of livestock is high.

Because (1) the population is sparse, it is suitable for the labour-saving, land utilization-type beef cow production; (ii) the rough production form based on the natural grass land is possible, and the production cost is low; and (iii) Because of the advantage that the shrubs such as quebracho for fencing are existing and available at a low price, the development potential of the beef cow production and dairy farming is high.

Furthermore, the development potential of apiculture exists because (i) the reserve of the honey source plants such as water hyacinth, palm, and algarroba is abundant; (ii) the initial investment is little, and it is useful for effective utilization of surplus labour in the family, and (iii) the profitability is high.

2) Constraints in development

(i) Since the development of infrastructure such as roads and electricity is backward, it is difficult to transport livestock, production materials, and equipment;

(ii) The protection of livestock sanitation is difficult as there are many wild animals which carry the viruses of livestock diseases, there are many marshes, the southwestern region is facing the border with Argentines, and the roads are not developed;

(iii) Because there are many lands with poor drainage and that the salt density in soil is high, the range of selection of the kind and variety of feed crops and grasses to be introduced is limited;

(iv) There are more P and Na as the mineral ingredients in the soil compared to the eastern region. Cu is little in some areas;

(v) The annual distribution of precipitation is biased, which makes the growth of grass unstable and causes the decrease of the productivity of livestock; and

(vi) The structure concerning the livestock improvement, supply of sire cows and farming guidance is weak.

5.6 MARKET AND ECONOMY

1) Development potential

Milk production is raised as the industry that has the potential of production expansion in the study area in the future. Since the worldwide demand of the oil crops is growing, they are promising as the agricultural products for export.

2) Constraints in development

The following constraints are raised:

(i) The Paraguayan economy is dependent solely on the livestock farming. The whole economy is susceptible to the meteorological fluctuations and trends of international prices;

(ii) Paraguay is susceptible to the economic fluctuations in the two big neighbours, i.e., Brazil and Argentines. In the agricultural and livestock products, Paraguay is in the competitive relationship with them;

(iii) Paraguay has less agricultural and livestock products which have relative superiority;

(iv) Since Paraguay is an inland country, it has a disadvantage in securing access to the international markets;

(v) The increased demand of beef in the world can be expected only because of the population increase. Dramatic increase of beef production has some problems in marketability.

5.7 OTHER CONSTRAINTS

1) Land ownership

The land owners who own more than 10,000 ha, representing only 6% of the area population, own 68% of the total land areas in the study area. As most of them are the absentee landlords, the lands are not effectively used. Since one's social status is proportionate to the land area that one owns in Paraguay, those landlords do not have intention to abandon their lands. The Law concerning the Institute of Rural Welfare and the Farmland Law are not necessarily functioning effectively. It is difficult for some settlers and small-scale farmers to continue their farming due to the harsh natural and distribution conditions. Therefore, they have to abandon their lands. The large landlords get those lands and come to own more lands. This is forming a sort of vicious cycle.

2) Environment

The study area has fragile natural conditions. In initiating development projects, there is a need to pay all due consideration to a variety of constraints in connection with environmental preservation, and to have full consultation and liason with government agencies in Paraguay.

CHAPTER 6

BASIC CONCEPT OF DEVELOPMENT

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6.1 DEVELOPMENT STRATEGY

6.1.1 National Plan and Policies concerning Agricultural and Livestock Farming Development

The themes of the agricultural and livestock farming sector in the Socio-economic Development Plan in Paraguay (1985-1989) was improvement of the income level of the rural people through productivity improvement, diversification of agricultural products, increase of employment opportunities, preservation of natural environment, and effective utilization of natural resources.

The subsequent Plan (1989-1990) has the contents to follow the route of the previous Plan with the people's welfare as the basis. The government formulated the policies to increase the crops for export and expand the employment opportunities facilitated by the above, and implemented the programs for the small-scale farmers.

The Socio-economic Plan for 1991 and beyond is not yet formulated. In the agricultural sector, the "Guideline for Agriculture" (February 1991) is serving as the base of a variety of policies as the substitute for the Plan. This is the implementation policies of the Ministry of Agriculture and Livestock which is in charge of administering the agricultural policies. This "Guideline" recognizes the reality that the agriculture and livestock farming in Paraguay is borne by the entrepreneur farmers, traditional small- and medium-scale farmers and landless farmers, and clarifies the following policies in summary:

a. Agricultural sector
   (i) Procurement of people's food
   (ii) Diversification of export products
   (iii) Providing the small- and medium-scale farmers with the ability to improve the production efficiency

b. Livestock sector
   (i) Encouragement of livestock farming among the small-scale farmers
   (ii) Program for the medium- and large-scale livestock farmers: Research and development to improve productivity and diffusion of the technology for that purpose, and reinforcement and expansion of the livestock sanitation management.

c. Forestry and environmental sector

To facilitate socio-economic development while maintaining good environment, and, for that purpose, give consideration to the preservation of natural resources and environment.

d. Land reform

(i) To secure the land for the settlement of 40,000 families of landless farmers by 1993.

(ii) To review and promote the laws and ordinances related to agriculture.

(iii) To clarify the status of land ownership

e. Program for small-scale farmers

(i) Organizing them.

(ii) To encourage and support mutual augmentation of the raw material production division and agricultural product processing division.

On the other hand, in May 1992, the "Strategies for Continued Development of the Chaco Region" was formulated with August 15, 1992 as the deadline by the Presidential Decree as the basic preparation for request of cooperation from EC concerning the development of the Chaco region.

The strategy clarifies the development of the western (Chaco) region on the basis of the "balanced development of the national land" in connection with the Socio-economic Development Plan and the policies to develop agriculture and livestock farming. The "continuous development" with emphasis on the environmental preservation is clearly set out.

6.1.2 Preconditions for Development and Strategies

Among the aforementioned policies concerning agricultural and livestock farming development in Paraguay, the "continuous development" presented as the framework of the Chaco development becomes the precondition in planning the development. Apart from the precondition by this policy, in view of the fragility of the natural environment in the area of study, the continuous development should be a natural consequence of how development should be implemented.

In this Comprehensive Development Plan, this precondition is fully taken into consideration, and is incorporated into all of its aspects. In summary, the precondition is comprehensively considered from the aspects of (i) land utilization, (ii) environmental and farmland preservation, (iii) farming system, (iv) cultivation technology, and (v) forest management.

6.1.3 Development Goals and the Strategies to Achieve Development Goals

1) Development goals

The development goals of this Comprehensive Development Plan shall be the following five items in line with the national agricultural and livestock farming development policy:

(i) Supply of the people's food;
(ii) Increase of production of agricultural products for export;
(iii) Creation and expansion of employment opportunities;
(iv) Programs for small-scale and landless farmers; and
(v) Realization of stable life for rural people.

2) Strategies to achieve the development goals

(1) Agriculture

(i) Joint farming with the livestock farming

The farmers' farming style should be the joint farming with the livestock farming to avoid the risk of monoculture;

(ii) Diversification of crops

Since export of agricultural products is the basis of the national economy, diversification of agricultural products for export on the basis of market projection on the worldwide viewpoint will lead to the increased export. Therefore, the export destinations will be considered from the viewpoint of emphasis on the marketability, and the crops to be introduced into farming will be diversified;

(iii) Production of crops according to a variety of farming styles

The human resources who bear agricultural and livestock farming development are extremely varied in terms of production efficiency. This will be solved separately by fostering human resources and extending agricultural support. A variety of rational farming model shall be devised to achieve required production and profitability in response to such diversified human resources.

(2) Livestock farming

Development of livestock farming shall be the main emphasis in the area of study in view of the development suitable to its agricultural environment. The livestock farming is related with the land utilization method in consideration of the natural and ecological conditions, and shall have the following two points as its strategy:

(i) Beef cow breeding

The measures to improve productivity of the current livestock farming shall be taken with consideration of minimum effect on the ecological system; and

(ii) Small- and medium-scale dairy and beef cow farming

Stabilization of farming management shall be secured by combining the kinds of cow and feeding styles, and participation of small-scale farmers in the livestock farming will be promoted.

(3) Forest management

The forests shall be preserved, and the windbreak forest shall be made and be properly managed to contribute to the environmental preservation. From this sense, the forest for the purpose of environmental and farmland preservation shall be considered.

(4) Addition of values to agricultural and livestock products

The Paraguayan trading is conducted in the form of export of the primary products and the processed products. In order to enhance its economy which is centred on the export of agricultural and livestock products, promotion of the processing industry is desired. However, the raw materials for processing are also the agricultural and livestock products. In this aspect, the export destinations shall be also considered through analysis of marketability to orient production of agricultural products.

(5) Development of production infrastructure

In crop cultivation, it is desirable that the cultivation environment can be managed by the farmers as much as possible to achieve the highest output. Therefore, farmland shall be developed to facilitate the cultivation management, and the irrigation and drainage systems shall be developed in accordance with the selected crops.

(6) Settlement

The settlement shall be established for those who will migrate to and settle in the area of the Plan and the existing farmers in the area of the Plan who will bear development of agriculture and livestock farming under this Plan.

The settlers shall be basically the farmers and indigenous people in the area of study and the landless farmers, small-scale farmers and general people from throughout the country.

(7) Development of social infrastructure

In order to promote the permanent settlement of the settlers and secure their stable life, the health and medical facilities, communication facilities, electrification, and educational facilities shall be introduced into the settlement.

(8) Fostering human resources

Training shall be conducted for the farmers with low level of agricultural technology to master the agricultural technology by establishing the training facility, and the technological diffusion shall be reinforced to improve the technology and farming management of the farmers.

(9) Agricultural support

Among the bearers of the agricultural and livestock farming development, especially small-scale farmers and indigenous people lack the technology and have fragile management basis. Therefore, a variety of support measures shall be considered in terms of technology and financing.

6.2 AREA OF THE DEVELOPMENT PLAN

6.2.1 Considerations for Environment

The considerations for environment which were decided to be concretely reflected and incorporated into this Development Plan as the basic concept of development with the "continuous development" as the precondition through a series of consultation with the Paraguayan counterpart are as follows:

(1) Setting the areas to be excluded from the subject of the Development Plan

The following areas shall be excluded from the subject of the Development Plan:

a) Areas designated as national parks (280,000 ha)

In Paraguay, 16 locations are designated by law for preservation as the environmental preservation areas. In the area of study, the Tinfunque National Park is applicable to it.

b) Environmental preservation areas (1,736,000 ha)

The survey was conducted by the Environmental Development Bureau and the National Park and Wildlife Bureau of the Ministry of Agriculture and Livestock and the Fundacion Chaco Paraguayo concerning the "Priority Areas to Be Preserved in the Western Region of Paraguay" from 1991 for two years. In the area of study, 16 locations are applicable to the environmental preservation areas. At present, the designation of these environmental preservation areas are not stipulated by law, but it is appropriate to designate these areas as the environmental preservation areas from the importance of environmental preservation.

c) The areas designated as the cultural asset preservation areas including the historical monuments (The land area to be preserved is not specified.)

According to the Ministerio de Defensa Nacional, Parques Nacionales y Monumentos Historicos, in Paraguay, there are many cultural assets as the historical monuments of the Chaco War during the 1930's. The Law No. 946 stipulates the preservation, repairs and restoration of these cultural assets.

There are 12 cultural assets to be preserved in the Chaco region. Among them, the following nine forts of the wartime are designated in the area of study: (i) Fortin Sorpresa (Adolfo Rojas Silva), (ii) Isla Poi Villa Militar, (iii) Fortin Boqueron, (iv) Fortin Nanawa, (v) Fortin Gondra, (vi) Fortin Muñoz, (vii) Fortin Arce, (viii) Fortin Falcon, and (ix) Pozo Favorito. However, the land area to be preserved of these designated areas are not specified.

d) Constantly inundated areas (1,801,000 ha), rivers, lakes, and ponds (29,000 ha)
The constantly inundated areas are environmentally and ecologically fragile. There are many wildlife including migrant birds inhabiting there. Therefore, from the viewpoint of natural environment preservation, these areas are excluded from the subject of the Development Plan.

e) The Mennonite settlements (405,700 ha)
Reasons: (i) Most parts of the settlement has been already developed, and the remaining lands are also planned for development; and (ii) the settlement has a unique community and system.

f) Some indigenous protection areas in the periphery of the Mennonite settlements (55,300 ha)
The areas where the indigenous people live who receive technological and economic cooperation from the Mennonite settlements and the Asociacion de Servicio y Cooperation Indigena Mennonita (ASCIM) and have deep relationship with them.

(2) Application of the Forest Resources Law to the land utilization plan
It was decided that the provisions of the Forest Resources Law (Draft) which has been currently under deliberations in the Congress should be applicable to the land utilization plan in the areas subject to the Development Plan. The concrete contents are shown in (1) and (2) of 2) of 7.2.9 Environmental Preservation Program.

6.2.2 Selection of the Areas subject to the Development Plan

1) The lands suitable for agricultural development
The selection criteria for the lands suitable for development were decided as the following two points: (i) soil and (ii) inundation. From the soil fertility and risk of salt damage, the area of study was divided into the lands suitable for agricultural development and those suitable for livestock farming development. Furthermore, from the inundation situation, the areas which are inundated throughout the year were excluded from the lands suitable for development as they have low development potential and natural and environmental preservation is needed. At this stage, the peripheries of Asuncion, the northern part of Pozo Colorado, the southern part of the Mennonite settlements, and the area along the right coast of Rio Paraguay were considered as the lands suitable for development. (See the Attached Drawing 6.2.2.1.) Among them, the area along the right coast of Rio Paraguay was excluded from the land subject to the Development Plan after consideration. (See 7.2.5 Irrigation Plan and 7.2.6 Drainage Plan.) These lands suitable for development are classified as follows as the area subject to the Development Plan by the Land Utilization Plan:

2) The areas subject to the Development Plan

(1) The areas for agricultural development plan

(i) The peripheries of Asuncion: 9,000 ha

(ii) The northern part of Pozo Colorado: 76,000 ha

(iii) The southern part of the Mennonite settlements: 68,000 ha

(iv) The eastern part of the Mennonite settlements: 185,000 ha

338,000 ha representing approximately 5% of the area of study are the areas subject to the agricultural development plan. In these areas, the agricultural development plan focused on cultivation of cotton and peanuts coupled with the livestock farming is envisaged.

(2) The areas of livestock farming development

2,655,000 ha excluding the areas of the agricultural development plan from the above are the areas of the livestock farming development plan. They occupy approximately 36% of the area of study. In this area, production of beef cows and small and medium-scale livestock farming is considered.

6.3 BEARERS OF FARMING

The bears of farming are basically classified into the following five groups and can be reflected in the respective plans.

(i) Those who have the production technology in terms of agriculture and livestock farming and capitals, can grow as individuals, and continue the farming management;

(ii) Those who have the level of agricultural technology to produce the agricultural products for export through the modern agricultural method, and have a certain amount of initial capitals;

(iii) Those who have the level of agricultural technology to satisfy the demand of the domestic market;

(iv) Those who do not have the level of agricultural technology to satisfy the demand of the domestic market; and

(v) Aborigines

CHAPTER 7

INDIVIDUAL DEVELOPMENT PROJECTS

CHAPTER 7. INDIVIDUAL DEVELOPMENT PROJECTS

7.1 THE LAND USE PLAN

1) Basic policy on land use planning

A land use program is designed to make the most of the social, economic and natural features of a region and identify optimum land use patterns for individual districts such as to maximize effective utilization of limited land resources.

Prior to the study JICA implemented a remote sensing survey, and the following thematic and classification maps have already been prepared:

(i) False-colour images (1:125,000 scale), dry and wet season
(ii) Vegetation and land-use maps (1:125,000 scale), dry and wet season
(iii) Soil classification map (1:125,000 scale)
(iv) Wetlands distribution maps (1:125,000 scale), dry, intermediate and wet season
(v) Wetland fluctuation map (1:125,000 scale)
(vi) Land classification map (1:125,000 scale)

These various types of maps will be utilized in drawing up a land use plan that takes into account such factors as topography and the environment; an effort will also be made to strike a balance with other fields that relate to land use.

2) The remote sensing survey

As already mentioned, six varieties of thematic and classification maps were prepared following a remote sensing survey. Since the land use project to be implemented under this plan will be formulated on the basis of these maps, a brief description of the survey is offered below

(1) Landsat TM data

The study area is covered by 8 scenes of Landsat TM data. Forming an accurate seasonal picture of distribution of vegetation, land use and wetlands is of great importance, and to this end use was made of Landsat TM data for three phases of the year, namely dry, intermediate and wet season. This data is given in Table 7.1.1.

(2) Topographical maps

The basic topographical maps used in the survey consisted of a series of eight maps at

1:250,000 scale issued between 1982 and 1987 by La Direccion del Servicio Geografico Militar of the Paraguayan Defence Ministry.

(3) Basic cartography work

a) Vegetation and land-use maps

More accurate vegetation and land-use maps were drawn for both dry and wet season at 1:250,000 scale employing photographic data etc. Vegetation and land use were classified into the seven categories of forest, sparse or scrub forest, dry grassland, wet grassland, wetland, farmland, and rivers and lakes as shown in Table 7.1.2. The total area of each is given in Table 7.1.3.

b) Wetland distribution and fluctuation maps

Wetland distribution maps were prepared at 1:250,000 scale for dry, intermediate and wet season, and these were then combined to produce a map of wetland fluctuations, again at 1:250,000 scale. The area of wetlands during dry, intermediate and wet season is given in Table 7.1.4.

c) Soil distribution map

A soil distribution map was drawn at 1:250,000 scale utilizing the 1:1,000,000-scale soil map compiled in 1985 by the Chaco Commission (the Comision Nacional de Desarrollo Regional Integrado del Chaco Paraguayo) on the basis of aerial photographs and field surveys, with partial modifications made in the light of independent field surveys and photographs.

(4) Land classification

a) Principles of land classification

The three categories of land classification employed were (i) fertility of soil, (ii) risk of excess sodium, and (iii) risk of flooding.

In classifying land the following types of agricultural activity were assumed in the study area:

(i) Farming on arable land where flooding is unlikely (areas where cultivation of such crops grown in the Filadelfia region as cotton, peanuts, sorghum, sesame and safflower appears feasible): Cropland I

(ii) Pasturage (areas subject to flooding with poor soil characteristics): Grassland

(iii) Farming on arable land subject to flooding (areas where cultivation of field crops would be difficult but that of rice or meadow grass appears feasible): Cropland II

b) Criteria for classification

In order to give the various classification results equal weight, one of three ranks was assigned for each item in each category to reflect relative merit: two points (good), one point (fair), and zero points (poor). In the case of the three land-use types Cropland I, Grassland and Cropland II, the criteria for classification of soil productivity given in Table 7.1.5 were assumed.

c) Classification by soil productivity

In classifying soil productivity use was made of the "Desarrollo Regional Integrado del Chaco Paraguay No. 1" compiled by the Chaco Commission. Three ranks or reference values were assigned for fertility and risk of salt damage as per the results of the survey; the seven alphabetical rankings used in the Chaco Commission study were consolidated into these three ranks according to their description in the legend so as to ensure consistency with other types of classification. Two points, one point or zero points were assigned according to relative merit. The criteria for classifying fertility and risk of salt damage are given in Table 7.1.6.

Furthermore, the criteria for classifying soil productivity, which combine the above, are listed in Table 7.1.7.

d) Classification by likelihood of flooding

The criteria for classifying likelihood of flooding, which were determined by considering effect on flooding by type of land use, are shown in Table 7.1.8.

e) Classification by land use potential

Land use potential was classified by combining the results of classification by soil productivity and likelihood of flooding. The criteria for classifying land use potential are given in Table 7.1.9, while the overall results of all types of classification are shown in Table 7.1.10.

3) Verification of land-classification maps

These thematic and classification maps were then used to verify various types of land-classification maps. Among the factors considered were (i) topography (height above sea-level, gradient of slopes), (ii) current land use and vegetation, (iii) soil, (iv) flooding, and (v) the environment. No serious discrepancies with present circumstances were recognized.

4) Land use planning zones

Two types of land-use planning zones were identified: (i) land suitable for development (as

cropland or areas in which to breed livestock); (ii) land with poor development potential (areas subject to constant flooding, rivers and lakes). These zones were determined on the basis of the maps of e.g. land use potential compiled on the basis of soil patterns and wetland distribution during the remote sensing survey.

Areas of poor development potential were excluded from the scope of the general development plan, as were the following five types of districts: (i) areas designated as national parks; (ii) environmental conservation zones; (iii) historical sites and other areas designated as cultural-heritage protection zones; (iv) the Mennonite settlements; (v) reserves for indigenous peoples around the Mennonite settlements. These areas are not to be covered by the plan in deference to Paraguayan law and policy.

The task the project faces is to identify effective patterns of land use that make the most of the ecological features of the region while taking full account of the delicacy of its natural environmental conditions. Thus farmland development planning, irrigation and drainage programs, agriculture and crop programs and so forth were examined in a comprehensive fashion, with due consideration also taken for environmental conditions, in order to maximize project benefits while minimizing the cost of establishing production infrastructure. As a result the area of each type of land use planning zone has been determined as follows: 4,307,000 ha (59% of the survey area) are to be excluded from the development project, while 2,993,000 ha (41%) are to be covered by it. A map of land use planning zones is given in fig. 7.1.1.

(1) Areas excluded from the development plan

a) areas designated as national parks (280,000 ha)

b) environmental conservation zones (1,736,000 ha)

c) historical sites and other areas designated as cultural-heritage protection zones (the exact area subject to protection has not been clearly specified)

d) areas with poor development potential (1,830,000 ha)
1,801,000 ha of land subject to constant flooding has been classified as having poor development potential, since areas with year-round flooding are not suited to the raising of crops and livestock. Rivers and lakes, with a total area of 29,000 ha, have been similarly classified.

e) Mennonite settlements (405,700 ha)
This has been counted as such because (i) most of this land has already been developed, and plans already exist for that which has not; and (ii) this area possesses its own separate social system.

f) reserves for indigenous peoples around the Mennonite settlements (55,300 ha)
Areas that receive technical and economic assistance from such institutions as the Asociacion de Servicio de Cooperacion Indigena Mennonita (ASCIM) in the Mennonite settlements, and which are inhabited by tribes with close ties thereto.

(2) Areas covered by the development plan

The right bank of the Rio Paraguay, which until the time of the second survey was considered suitable for agricultural development, consists in large part of wet grasslands and swamp. However, as described in the section on drainage planning, later study revealed that natural drainage was impossible in these areas, while forced drainage would be prohibitively expensive, and thus the district was ill-adapted to development under the plan. Furthermore, the two districts in which natural drainage is possible are 200 km apart and both relatively small in size, having an area of 2,000 ha and 1,300 ha respectively; it was also concluded that due to soil conditions agricultural activity would be restricted to rotation between wetland rice cultivation and stock farming. It was therefore decided that under the plan these areas should be developed as land for breeding livestock rather than raising crops.

It was similarly concluded that natural drainage was not possible in the wetland districts around Asuncion, while forced drainage would again require a massive investment. If these wetlands are not developed, effective land use will not be feasible in wetland districts due to the fact they are surrounded by permanently-flooded areas. They have therefore been excluded from the plan as showing poor development potential.

Thus the total area covered by the development plan is as follows: 338,000 ha designated as agricultural development planning districts, and 2,655,000 ha designated as livestock farming development planning districts. A list of land use planning zones appears in Table 7.1.11.

5) Land use planning in the development area

Land use plans are to be formulated for both types of land covered by the development program, i.e. agricultural development planning districts and livestock farming development planning districts, each of which are subdivided into (i) agricultural land, (ii) public lands, and (iii) rivers and lakes. The areas for each category were calculated according to the criteria given below.

The areas of actual and planned land use as deduced from these calculations are shown in Table 7.1.12, while the area of the land use plan is indicated in Table 7.1.13.

(1) Agricultural land

Agricultural land covers those areas that currently consist of forest, sparse or scrub forest, farmland, dry grassland, wet grassland, or wetlands. Land use plans will be drawn up in these zones to develop ordinary croplands, fodder cropland, improved grasslands, natural grasslands, wetlands, forests, etc. In general, areas currently classified by land use as forest, sparse or scrub forest, or farmland will be designated as agricultural land and developed as ordinary croplands, fodder cropland, orchard areas, improved grasslands, etc., while areas currently considered dry or wet grassland or wetlands will be treated as natural grasslands. Article 422 of the Forests Act states that "persons owning 20 ha or more of land in forest districts shall maintain 25% of the area of forest as non-exploitable land." In addition, the Paraguayan government has asked that the general development program be formulated on the basis of the draft Forest Resources Act, although this has yet to be passed. Therefore 25% of the project area minus public lands and rivers and lakes will be treated as forest districts under the plan, except in the suburbs of Asuncion, where all forested land will be counted as such since forest is already scarce there.

The land use plan is to incorporate 74,000 ha of ordinary cropland, 8,800 ha of orchard areas, 92,700 ha of fodder cropland, 479,100 ha of improved grasslands, 1,274,600 ha of natural grasslands, 183,700 ha of wetlands, and 703,100 ha of forest.

(2) Public lands

Public land refers to public roads (trunk roads, principal roads and secondary roads), waterways (main and auxiliary drainage channels), public facilities, and so forth. In the light of actual circumstances in the Mennonite settlements, 10% of the project area will be reserved as public land, except in livestock farming development planning districts, where only 5% will be set aside since few roads and waterways are needed. Thus the plan calls for 33,800 ha of public land in livestock farming development planning districts, and 132,000 ha in agricultural development planning districts.

(3) Rivers and lakes

This category covers the current area of rivers and lakes in the project area. The plan makes provision for 8,800 ha of rivers and lakes in livestock farming development planning districts.

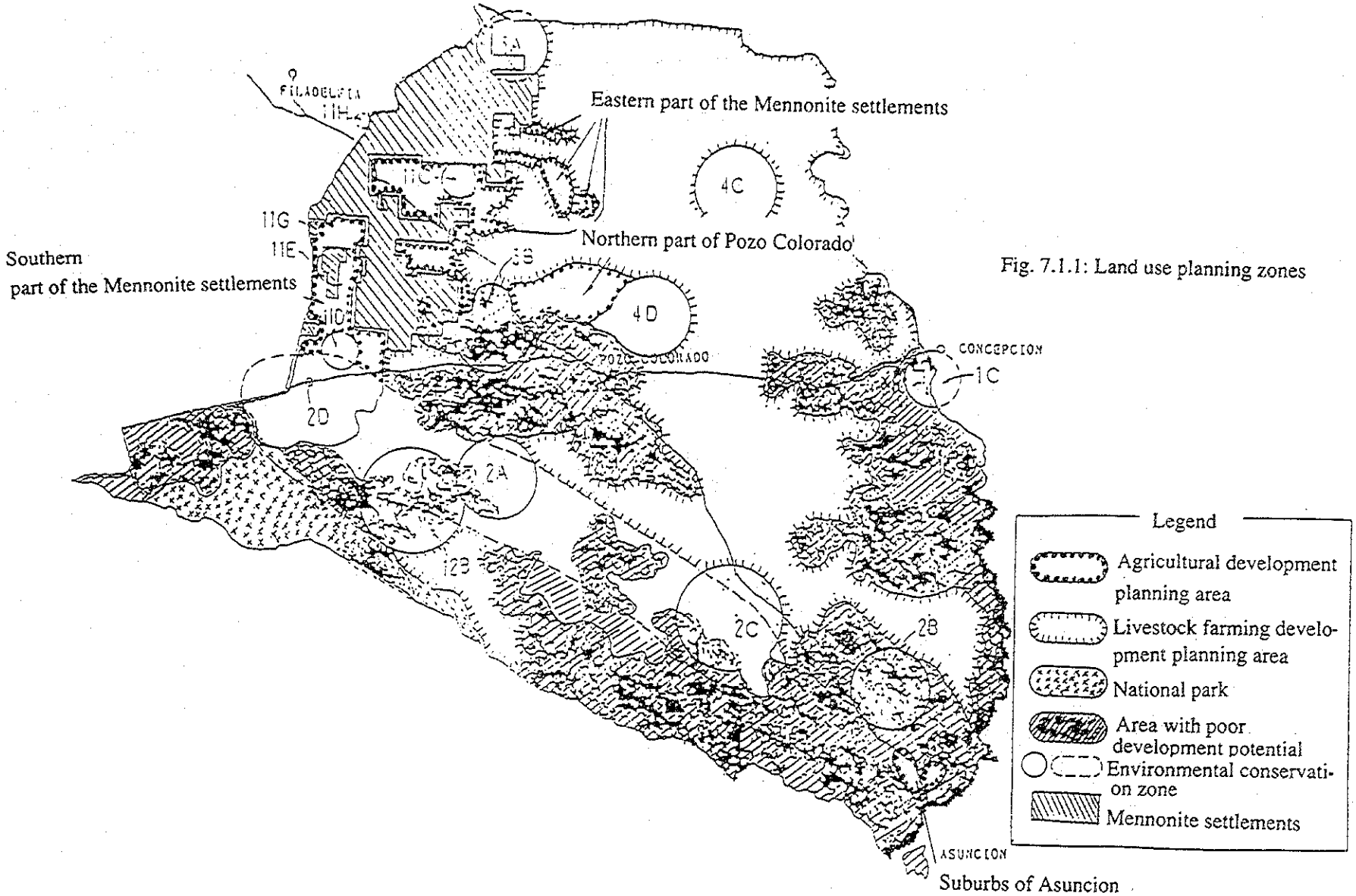


Fig. 7.1.1: Land use planning zones

① Southern part of Pozo Colorad

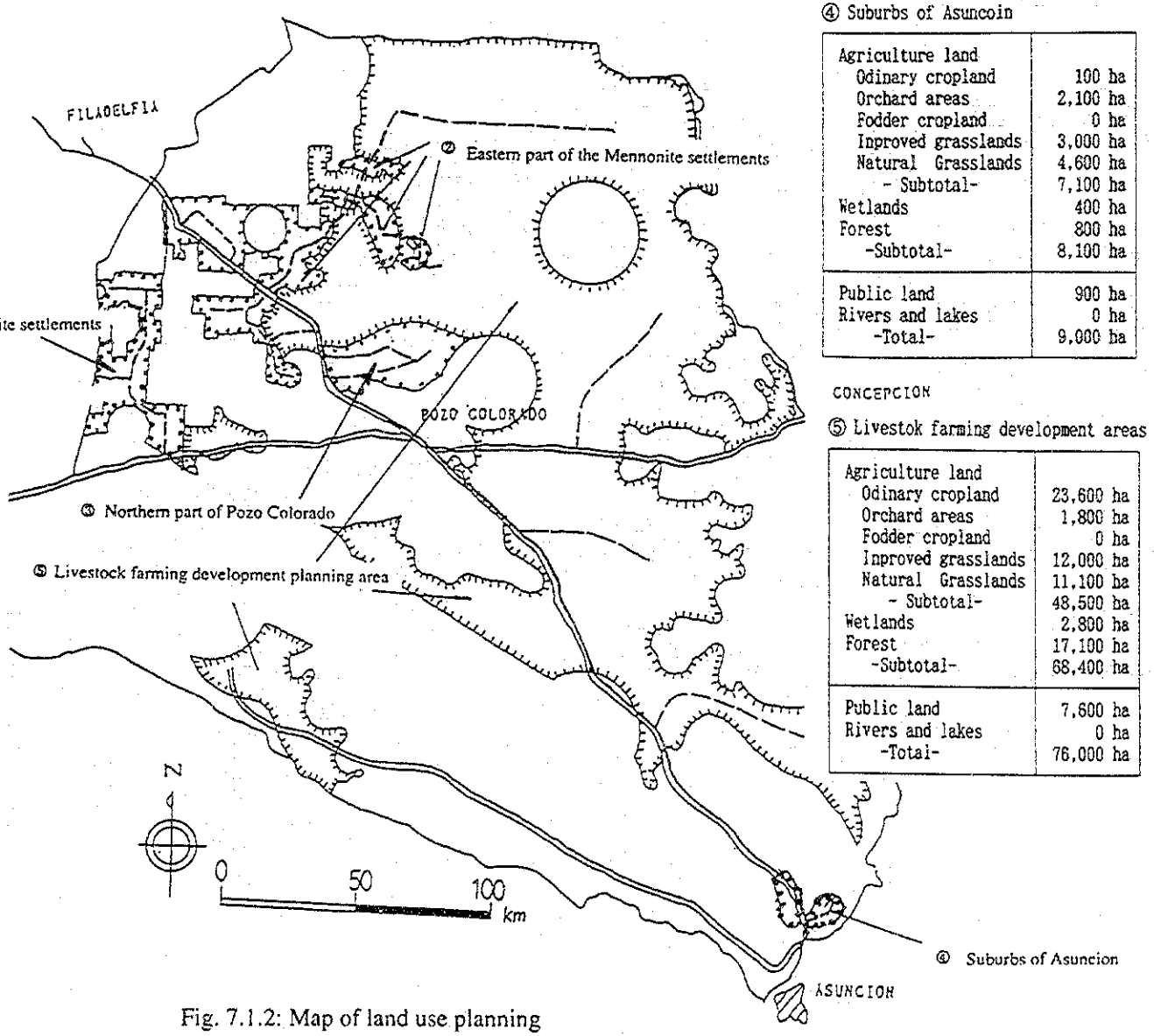
Agriculture land	
Odinary cropland	23,700 ha
Orchard areas	2,300 ha
Fodder cropland	200 ha
Inproved grasslands	15,100 ha
Natural Grasslands	4,300 ha
- Subtotal-	45,600 ha
Wetlands	300 ha
Forest	15,300 ha
-Subtotal-	61,200 ha
Public land	6,800 ha
Rivers and lakes	0 ha
-Total-	68,000 ha

② Eastern part of Pozo Colorad

Agriculture land	
Odinary cropland	26,600 ha
Orchard areas	4,200 ha
Fodder cropland	7,300 ha
Inproved grasslands	24,000 ha
Natural Grasslands	57,300 ha
- Subtotal-	119,700 ha
Wetlands	5,100 ha
Forest	41,700 ha
-Subtotal-	166,500 ha
Public land	18,500 ha
Rivers and lakes	0 ha
-Total-	185,000 ha

③ Northern part of Pozo Colorad

Agriculture land	
Odinary cropland	23,600 ha
Orchard areas	1,800 ha
Fodder cropland	0 ha
Inproved grasslands	12,000 ha
Natural Grasslands	11,100 ha
- Subtotal-	48,500 ha
Wetlands	2,800 ha
Forest	17,100 ha
-Subtotal-	68,400 ha
Public land	7,600 ha
Rivers and lakes	0 ha
-Total-	76,000 ha



④ Suburbs of Asuncoin

Agriculture land	
Odinary cropland	100 ha
Orchard areas	2,100 ha
Fodder cropland	0 ha
Inproved grasslands	3,000 ha
Natural Grasslands	4,600 ha
- Subtotal-	7,100 ha
Wetlands	400 ha
Forest	800 ha
-Subtotal-	8,100 ha
Public land	900 ha
Rivers and lakes	0 ha
-Total-	9,000 ha

⑤ Livestok farming development areas

Agriculture land	
Odinary cropland	23,600 ha
Orchard areas	1,800 ha
Fodder cropland	0 ha
Inproved grasslands	12,000 ha
Natural Grasslands	11,100 ha
- Subtotal-	48,500 ha
Wetlands	2,800 ha
Forest	17,100 ha
-Subtotal-	68,400 ha
Public land	7,600 ha
Rivers and lakes	0 ha
-Total-	76,000 ha

Fig. 7.1.2: Map of land use planning

7.2 INFRASTRUCTURE PLANNING

7.2.1 The agricultural road plan

1) Basic policy on road planning

Roads will serve to provide the transportation links between beneficiary farmers, farms, and market distribution facilities essential to maintaining the day-to-day production activities of agricultural communities in the study area. Roads have been classified by function and size into trunk roads, principal roads, secondary roads, and farm roads. A road plan will be drawn up for all these types of roads except the first.

In laying out the road network a comprehensive examination will be made of such factors as area and location of scheduled sites of agricultural and livestock development, location, structure, traffic patterns, potential for use and density of existing national and departmental roads, and location of agricultural facilities. The most effective routes will be selected after determining what is required, what is appropriate, and what patterns of use are expected as far as transportation and distribution of production supplies and agricultural goods are concerned.

The following specific standards have been kept in mind with respect to road planning:

(i) ensuring maximum use;
(ii) facilitating maintenance;
(iii) keeping project costs within reasonable bounds;
(iv) attaining a reasonable level of density from the point of view of intensity of agriculture in the beneficiary district and location of existing roads;
(v) guaranteeing smooth integration with existing or planned farm plots;
(vi) creating an appropriate network of farm roads;
(vii) formulating a safe and reasonable agricultural road plan;
(viii) ensuring a positive effect on the evolution of agriculture in the survey area.

2) Types of roads

For the purposes of this project roads are classified into trunk roads, principal roads, secondary roads, and farm roads.

(1) Trunk roads

Trunk roads are transportation routes indispensable to regional development. They are of such importance that, even in the absence of the present project, they would need to be included in any regional development programme.

(2) Principal roads

Principal roads link market distribution facilities, communities, and production units.

They serve as a basis for agricultural activity, providing an essential means for transporting agricultural supplies and products to and from the farm.

(3) Secondary roads

Secondary roads are branches of principal or pre-existing roads that fulfil the critical function of linking agricultural centres and farms, and thus enable agricultural activity to proceed. Planning of secondary roads will be conducted under the farmland development programme.

(4) Farm roads

Farm roads are branches of secondary roads located within individual farms in agricultural districts. Planning of farm roads will be conducted under the farmland development programme.

3) Road planning

The basic principles to be followed in compiling a road plan are as follows:

(i) Construction of new roads will be kept down to the bare minimum so as to cut project costs and conserve the environment. The road network will as a basic rule be established through repairs and improvements to existing routes.

(ii) Roads are classified into trunk roads, principal roads, secondary roads, and farm roads, and as a rule no construction work will be done on trunk roads.

(iii) In terms of construction trunk roads will remain as they are, principal roads will be covered in gravel, and secondary and farm roads will be unpaved.

(iv) There are to be five trunk routes under the plan as indicated in Table 7.2.1.1.

(v) Principal roads are basically to run between trunk roads and development planning districts as required, but in general they will simply cut across each district. A list of planned principal road routes appears in Table 7.2.1.2, and a map of these routes is given in fig. 7.2.1.1.

(vi) In order to enable farm goods to be shipped and production supplies secured within about a day even when roads are impassable due to rain etc., care is to be taken to ensure that agricultural development planning districts are situated within 5 km, and livestock farming development planning districts within 30 km, of a principal road.

4) Road design specifications

(1) Design speed

Design speed is the speed at which a driver of average competence can drive safely and pleasantly when the weather is favorable and traffic density is low, and thus driving conditions are determined solely by the structural characteristics of the road itself. It is also the speed assumed in analyzing and deciding the geometrical structure of a road, and is therefore closely related to such factors as radius of curve, one-way grade, and sight distance. Although it is difficult to make a direct connection between width of lanes or shoulders and design speed, these factors clearly do have a bearing on how fast one can drive, and thus design speed needs to be taken into account when deciding width. The road planning guidelines issued by the Paraguayan Ministry of Public Works and Telecommunications, the government agency that oversees public roads, prescribe the following design speeds: 80-100 km/hr for ordinary asphalt roads, 60 km/hr along flat sections and 40 km/hr along up-and-down sections of principal roads, and 40 km/hr along flat sections and 30 km/hr along up-and-down sections of secondary roads.

Under the present project design speed has been set at 60 km/hr for principal roads and 40 km/hr for secondary and farm roads in the light of these guidelines and after analysis of the different types of existing roads in terms of vehicle speed and linearity. Road design specifications are listed in Table 7.2.1.3.

(2) Road width

The width of each type of road has been set as follows on the basis of the Paraguayan government's road planning guidelines and in the light of actual conditions in the survey area:

a) Principal roads

Principal roads will have an effective width of 6.0 m, since large vehicles will need to be able to pass each other easily, while the design speed for such roads is 60 km/hr. There will also be an extra 0.5 m strip along either side for a total width of 7.0 m. In light of circumstances in Paraguay the total width of land occupied by the roadway will be 20.0 m. A standard cross-sectional diagram of a principal road is given in fig. 7.2.1.2.

b) Secondary roads

Much of the traffic along secondary roads, which are to serve mainly as a transportation route for agricultural goods and production supplies, will consist of tractors and combines. Therefore the effective width for such roads will be set at 6.0 m, enough

to allow the largest type of vehicle, a combine, and a pedestrian or two-wheeled vehicle to pass each other without difficulty. The total width of land occupied by the roadway will again be 20.0 m in light of circumstances in Paraguay. A standard cross-sectional diagram of a secondary road is given in fig. 7.2.1.3.

c) Farm roads

Farm roads will be planned according to same criteria as secondary roads. A standard cross-sectional diagram of a secondary road is given in fig. 7.2.1.4.

(3) Road structures

The main structures to be set up under the plan are bridges or culverts, whichever is more appropriate, where roads intersect with rivers or waterways.

As is the norm in Paraguay, bridges along principal roads will be of concrete, while those along secondary roads will be of wood. Both types of bridges will have a width of B=7.0 m. Due to the difficulty of accurately assessing river breadth at bridge sites, under the present plan two standard bridge types with a span of 20.0 m and 10.0 m respectively will be used for primary roads, and a single standard type with a span of 10.0 m for secondary roads. Bridge locations have been determined by referring to topographical maps (1:250,000 scale) to identify where roads and rivers intersect. Bridges along both principal and secondary roads will be designed to withstand a maximum load of 40 tons.

Transverse culverts will be constructed mainly where a road passes across a waterway or depression. Along principal roads twin sections of centrifugal reinforced concrete pipe will be used, while along secondary roads a single section of such pipe will be used.

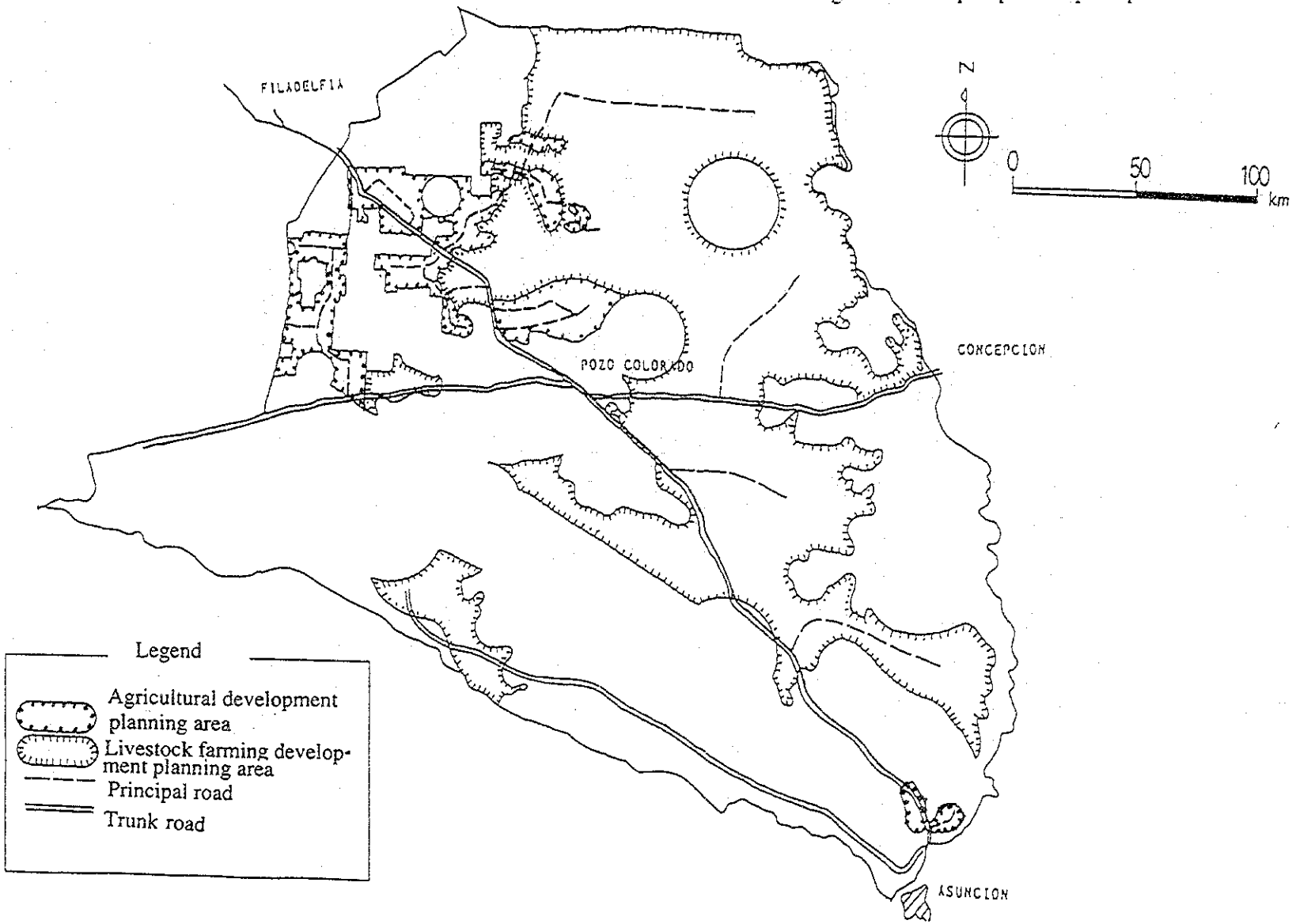
5) Cost

As shown in Table 7.2.1.4, the agricultural road plan will require an expenditure of US$63,275,000. This covers the cost of constructing 701 km of principal road and 21 bridges.

Of this amount US$61,423,000 will be spent on roads, and US$1,852,000 will be spent on bridges.

A detailed breakdown of relevant expenses is given in Table 7.2.1.5.

Fig. 7.2.1.1: Map of planned principal road routes



7.2.2 The farmland development plan

1) Basic policy on farmland development

The farmland development programme involves formulating a model for each basic category of agricultural activity. In the main it covers development of farm sites, secondary roads, farm roads, auxiliary drainage channels, farm drainage channels, and related facilities. The relevant plans will be drawn up upon examination of such factors as category of agricultural activity, type of crop, and system of operation. The fundamental considerations to be taken into account in deciding farm boundaries are the lay of the land, irrigation planning, and crop and farm management planning, but attention will also be paid to types of agricultural activity in adjacent areas.

2) Area subject to farmland development

The area subject to farmland development as determined under the land use plan is as indicated in Table 7.2.2.1.

3) Farmland development techniques

The following four methods will be utilized in clearing land in the survey area: (i) Two bulldozers at a distance of 30-40 m apart with a chain stretched between them will advance felling any trees in the way, and after the area sufficiently dry, in September or October, it will all be burned. (ii) A single bulldozer will be used to fell trees, clearing an area 35 m across; the roots will then be gathered and carried away by hand and the site ploughed over. (iii) Trees will be crushed and pulverized with a machine called a pisamonte, and the resulting chips will be burned after being left to dry for about 15 days. (iv) Trees will be chopped down manually using an axe, dried out, then set on fire; any logs left over will be collected by hand and again burned.

Under the project farmland will as a rule be cleared by mechanical means.

(i) Clearing of land covered in forest or sparse or scrub forest will in principal proceed as follows:

Trees levelled and burned - roots extracted and disposed of - ground ploughed up - extraneous objects removed

In order to prevent wind erosion care will be taken to ensure topsoil is not lost when felling trees. The felled logs will be gathered at intervals of approximately 30 m and burned in such a way that scarce organic matter is not incinerated. Measures will likewise be taken to avoid loss of fertile topsoil during removal of roots.

(ii) A strip of forest no less than 50 m across will be left around swamps in order to prevent contamination of river water and damage to agricultural land.

4) The farm facilities plan

(1) Basic policy on farm facilities planning

The farm facilities plan covers not only farms themselves but also roadways, i.e. secondary roads and farm roads, waterways, i.e. auxiliary drainage channels and farm drainage channels, and supplementary facilities, i.e. transverse culverts.

(2) Farm facilities

a) Farm plots

As the crop and farm management plan suggests, there are various possibilities as to types of plot on ordinary cropland. Two standard types of farm plot are to be adopted for the present project as illustrated in figs. 7.2.2.1 and 7.2.2.2, one with an area of 100 ha, the other with an area of 10 ha.

Each 100 ha plot is to be a square with a length of 1,000 m on each side. There are also to be five shelterbelts laid out in an east-west direction and located 200 m apart as described in the section on the farmland conservation plan.

b) Secondary and farm roads

Secondary roads will link principal roads to farms, and as a rule will be bordered on one side by a farm. Farm roads will be used mainly for farm work, serving as a place to turn around large equipment and temporarily keep machinery and supplies. These roads will be built by the farmers themselves.

c) Terminal drainage channels

Terminal drainage channels will consist of auxiliary drainage channels and farm drainage channels. Farm drainage channels will be placed on the downstream side of each farm district and flow into auxiliary drainage channels. They will be earthen in construction, and culverts will be built where they intersect with roads. These farm drainage channels will be constructed by the farmers themselves.

d) Transverse culverts

Transverse culverts made of centrifugal reinforced concrete pipe will be built wherever a secondary or farm road intersects with an auxiliary or farm drainage channel or a river.

(3) Infrastructure standards for the farm facilities plan

The infrastructure standards to be followed in the farm facilities plan are as listed in Table 7.2.2.2. These standards take into account farm management planning, types of site preparation, road planning, drainage planning etc.

(4) Planning specifications for farm facilities

Planning specifications for roads under the farm facilities plan are given in Table 7.2.1.3. Design of waterways is discussed in the separate section on the drainage plan; design specifications for waterways are listed in Table 7.2.2.3.

5) Cost

As shown in Table 7.2.2.4, the farmland development plan will require an expenditure of US$104,539,000. This covers the cost of reclaiming 177,100 ha of land for agricultural development and constructing 1,060 km of secondary roads.

Of this amount US$75,185,000 will be spent on land reclamation, and US$29,354,000 will be spent on road construction.

A detailed breakdown of relevant expenses is given in Table 7.2.2.5.

Fig. 7.2.2.1: Sample farm layout under the farm facilities plan (standard plot area: 100 ha)

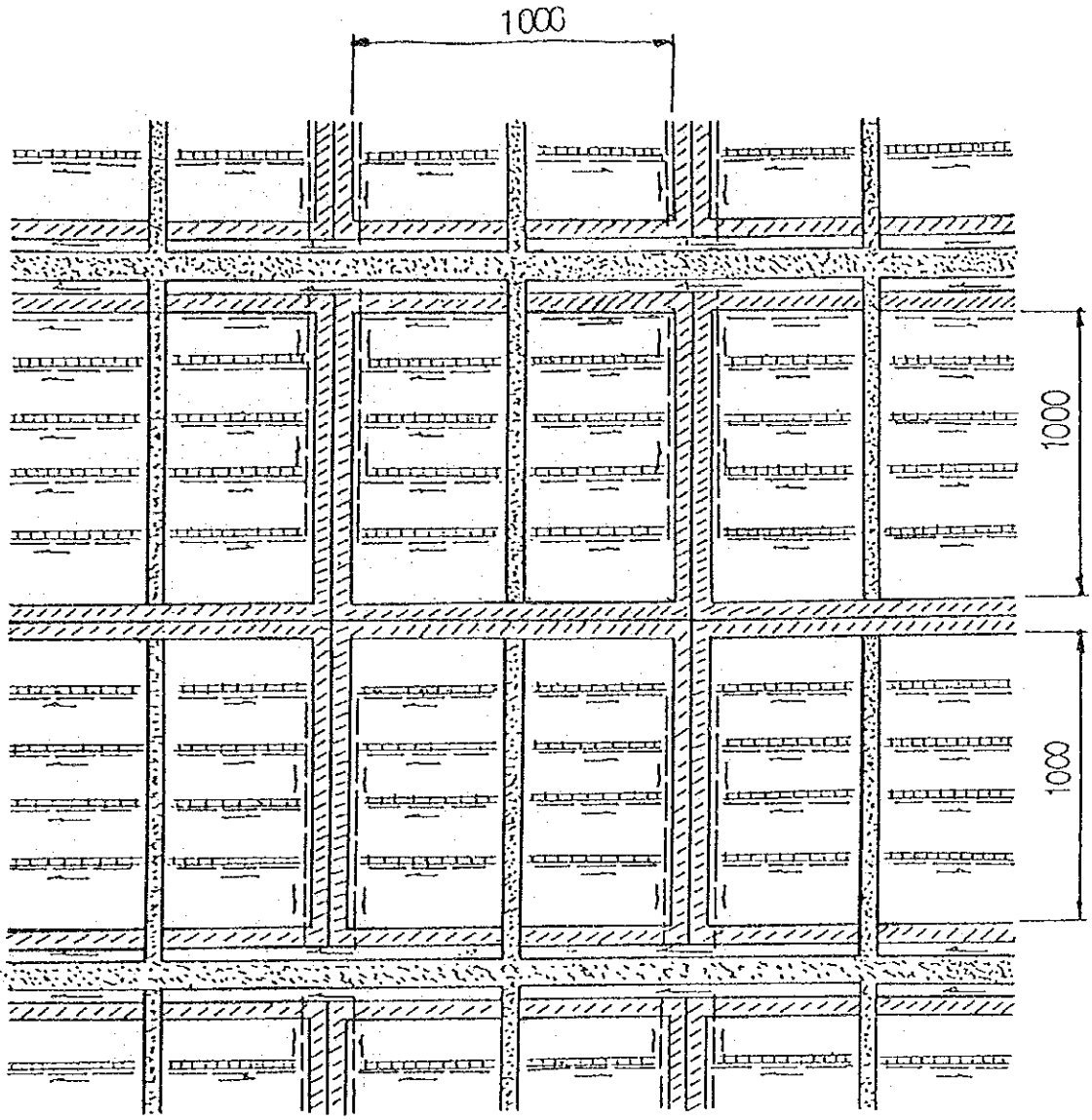
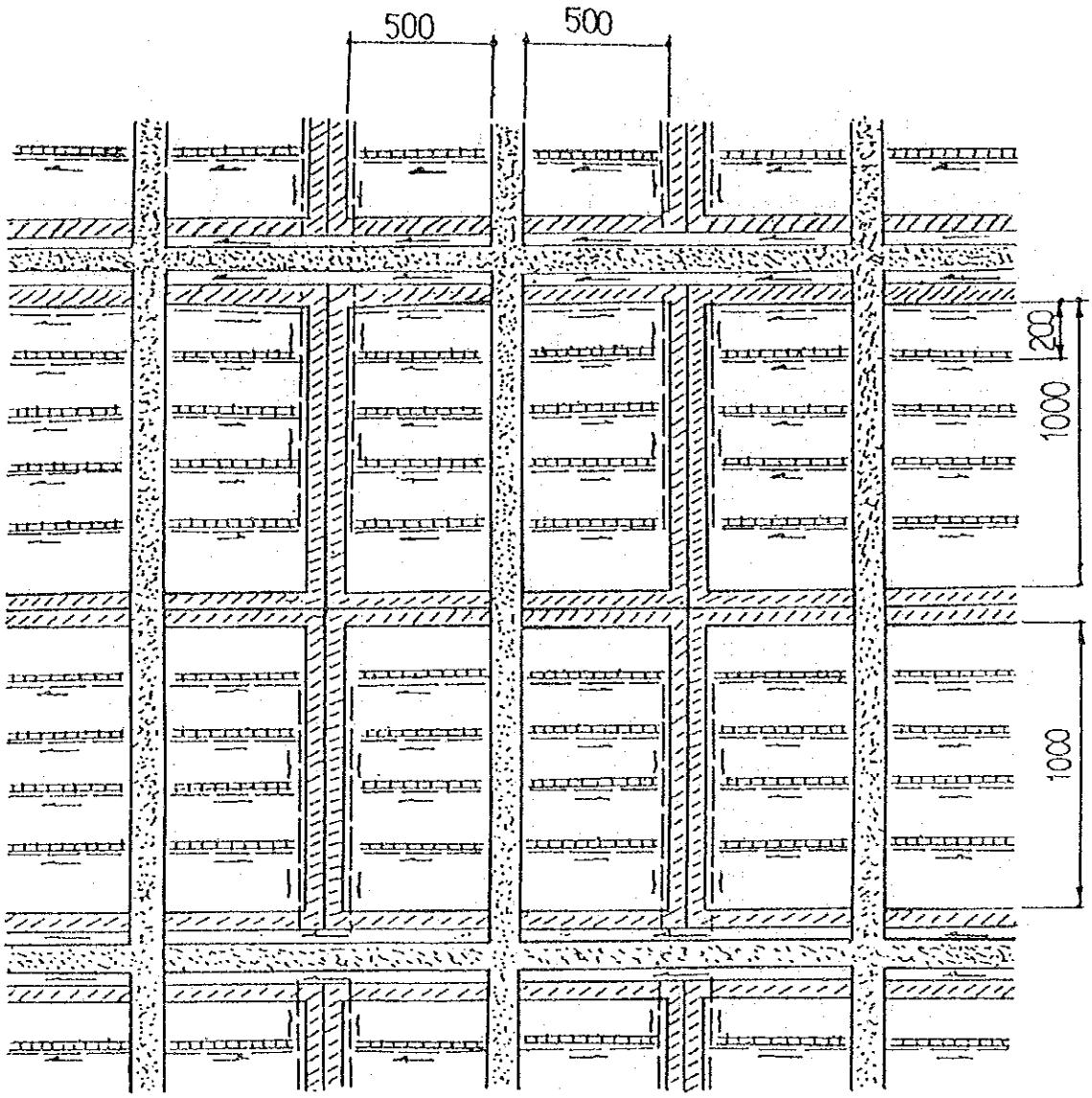


Fig. 7.2.2.2: Sample farm layout under the farm facilities plan (standard plot area: 10 ha)



Shelterbelt

Forest

Secondary road

Auxiliary drainage channel

Farm drainage channel

7.2.3 The grassland establishment plan

1) Management of grassland establishment

(1) Basic planning policy

(i) The typical grazing capacity of natural grasslands in the study area is a poor 0.5 U.A./ha. The primary reason for this is the existence of considerable seasonal fluctuations in amount of pasturage. During the summer grass grows well and grazing capacity is more than adequate as there is ample rainfall and temperatures are high, but during the dry season between July and September only an extremely limited quantity of grass is produced, while crude protein content falls and crude fibre increases; as a result supply of nutrition is extremely unevenly distributed over the course of the year. For this reason the plan will incorporate a scheme of utilization that averages out wild grass production in natural grasslands throughout the year. Seasonal dry-matter production on natural grasslands in the semi-arid zone of Argentina Chaco, which displays similar natural conditions to the northern part of the survey area, is shown in fig. 7.2.3.1.

(ii) The flood situation on the flood plain of the Pilcomayo River that covers most of the survey area has been undergoing a change over the course of the past several decades. This has resulted in turn in a change in vegetation patterns in the survey area. As shown in Table 7.2.3.1, viñal, aromita, and other thorny shrubs and weeds now grow in profusion, while coverage of useful grasses has declined; furthermore, the intrusion of weeds has led to decreasing rates of utilization for grazing purposes, which is one reason productivity is low.

(iii) Existing shrub forest and weeds will be subject to a thoroughgoing control programme in order to solve this problem. As indicated in Tables 7.2.3.2-7.2.3.5, the improvement rate for grasslands in the survey area is generally low except in the Mennonite settlements. Therefore measures will be implemented to raise grazing capacity per unit of area by planting fodder crops that will increase nutritional supply and undertaking grassland improvement. These measures will result in dramatic gains in land productivity and thus enable a considerable increase in number of livestock.

(2) Management of natural grassland utilization

Natural grasslands will be developed for use in their current state; the cost of maintaining them will be budgeted for under the management plan, and will not be included in the initial investment. Due to the necessity of reducing the production cost of beef, infrastructure standards for natural grasslands will be kept down to the bare minimum,

with no drainage channels etc. being installed. Planned area of natural grasslands by district is as given in Table 7.2.3.6.

(i) Method of natural grassland control

Grassland shrubs and weeds will be cleared with chains attached to bulldozers, the cheapest technique available; rotary cutters will also be used. The stages to be followed in clearing shrubs and weeds are shown in fig. 7.2.3.2, while the costs involved are presented in Table 7.2.3.7.

Shrub forest levelled (bulldozer + chain) ——— Gathered together (rake-dozer) ——— Burned (by hand) ——— Ready for grazing

Fig. 7.2.3.2: Stages in natural grassland control

Natural forests will need to be levelled and burned during the dry season that lasts until October in order to ensure an abundance of natural pasturage in rainy season.

(ii) Grassland utilization

Natural grasslands will all be used for grazing purposes. Grazing will take place throughout the year, but sections of grassland will be reserved for stand-by grazing in winter so that pasturage left over in the summer is available during that time of year when supply of fodder is low.

(iii) Dry-matter production targets

Current dry-matter production in wet natural grasslands is around 4,400 kg/ha; an increase of 1,000 kg/ha is anticipated after grassland improvement through clearing of weeds etc., giving a total of ¥5,400 kg/ha. In the case of dry natural grasslands the expected yield is 3,000 kg/ha, a figure calculated by applying data from Proniega on dry-matter production in savanna areas.

(iv) Grassland utilization rate

The utilization rate for both dry and wet grasslands will be set at 50% over the course of the year.

(v) Grassland management

The most important aspect of natural grassland management in areas to be developed for livestock farming is controlling shrubs and weeds. Weed control programmes also need to be implemented from an early stage on newly established grasslands,

since after the passage of a few years thorny leguminous plants tend to encroach on the land, resulting in lower productivity. Among the techniques available for controlling shrubs is treatment with herbicides. This involves making a cut in the base of the trunk to which the herbicide is then applied, and is employed mainly on thorny leguminous shrubs. In view of possible impact on the ecosystem the chemicals to be used include Togar BT (Picloram + Triclopyr) and Tordon (a 5% mix in gas oil), which are as effective as 2,4,5-T but also have low toxicity and residual effect. This technique must be done by hand and is thus expensive, for which reason it will be considered for use in limited areas of grassland or in combination with mechanized methods of weeding. Where there are vast expanses of grassland one option will be to employ this technique alongside mechanical equipment, e.g. the shovel of a bulldozer, a roller-type cutter known locally as a rolo, rotary cutters, ploughing harrows, etc. Again, in the Montelindo and other river basins in the region, shrubs and weeds are cleared using a method called anillado (see fig. 7.2.3.3). Several dozen to several hundred hectares of shrub forest located on flat land near the river or one of its branches are surrounded by a mound of earth approximately 2 m in height running along lines of contour; the river is then dammed up, the area is flooded with water, and the shrubs wither and die. An effective technique in the case of trees with a large girth is to manually strip off circles of bark at the base of the trunk or cut notches into it before flooding. While this procedure is only possible under certain topographical conditions, i.e. in a river basin, it is a feasible way of controlling weeds and shrubs in extensive areas of grassland. However, it has been argued that this technique causes salt damage on the upstream side of the dam, and since absolutely no assessment has as yet been made of its possible impact on the natural environment of the basin careful analysis will be needed before deciding to resort to it. The anillado method will be incorporated into the plan as a means of weed control if it is found to be consistent with protection of the ecosystem as the result of subsequent research on extent of environmental impact.

Bark removed (by hand) — Earthen mound constructed (bulldozer) — Area flooded (river water left to stand for several months) — Water drained — Ready for grazing

Fig. 7.2.3.3: Stages in grassland control using the anillado method

Another possibility is the spraying of herbicides across a large area, but again no assessment has been made of the environmental impact; therefore such an approach will not be included in the plan at the present stage, although it may ultimately prove feasible depending on the results of later research.

(3) Management of improved grassland development

The improvement rate for grasslands in livestock farming development planning districts is on the whole low. In order to make gains in grassland productivity, reduce the time needed to fatten beef cattle, and raise dairy-farming productivity, grassland improvement will be planned according to the criteria listed below. Dry natural grasslands and natural forests in livestock farming development planning districts, along with cleared natural forests in agricultural development planning districts, will be converted into improved grasslands as a way to expand the production base. The total area of improved grasslands to be established for each district will be set on the basis of the land use plan; a general idea is provided in Table 7.2.3.8.

(i) Development procedures

Bulldozers with chains attached will be used to achieve maximum work efficiency at minimum cost. This technique is well suited to the job in that it involves little disturbance to topsoil, since in areas where the top layer consists of fine sandy soil there is a risk of runoff of organic materials caused by erosion due to seasonal winds and rain. The following diagram illustrates procedures for developing improved grasslands in forested areas.

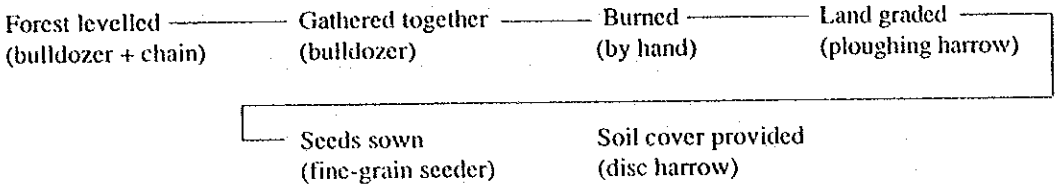


Fig. 7.2.3.4: Stages in developing improved grasslands

As a rule the soil will not be ploughed over, and the land will be graded through direct application of a Rome-type ploughing harrow. The first part of the job, from levelling of forest to grading of land, will in so far as possible be carried out during the dry season, while seeding will be conducted in or after October at the same time as the land is graded, for which use will be made of a locally-developed electric-powered fine-grain seeder attached to the harrow. Soil cover will be provided by lightly ploughing over the ground with a disc or tooth plough. Diagrams of sample farm layouts in improved grassland areas are given in figs. 7.2.3.5-7.2.3.6, while the costs involved are listed in Table 7.2.3.10. The cost of developing improved grasslands in each district is given in Table 7.2.3.10.

(ii) Species of grass to be introduced

a) Gramineous grasses

The types of grasses to be introduced will be separately selected for dry and wet areas. In the dry zones that make up the majority of the livestock farming development planning districts there is frost about two to three times a year, and while flooding occurs in the rainy season the soil tends not to retain water due to a lack of organic content, for which reason the surface of the ground solidifies during the dry season. In the light of these natural conditions the species pangola (Digitaria decumbens) and estrella (Cynodon plectostachyus) are to be introduced in such areas. Among the species to be planted in wet grasslands are gatton panic (Panicum maximum cv. gatton), colonial (Panicum maximum), estrella (Cynodon plectostachyus), buffel grass (also known as salinas, Cenchrus ciliaris), Brachiaria brizantha, and Rhodes grass (Chloris gayana). In addition, the species paso nilo (Acrocera macrum) has proven highly successful in the province of Corrientes in Argentina, which is subject to similar conditions, and has done relatively well since being introduced at the PRONIEGA experimental station last year; it will therefore be included under the present plan. A list of factors considered in selecting species of grass to be introduced is given in Table 7.2.3.11.

b) Leguminous grasses

There are numerous species of leguminous shrubs native to the natural grasslands of the survey area, but the majority are tall and have thorns, rendering them of little value as a source of fodder for livestock. On the other hand, harsh natural conditions in terms of soil salinity, amount of precipitation, and temperature make for an environment inhospitable to the growth of leguminous grasses. One possibility would be the introduction of the arboreal legume ginnem (Leucaena leucocephala). Ginnem has grown well at the PRONIEGA experimental station, and shows promise as a forage crop. In addition, this species is said to fixate nitrogen in the air at a rate of some 400 kg/ha annually, which would make it a valuable plant for improving soil quality as well as feeding livestock. It has a relatively high tolerance to salinity, and is said to grow well even with just 700 mm of rainfall. The PRONIEGA experimental station has also started experimenting with the cultivation of other species, including alfalfa (Medicago sativa), cajanus (Cajanus cajan), and meliloto (Melilotus alba), some of which may be introduced under the plan depending on the results of this research.

(iii) Amount of seed to be sown

The amount of fodder-grass seed to be sown and the costs involved are as given in

Table 7.2.3.12. Since there are at the present time no leguminous grasses suited to mixed seeding, for now species will be sown individually.

(iv) Targets for yield and nutritive value

The yield of dry matter in improved grasslands in the survey area is 9,000-20,000 kg per hectare; the target yield will be set at 11,000 kg/ha annually, taking the average for all grass species. Nutritive value for each type of fodder crop is as shown in Table 7.2.3.13. Table 7.2.3.14 gives dry-matter production and available nutrition per hectare of grassland (wet and dry natural grassland, improved grassland) and fodder cropland. A fodder crop production utilization plan for each district (as calculated by fresh forage and TDN) is outlined in Table 7.2.3.15 as well as Table 7.2.3.16.

(v) Method and rate of utilization

Improved grasslands will not be harvested on the assumption they will be used for grazing throughout the year. The annual grazing utilization rate will be set at 60%. In order to ensure a balanced supply of nutrition for beef cattle grazing will be suspended during the summer and autumn so as to allow for stand-by grazing in winter, when fodder crop production on natural grasslands declines.

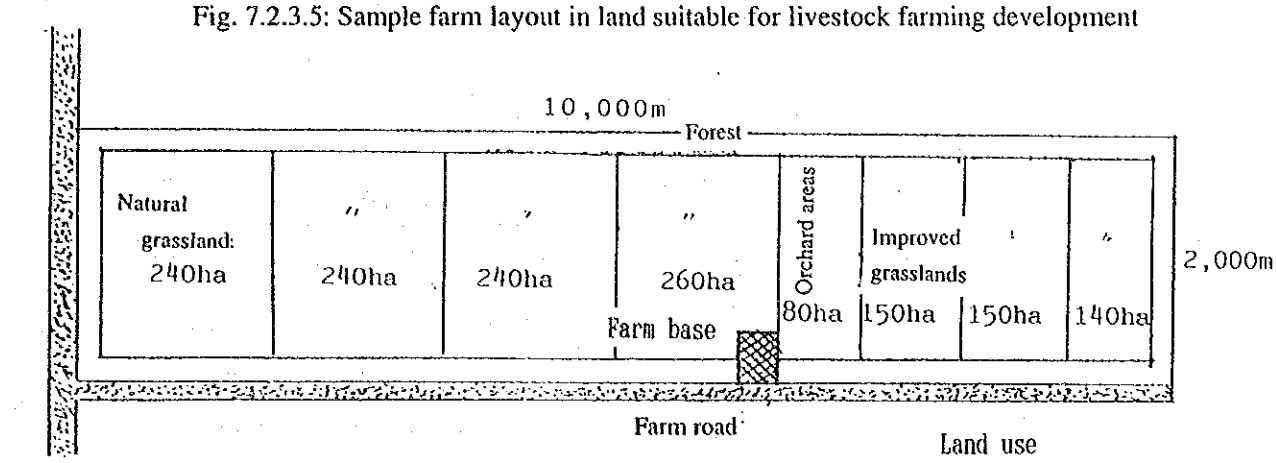
(vi) Period of utilization

Improved grasslands become choked up with weeds after the passage of several years from the time of their establishment, and the physical properties of the soil deteriorate as it is stamped down by cattle, resulting in a loss of productivity. Therefore the plan calls for such grasslands to be renewed every six years.

(vii) Grassland management

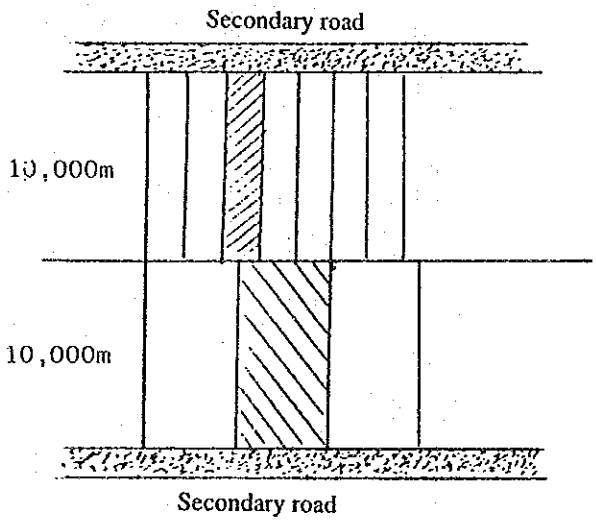
In order to keep down the cost of fattening cows for beef production no fertilizer will be used in grassland districts, since no significant results were obtained from fertilizer experiments conducted on improved grasslands in the survey area and vicinity. Leguminous weeds and shrubs will be kept under control by clearing them with rotary mowers, the roller-type cutter known as a rolo, etc. or through the application of such herbicides as Togar, or by uprooting them by hand. Finally, the soil in the survey region has low organic content, while in clayey soil porosity and permeability will tend to decline as the surface of the ground is trodden down and hardened by cattle; there are thus concerns that the root system of fodder plants could be affected, and the area will therefore be gone over with a disc harrow once or twice during the period of utilization in order to revive depleted soil productivity.

Fig. 7.2.3.5: Sample farm layout in land suitable for livestock farming development



Land use

Natural grassland	980ha
Improved grassland	440ha
Orchard areas	80ha
Forest	500ha
Total	2000ha



Land use

Natural grassland	2450ha
Improved grassland	1100ha
Orchard areas	200ha
Forest	1250ha
Total	5000ha

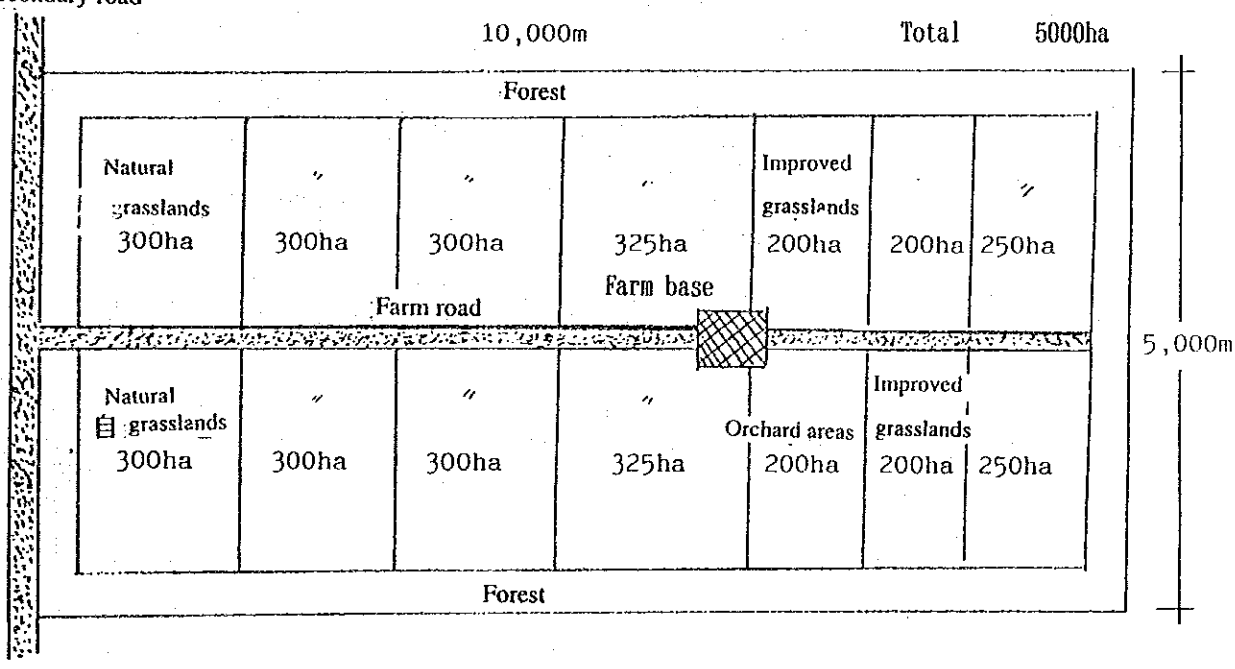


Fig. 7.2.3.6: Sample farm layout in land suitable for agricultural development

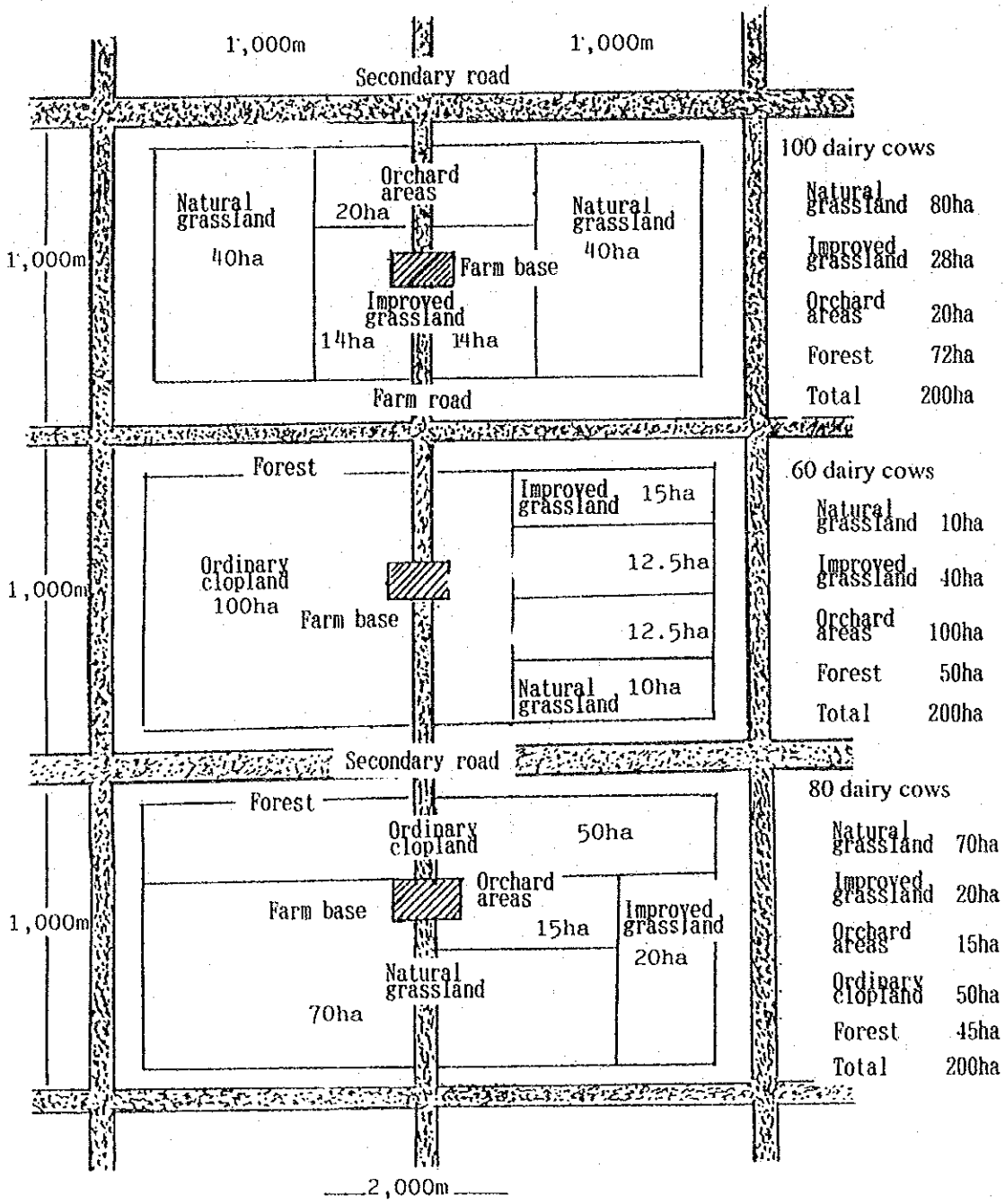


Table 7.2.3.15 Fodder crop production utilization plan(as calculated by fresy forage)

Area	Type of live stock farming	Number of farms	Amount of fodder poduction(in tons)														
			Fodder cropland(A)			Fodder cropland(B)			Improved grassland			Natural grassland(dry)			Natural grassland(wet)		
			Area	Production	Use	Area	Producti	Use	Area	Production	Use	Area	Production	Use	Area	Production	Use
Northern	50dairy cows	200				7,200	72,000	50,400	7,200	360,000	216,000	940	9,400	4,700	1,280	23,040	11,520
part of	10cows+40sheep	175				1,575	15,750	11,025	1,750	87,500	52,500	1,418	14,175	7,088	1,925	34,650	17,325
Pozo	10cows+40goats	175				1,575	15,750	11,025	1,750	87,500	52,500	1,418	14,175	7,088	1,925	34,650	17,325
Colorado	15sheep+5bees	80							0			392	3,920	1,960	544	9,792	4,896
Subtotal		630				10,350	103,500	72,450	10,700	535,000	321,000	4,167	41,670	20,835	5,674	102,132	51,066
Southern	50dairy cows	200				7,200	72,000	50,400	7,800	390,000	234,000	520	5,200	2,600			
part of	80dairy cows	10	135	8,100	5,670				380	19,000	11,400	181	1,810	905			
Menno.	10cows+40sheep	180				1,620	16,200	11,340	2,664	133,200	79,920	936	9,360	4,680			
	10cows+30goats	180				1,620	16,200	11,340	2,664	133,200	79,920	936	9,360	4,680			
	15sheep+5bees	70										1,204	12,040	6,020			
Subtotal		640	135	8,100	5,670	10,440	104,400	73,080	13,508	675,400	405,240	3,777	37,770	18,885	0	0	0
Eastern	50dairy cows	200				7,200	72,000	50,400	7,200	360,000	216,000	680	6,800	3,400	1,600	28,800	14,400
part of	80dairy cows	20	270	16,200	11,340				360	18,000	10,800	428	4,280	2,140	1,022	18,396	9,198
Menno.	100dairy cows	350	6,300	378,000	264,600				8,750	437,500	262,500	8,050	80,500	40,250	19,320	347,760	173,880
	10cows+40sheep	320				2,880	28,800	20,160	2,656	132,800	79,680	2,144	21,440	10,720	5,152	92,736	46,368
	10cows+30goats	320				2,880	28,800	20,160	2,656	132,800	79,680	2,144	21,440	10,720	5,152	92,736	46,368
	15sheep+5bees	150										495	4,950	2,475	1,155	20,790	10,395
Subtotal		1,360	6,570	394,200	275,940	12,960	129,600	90,720	21,622	1,081,100	648,660	13,941	139,410	69,705	33,401	601,218	300,609
Suburbs	10dairy cows	90							270	13,500	8,100	234	2,340	1,170	1,215	21,870	10,935
of																	
Asuncion																	
Subtotal		90	0	0	0		0	0	270	13,500	8,100	234	2,340	1,170	1,215	21,870	10,935
Livesto.	Bef cattle only		76,560	4,593,600	3,215,520				384,714	19,235,700	11,541,420	138,446	1,384,460	692,230	916,168	16,491,024	8,245,512
farming																	
area	15sheep+5bees	1,640										3,444	34,440	17,220	18,204	327,672	163,836
Subtotal		1,640	76,560	4,593,600	3,215,520	0	0	0	384,714	19,235,700	11,541,420	141,890	1,418,900	709,450	934,372	16,818,696	8,409,348
Total		4,360	83,265	4,995,900	3,497,130	83,750	837,500	236,250	430,814	21,540,700	12,924,420	164,009	1,640,090	820,045	974,662	17,543,916	8,771,958

Note:Fodder cropland(A)is devoted exclusively to the cultivation of fodder;fodder cropland(B)refers to ordinary cropland used in the off-season to grow fodder.

7.2.4 The water resources plan

1) Basic policy

According to the results of the second survey the primary water sources available for the use of this project are rainwater, groundwater in the patiño layer (Benjamin Aceval), and the Rio Paraguay. Basic policy on developing each of these sources is as follows:

(i) Reservoirs or tajamares, whereby rainwater is collected in an old riverbed, will be developed in order to supply drinking water for people and livestock, as well as water for processing and miscellaneous purposes.

(ii) As far as groundwater is concerned, no attempt will be made to exploit the groundwater of the Chaco layer extending over most of the survey region as its water quality and pattern of distribution would make systematic use difficult. The groundwater in the patiño layer shows potential in terms of both water quality and volume; but while with an estimatedusable volume of 14-28 x 10^3 m^3/km^2 it may be a feasible source of drinking and irrigation water, caution will need to be exercised in order to avoid overpumping and thus lowering the water table, which would cause saline water to seep in from the Chaco layer. The plan calls for wells with a diameter of at least 10" and an excavated depth of 100 m, while motor pumps and airlift pumps will be used to raise the water.

(iii) The Rio Paraguay has enough volume of flow to supply water at a rate of 50 m^3/s. A point downstream from its confluence with the Rio Apa, where no international dispute about water rights will arise, will be selected; alternative proposals on the cost of electric power to run the facility, water conveyance systems, pumping site, construction of water channels, and so forth will be compared, and the most advantageous will be incorporated into the current project. A water intake of 50 m^3/s will cause a drop in water level of approximately 12 cm when the Rio Paraguay is at its lowest; hence this was chosen as the limit beyond which there might be an effect on shipping traffic along this international waterway.

The amount of water used for irrigation along the right bank of the Rio Paraguay totals about 40 m^3/s, but the rate at which water seeps into the river from both banks and water utilized for irrigation is returned is believed to be fairly rapid, for which reason there was judged to be no difficulty in this regard.

On this subject it may also be mentioned in passing that there is a proposal to supply water to the central Chaco region by drilling deep wells in the Timane River and its basin. Estimated volume of supply is 320 x 10^6 m^3 a year. Another idea under scrutiny

is that of collecting freshwater from such locations as Lake Pitiantuta, then conveying it along a channel leading from the Timane River to central Chaco. The difference in elevation between the point on the Timane River at which the water will be collected and the central area of Chaco is somewhat less than 100 m, and the distance is 240 km, or 120 km from Lake Pitinta. In the area along the Bolivian border north of the Bahia Negra fault line that runs from the northeast to the southwest in the vicinity of the port of Bahia Negro there are outflows of groundwater connected to the Rio Grande and Lake Abapo-Izozog on the lower reaches of that river, from which it has been ascertained fresh water can be obtained.

Of the usable water resources mentioned above, the use of the Rio Paraguay and groundwater from the patiño layer will be discussed in section 7.2.5 following. Meanwhile, here we shall examine methods of harnessing rainwater for practical application, as follows.

2) Supplying livestock drinking water from tajamares

Precipitation patterns in the project district are extremely unbalanced, with 75% of annual rainfall concentrated in the wet season between November and April. Thus reservoirs or tajamares will be needed in which to collect rainwater during the wet season in order to ensure a supply of drinking water for livestock during the dry part of the year.

However, there will be considerable losses from evaporation and seepage if only rain that falls from directly above is used; thus the tajamar will prove unable to retain the water. For this reason one of the options that will have to be considered is collecting and storing runoff from precipitation falling in the vicinity of the tajamar.

(1) Amount of demand for water

The standard quantity of water required per head of cattle per day has been set at 60 litres for beef cows and 150 litres for dairy cows on the basis of interviews and previous reports. Water consumption by month is shown in Table 7.2.4.

(2) Water loss

a) Through evaporation

Livestock farming development planning districts will be divided into two regions depending on amount of evaporation (see Table 7.2.4.1):

Region A (the western and central region): 1,600-1,400 mm (a figure of 1,600 mm will be adopted)

Region B (the eastern region): less than 1,400 mm (a figure of 1,400 mm will be adopted)

Evaporation by month is shown in Table 7.2.4.2.

b) Through seepage

Silt originating in the alluvium that makes up the region increases the further northwest one goes, and such areas display a water permeability of 10-20 mm a day. In the southeast, by contrast, water permeability is less than 5 mm due to the thick clay layer. For the purposes of the present project a figure of 10 mm will be adopted for Region A and 5 mm for Region B.

(3) Standard ranch size

a) Number of livestock

The number of livestock per ranch for each type of farm will be as shown in Table 7.2.4.3.

b) Size of ranch

(a) Beef cattle

Standard ranch size will be around 5,000 ha (10 km x 5 km), an area that will allow rounds to be made on horseback. Each ranch will consist of areas of natural and improved grassland, fodder cropland, and forest (see Table 7.2.3.5). There will be eight natural grassland fields, five improved grassland fields, and one fodder cropland field. Ranch size and number of cattle (for farms specializing in beef production) are shown in Table 7.2.4.4.

(b) Dairy cattle

Standard ranch size is to be about 200 ha (2 km x 2 km), with each ranch consisting of areas of natural and improved grassland, fodder cropland, and forest (see Table 7.2.3.6). There will be two natural grassland fields, two improved grassland fields, and one fodder cropland field. Ranch size and number of cattle (for farms specializing in dairy production) are shown in Table 7.2.4.5.

(4) Catchment area

The volume of collectable rainfall varies depending on the amount of evaporation and seepage as well as topography, the location of tajamar reservoirs, etc. The catchment area is generally expressed by the following formula:

$$Sc = \frac{Da}{Eu}$$

Sc: Superficie de la Cuenca de colecta de agua de lluvia en ha

Da: Demanda de agua anual del potrero en m^3

Eu: Escurrimiento unitario expresado en m^3/ha

See Table 7.2.4.6 for the results of calculation of catchment area.

a) Probable rainfall

Probability of rainfall is 1/10. The results of calculation of non-excess probable rainfall are given in Table 7.2.4.6.

b) Monthly rainfall

The amount of rainfall for each month as computed from the above figure for probable rainfall is shown in Table 7.2.4.7.

(5) Tajamar size

Tajamar size (i.e. storage capacity) varies depending on type of grassland, topography and geology, and meteorological conditions, and is therefore determined with these factors in mind.

Tajamar depth is controlled by level of groundwater containing salt and soil conditions such as impermeable layer thickness. A shallow tajamar requires a more extensive surface area even if the quantity of water stored remains unchanged, resulting in extensive loss through seepage and evaporation. This consideration has been factored into calculations of the number of tajamares per ranch, as the result of which it has been decided that there should be two tajamar reervoirs constructed in the natural grassland section and two in the improved grassland section of each beef cattle farm, and one tajamar in the natural grassland section and one in the improved grassland section of each dairy farm.

Since the shape of a tajamar varies depending on the topography and geology of the construction site, tajamar size is more usefully expressed in terms of storage capacity.

Tajamar capacity as calculated on the basis of these factors is given in Table 7.2.4.8. The pattern of tajamar water storage and consumption is illustrated in fig. 7.2.4.2.

(6) Tajamar construction

a) Selecting a construction site

A construction site will be selected for each tajamar that fulfils the following requirements:

(i) Is the lowest point in the catchment basin, enabling efficient collection of surface water from the surrounding area.

(ii) Provides access to a catchment basin of the area required.

(iii) Is unaffected by groundwater containing salt.

(iv) Will suffer minimum loss through seepage.

b) Tajamar structure

Each tajamar will be of a size large enough to hold the capacity given in Table 7.2.4.8.

c) Catch drains (water collection channels)

An effort will made to procure enough water to satisfy demand by restricting seepage of rain and surface water into the soil and maximizing outflow speed so as to increase runoff percentage. However, at the same time caution will need to be exercised in order to prevent soil erosion and sedimentation, which would cause the tajamar to do its job less efficiently.

Since there is little risk of sedimentation as the region is extremely flat, primary water collection channels will be laid out following the slope of the land, and to these will be connected auxiliary catch drains. Spacing of catch drains is normally determined on the basis of the length of slope at which erosion commences; in the current project they will be placed approximately 100 m apart. Also, catch drains will have a maximum extension of 500 m.

7.2.5 The irrigation plan

1) Basic policy on irrigation planning

An irrigation plan has been drawn up to a sufficient degree of accuracy to allow the adoption of a basic development policy for the purposes of this general development programme. Materials and data currently available in Paraguay have been utilized in formulating this plan. Topographical maps with a scale of 1:50,000 were used, while unit construction costs were worked out on the basis of prices in Asuncion or Concepcion, to which were then added transportation and other extra expenses that would be incurred when construction got underway on site in Chaco.

Districts subject to agricultural development planning under the general development programme fall into three groups, for each of which independent methods of irrigation will be used. The first group is in the environs of Asuncion; here deep wells will be employed to extract fresh water from the groundwater of the patiño layer. The second group consists of three separate zones along the right bank of the Rio Paraguay; here water will be taken from the river itself. The third group comprises the three zones situated in the eastern and southern parts of the Mennonite settlements and the northern part of Pozo Colorado, and these too will be supplied from the Rio Paraguay.

The procedure taken in formulating the plan was as follows. Potential transpiration was worked out from data on temperature and sunshine, then crop transpiration was estimated by the Blancy-Criddle method. In the case of water being supplied from the Rio Paraguay, an application efficiency of 70% and losses during conveyance of 10% were postulated, yielding an irrigation efficiency of 63%, from which gross water requirements were then calculated. For deep wells irrigation efficiency worked out to 84%, a figure based on an application efficiency of 90% and losses during conveyance of 5% on the assumption irrigation would as a rule be done by spraying.

2) Water requirements

(1) Effects of quantity of rainfall on irrigation

A rainfall of 28 mm per month was postulated for the summer (the six months from October through March), and 2 mm per month for the winter (the six months from April through September) with ten-year non-excess probability. Calculations were worked out by the Iwai method based on monthly volume of precipitation in Filadelfia in the twenty years between 1969 and 1988. Daily rainfall intensity is 50% or above for less than 10 mm and 24% for between 10 and 20 mm based on frequency of rainfall as derived from the amount that falls per day (Daily Rainfall in Filadelfia 1932-1969; UNDP-Paraguay Chaco Development Project PAR/75/002 — April 1982). This suggests that the monthly rainfall of approximately 30 mm is spread over three to four days.

In calculating water requirements the winter rainfall of 2 mm a month is equivalent to zero, while the summer rainfall of 28 mm a month equals 11% of gross water requirements (240 mm a month). Since the distance over which the water must travel is too far to pump it as rain falls, a regulating reservoir or other water management system has been assumed, and the figure for gross water requirements has been taken as equal to the amount of water pumped.

(2) Gross water requirements

Gross water requirements were calculated by applying amount of crop transpiration to the crops to be irrigated, and factoring in an application efficiency of 70% and loss during conveyance of 10%.

a) Crop transpiration (ETc): (see Tables 7.2.5.1-7.2.5.8)

(a) Central Chaco region: Cotton — 6.1 mm/day Peanuts — 5.3 mm/day Sorghum — 2.6 mm/day

(b) Suburbs of Asuncion: Watermelons, melons, cucumbers, and other summer vegetables — 5.1 mm/day

Cabbage, onions, tomatoes, and other winter vegetables — 3.0 mm/day

(c) Right bank of the Rio Paraguay

There is a land reclamation plan for the left bank of the Rio Paraguay directly opposite this district where the Aquidaban River flows into the Paraguay, for the purposes of which unit water requirements of 2 litres/s/ha are assumed for paddling, leveling, and irrigation, and 0.7-1.3 litres/s/ha in order to maintain water depth in paddy land. The quantity of water needed to irrigate wetland rice in this region, which has similar conditions to those on the right bank of the Rio Paraguay, is 109 m^3/ha/day (1.26 litres/s/ha), an amount determined mainly by the number of hours of sunlight during growing season and how much energy is received. These two pieces of data suggest a water requirement at the entrance of paddy farms in this district of 10 mm per day (1.16 litres/s/ha).

b) Crop acreage and gross water requirements (see Table 7.2.5.9)

The area of farmland subject to irrigation is limited by the amount of water available. In the central Chaco region the ratio of cotton to peanuts is 7:3, and an ETc for these two crops of 6.1 mm/day and 5.3 mm/day respectively, in combination with the postulated irrigation efficiency of 63%, yields a gross water requirement of 9.3 mm/day. Therefore some 46,500 ha can be irrigated at a water intake rate of 50 m^3/s. Thus, of the central Chaco region, the whole of Pozo Colorado and about 70% of the eastern part of the Mennonite settlements will be irrigated under the plan. There is not enough water to irrigate the southern part of the Mennonite settlements.

The amount of water required at the entrance of farms along the right bank of the Rio Paraguay is 10 mm/day, which, with an assumed irrigation efficiency of 63%, gives a gross water requirement of 16 mm/day (1.85 litres/s/ha), or in other words a total gross water requirement of 43 m^3/s.