2.9.2 Soybean

In the 1970s the demand for feed expanded owing to the increase of pig raising and poultry farming in the world. As a result they concentrated on the soybeans which contain more protein to make the feed. Therefore, the soybean production in Paraguay, which had conventionally aimed at supplying materials for oil expression, has made rapid progress with the promotion of mechanization based on the national soybean project from the latter part of 1970s. In 1981 the soybeans reached approx. 400,000 ha in the actual growing area and about 700,000 t in the amount of production. It is considered that soybean production will continue to grow in the future as the demand for soybean tends to go upward in the world market.

The most recent national soybean project (1977 ∿ 1981) set up for every 5 years and the actual records in the past are shown in Table 2-9-3. In the national soybean project it is estimated that the growing area will be doubled, yield par unit area will increase by 16% and the projected amount of production will increase by 230% for 5 years. On the other hand the actual records of production exceeded the national project in terms of growing area and amount of production (except 1978) though they have sometimes fallen short of projected yield par unit area. Soybean production shows a steady growth (Figure 2-9-3).

Most of the soybeans produced was forwarded to the domestic market while the rest was exported. As shown in Table 2-9-4, more than approximately 60% of the production is to be exported in the aforementioned national project. If these are seen from the standpoint of actual production and exports, the amount of export fell short of projected amount after 2 years and was almost equivalent to it before three years as shown in Table 2-9-5. The actual exports have recorded the highest level with 468,000 t in 1982.

The price for domestic producers increased, as shown in Figure 2-9-6. Soybeans in both bean and processed forms, occupy 90% of the value of all exports (refer Figure 4-2-2 Soybeans). The soybeans for export, which are collected to the exporters by way of either producers/associations or brokers, are mainly exported from Stroessner to Brazil by land.

Table 2-9-3 Comparison between National Plan and Actual Soybean Production

Item / Year	Area (1,000 ha)		Production per hectare (kg/ha)		Amount of production (1,000 t)	
	Planned	Actual	Planned	Actual	Planned	Actual
1976	180.4 (100)	173.4	1,400 (100)	1,635	252.6 (100)	283.5
1977	206.9 (115)	228.8	1,460 (104)	1,647	302.2 (120)	376.9
1978	236.7 (130)	272.2	1,510 (108)	1,224	357.5 (140)	333.1
1979	271.9 (150)	360.3	1,555 (111)	1,524	422.7 (165)	549.2
1980	314.3 (175)	475.3	1,595 (114)	1,551	501.4 (200)	737.3
1981	362.1 (200)	396.0	1,630 (116)	1,927	589.9 (234)	763.0

Source: M.A.G. Planned figures are from National planned data and the actual from Statistical data.

Table 2-9-4 Breakdown of Soybeans by Category of Demand Based upon National Soybeans Plan

Upper t
Lower %

Item / Year	Seed	Consumption at home	Oil extraction	Loss	Export	Total
1977	16,569	9,300	86,400	33,200	156,731	302,200
	5	3	29	11	52	100
1978	19,033	10,100	94,200	33,600	200,567	357,500
	5	3	27	9	56	100
1979	22,001	11,300	102,800	36,000	270,599	442,700
	5	3	23	8	61	100
1980	25,374	12,200	112,800	32,000	319,753	501,400
	5	2	23	6	64	100
1981	25,550	13,600	122,300	26,000	401,850	589,900
	4	2	21	4	68	100

Source: M.A.G. National plan data

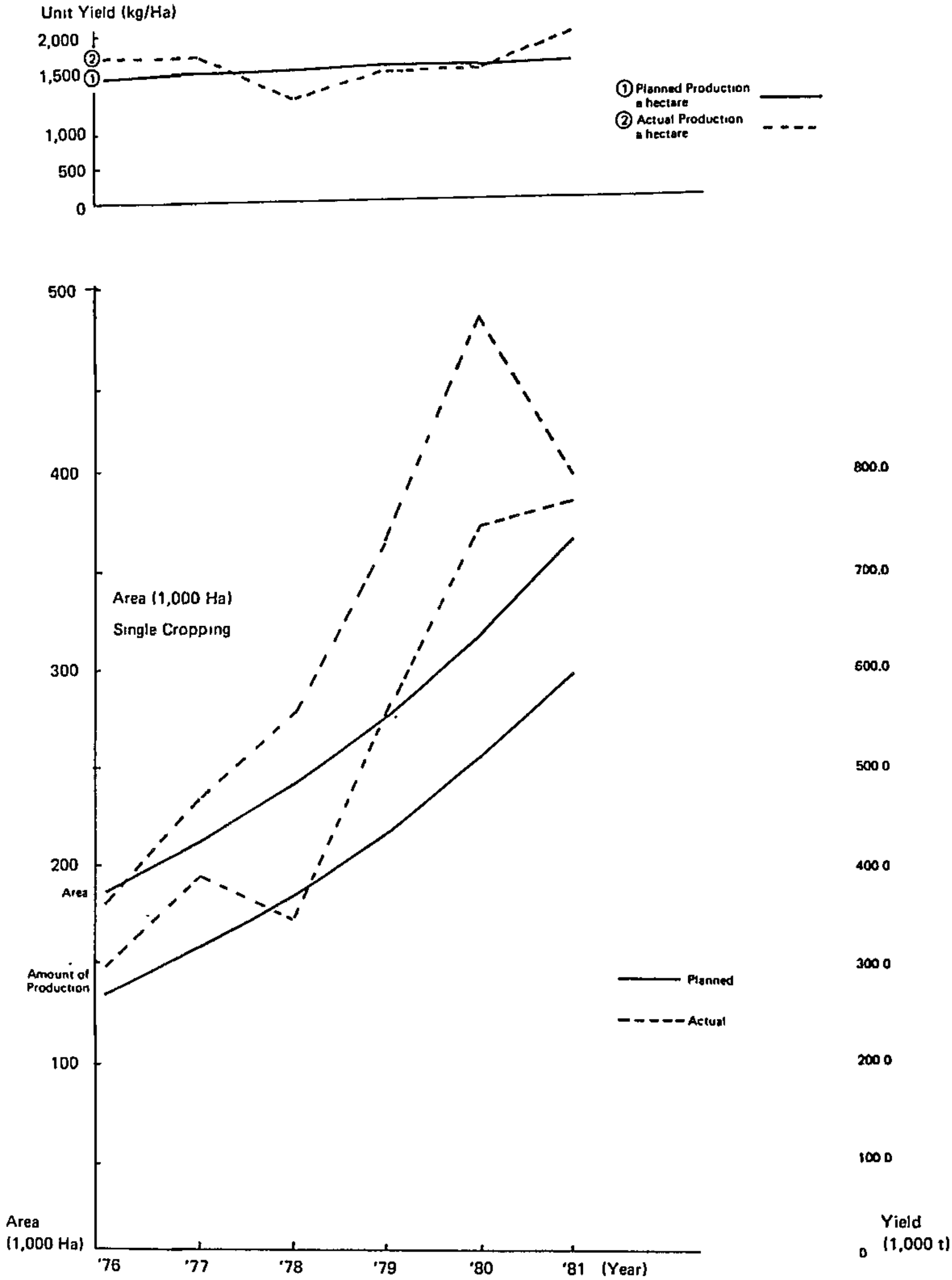


Fig. 2-9-3 National Plan and Actual Records of Soybean

Table 2-9-5 Comparison of Production and Export of Soybeans

(Unit: 1,000 t)

Item \ Year	1977	1978	1979	1980	1981	1982
Actual production ①	376.9	333.1	549.2	737.3	763.0	
Actual export ②	241.2	192.2	334.1	235.3	221.8	467.6
② / ① (%)	64	58	61	32	29	
Export rate (%) the total production of national plan	52	56	61	64	68	

Source: Actual production ..... M.A.G. Statistic data
Actual export ..... Boletin Estadistic data

Table 2-9-6 Price of Soybean

(Gs/Kg)

Item \ Year	1978	1979	1980	1981	1982	Average
Producer's price	20	25	19	28	25	30

Source: Producer's price ..... M.A.G. Statistic data

Under the circumstances the Government of Paraguay considers that a goal has been achieved concerning the soybean. Therefore, a national soybean project covering the years later than 1981 has not yet been set up.

Because Paraguay is a landlocked country, the cost of land transportation to and from the port becomes a very important factor in importing and exporting. Such a problem does not confront only with Paraguay but also with Brazil, the neighboring large-scale agricultural country. In order to solve the problem of high costs for land transportation. Brazil establishes "Paranagua Exports Corridor Plan". In the near future, this plan aims at "transporting the mass-produced cereals at lower cost to the port from the inland areas more than 1,000 km distant from the sea". This is the important plan which contribute to the agricultural development of inland areas such as Parana and Mato · Grosso do Sul states.

The plan, which is called "Soybean railway project" in other words, provides a grand conception covering the transportation of not only domestic agricultural products in Brazil but also the soybeans produced in Paraguay. As it is of great interest to Paraguay, the outline of the plan is mentioned below.

(1) Paranagua Exports Corridor Plan

The purpose of this plan, which they call "Soybean railway project" is to transport the agricultural products such as soybeans by railway to Paranagua Port from the widespread areas of approx. 50 million ha covering Parana, Mato · Grosso do Sul states (Brazil) and eastern parts of Paraguay and export them to the other countries by large vessels.

Parana state is called the granary of Brazil whose production of wheat and corn is ranked first in Brazil respectively. In 1980 the production of wheat amounted to 1.35 million t, 51% of the total production in the country, and that of corn was equivalent to 5,467,000 t, 27% of the total production. The soybean production is ranked second in the country next to Rio Grande do Sul state with the production of 5.4 million t in 1980 (36% of the total production). In Parana the total production of 3 major cereals amounts to 10 million t annually.

Mato · grosso do Sul state is new in producing soybeans and is expected to increase the production due to the realization of this plan.

In Paraguay the soybean production recorded 570,000 t in 1980. The eastern part of Paraguay, whose center is Itapua department, produces a greater portion of soybeans and is adjacent to Parana state by Prana River.

The cereals produced in this region exceed 10 million t annually which will be transported to Paranagua Port by a railway to be constructed. Viewing from the standpoint of time and cost required, it is very uneconomical to transport the cereals by 40,000 to 50,000 t vessel little by little. Mass-transportation system by sea will be required which adopts 100,000 to 150,000 t vessel, as the railway is to be constructed on land. When this system is developed, it is necessary for importer's side to contruct a large-scale port with modern facilities which enable a large vessel to drop into as well as exporter's side. With this condition prepared, the Corridor Plan will be made complete.

In Paranagua Port, which is the starting point of the Corridor Plan and is surrounded by favourable natural condition, the vessel (up to 45,000 t) will be able to come alongside as the depth of water is 12 m. It is reported that they will be able to make the water depth down to 30 m by dredging. In Buenos-Aires Port, from where a greater portion of products of Paraguay is exported, the class of vessel is confined to 40,000 t at the maximum as the water is shallow. It is considered that the capacity of port will become insufficient owing to the increase of Argentine products to be exported in the future. Under such circumstances this plan is of great importance to the future of Paraguay.

The areas to be covered by the plan, railway project and it's costs are as follows.

The Subject Area of Project

Item / State/Country	Total Area (1) ($10^3 km^2$)	Project Area (2) ($10^3 km^2$)	(2)/(1) (%)
Parana State	199.6	106.4	53
Mato Grossa do Sul State	350.5	248.0	71
Sub Total of Brazil	550.1	354.4	64
Paraguay	406.8	159.8	39
Total	956.9	514.2	54

The Distance of Existing Railways and Soybean Tentative Railways

Division	Distance (km)
Existing Railways	
Paranagua ∿ Curitiba	110
Curitiba ∿ Ponta Grossa	147
Ponta Grossa ∿ Guarapuava	267
Tentative Railways	
Paranagua ∿ Guarapuava	388
Guarapuava ∿ Cascavel	242
Railways derived of Paraguay	
Cascavel ∿ Dourados	1,108
Dourados ∿ Miranda	324

Source: GEIPOT

The Estimated Amount of Construction Cost for Soybean Railways (January 1979)

Division	Amount (Million Crs)
Paranagua ∿ Curitiba	6,241
Curitiba ∿ Guarapuava	7,179
Guarapuava ∿ Cassavel	7,464
Cascavel ∿ Douvados	9,132

Source: GEIPOT

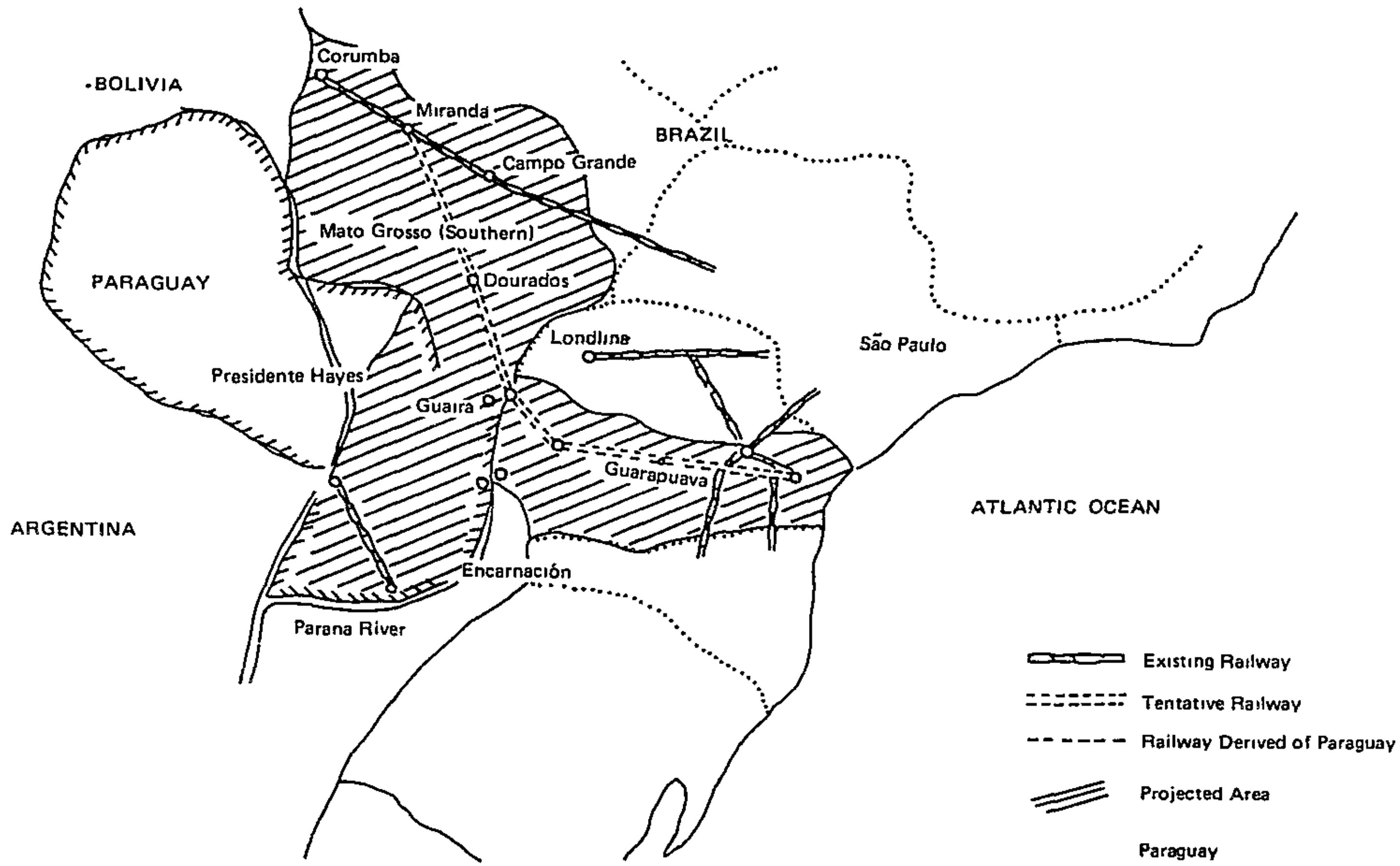


Fig. 2-9-1 Paraguana Export Corridor Plan

2.9.3 Wheat

As the production of wheat has been encouraged by the National Wheat Project in Paraguay, it shows a remarkable growth especially in Itapua. Due to damage by disease, however, the production a hectare tends to fluctuate depending upon the year within the limit of 1,000 kg/ha. The growth of production is supported by expansion of the growing area.

As shown in Table 2-9-7, the actual records of wheat production have fallen short of the National Wheat Project in recent years excluding 1979 when planned figures are somehow equivalent to actual records (planned growth rates are similar to those of soybeans). The reasons for such lower growth rate of wheat production are considered to be aforementioned damage by disease, scarceness of optimum variety, lack of funds on producer's side, high costs of material needed for raising production a hectare and the delay of diffusion activities.

Thus, wheat is the only agricultural product, which is imported in bulk to make up for the lack of domestic production, in spite of the fact that it is indispensable to the daily life of the Paraguayans. A greater portion of wheat imported comes from Argentina and more than 50% of domestic consumption is imported every year as shown in Table 2-9-8.

The actual records of wheat production has not yet reached the targets of the National Project as mentioned before and, furthermore, a revised national project has not yet been set up. For the purpose of encouraging wheat production the Government determines the producer's price every year. (Refer to Table 2-9-9)

Table 2-9-9 Trend of Domestic Price of Wheat

Item \ Year	1979	1980	1981	1982	1983
Producer's price	22	24	26	35	45

Source: M.A.G. Statistical data.

Table 2-9-7 Comparison between National Project and Actual Records of Wheat

Item / Year	Area (1,000 ha)		Production per hectare (kg/ha)		Amount of production (1,000 t)	
	Planned	Actual records	Planned	Actual records	Planned	Actual records
1976	28.8(100)	24.2	1,120(100)	1,211	32.2(100)	29.3
1977	36.0(125)	28.5	1,150(103)	993	41.4(155)	28.3
1978	43.0(150)	31.5	1,180(105)	1,200	50.7(155)	37.8
1979	49.0(170)	52.3	1,200(107)	1,115	58.8(185)	58.3
1980	54.0(185)	47.0	1,230(110)	915	66.4(205)	43.0
1981	58.0(200)	49.4	1,250(112)	1,249	72.5(225)	61.7

Source: M.A.G. Planned figures are from National Project data.
Actual records are from statistical data.

Table 2-9-8 Comparison between Production and Import of Wheat

Item / Year	1977	1978	1979	1980	1981
Actual production	28.3	37.8	58.3	43.0	61.7
Actual import ①	44.3	48.8	64.8	75.0	68.1
Total ②	72.6	82.6	123.1	118.0	129.8
①/②	61	54	53	64	52

Source: Actual production M.A.G. Statistical data
Actual import Boletin Estadistic data

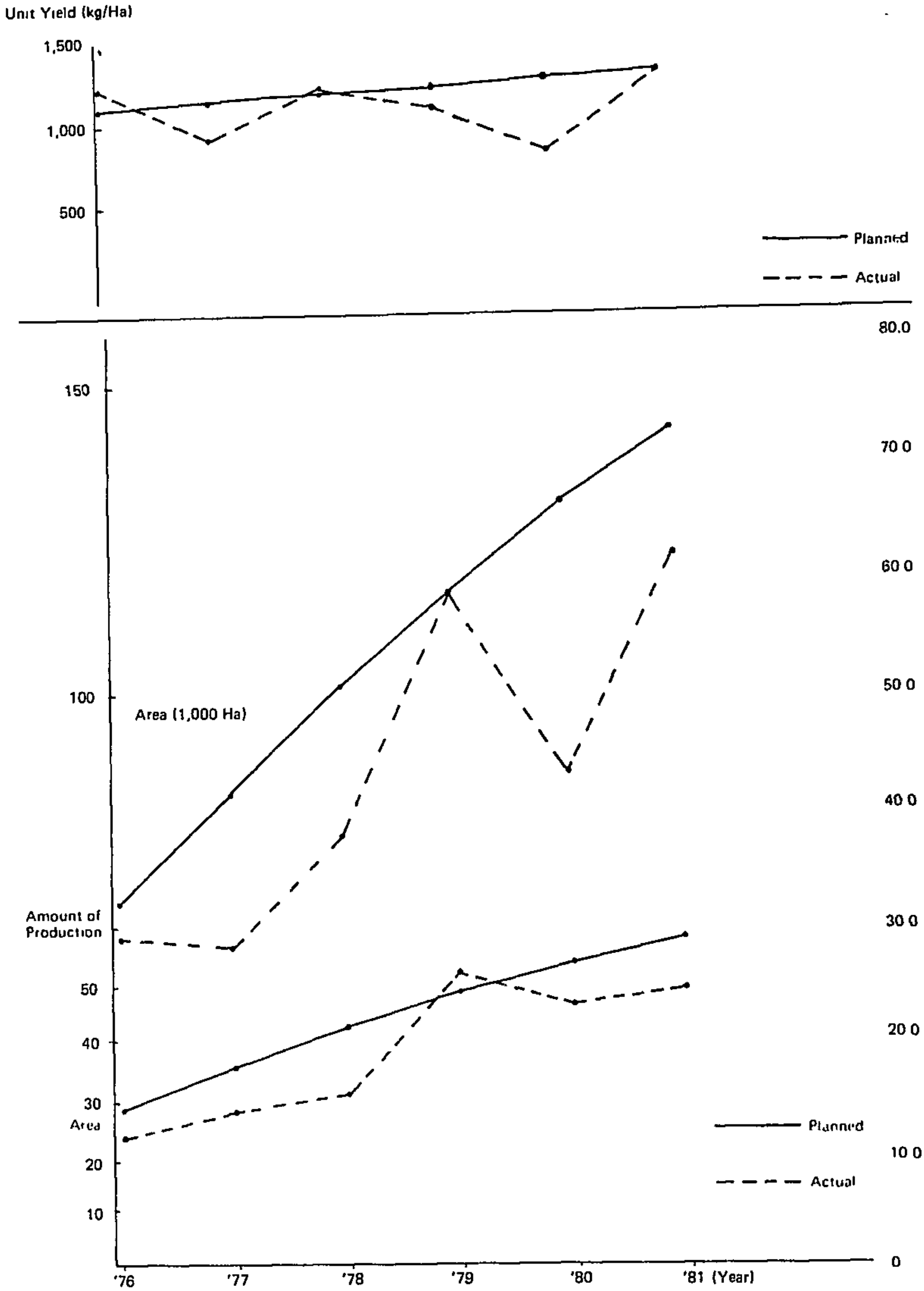


Fig. 2-9-4 The Relation of Net Income with Production Net Income (GS/Ha)
Production Costs ((1,000) GS/Ha)

2.10 Settlement and Agricultural Land Systems

2.10.1 Settlement system

Paraguayan settlement projects are being launched by the Institute of Rural Welfare, a government agency created in accordance with the Instituto de Biensestar Rural or IBR (No. 852 law). This institute supervises those projects in compliance with the Agricultural Land Law (No. 854 law). The two laws went into force in March, 1963, and the institute started operations simultaneously.

As is specified in Article 2 of the law on creating the IBR, each is aimed at gradually abolishing both large and small farm land, and an unbiased system will take their places, with which to remove the conventional inequalities in the ownership, possession or use of land. The article also says that to achieve that end, the government has to take reasonable problem-solving measures in a bid to rennovate the country's agricultural systems and promote agricultural farmers to participate more positively in the national efforts of developing the economy and society.

Article 1 of the Agricultural Land Law, meanwhile, stipulates that the private ownership of agricultural real estages should be promoted and guaranteed in order to expand agricultural welfare and the national economy.

Article 3 of the same law says that agricultural real estates in private ownership can fulfill their social and economic responsibilities only when they meet the following two fundamental requirements.

1) The effective development and rational application of land
2) Preservation of the regulations with respect to the conservation and regeneration of renewable natural resources

As such, the two agricultural laws were enacted with a belief that any land potentially able to be agriculturally developed should be cultivated in the most effective way and that the ownership of ineffectively developed agricultural land should be restricted. They also called for increased chances for those people highly motivated for the agricultural or livestock industry, but short of the land of their own, to possess new or more properties, which would contribute to Paraguay's agricultural productivity and boost the national economy.

(1) Institute of rural welfare: organization and budget

The Institute of Rural Welfare, or Institute de Bienestar Rural (IBR), is being directed and managed by a committee of six members including the chairman. The committee is delegated all the powers and responsibilities as to the activities of the institute. It also is entitled to create proper divisions within itself and to employ both full-time and part-time staffers in order to fulfill the duties sufficiently.

As is shown in Figure 2-10-1, the institute is now broadly broken down into presidential bureaus and administrative bureaus.

1) Presidential bureaus
   ① Planning
   ② Personnel
   ③ Public relations
   ④ General affairs
   ⑤ Internal supervision
   ⑥ Economic and financial supervision
   ⑦ Legal counsel
   ⑧ Agricultural protection

2) Administrative bureaus
   ① Land and settlement administration
   ② Market administration
   ③ Government and financial administration
   ④ Agricultural industry administration

In addition to these bureaus, the insutitute has local branch offices in department and municipalities.

As for its budgets, revenues stood at 1.17 billion Gs in 1984, slightly down from about 1.2 billion Gs in 1983. (Refer to Table 2-10-1) Of the revenues in 1984, 61% came from selling settlement land and properties, and 10% were external debts.

Land assets, which make up a large part of the revenues from selling real estate properties, have been on the decrease as settlement projects have been executed extensively. Therefore, it is no so probable that more land assets will become parts of the institute's properties gratis in the future.

Government subsidies to the Institute of Rural Welfare have not been so large; they now take up an average 6% in ordinary cases and 21% in special assistance.

In terms of expenditures, meanwhile, such general costs as personnel and administration expenses account for about 30%. Besides the expenditures for post-settlement efforts such as agricultural product marketing and settled land administration, about 40% of the institute's whole costs go to various projects related to the settlement itself. Much of those expenditures are being catered for by the loans from international organizations.

To take into account the size of budgets, high ratio of project costs, large dependence on foreign loans, the Paraguayan institute will not will not be able to expand its settlement efforts sharply without resorting to external forces like radical changes in the conventional measures.

(2) Settlement project

1) Settled areas

The land settled from 1954 to 1981 totalled about 7.117 million ha - in terms of both government and private projects - including those land under the supervision of the Institute of Agricultural Reform (formerly the Instituto de Reforma Agraria). During that period, about 115,000 families settled.

Broken down by areas, 2,510,000 ha of land were settled in the oriental of the country, while 4,600,000 ha were settled in the occidental. In the former area, 110,000 families settled, and 3,000 families immigrated into the latter region during the twenty seven-year period.

As can be found from these figures, the settlers in the oriental sought a relatively smaller agriculture - the per-family land of settlement reached about 23 ha - while those in the occidental hoped to operate a large-scale livestock business, where they cultivated an average 1,500 ha. (Refer to Table 2-10-2)

As is found in Figure 2-10-2, settlement projects in the oriental are scattered equally in all department, but in the Occidental, both the number and distribution of such projects are limited considerably, leaving much room for future expansion.

2) Continued settlement and target areas

From the beginning of the 1970s, settlement projects have likely been launched as parts of the comprehensive agricultural development project, along with building up such supporting services as infrastructures, farmers' finances and education. To those ends, the Institute of Rural Welfare has joined hands with the Departments of Agriculture and Livestock, Public Projects, Education and Health and Welfare and the National Development Credit Bank.

Those comprehensive agricultural development projects presently under way include those in Itapua, Paraguari, Caazapa and Eje Note, in which the World Bank and the Inter-American Development Bank are providing financial assistance. The Paraguayan government also is negotiating with the World Bank for aid to new settlement projects in Amambay, Concepcion and Caaguazu departments. Such aid is expected to be concluded by the end of 1984.

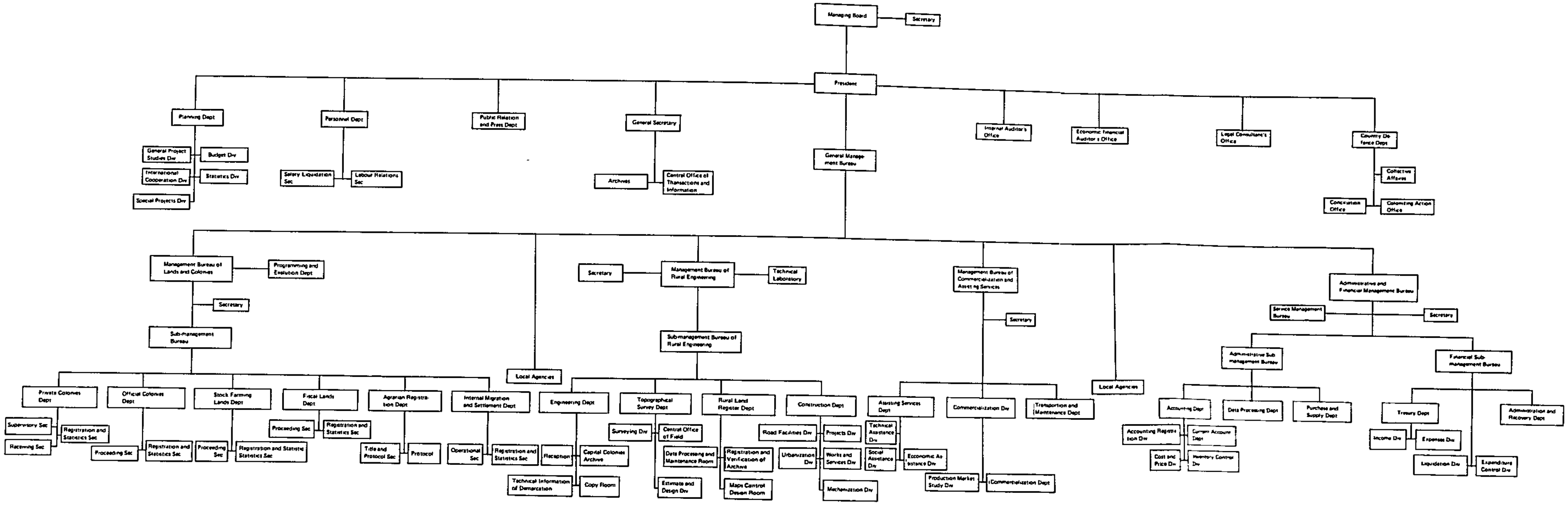
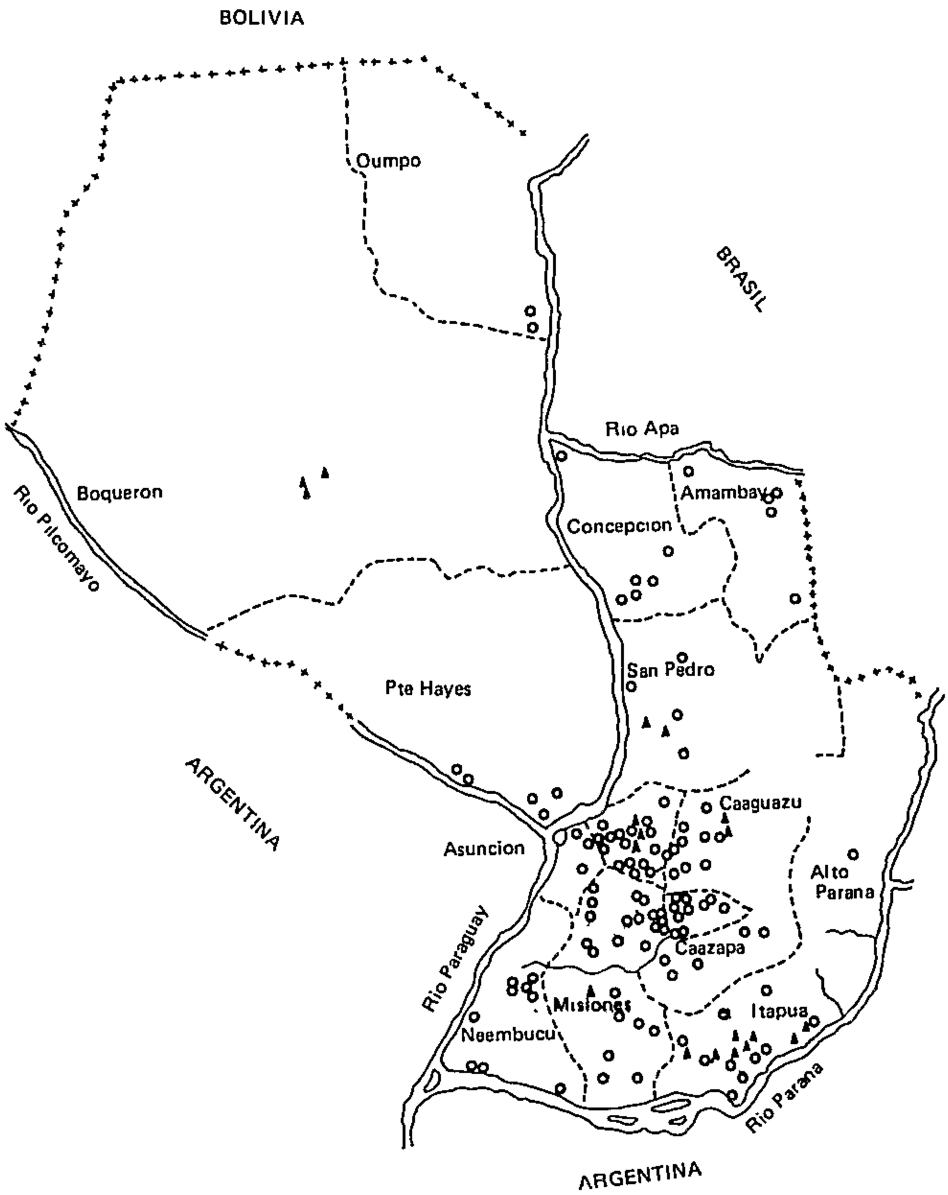


Fig. 2-10-1 ORGANIZATION CHART – I.B.R.



O	OFFICIAL	112 Col	904 662 Ha	38 737 Lots
▲	PRIVATE .	21 Col.	399 334 Ha	6 690 Lots
	TOTAL .	133 Col.	1.303 996 Ha	45 427 Lots

Source. Frutos, J.M Con el Hombre y La Tierra Hacia el Bienestar Rural. Asunción, 1982

Fig. 2-10-2 Established Colonies (Dpt. Conception)

Table 2-10-2 Settlement Project

Department	No. of Colony	Area	No. of Family
Concepcion	43	221,529	9,278
San Pedro	79	322,019	15,285
Cordillera	27	22,885	2,879
Guaira	20	50,334	3,241
Caaguazu	65	329,303	21,248
Caazapa	30	224,491	6,999
Itapua	62	548,387	21,097
Misiones	21	35,057	1,851
Paraguari	46	112,302	7,033
Alto Parana	37	472,603	11,901
Central	15	13,190	1,801
Neembucu	20	38,560	1,895
Amambay	40	123,881	2,822
Cannendiyu	36	258,923	5,190
Occidental	37	4,602,450	2,966
Total	578	7,116,991	115,486

Source: Frutos, J.M. Con el Hombre y La Tierra Hacia el Bienestar Rural. Asuncion, 1982

Table 2-10-1 Budget of the Institute of Rural Welfare (Expenditures)

In thousands of Gs

Item	1983	1984
1. Personnel	208,462	208,134
2. Administration	135,311	135,073
3. Agricultural market development	136,415	95,847
4. Settlement project	44,936	42,550
5. Management of settled area	60,185	53,021
6. Preliminary	13,680	12,840
7. Infrastructure buildup	79,380	126,090
8. Public burden	260,170	174,907
9. Purchase of construction machinery	30,283	--
10. Project	121,454	323,644
1) Itapua agricultural development	51,786	51,786
2) Paraguari agricultural development	69,668	56,452
3) Caazapá agricultural development	--	127,543
4) Eje Norte agricultural development	--	87,863
11. Total	1,090,276	1,172,106

Table 2-10-1 Budget of the Institute of Rural Welfare (Revenues)

In thousands of Gs

Item	1983	1984
1. Selling public land and properties	881,136	718,322
2. Government subsidy	72,000	72,000
3. Subsidy under special law	98,448	248,355
4. Loan from International financial organization	144,298	117,792
5. Others	13,620	15,600
Total	1,209,502	1,172,069

2.10.2 Agricultural land system

Systems with respect to land, especially agricultural land, are specified in the Agricultural Land Law (No. 854 law), as is the case with settlement projects. This law, as was mentioned before, is aimed to restrict ineffective uses of agricultural land, promote expanded land ownership for those motivated people who have no sufficient acreage of farm land and then to contribute to the development of the country's agricultural industry and economy.

To achieve those ends, the agricultural land law has various restrictive clauses, which include;

1) Large agricultural land

"Any irrationally developed land of more than 10,000 ha in the oriental of the country and all real estate of more than 20,000 ha in the occidental can be regarded as a large agricultural land." (Agricultural Land Law, Article 4)

The land of irrational development, in this case, refers to a lot, 50% and more of which are not being used for agriculture, livestock, forestry, manufacturing industry, or those industries combined.

These land are to be progressively taxed, and the real estate law is applied to. At the same time, individuals and corporates will be restricted for their largest space of land to be possessed by the clauses designed to contribute to the development of each department's economy and society. Also, each department enforces its own special law which restricts the size of land ownership according to its space and population density.

2) Small agricultural land

"In accordance with the standards of the Institute of Rural Welfare, any agricultural lot must exceed 2 ha in area in urban districts and 7 ha in suburban districts." (Agricultural Land Law, Article 11)

The institute is supposed to promote voluntary agreements between owners of smaller land, and, if necessary, to integrate those land lots with larger ones by purchasing them. Agricultural land is defined as that scale for rationed development, and of area intermediate in size between the small and large farms defined here.

3) Beneficiaries

Beneficiaries of the Agricultural Land Law are "those who, irrestectige of nationality, are 18 years of age and older and are engaged in agricultural works permanently or those who are determined to do so." (Agricultural Land Law, Article 14), and land is also released for foreigners, with agricultural emigration is being encouraged.

4) Planation settlement

"Any planation settlement land, to be separated from those for other purposes, is to be over 20 ha more in area, ..." (Agricultural Land Law, Article 45)

Any settler, who will operate dairy farming centered on cultivating agriculture, or pursue livestock operations with smaller cattles, is hoped for to own 20 ha of land or more, but it is not an absolute condition.

5) Settlement for forestry

"Any land lot for forestry should be separated from the land for other purposes and is supposed to top 50 ha in area." (Agricultural Land Law, Article 47)

Besides those for plantation, settlement projects designed to promote aforestation or develop forestry resources concentratedly should be over 50 ha in area each, but it is not an absolute condition.

6) Livestock settlement

"The land allocated for livestock settlement should be divided into lots as large as 1,500 ha to 8,000 ha each in the occidental of the country and into those as large as 300 ha to 1,500 ha, respectively, in the oriental ." (Agricultural Land Law, Article 50)

In those settlement areas for livestocks, concentrated development is called for through artificial growth of grass, breeding cattles and growing cows, and farmers are requested to preserve individually optimum sizes of management.

7) Purchase of lots

"In the settlement areas for plantation or forestry growth, each beneficiary can purchase a lot up to 100 ha of land according to the number, labour force and production capacity of his or her children."

(Agricultural Land Law, Article 66)

"In those areas for livestocks, however, each beneficiary can purchase the maximum 1 lot of land." (Agricultural Land Law, Article 67)

8) Occupier

"Land lots should be approved to settlers in the following priority order. i) Those people who now possess the land to be cultivated reasonably. ....." (Agricultural Land Law, Article 79)

"In the case where two and more occupiers reside in a single land lot and it cannot be divided between them, the person who first was granted the occupation will win the top priority." (Agricultural Land Law, Article 80)

"Those co-occupiers, who are forced to leave their settled land as a result of the selection in Article 80 above, can be guaranteed by the eventual owner to obtain a certain portion of land improvement through settlement efforts after evaluation is properly made by the Institute of Rural Welfare." (Agricultural Land Law, Article 81)

Those settlers who share the ownership with the institute can be officially evaluated as the farmers who are strongly motivated to agricultural works and are making an effective agricultural use of land.

9) Rent

"Annual rents are fixed for each ha of land and supposed to be paid in cash. Any rent should not exceed a level equivalent to 12% of the official price of the land in rent." (Agricultural Land Law, Article 124)

10) Benefit-sharing

"Any land owner should not take in 20% or more of the products, the ratio specified in a benefit-sharing contract as his or her portion of the total benefit." (Agricultural Land Law, Article 127)

11) Expropriation

"The following privately owned land lots can be expropriated as properties of public interest. i) The lots not effectively being developed and suitable for the development of agricultural or livestock settlements. ....." (Agricultural Land Law, Article 146)

As can be understood from these rules, the Paraguayan government emphasizes the following points in its agricultural policies.

"Agricultural land should be developed and used effectively and rationally. To meet this goal, lots are advised to be integrated to a certain scale. At the same time, any people interested in agricultural works and management should be protected and assisted in land ownership, regardless of citizenship or sex."

This is apparently because of Paraguay's awareness that the South American country, with a sparse population in relation to its territorial space and abundance in agricultural land resources, depends largely on the agricultural and livestock industries. To rectify this situation, that country seems to understand that the rational development of national space and the sound growth of those industries will certain help promote its overall prosperity.

2.11 Environmental Conservation

2.11.1 Outline of the natural environment in the survey area

The survey area for the agricultural development extending from Misiones Dept. to Itapua Dept. borders in it's west end on the huge marshland, Neembucu, which extends eastward along River Parana, from the junction of River Paraguay and River Parana and is surrounded by San Cosme in it's east side, a hilly land with 90 m altitude in it's north side, and a road along River Parana in it's south side.

Its size is 152,300 ha the natural environment of this region is shown in Table 2-11-1 in terms of the present vegetation.

Table 2-11-1 The Present Conditions of the Survey Area by the Present Vegetation

Division		Area	Component proportion	Remarks
		ha	%	
Farming land	Upland field	1,100	0.7	
	Paddy field	4,500	3.0	
	Subtotal	5,600	3.7	
Native pasture		109,400	71.8	Inundation at flood
Swamp		29,200	19.2	Continuous inundation
River		100	0.0	
Forest		8,000	5.3	
Total		152,300	100	

This figure indicates that the marshland always in flooding accounting for 19% and the additional wild grass land submerged only during a flood, which are influenced by water, reach 90%. The whole planned area can generally be said a low marshland.

Currently, approximately 5,600 ha is used for agricultural purposes as field and paddy field. A large part of the field distributes in the northern hilly land and the sandy land with relatively good drainage along River Parana from Ayolas to Yabebyry. In the northern hilly land a major crop is maize, while in the area between Ayolas and Yabebyry manjoca and maize are mainly cultivated for self-consumption. Paddy rice is in cultivation in the flat lands in the northern and eastern areas.

Although the wild grass land is submerged during flooding, it is usually used for grazing of cattle and horse. The typical vegetation includes galingale (Cypernus rotundus) and wild grass of graminaceae.

The marshland always being submerged has a highest water depth of 2-3 m. The typical vegetation includes waterhyacinth (Eichhornia crassipes), duckweed (Pistia Stratiotes) and cattails.

Within the survey area there are two major rivers, River Atinguy and River Yabebyry, in addition to small rivers including Rivers Ciervo Paso, San Antonio and Yacarey. These rivers, of which canal disapper near the sections of the shift from the hilly land to the flat land, forms a flooding region.

The forests which account for only 5% of the total region mainly distribute along the northern hilly land and Rivers Atinguy and Yabebyry, and in the south-west side of the region, and also small size forests scatter in the region. These forests mainly consisting of trees with inclination to humidity are of low utility value. Meanwhile, outside the survey area forest extending along River Parana abuting on the southern part of the region forms a natural dike of River Parana.

2.11.2 Forest ecology of the survey area

(1) Details of the forests

The forests within the survey area can be roughly divided into the following groups in terms of their distribution.

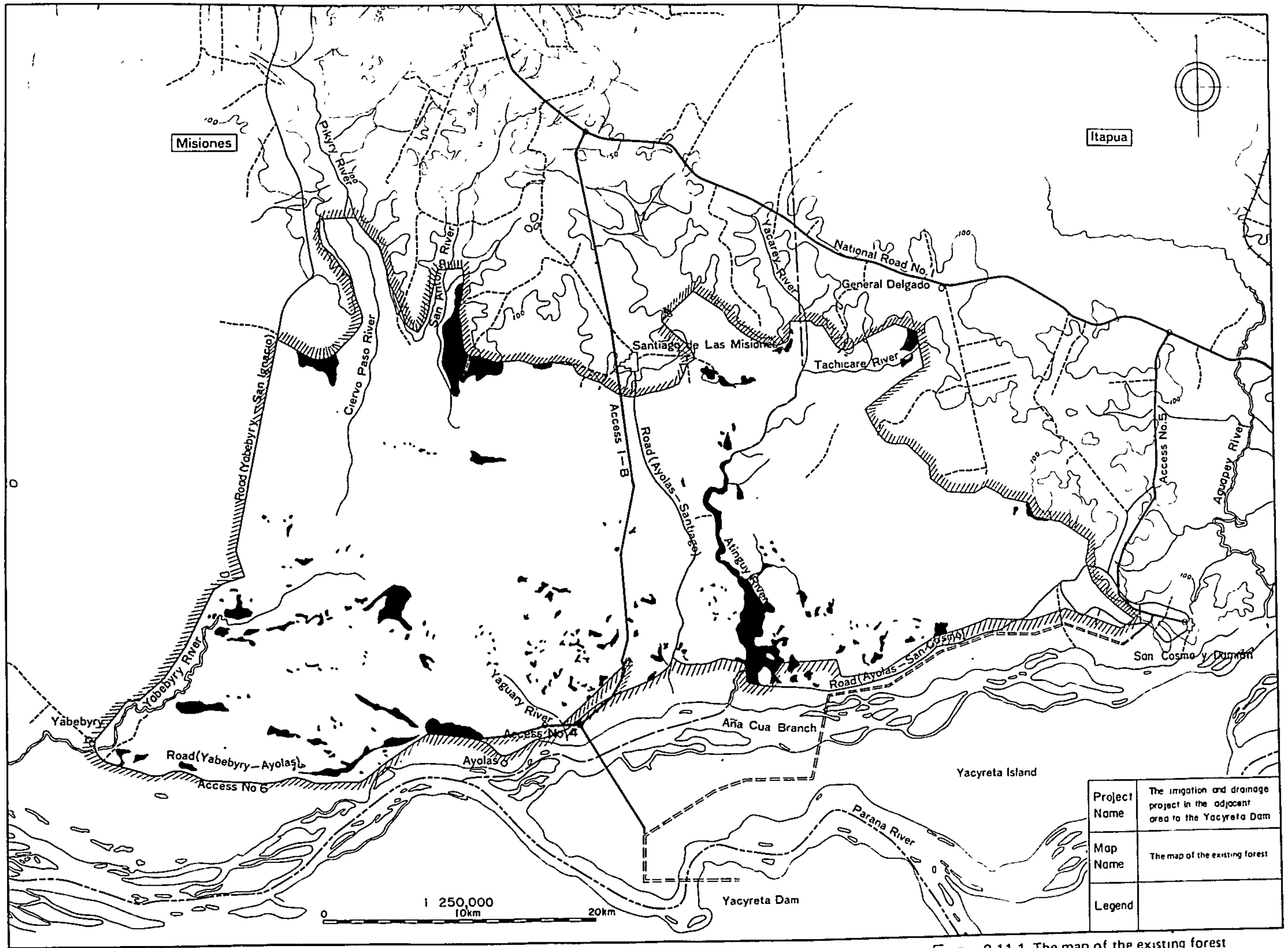


Fig 2-11-1 The map of the existing forest

Table 2-11-2 Distribution of the forests

Division	Area	Notes
Forest along the northern hilly land	2,600 ha	
Clustered small forest	3,900	
Gallery forest along rivers	1,500	Forests extending along River Atinguy and River Yabebyry
(Natural leaves forest along River Parana)	(3,000)	Outside the survey area
Total	8,000	

The forests along the northern hilly land covers an area from 80 m altitude of the low marshland extending northward from River Parana to 90 m altitude where it forms a soft hill at the northern limit of the planned region (The First Year Survey did not cover this area, because it was outside the area to be planned). This area forms a complex feature of hills, rivers and marshlands, and the forests are mainly composed of trees with inclination to humidity.

A forest-survey by sample plot (10 × 10 m) indicates 17 kinds and 53 numbers of trees, of which 3 kinds and 3 numbers of trees, Yvyra-hu (Actionostemon concolor), Ombu (Phytolacca sp.) and Aratiku(Annona sp.), with a 16 ∿ 18 m tree height occupy the upper layer. The other trees are largely middle layer with a 6 ∿ 8 m tree height, while low layer tree (1 ∿ 2 m tree height) is very rare. The most dominant tree in terms of number is Catigua (Trichilia Catigua) accounting for 1/3 of the total, then followed by Mbavy'ra (Casearia sp.), Yva'poroity (Myrciaria baporeti) and Mbavy'i (Bauara sp.). All of these trees are middle layer ones characteristic to areas along rivers and marshland.

Looking at the forests outside, the middle layer trees grow at a uniform height and above the middle layer the upper layer trees tower here and there. Along the forest edge shrubs form manto communities and at first sight it looks very difficult to enter the forest.

The inside the forest has a crown density of 10 (decimal percentage of forest area to crown projection area) and is so dark that undergrass is hardly seen. In addition, paths have been formed in the forest by the intrusion of cattle looking for shade or moving from one pasture to another.

Secondly, the clustered small forests distributing here and there within the survey area exist slightly higher parts than surroundings in the low marshland. An area of one spot varies from less than 1 ha to 100 ha, while a large scale forest of some 500 ha exists near the upper reaches of River Yabebyry in the south-western part of the survey area. It is the only group of such a large scale.

The result of the forest-survey by sample plot shows 11 kinds and 23 numbers of trees, and the upper layer trees include 3 kinds and 3 numbers of trees, Yvyra piu (Reprechtia laxiflora), Yva'hai (Eugenia sp.) and Guapo'y (Ficus monckii) with a 18 m tree height. Then, Yvyra paje (Myrocarpus frondosus), and Ka'a oveti (Luehea divaricata) with a 10 m tree height occupy the middle layer, and under them trees with a 4 ∿ 6 m tree height form the lower layer. Thus, this forest is characterized by stand composition distinguished by the upper, middle and lower layers.

The most dominant tree in terms of number is Ñuati arroyo (Sabastiana sp.), then followed by Catigua'i (Trichilia sp.). These trees are common in the low land and marshland.

This forest with a 10 crown density is lighter than the above-mentioned forest along the hilly land due to the less number of trees, and undergrass can be seen although very little. Also, in this forest stepping of cattle has been done. The typical example of the gallery forests extending along the rivers is one along River Atinguy. Namely, on the lower Atinguy the forest with a 1 km width extends on the both sides of the river, and gets narrower as it extends upstream, but even at the most upper stream it still has about 20 m width, forming a condition to protect the riverbank naturally.

According to the result of the forest-survey by sample plot, this forest is composed of 11 kinds and 34 numbers of trees, of which 3 kinds and 3 numbers of trees, Ca'a oveti (Luehea divaricata), Yvyra'ovi (Helietta longifoliata), and Curupay'ra (Anadenanthera rigida), have a 20 m tree height. There are only 6 numbers of middle layer trees with a 10 m tree height, while lower layer trees with a 2 ∿ 3 m tree height are dominant.

The most dominant tree in terms of number is Yvyra hu (Actionostemon concolor), accounting for 1/3 of the total. This tree is one of the typical trees growing along rivers. Next to it, Yvavy ju (Eugenia sp.) is dominant, which can be seen on the Parana coast and in the low land.

This forest of which crown density is 10 is darkest among the forests where the forest-survey by sample plot was conducted, and has no undergrass. This may be owing to the preservation of the natural condition in the survey spot without grazing, since the spot is located within the Experimental Wildlife Sanctuary set by the Yacyreta Public Corporation.

In addition to these forests, the forest abuting on the south of the region with the formation of a natural bank should be mentioned, although it is outside the survey area. Because this forest is associated with the agricultural development project in terms of the conservation of agricultural land, the survey result is described.

This forest forming a natural enbankment extends along River Parana with a width of 10 m to 1 km. The forest-survey by sample plot shows 11 kinds and 48 numbers of trees, of which upper layer trees with a 18 ∿ 20 m tree height number 5, more than in other survey sites. There are 3 Laurell amarillo (Nectandra lanceolata) and each one of Lapacho (Tabebvia sp.) and Kurupa'y (Parapitadenia macrocarpa).

At this survey spot a middle layer tree is hardly seen, while lower layer trees with a 5 ∿ 6 m tree height are common. The most dominant tree in terms of number is Ñangapiry (Eugenia uniflora) accounting for 1/3 of the total, then followed by Yva'viju (Eugenia sp.) and Ñuati arroyo (Sebestiana sp.). These three trees are very usual in the forest of natural embankment. It's crown density is 10 with no undergrass, but cattle enters for grazing.

In summary, the results of the forest survey by sample plot at 4 sites chosen according to the forest distribution zone show that there is no distinguished characteristic by site. Furthermore, the forests in this region are mainly composed of trees growing river coast and low marshland such as Catigua, Yvavi Ju, Ñangapiry and Ñuati arroyo, which indicates a strong impact of water on the forests.

In addition, since these forests abut on grassland (grazing land), stepping of cattle into the forests is made, which provide natural shadow forests.

(2) Living condition of the forests

The growing condition of the forests within the survey area is not so good, because they distribute here and there in a broad expanse of low marshland. However, according to the results of the forest-survey by sample plot densed forests with a crown density of 10 develop at 4 surveyed site, where 35 kinds and 2,300 to 5,300 numbers of trees per ha, in average about 4,000, grow.

Although the growth of forest is disturbed in an excessively humid area in general, it is assumed that the forests are maintained, because the forests in this region develop in slightly higher spots than the surroundings, although in low marshlands (there are cases that a forest develops even in a place only 20 ∿ 30 cm higher than the surrounding grassland), and these spots are not submerged for a long time even if inundated during a flood. In addition, a humid condition just enough to keep the growth of tree seems to be maintained due to a high infiltration capacity of the sandy soil.

The following cases prove that the living condition of the forests in the region is closely related to the peculiar locating condition of the low marshland.

1) In some spots trees grow as single trees in the wild grass land which is influenced by inundation during a flood, but they can not develop to a forest. This seems to be due to long-term effects of inundation.

2) Since sand and soil were collected from the both sides of the access road No. 1 running in the central part of the survey area from south to north during the construction work, in some places grassland abuting on the sand collection sites got dry resulting in the growth of bush.

3) On the contrary, there are some cases that the effects of water lead to withering of trees. For instance, after muddy water inflew

into the low part of the urban district of Ayolas during a heavy rain and long-term inundation occured, although it is outside the survey area, valuable trees growing only in this area, Arary (Calophyllum brasiliense Camb.) has begun to wither.

With regard to the forests in the past, although at present there are a few forests in the area, according to officers of the Forestry Agency of Paraguay this area has never been covered with forest and there is no record of large scale cutting.

The living condition of the gallery forest extending along the river could be explained by the role of the river as a natural drainage canal and the resultant development of the forest along the river because of dry condition near the river coast. This gallery forest develops almost continuously from the upper Atinguy to the lower Atinguy, while along River Yabebyry it can be seen at places. This could be because River Yabebyry is situated in adjacent to the Ñeembucu marshland, so that it is more prone to the effect of flooding than River Atinguy is and consequently more places are always inundated.

(3) Forest assessment

In Paraguay forest is roughly divided into high forest (Bosque alto) and low forest (Bosque bajo). The high forest means forest consisting of useful and high trees mainly in the forestry zone in the east part (Oriental), while the low forest means forest consisting of trees with lower tree height and lower economic value than those in the high forest.

The high forest is composed of many kinds of trees, of which some 10 trees have a high economic value, including Cedro (Cedrela tubiflora), Guatambú (Balfourodendron riedelianum), Kurupa'y (Anadenanthera macrocarpa), Lapacho (Tabebuia sp.) and Timbo (Enterolobium contortisiliquum), while others are used for limited purposes in limited areas. Trees composing the low forest have also almost no market value as timber at least at present.

The forests within the survey area mostly belong to the low forest, and the survey result also proves that practically there is no useful trees in terms of the quality of the lumber. This could be attributable to the unfavorable locating condition in the low marshland.

From these facts, it can be safely concluded that the forests in this region can hardly be the subject of timber management.

Nevertheless, the feature of the distribution indicates the importance of the forests in the conservation of the natural environment and the protection of grazing; the forests growing along the hilly land abuting on the low marshland not only control soil runoff from the hilly land, but also serve for water charge and flood control. The clustered small forests scattering in the region are used as settlement centers for grazing and for the protection of cattle. The forests estending along the river serve as a natural embankment to control erosion in the coast line.

In addition, these forests provide wildlives with habitat as well as wild grass land and lakes and ponds.

CHAPTER 3

CULTIVATION & LIVESTOCK PLAN

3.1 Cultivation Plan

3.1.1 Selection of the proposed crops

(1) Standard of selection

For the crops to be introduced after the survey areas are developed, the following conditions should be discussed.

1) Natural condition

Temperatures, rainfall, sunshine hours of the survey areas should have the levels to which the proposed crops can adapt themselves. The same is true of other natural conditions such as soil and ground water.

2) Cultivation technique

It is advisable that Paraguayan techniques for growing the proposed crops should have certain standards. It is because this development project will eventually cover as much as about 150,000 ha and because the time and cost for experiment, research and extension to start generating effects and those will apparently increase substantially, once the crops, not cultivated previously in Paraguay, are brought in. Therefore, the selection of key crops to be introduced will be made from among those which are currently being grown in that country.

3) Level of labor intensiveness

Crops can be broadly divided into extensive crops and intensive ones on the basis of hours required to cultivate. If development scale and population density are taken into account, the proposed crops should belong to the former category. However, when we observe the settlement and agricultural management in various classes, it also will be necessary to combine both types of crops.

4) Marketability

In terms of population, Paraguay is a small country of about 3.2 million people, however, except for a few crops like wheat, the country is almost self-sufficient in agricultural supplies. Subsequently, it will need to select crops to be introduced carefully, with the size of domestic demand and overseas shipments taken into consideration.

5) Irrigation effect

At present, there is no plan that agricultural development side will finance the construction of the Yacyreta Dam. This means that relatively cheap water resources can be available for effective application, as agriculture side are free from shouldering the burdens of constructing water-resource facilities. Consequently, the crops like paddy rice, which are highly sensitive to the effects of irrigation, are advised to be chosen.

6) Others

Steps also will have to be taken with respect to the crops whose increased production is being encouraged by the Paraguayan government as part of its agricultural policies and those crops to be grown in combination forms through rotation culture.

(2) Proposed crops

In discussing which crops should be introduced, any target crops should be selected from those for which Paraguay already has a certain level of cultivation technology. The Ministry of Agriculture and Livestock so far has designated 63 crops as encouraged ones. The Ministry is to encourage expected cultivation and farm management to pick from among them. (See Table 3-1-1)

The list of crops suitable to large-size and extensive culture includes cotton, paddy rice and upland rice, oats, sugar canes, corn, cassava, porot bean, soybean, sorghum, coffee and wheat. This list excludes pasture grass and orchard species. Of them, oats and sorghum are removed from the target crop list, because they are currently grown in smaller space of land (about 10,000 ha as of 1979 altogether) and they may topple the domestic balance of supply and demand, once introduced in this project.

At the same time, from the viewpoint of cultivation stability, with enough water available as an irrigation effect, upland rice will not introduced. Close to 2 million tons of Cassava were produced in 1980 (See Table 3-1-2), but the chance for the crop to be largely distributed as feed is rather remote, because it has good equilibrium between demand and supply, is likely to be consumed by producers and because the livestock industry, while taking up a major part of Paraguay's industrial structure, is only centered on beef production through grazing.

Also, since it has no high value as distribution forage, it is unlikely that domestic demand will increase in the future.

Table 3-1-1 List of Encouragement Crops

No.	Crop name (Spanish)	Crop name (English)	No.	Crop name (Spanish)	Crop name (English)
1	Acelga	Spinach beet	33	Mani	Peanuts
2	Aguacate	Avocado	34	Mamón	Papaya
3	Ajo	Garlic	35	Melón	Melon
4	Albahaca	Sweet-basil	36	Menta	Japanese peppermint
5	Alfalfa	Alfalfa	37	Naranjo agrio	Bitter orange (perfumed oil)
6	Algodonero	Cotton	38	Naranjo injertado	Orange
7	Apio	Celery	39	Orégano	Marjoram
8	Arroz	Rice	40	Papa	Potato
9	Arveja (legumbre)	Green peas	41	Pasto elefante	Pasture (elephant)
10	Arveja (semilla seca)	Green peas (seed)	42	Pasto pangola	Pasture (pangola)
11	Avena portuguesa	Portuguese oats	43	Pasto rojas	Pasture (rojas)
12	Banano	Banana	44	Perejil	Parsley
13	Batata	Sweet potato	45	Pimiento	Green pepper
14	Berro	Watercress	46	Pino eliotti	
15	Cafeto	Coffee-tree	47	Piña	Pineapple
16	Caña de azúcar	Sugar cane	48	Pomelo	Grapefruit
17	Cebolla	Onion	49	Poroto	French bean
18	Cebolla de Hoja	White stemmed onion	50	Rabanito	Radish
19	Ciruela	Plum	51	Remolacha	Beets
20	Coco	Coconut	52	Repollo	Cabbage
21	Curatú	hierlia de medicina	53	Sandía	Watermelon
22	Chaucha	Pod beans	54	Soja	Soybeans
23	Duranzno	Peach	55	Sorgo	Sorghum
24	Eucalipto	Eucalyptus	56	Tabaco	Tobacco
25	Frutilla	Strawberry	57	Tártago	Spurge
26	Girasol	Sunflower	58	Tomato	Tomato
27	Habilla	Arabian been	59	Tung	Paulownia
28	Lechuga	Lettuce	60	Trigo	Wheat
29	Limón	Lemon	61	Vid	Grapevine
30	Maiz	Corn	62	Yerba Mate	Mate tea
31	Mandioca	Tapioca	63	Zanahoria	Carrot
32	Mandarina	Mandarin (orange)	64	Zapallo	Pumpkin

Table 3-1-2 Food Demand & Supply Data in 1980

(Unit: tons)

Item	Supply				Seed, feed, processing purpose				Consumption food amount		Net food amount/person		User's rate
	Production amount	Import amount	Export amount	Total supply amount	Seed	Live-stock feed	Proces-sing resource	Natural decrease	Total food amount	Net food amount	Consumption amount/ capita/year	Consumption amount/ capita/day	
											g	g	%
Cereals	463,452	113,693	15,805	561,340	10,106	146,730	-	42,843	361,661	254,850	83,200	227.9	-
Wheat	34,444	113,693	-	148,137	3,298	-	-	2,849	141,990	104,363	34,100	93.4	73.5
Rice	62,188	-	1,595	60,593	2,518	-	-	3,314	54,761	35,050	11,400	31.2	34.0
Maize	366,820	-	14,210	352,610	4,290	146,730	-	36,680	164,910	115,437	37,700	103.3	70.0
Corms	2,116,820	6,100	6,700	2,116,220	1,797	863,817	-	400,227	850,379	503,150	164,300	440.2	-
Cassava	1,970,100	-	-	1,970,100		857,117	-	378,224	734,759	404,117	132,000	351.6	55.0
Potato	12,720	6,100	-	18,820	1,797	-	-	1,903	15,120	13,608	4,400	12.2	90.0
Sweet poteto	134,000	-	6,700	127,300	-	6,700	-	20,100	100,500	85,425	27,900	76.4	85.0
Pulse crops	529,600	-	336,286	193,314	26,430	-	67,771	35,160	63,953	60,500	19,730	54.1	-
Pea	3,900	-	-	3,900	328	-	-	381	3,191	3,191	1,040	2.9	-
Poroto beans	60,800	-	12,173	48,627	2,160	-	-	8,192	38,275	38,275	12,500	34.2	-
Peanut	19,900	-	-	19,900	1,692	-	3,691	3,005	11,512	8,057	2,600	7.2	70.0
Soybean	445,000	-	324,113	120,887	22,250	-	64,080	23,582	10,975	10,975	3,590	9.8	-
Vegetables	95,610	3,540	3,490	95,660	240	-	-	7,409	88,011	78,468	24,730	65.2	-
Onion	26,670	3,540	-	30,210	-	-	-	2,990	27,220	24,498	8,000	21.9	90.0
Garlic	960	-	-	960	-	-	-	29	691	670	220	0.6	97.0
Pumpkin	23,400	-	-	23,400	-	-	-	1,160	22,240	17,790	5,810	15.9	80.0
Tomato	19,870	-	3,490	16,380	-	-	-	1,990	14,390	14,390	4,700	12.9	-
Other vegetables	24,710	-	-	24,710	-	-	-	1,240	23,470	21,120	6,000	13.9	90.0
Fruits	663,751	-	3,290	660,661	-	-	-	115,050	545,611	401,354	131,500	258.2	-
Avocado	2,900	-	-	2,900	-	-	-	500	2,400	1,440	500	1.4	60.0
Banana	148,830	-	-	148,830	-	-	-	28,110	120,720	96,576	31,500	36.4	80.0
Japanese apricot	1,390	-	-	1,390	-	-	-	70	1,320	1,120	400	1.1	85.0
Peach	1,980	-	-	1,980	-	-	-	100	1,880	1,600	500	1.4	85.0
Strawberry	600	-	-	600	-	-	-	30	570	570	200	0.5	-
Lemon	1,030	-	-	1,030	-	-	-	60	970	870	300	0.8	90.0

Taking all this into account, cotton, paddy rice, sugar cane, corn, poroto bean, soybean, coffee and wheat are recommended as extensive crops to be introduced. These crops are mere candidates as key proposed crops, so their catch-cropping, rotation culture and the labor-intensive crops difficult to be grown in the areas on a large scale are to be studied after cropping plans are established for the key crops.

(3) Discussion of the crops to be introduced

Generally speaking, the relationship between agricultural crops and meteorological conditions is universal, so those conditions can be expressed in such physical amounts as temperature, sunshine hours, rainfall and wind direction and velocity. Before studying closely relations between the eight crops mentioned above and these physical amounts, agricultural meteorological disasters will have to be checked as phenomena taking place in case local meteorological features do not fit crop cultivation.

Table 3-1-3 indicates the types and patterns of various agricultural meteorological disasters. While paddy rice, shows high sensitivity to cold weathers and high temperatures, wheat is confirmed to react sharply to various problems in winter -- damage from low temperatures, frost, snowfall, etc. -- as well as to the rainfall and drainage. Meteorological characteristics, such as temperature and rainfall, are given in Table 3-1-4. According to this table, the average annual temperature in this area stands at about 21°C, while the total annual sunshine hours about 2,500 hours. The annual rainfall averages about 1,600 mm with the average day of frost fall is 3. Studies should be carefully made to know if these meteorological conditions are reasonable in growing each target crop.

As is shown in Table 3-1-5, the soil of the survey areas is made up of seven different types of soil Coarse and fine gleysols, formed in lower horizons by the flood-triggered secondary pile-up of clay on top of alluvial sandy soil, are divided in terms of grading according to whether they are heaped up with soil from the Parana River or hilly lands.

Meanwhile, both coarse and fine regosols are the soils whose horizons are not fully grown, and well-drained sandy soils carried over from rivers. In this case, grading can be classified in the same way as gleysol.

When rated in pH, both gleysol and regosol are quasi-acid. In some areas, regosol below a pH level of 5.0. Both humic planosol and planosol are comparatively clayey and aquatic, and have non-permeable layers in lower horizons. Levels of pH are higher in general at 5.5 to 6.0, compared with other soils. Humic planosol is more clayey and more humic than planosol.

Acrysol, grown in heavily weathered layers of sandstones and basalts, has clayey soils transferred to lower horizons and has high water retention.

The range of crops to be introduced also has to be discussed in terms of socio-economic features and cultivation technology in addition to such natural conditions as meteorology and soil characteristics. Detailed discussions on the 8 crops are made below.

Table 3-1-3 Various Agricultural Meteorological Damage

Name	Contents	Main damaged crops
Cold Weather damage	Damages of summer crops caused by cold weather (or cold weather and few sunshine) at growth period.	Rice, Soybean
Cold water damage	Poor growth and inpediment in ripening near water intake caused by cold irrigation water.	Rice
Low temperature	Crop damages caused by low temperature in winter season.	Wheat, Fruits, Vegitables
Warm winter damage	Damages caused by extraordinary high temperature from early winter to early spring.	Wheat, Rapeseed
Frost damage	Damages because crops are Frozen by low night temperature in late frost period or early frost period.	Mulberry, Wheat, Fruits, Tea
Freezing damage	Damages because crops are frozen by intense cold winter.	Mulbery, Fruits
Frost heaving damage	Damages because soil is frozen by low temperature of winter.	Wheat
High temperature damage	Poor growth caused by environmental temperature (atmospheric temperature, soil temperature, water temperature) higher than proper temperature.	Rice, Sweet potato
Wind damage	Damages caused by strong wind, dry wind etc.	Rice, Wheat, Fruits
Saltywind damage	Damages caused by salty strong wind.	Rice, Fruits, Tea
Flooding damage	Damages caused by flooding.	Rice, Wheat, Potato
Damage by wind and flood	General mean of wind damage, salty wind damage and flooding damage.	
Rain damage	Damages caused by long rain at harvesting period.	Wheat, Industrial crops
Wet damage	Damages caused by excess soil water.	Wheat, Fruits, Vegitables
Snow damage	Damages caused by deep snow.	Wheat, Fruits, Feed crps
Hail damage	Damages caused by hail.	Wheat, Vegitables, Tabacco, Fruits
Fog damage	Damages caused by frequent fog.	Soybean, Feed crops, Potato
Salt damage	Damages caused by excess salt in soil or salty water.	Rice, Wheat, Vegitables
Water erosion	Soil flowing out by heavy rain.	--
Wind erosion	Soil flowing out by strong wind.	--
Drought damage	Damages caused by drought.	Rice, Wheat, Fruits

Source: Agricultural meterological handbook.

Table 3-1-4 Meteorological Conditions in the Survey Areas

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Rain-fall	Amount of rainfall mm	158.8	125.6	149.1	120.6	130.4	125.1	88.4	114.1	113.7	180.6	156.4	155.5	1,618.5
	Rainfall days	9	7	8	7	7	7	7	7	6	9	8	7	89
Tempe-rature	Ave. maximum temperature °C	32.2	31.9	30.5	27.3	24.0	22.1	22.6	22.7	25.2	27.3	29.1	31.3	27.2
	Ave. minimum temperature °C	20.9	20.7	19.5	15.3	12.9	11.1	11.4	11.5	13.3	15.5	17.1	19.6	15.7
	Max. temperature	39.5	39.3	38.3	35.9	33.5	31.5	32.5	33.6	36.5	37.9	36.9	39.1	40.1
	Min. temperature	12.7	11.6	7.3	4.5	-0.2	-0.9	-1.7	0.2	1.5	5.3	8.5	9.6	-1.7
	Ave. tempe-rature	26.3	25.9	24.4	20.7	17.9	16.0	16.4	16.7	18.9	21.2	23.0	25.4	21.0
Sun-shine	Sunshine hours	165.5	154.7	133.1	138.9	120.1	113.5	111.8	117.4	126.1	144.4	156.1	171.7	1,653.4
Frost	Frost days	0	0	0	0	0.4	1.0	1.0	0.3	0.1	0	0	0	2.8

1971 ∿ 1980 10 year averages

Yacyreta, Encarnacion, San Jan Bautista averages

Table 3-1-5 Mean Properties of Soils by the Soil Type

		Soil color	Mottles	Gley	Moisture	Stickness	Hardness	Humus	pH (H_2O)	pH (KCl)	Electric conduc-tivity	ex. Ca	ex. Mg	ex. K	ex. Na	Al	CEC	Base saturation percentage	Phosphate absorption coefficient	Available phosphate	Particle size composition			Soil texture name		Tempo-rary s.g.	Remarks
																					C	Si	S	Japan	USDA		
Coarse-textured regosols	Surface soil	10YR 4/3	-	-	Weak None	Weak None	15	0.52	5.1	4.2	0.07	2.7 75.7	0.77 15.52	0.07 3.30	0.2 6.2	0.6	7.0	53	125	2	16.7	16.2	67.1	SCL	SL	1.46	12 profiles
	Subsoil	10YR 6/4	-	-	Half wet (Less than 1 m)	Weak	14	0.29	5.1	4.0	0.07	2.6 72.9	0.81 16.33	0.06 2.83	0.1 3.1	0.8	5.6	64		3	18.0	16.4	65.6	SCL	SL	1.51	
Fine-textured regosols	Surface soil	7.5YR 4/3	-	-	Half wet	Moderate	24	0.61	4.9	3.8	0.0	2.5 70.1	0.75 15.12	0.06 2.83	0.0 0.0	0.8	22.7	15	585	1	24.5	29.9	45.6	CL	L	1.43	3 profiles
	Subsoil	7.5YR 4/3	Few	-	Wet (About 1 m)	Moderate	21	0.42	5.6	4.1	0.04	2.8 78.5	0.96 19.35	0.04 1.88	1.2 37.2	1.7	16.3	31		1	34.3	21.0	44.7	LiC	CL		
Coarse-textured gleysols	Surface soil	7.5YR 4/2	-	-	Half wet	Weak	21	0.67	4.7	3.6	0.0	2.6 72.9	0.82 16.53	0.06 2.83	0.0 0.0	1.4	7.4	47	650	2	17.9	23.6	58.5	CL	SC	1.34	12 profiles
	Subsoil	7.5YR 5/3	Few	G	Very wet (Within 1 m)	Weak	18	0.38	4.8	3.6	0.0	2.7 75.7	0.86 17.34	0.06 2.83	0.0 0.0	2.3	9.9	37		1	22.2	20.7	57.0	CL	SCL		
Fine-textured gleysols	Surface soil	7.5YR 4/2	-	-	Wet	Moderate	19	0.98	4.7	3.5	0.0	2.8 78.5	0.80 16.13	0.09 4.24	0.0 0.0	1.5	15.0	25	325	3	25.9	26.9	47.2	LiC	SCL	0.99	12 profiles
	Subsoil	10YR 5/2	Included	G	Very wet (Within 1 m)	Strong	18	0.50	4.7	3.3	0.0	2.9 81.3	0.90 18.14	0.06 2.83	0.0 0.0	3.4	14.8	26		1	36.5	23.2	40.3	LiC	CL		
Planosols	Surface soil	7.5YR 4/2	-	-	Half wet	Moderate	24	0.73	4.7	3.6	0.05	2.7 75.7	0.84 16.93	0.08 3.77	0.05 1.55	1.6	12.2	30	640	2	23.1	28.0	48.9	CL	L	1.38	15 profiles
	Subsoil	7.5YR 5/2	Included	G	Wet (About 1 m)	Moderate	22	0.33	4.8	3.5	0.01	2.8 78.5	0.88 17.74	0.05 2.36	0.07 2.17	3.4	11.9	32		1	31.9	20.2	47.9	LiC	SCL	1.71	
Humic planosols	Surface soil	7.5YR 3/1	-	-	Wet	Weak	22	1.08	5.0	3.7	0.0	2.8 78.5	0.83 16.73	0.07 3.30	0.0 0.0	0.8	13.3	28	630	2	21.1	23.5	55.4	CL	SCL	1.40	2 profiles
	Subsoil	10YR 4/3	Few	G	Very wet (About 50 cm)	Weak	12	0.21	5.7	4.2	0.3	2.8 78.5	0.84 16.93	0.04 1.88	0.5 15.5	0.2	10.1	41		2	31.1	11.9	57.0	SC	SCL		
Acrisols	Surface soil	5YR 4/6	-	-	Half wet	Moderate	22	0.86	5.2	4.1	0.01	2.7 75.7	0.84 16.93	0.13 6.12	0.02 0.62	0.4	10.4	35	540	1	29.2	27.3	43.5	LiC	CL	1.66	4 profiles
	Subsoil	2.5YR 5/8	-	-	Half wet (Less than 1 m)	Strong	20	0.49	5.3	4.1	0.0	2.9 81.3	0.95 19.15	0.12 5.65	0.1 3.1	0.7	10.6	38		1	36.7	22.9	40.4	LiC	CL		
Fluvisols	Surface soil	10YR 7/3	-	-	Half wet	None	Less than 1	None																	SL		3 borings
	Subsoil	10YR 7/3	-	-	Wet	"	"	"																	SL		

1) Cotton

The optimum temperature for growing cotton is generally set at 25°C on an average, and the range of 20°C ∿ 28°c also is acceptable. Rainfall is ideally 1,000 mm ∿ 1,500 mm a year. Though a considerable amount of rain is required while in growth, concentrated rainfall in the flowering time and afterwards will help downgrade the qualities of crops, ultimately reducing the yield. In Paraguay, seeding is performed in the October ∿ November, while the harvesting period falls in March and April. The harvesting time is relatively long, 2 ∿ 3 months when mannually picked.

The overall meteorological conditions of the areas are suitable to cotton growing, but the rainfall totalling 120 mm to 160 mm a month in March and April is feared to be a factor adversely affecting the qualities.

From a viewpoint of soil, cotton is said to be suited for sandy soils with improved drainage, but it cannot be grown in the soils with high acidity.

At the same time, cotton grows well in dry-land instead of wetland.

In this area, much gleysol, regosol and other sandy soils can be sighted. The Area A will be much improved with respect to drainage after the projects are completed. Also, since this area indicates a high degree of soil acidity in general, it needs to improve acidity with the use of carbonic calcium.

In Paraguay today, the cultivation, particularly harvesting, of cotton is being made manually in most cases, the fact that indicates cotton is a highly labor-intensive product. In general, the manual harvesting method leads to the production of high-quality cotton. And since Paraguayan-produced cotton now scores high marks in terms of quality, it will not be required immediately to introduce machinery in harvesting. As such, the introduction of cotton into this area needs to be reviewed, for the agricultural product does not suit large-size farm management, but smaller one.

2) Paddy rice

In growing paddy rice, the important factors include germination temperature, accumulated temperature during cultivation period and the temperature at heading time. Low temperatures in the last case should be taken into particular consideration, since they may invite delayed cold damage, eventually lowering the level of yield.

Generally speaking, germination temperature is in the range of 10°C to 13°C at the minimum, and optimum and maximum temperature are said to be in the 30°C ∿ 35°C range and 40°C, respectively.

During the period of October to December, the seeding term in southern Paraguay, the germination temperature is more than an average 20°C and the maximum monthly temperature exceeds 35°C, the reasonable levels.

Meanwhile, the accumulated temperature for growing paddy rice is said to stand at 2,400°C ∿ 4,500°C. Given the seeding term will be in early November and the cropping period be 140 days, the survey areas will supply the accumulated temperature of 3,000°C and more, the level suited to paddy rice growth.

Whether cold damage will take place before heading time is said to have the relation with the levels of temperature and sunshine. Previous experimental data indicate that the rice processed in low temperatures (14°C) for three days are free from such damage, however, the processed in 17°C for 6.5 days are damaged, so that a similar processing lasted more than 1 week at 20°C or below would contribute to such damage.

The survey areas appear invulnerable to cold damage because they are likely to have a spell of high temperatures before heading time. Nevertheless, much care should be paid to seasonal winds which may brought in continuous cold days. All in all, however, the effects of those winds will not be substantial enough to determine the availability of paddy rice to be introduced, and so the overall meteorological features of the area will be suited to growing paddy rice.

Next, we like to observe the availability of paddy rice growing from the viewpoint of soil. First of all, paddy rice differs largely from other crops in that it is grown by means of inundation. The general agreement is that acid soils, when flooded, will grow in pH and then be neutralized, the fact that makes soil acidity as an unimportant problem.

The more fertile soils are, the more welcome, but even this issue of soil fertility will be solved, if fertilization is sufficiently made to upgrade the level. The permeability of soils, however, will become an issue, because paddy rice needs to be flooded constantly. In this respect, planosol and other types of soil, which have impermeable lower horizons, will be suitable to this crop.

As for Regosol and others we have to solve the problems as to water permeability, but some civil-engineering techniques may be employed to prevent leaks, making those soils suitable to paddy rice growing.

At present, Paraguay sees some machinized farming of paddy rice, each spreading in 300 ha to 500 ha, the fact that indicates the country already has the established machinized cultivation technique of paddy rice.

As for the chance of marketing overseas, as will be mentioned later, Paraguay is expecting shipments to Brazil. From all this, we conclude that paddy rice will be suited enough as one of the crops to be introduced into the survey areas and as a key agricultural product in the future -- in a large scale.

3) Sugar cane

Previously, sugar canes have been thought to be a crop suited to tropical areas, and limited to those with an annual average temperature of 20°C in order to grow them in an economically advantageous way. But, in recent years, the development of varieties fitted to the temperature zone has been under way. These new sugar cane varieties indicate the possibility of successful growing in areas with an annual average temperature of 20°C or below.

As regard rainfall, sugar canes used to need 1,200 mm to 2,000 mm of rainfall a year, particularly calling for rainfalls in the growth period and dryness in the ripening stage. As the survey areas meet both temperature and rainfall conditions simultaneously, we regard sugar canes to be a suitable crop to be introduced.

In view of soil, sugar canes are not so sensitive to soil patterns, but like clayey soils and instead, react sharply to those with insufficient drainage. It is because of this reason that sugar canes are hard to be grown in swampy area along rivers.

With respect to the degree of pH, neutral soils are the most welcome, and the pH range of 5.6 to 6.0 will be reasonable for sugar cane to be cultivated properly. Inundation, meanwhile may lead to rotten roots in varying degrees, and efforts should not be saved to avoid this situation.

The demand-supply conditions for sugar are not perfectly good throughout the world, and the chances are slim that the present situations, when viewed from a long-term viewpoint, will be rectified immediately.

In non-oil-producing Paraguay, the production of sugar cane as automobile fuel oil is currently being promoted as part of government policies. Therefore, there is a high probability that sugar cane will be introduced to the survey areas. Still, the chance to bring it into the Area B will be remote, because its soil and drainage conditions have yet to be met properly.

The same can partially be said of the Area A: When the size of its alcohol-manufacturing plant is taken into account, sugar cane, if introduced, will not become a staple. Nevertheless, further studies should be made, because sugar canes can be grown in non-fertile soils, because their bagasse are able to be brought back into the field.

4) Corn

When observed globally, corn is one of the agricultural crops being grown on the most extensive basis. To put it another way, corn is suitable to the largest range of weather conditions.

In general, corn is said to be subject to drought damage during the first one month after its heading. Yet, rainfall is not a major factor, only if an average monthly rainfall reaches 100 mm and more. The average temperature needed during the growing period is in the range of 23°C to 24°C, and with the survey areas' temperature levels in summer, sugar canes will be a proper item to be introduced there.

Soil conditions or restrictions are less. Since sugar canes are generally acidity-resistant, they can be grown in even acid soils such as the survey areas. But, as they are not drought-proof, some measures should be taken for sandy soils, such as irrigation and the application of organic fertilizers.

At the same time, it is imperative to crop a rotated cultivation simultaneously with other crops and to maintain soil fertilization, because corn is highly fertilizer-absorptive and then continuous cropping its with no fertilizer applied may result in considerable decrease in yield.

The production of corn in Paraguay totalled about 370,000 tons in 1980, of which about 55 percent were used as food, 41 percent as fodder and four percent shipped overseas. When the domestic levels of corn production and consumption are taken into account, the output for internal markets will be limited. Also, corn is the most widely distributed among crops in international market, and forced to be grown with low cost and less development expenditures. It seems likely that production cost will increase and large-scale introduction will be impossible, if the present production style is maintained in the areas. Further studies should be made on this issue, in addition to the possibility of expanded exports.

5) Poroto bean

The production of poroto beans is suited to the temperature zone, so irrelevant temperature levels during the flowering period may result in decreas of yield. The bean also is not much resistant to cold weathers such as frost fall and low temperature. In this respect, the survey areas appear fitted to growing of the crop.

In terms of soil, poroto beans need well-drained soil or clayey loam, and grow well in quasi-acid and neutral soil with the potential of pH from 6.0 to 6.5. In the Area A, they apparently will be grown in planosols and acrysols, either soil will need the application of carbonic calcium with which to improve acidity.

In Paraguay, about 60,000 tons of poroto beans are being produced, of which about 20 percent are for shipment overseas. A regional crop (the staple in Brazil), this bean encounters scant demands in other countries, so its large-size production, aimed at moving into international market, may topple the balance currently maintained between supply and demand. With these in mind, we recommend the poroto bean not be produced as a key agricultural product in the survey area.

6) Soybean

A crop suited to the temperature zone, soybean grows well in the temperature range of 25°C to 35°C., and needs the total precipitation of 700 mm ∿ 1,200 mm during its growth period. To maximize vegetative growth for soybeans, relatively high levels of temperatures have to be maintained in the periods of reproductive stage to ripening stage. Also necessary are large diurnal range in temperature and proper or sufficient levels of rainfall and sunshine. The reasonable accumulated temperature level is set at 2,000°C to 2,100°C during growth period.

In recent years, however, owing to remarkable diversification of varieties in breeding and, especially, photosensitivity, soybean, like corn, has become adaptable to a wider range of temperatures.

Given seeding will be made in early November and a cropping period of 130 days in the survey areas, the accumulated temperature concerned will top the 3,000°C level and the rainfall will reach 700 mm, the levels suitable enough to soybean growing.

As regard soils, soybean can be grown in relatively course-textured soils efficiently, but the yield likely will drop in volcanic-ash soils where bases are generally in shortage. The crop also is resistant to droughts and high ground water, since its major root runs into relatively deep layers.

In Paraguay, the production and export of soybeans are brisk: Brazil, with its excessive oil-extraction capacity, encourages the import of Paraguayan soybeans.

This crop, therefore, may be introduced to the survey areas as a major crop, on condition that the production should be made in costs competitive enough in overseas markets.

7) Wheat

The world's wheat-producing centers are distributed in the zones located between 30°N and 60°N and between 27°S and 40°S, and not much wheats are not being grown in the regions up to 20° ∿ 25° north and south of the equator with the exception of high land areas with extremely low temperatures.

About 75 percent of those wheat-producing districts are concentrated in the regions whose annual rainfall reaches 380 mm to 890 mm, the fact the crop grows in areas with relatively low rainfall and cool weathers. The allowance rainfall range, meanwhile, is said to be 250 mm to 1,800 mm a year. With all these conditions taken into consideration, the survey areas will not be much suited to wheat growing, as compared with other parts of the world. This is attributed to comparatively high temperatures, much rainfall (about 100 mm a month during harvesting period), etc.

However, wheat has traditionally been grown as the secondary crop followed soybean in Paraguay. This is because these two crops can share the same agricultural machines and the government has promoted wheat production in an effort to save the spending of foreign currencies and has set price guidelines: In Paraguay wheat has chronically been imported-oriented agricultural product. From these viewpoint, we recommend that wheat should be grown as the secondary crop followed soybean in Paraguay.

8) Coffee

The annual average temperature range of 18°C to 22°C suits growing coffee best. In addition, maximum and minimum levels of temperatures also are the leading factors. Still more important is whether frost will fall. Coffee is a crop regarded as vulnerable to cold weathers and so the chances are remote that it will be grown successfully in the areas subject to frost falls. When we examine records for the survey areas for the past 10 years, they certainly will have frost-falls in the June ∿ July period every year. As such, growing of coffee in this area seems to encounter much troubles.

From all the discussions made above on the eight candidate crops, where Paraguay's socio-economic and natural conditions and agricultural cultivation technology levels, we recommend that paddy rice, soybean and wheat should be introduced to the survey area as main crops in the future. As for sugar cane and corn, additional studies should be made, because they have high potentials as major agricultural items.

3.1.2 Program dimensions of main crops

Close discussions will be made on paddy rice, soybean and wheat -- the three crops decided in the preceding clause as main crops, details of the cultivation program, which constitute the foundation of the development project, are to be finalized.

(1) Paddy rice

1) Variety

Paddy rice varieties adopted currently in Paraguay can be broadly classified into the Bonnet, Fortuna and CICA. Bonnet varieties are represented by the Bluebelle, which now is widely grown in the United States. The Fortuna is a traditional variety which is broadly cropped in South American countries including Argentina. CICA varieties were firstly developed by the International Rice Research Institute (IRRI) in the Philippines and improved by Centro Internacional de Agriculture Toropical (CIAT) in Colombia. Features of these major varieties are given in Table 3-1-6.

The CICA, from the Philippines' IRRI, has been extensively introduced in such South American countries as Brazil, Argentina and Colombia in recent years. This is because of various reasons, including:

i) High levels of yield can be expected through proper fertilizing

ii) Owing to the variety's high resistance to diseases and lodging, it's growing can reasonably be controlled.

iii) Like bonnet varieties, it is long grain, satisfying the linkings of South American people.

All this add up to boost the total land for CICA cultivation in Argentina, Brazil and Paraguay.

Since parts of the rice from the survey areas are supposed to be shipped to other countries, controlling the qualities of export-oriented agricultural products will be a major issued. With all this, CICA varieties appear the most suited as crops to be introduced in the survey area.

Table 3-1-6 Properties of Paddy Rice Varieties

Item \ Varieties	Blue Belle	Fortuna	*2 CICA
Cropping season (day)	*1 100 ∿ 150 days	140 ∿ 155 days	140 ∿ 150 days
Height (cm)	100 ∿ 110	105 ∿ 110	90 ∿ 95
Grain shape	Long and narrow grain	Long and wide grain	Long and narrow grain
Lodging resistance	Rather low	Low	High
Disease resistance	High	High	High
Seeding rate	150 kg/ha	180 kg/ha	120 kg/ha
Yield	Good	Good	Very good
*3 Yield (Experiment result)	3,500 kg/ha	3,500 kg/ha	5,000 kg/ha ∿ 6,000 kg/ha

*1. There are 3 types, early maturing, ordinary maturing and late maturing.

*2. It is called IR-841-63-5-18 in Argentina, BR/IRGA 409 in Brazil.

*3. Agricultural experiment result of Corientece, Argentina.

All data above are taken by interviewing investigation of agricultural experiment stations of Argentina, Brazil and Paraguay.

2) Seeding

As seeding methods for paddy rice, direct seeding without inundation field seeding, direct seeding with inundation and transplantation are available. In Paraguay, direct seeding without inundation has long been exclusively dominant for croping paddy rice, which apparently is for the following reasons.

i) Labor-intensive transplantation is hardly available in large-size cultivation performed in lands covering an average several hundred hectare.

ii) In case of direct seeding with inundation, seeding has to be made with a certain depth of inundation after buddling. So the paddy field should be flattened equally. When the contour ditch method is adopted, this land levelling is unnecessary, though a certain level of inundation depth cannot be secured.

These discussions can fully be applied to paddy rice croping in the survey area. In our view, direct seeding without inundation will be most adequate under this development project.

3) Fertilization

Table 3-1-7 indicates the results of a fertilizer test for CICA-8 conducted at the paddy rice experimental station in Carmen del Parana. From those results, we find that the fertilization of 60 kg of phosphoric acid per ha results in increases in yield and that more than 30 kg of potassic fertilization is necessary.

As for nitrogenous fertilizers, test results show a large difference between fertilizing of 50 kg or more per ha and the otherwise case, so the former level of fertilization is called for.

An manual on paddy rice cropping, prepared by the Agriculture and Livestock Ministry's promotion division (See Table 3-1-8) sets fertilizing guidelines for individual fertilizers, in which 40 ∿ 80 kg of nitrogenous fertilizer, 40 ∿ 60 kg of phosphoric fertilizer and 20 ∿ 30 kg of potassic fertilizer are given as optimum amounts of fertilizing for every ha. The guidelines also include a proposal that nitrogenous fertilizer should be added as an additional manure.

This additional fertilization is required since in direct seeding without inundation, the amount of denitrification, such as nitrification while paddy fields are dry prior to inundation, is large enough, giving way to nitrogen disappearance into the air.

If a compound fertilizer (N : 5, P : 30, K : 20), which is currently used generally in Paraguay as less nitrogenous materials, are applied as the basal application (the amount is 180 kg per ha), N will be 9 kg per ha, P be 54 kg per ha and K (potassium) be 36 kg per ha.

If 70 kg of urea (N : 46, P : 0, K : 0) is additionally dressed, N stands at 41.2 kg per ha, the level will meet the fertilization standards specified in the government's farm management manual and match test results.

Since the nitrogenous ingredient is to be accumulated during the grazing period following the exchange with pastureland, the above-mentioned level will be satisfactory. So under fertilization standards, 170 kg ∿ 180 kg of compound (N : 5 , P : 30, K 20) fertilizers as basal application should be dressed for every ha, while 70 kg ∿ 80 kg of urea are required as an additional manure.

To be specific, fertilization effect will differ according to the soil classification in the survey area. Therefore, in actual cropping close fertilizer tests have to be conducted to determine the amounts of fertilizing.

4) Disease, insect and weed control

Generally speaking, farmers engaged in large-scale paddy rice cultivation are reluctant to invest funds in disease, insect and weed control, because they see such efforts never will lead to increases in revenues directly. Instead, those farmers are likely to seek high weed-controlling effects through rotation from paddy to other crops, not resorting to the application of chemicals or herbicide. They also adjust cropping periods in an effort to elevate ecological anti-insect effects.

These non-chemical weed-control methods prevalent in Paraguay is to conserve soil fertility and control weeds by means of rotational cropping along with grazing. (Details are to be discussed later)

Table 3-1-7 Fertilizer Experiment of Paddy Rice

Variety CICA-8

Application rate of fertilizer (kg/ha)			Yield amount (kg/ha)			Average yield amount (kg/ha)
N	P	K	Experiment plot 1	Experiment plot 2	Experiment plot 3	
0	0	0	6,400	6,072	5,750	6,072
0	60	30	6,300	6,750	6,100	6,383
50	0	30	5,800	6,600	5,950	6,117
50	60	0	6,650	6,466	6,000	6,372
50	60	30	7,250	7,100	7,200	7,183
50	60	60	7,400	5,672	7,750	6,950
50	120	30	6,850	7,204	7,600	7,218
100	60	30	7,250	7,350	7,350	7,317
100	120	60	8,900	9,100	7,150	8,383

Table 3-1-8 Project Mannual for "Rice Culture" *1

Crop	Variety	Varietal characteristics	Seeding rata	Seeding season	Fertilization	Seed dis-infection	Cultivation management: ○ Insect pest Δ Disease ⊗ Weed	Cultivation management: Agricultural chemicals	Cultivation management: Using amount	Cultivation management: Using time	Harvest season	Yield (/ha)
Rice "Rice culture" Project manual Department of extension of agriculture and stock farming, ministry of agriculture and stock farming.	CICA 8	Height is low, yield is high, 145∿150 days. Grain is long and narrow.	120 kg ~ 130 kg	Sep. Dec. Most suitable season is Oct. Nov. Early seeding causes long period and problems of insect pest and weed, while late seeding causes bad conditions for growing, blooming and seed setting because of low temperature in autumn.	Nitrogenous fertilizer 40∿80 kg Phosphatic fertilizer 40∿60 kg Potash fertilizer 20∿30 kg P_2O_5 and K_2O are applied simultaneously with seeding, N at 3 times 25∿30 days, 50∿60 days, and 80∿90 days after seeding.		○ 1. Orga pro-cesionvia 2. Chinche Hediono 3. Gorgoja Ocuatiro Δ 1. Piricularia oryzae(Rice blasa) 2. Helminthos porius oryzae 3. Cercospora oryzae ⊗ 1. For eulalia 2. Foe eulalia and broad-leaved weed 3. For broad leaved weed	Sevin 85 s Thiodan metil Dipterex Sevin 85 s Dipteres Aldrin O diedrin Aldrin 40% Satanil-E Stan L.V.10 Machete Hedonal Shell 40 U-46	kg/ha 1.5∿2.5 1.0∿1.5(ℓ) 1 1.5∿2.5 2 0.250∿0.300 7 ∿ 8 ℓ 3 ∿ 5 ℓ 1 ∿ 2 ℓ 2 ∿ 4 ℓ 2 ℓ	Apply after dis-discovered. " Apply just before putting last harrow.		
	Fortuna	High standardization, favourable to rice miller. 140∿145 days. Long and narrow.	130 kg									
	Blue belle	Early maturing 115∿120 days										

*1 Editted by Department of Extension, Ministry of Agriculture and Livestock.

In addition to these weed-control methods, chemical approaches will have to be taken. In these areas of Paraguay, no systems or procedures to foresting of occurence are full-grown, so farmers resort to spraying agricultural chemicals each time insect and diseases are threatened. The areas also have no effective systems for enhancing people's awareness of insect diseases.

Under these circumstances, it will necessary to establish a preventive and forecast system in order to launch effective chemical controls after the development is over, along with the procedures with which to propagate such systems throughout the country.

Major injurious insects specified in the cropping manuals on paddy rice growing include Orga Processionaria, Chinche Hedionda and Gorgojo Acuatico, and among the diseases concerned are rice blast and blight.

5) Yield

With the results of the Carmen del Parana test (Table 3-1-7) 7,000 kg or more of yield per ha can be expected if fertilization control is properly made. This test and its results cannot be universarily applied, because the experiment concerned limited fields in which fertilization control was more strictly made.

The results of paddy rice growing tests by the national agricultural experimental station in Caacupe can be used as references in universal cases. The field tests started in 1981 under a three-year project to determine optimum paddy rice cultivation methods for the CICA-8 variety. The data from the tests in 1981 and 1982 indicate that the areas dressed with 150 kg-per-ha base fertilizer, and 50 kg of urea as an additional fertilization, when compared with non-dressed areas, harvested yield increases of 1,600 kg per ha and 5,600 kg per ha. Because the field of 0.1 ha used in those tests were all close to actual paddy rice cultivation, these figures of yield also will be secured for the cultivation programe in the survey areas.

Table 3-1-10 shows data of a sampling of Bolf Farm, the facility engaged in paddy rice growing in the survey areas, as a part of the harvest research on general farm houses. The table indicates that a dressing with 150 kg of base fertilization (N : 9, P : 30, K : 30)

Table 3-1-9 Result of Cultivation Experiment

Caacupe agricultural experiment station 1981 and 1982

		Fertilizer application plot	Non-fertilizer application plot
Experimental field area		0.1 ha	0.1 ha
		CICA-8	CICA-8
Seeding rate		15 kg	15 kg
Seeding method		Direct sowing culture of paddy rice on well-drained paddy field, 30 cm stripe seeding	Direct sowing culture of paddy rice on well-drained paddy field, 30 cm stripe seeding
Fertilization	Basal application	(N48, P60, K30)	Non
	Top dressing	Urea for feed	Non
Herbicide		2 - 4 - D	2 - 4 - D
Pest control		Non	Non
Yield		560 kg	400 kg

Work schedule

Sowing seeds (Basal application was on same time)	10 Nov., 1981
Weeding	12 Dec., 1981
Top dressing	25 Jan., 1982
Harvesting (hand cutting)	3 Apr.
Cropping season	145 days

Table 3-1-10 Investigation Yield in Bolf Farm

(1981 and 1982)

		Investigation result	Remarks
Growing area		450 ha	
Cropping variety		CICA-8, CICA-9 and others	Others: Blue Belle, Sdeccion
Seeding rate		120 kg/ha	
Rotation system		Newly reclaimed paddy field	It will be transfered a grazing land after used as paddy field for a year.
Fertilization	Basal application	150 kg/ha (N9, P30, K30)	Blended fertilizer
	Top dressing	Non	
Pest control		Rice stem borer	Sistemico
Yield		5,000 kg/ha (average)	Maximum 5,500 kg/ha Minimum 2,250 kg/ha

Table 3-1-11 Planning Dimensions of Paddy Rice Culture

		Planning dimensions	Remarks
Cropping variety		CICA-8	
Seeding rate		130 kg/ha	
Seeding method		Direct sowing culture of paddy rice on well-drained paddy dield, stripe seeding	
Fertili-zation	Basal application	170 ∿ 180 kg/ha	Blended fertilizer (N5, P30, K20)
	Top dressing	60 ∿ 70 kg/ha	Urea for feed (N46, P0, K0)
Weeding			If necessary
Yield		5,000 kg/ha	Unhulled rice weight
Cropping season		140 ∿ 150 days	
Work schedule	Sowing seed	20 Oct. ∿ 30 Nov.	40 days
	Basal application		Workperformed simultaneously with seed sowing
	Top dressing	Just before panicle formation stage	
	Harvesting	20 Mar. ∿ 20 Apr.	30 days

per ha resulted in harvests averaging at 5,000 kg per ha. The extremely low level of nitrogenous fertilizer herewith apparently came with the fact that the field in the farm is reclaimed every year and then the fertilizer accumulated prior to each paddy field reclamation because of using as ranching, promising higher levels of yield for the amount of nitrogenous elements.

Details of the Program are to be finalized after all these experiment and sampling results are integrated. (See Table 3-1-11)

(2) Soybean

1) Variety

The characteristics of representative soybean varieties being croped in Paraguay are given in Table 3-1-12. We will have to consider closely the relationship with wheat in choosing the varieties to be introduced under this project.

A combined cultivation of soybean and wheat will certainly prove most advantageous, when we view the effective application of agricultural machinery and simultaneously use of the fertilizers previously applied to wheat growing.

On the other hand, both wheat and soybean need 120 ∿ 150 days as a cropping period, making production schedules tight all the more for it. In this respect, we recommend to choose varieties whose cropping periods are short and photo-sensitivity is low.

To cope with a long spell of rain likely to happen in October and November, the key seeding period, varieties which can be properly sown in a longer span of time, should be chosen.

Such varieties as Davis and Santa Rosa, in this respect, are not advisable because of their cropping periods exceeding 150 days, which may affect those periods for wheat croping. Meanwhile, Visoja, when its optimum seeding period is missed, will suffer from sharp declines in harvest volume. This is because the variety by far excels in photo-sensitivity.

Instead, we will recommend the introduction of Parana in the project areas, because the variety, though it expects lower levels of yield, has a cropping period of a modest 110 ∿ 120 days and is low in photo-sensitivity.

Table 3-1-12 Soybean Cultivation Characteristics

Type name / Characteristics	Parana	Bragg	Bossier	Visoja	Davis	Santa Rosa
Cropping period	110 ∿ 120	140 ∿ 150	130 ∿ 150	120 ∿ 140	150 ∿ 160	160 ∿ 170
Disease resistance	Moderately good	Moderately good	Moderately good	Moderately normal	Moderately poor	Normal
Lodging resistance	Moderately good	Normal	Poor	Moderately good	Moderately poor	Poor
Yield	Normal	Good	Good	Moderately good	Normal	Normal

The cropping period is longer for Bragg and Bossier. The two varieties have relatively higher photo-sensitivity. While featuring higher levels of yield, Bragg may suffer from weakened yield, when compared with the case of early seeding. The variety, on the contrary, features high resistance to delay in cropping works.

After all these data and test results are taken into consideration and reviewed closely, we recommend that the Bragg and Bossier varieties be introduced in the survey areas.

2) Fertilization

Soybean croping practices currently under way in Paraguay are given in Table 3-1-13. As can be found from the table, fertilization-free growing is adopted for soybean, because of root nodule bacteria nitrogen fixation.

Though the shortage of phosphoric acid may take place during a long period of continuous cropping, it still can be expected that the residual effects of fertilization for wheat as the secondary cropping item.

On this problem, fertilization tests will have to be launched in a close way, and if necessary, the application of fused phosphate may be reviewed.

3) Disease

To build up existing curing steps, well-planned preventive efforts should be made. In an effort to combat larvae of the Lepidoptera, likely to hit in the early to closing periods of growth, and the soldier bug spreading in the intermediate-to-closing periods, weeding efforts should be taken on a systematic basis.

4) Yield

Presently, the average yield reaches 1,800 kg per ha. Previous sampling indicates that some specialized farmers harvest as much as 2,500 kg per ha.

Also, data from the CRIA (Refer to Table 3-1-14) shows that the regional agricultural research center recorded a yield of 2,000 ∿ 3,600 kg per ha in fertilization-free growing.

Table 3-1-13 Soybean Routine Cultivation System

	Cultivation system	Notes
Major types	Parana, Bragg, others	Visoja, Bossier, others
Broading amount	60 ∿ 100 kg/ha	
Fertilizer amount	None	
Disease control	No routine diseases	Curing control
Insect control	Lepidoptera, Soldier Bug	
Yield	1,800 kg/ha	

Table 3-1-14 Soybean Cultivation Experiment

Type	1980/81		1981/82	
	Bragg	Bossiev	Parana	Visoja
Experimental field area	0.03 ha	0.03 ha	0.05 ha	0.05 ha
Broading amount	2.0 kg (67 kg/ha)	2.0 kg (67 kg/ha)	3.0 kg (60 kg/ha)	3.0 kg (60 kg/ha)
Fertilizer	None	None	None	None
Weed control	Cultivator weed removal	cultivator weed removal	Cultivatorweed removal	Cultivator removal
Insect control	4-times and others	4-times and others	4-times and others	4-times and others
Disease control	None	None	None	None
Cropping season	145 days	145 days	130 days	155 days
Harvest	3,600 kg/ha	3,300 kg/ha	2,100 kg/ha	3,100 kg/ha

Table 3-1-15 Program Dimension of Soybean Cultivation

		Program Dimension	Notes
Variety		Parana	(Bragg)
Cropping period		110 ∿ 130 days	140 ∿ 150 (Bragg)
Broading amount		60 ∿ 100 kg/ha	Average 80 kg/ha
Fertilizer		None	Experimental fertilization with 50 kg/ha serpentine phoaphate
Pest control		Preventive control	
Weed control		Cultivator weed removal	
Yield		2,000 kg/ha	
Work Schedule	Sowing	Oct. 20th ∿ Nov. 30th	
	Harvesting	Mar. 1st ∿ Mar. 31st	

Under this project, the target yield is set at 2,000 kg per ha of soybean by means of systematic preventive disease, insect and weed control efforts, effective application of the residual fertilizers applied previously in wheat production, improved drainage with land consolidation, built-up road facilities and other tools to upgrade productivity. These efforts, once taken fully, will make the target yield attainable and the current production capacity will be dwarfed.

As part of the soybean and wheat growth program, green-manure cropping is planned for once every four years and more organic fertilizers are to be applied, which we believe will contribute to boosting the tempo of production increases.

(3) Wheat

1) Variety

The characteristics of representative wheat varieties being grown in Paraguay are given in Table 3-1-16. As can be found in the table, high-yielding varies include the Itapua-25 and Cardillera which excel in resistance to lodging and diseases. The Itapula-25, highly resistant to viviparity, is superior in withstanding rainfall during the harvest period.

Cardillera, meanwhile, has high resistance to powdery mildew, stalk rust and other diseases, but is weak to leave rust, punctation and mold. Germicides will have to be properly applied to help this variety prove high productivity. Much success also is anticipated for Cardillera application throughout Paraguay's wheat-producing districts.

As was mentioned in the preceding clause, the survey areas are not best suited to growing wheat. For this particular reason, much care should be paid in choosing varieties, with respect to resistance to rainfall during the harvest period, for example.

When we observe their productivity, anti-disease resistance, and the resistance to viviparily (anti-rainfall resistance during the harvest time), the Itapua-25 and Cardillera should be recommended as varieties to be introduced in the survey areas.

The following discussions have their bases in the test data on the Itapua-25.

Table 3-1-16 Wheat Characteristics

Type / Characteristics	281/60	Itapua No. 1	Itapua No. 5	Itapua No. 25	Cardillera	7605	5849
Cropping period	150 ∿ 160	120 ∿ 140	120 ∿ 140	120 ∿ 140	150 ∿ 160	140 ∿ 150	150 ∿ 160
Lodging resistance	Moderately poor	Moderately good	Good	Good	Good	Moderately poor	Moderately poor
Diesese resistance	Moderately poor	Good	Moderately poor	Normal	Good	Moderately poor	Normal
Yield	Good	Normal	Normal	Good	Good	Good	Normal
Prefectures promoting cultivation	Amambay misiones San Pedoro Caaguazu	Itapua Alto Para Parana Canendiyu	--	Itapua Alto Parana Canendiyu	All prefectures	San Pedro Misiones Caaguazu	Amambay Sau Pedro Caaguazu Misiones

Ministry of Agriculture and Livestock: from Wheat cultivation, Wheat program, Paul torres, et al.

2) Fertilization

Table 3-1-17 shows Paraguayan practices in cropping wheat, which were organized in a research by the Asuncion branch office of the Japan International Cooperation Agency (JICA). With this list compiled in accordance with the results of a survey in the Japanese settlement of Iguazu, those cultivation methods and yields are average, when compared with those in other parts of the country.

According to a wheat production buildup program previously launched by the Ministry of Agriculture and Livestock, the soil content of nitrogen will lower in areas where rotated cultivation of soybean and wheat continues for five years and more, a factor adversely affecting the production of wheat. Also, there is interdependence between the amount of phosphoric acid and yield, so the shortage of that acid is likely to restrict the scale of yield. In general, sandy soils are low in potassium content, which require for farmers to take to fertilization efforts.

The results of wheat cultivation tests, currently under way at the Centro Regional de Investigacion Agrila (CRIA), are shown in Table 3-1-18. In those tests, dressing of 40 kg/ha of nitrogen, 70 kg/ha of phophor and 35 kg/ha of potassium as base fertilizers brought in 1,800 kg of yield per ha, while 2,700 kg of yield were reaped with additional dressing of 20 kg/ha of nitrogen, 35 kg/ha of phosphor and 15 kg/ha of potassium.

It will not be fully adequate to apply these figures universarily because concerned experiments were launched in areas of 0.05 ha and 0.06 ha, respectively. Still, as is apparent from the tests, additional fertilization should be conducted under this project in anticipation of yield greater than those expected in traditional practices.

Since the soils of the survey areas are sandy in general, we advise that potassium be used as the base dressing material, along with a compound fertilizer made up primarily of phosphor. For the planned continuous cropping of soybean and wheat, nitrogenous fertilization also should be taken into account.

In case of dressing of 150 kg/ha of compound fertilizer (N : 5, P : 30, K : 20) under this project, it is translated into the following ingredients.

N : 7.5 kg/ha,
P : 45 kg/ha,
K : 30 kg/ha

If 40 kg/ha of urea (N : 46, P : 0, K : 0) is dressed as additional fertilizer, it is translated into the dressing of 25.9 kg/ha of nitrogen, the levels able to satisfy the fertilization standards under the present practices and then to compensate for potassium shortage in sandy soils, resulting in expected yield increases.

3) Disease, insect and weed control

No systematic procedures or systems have been established in Paraguay with respect to the control of disease, insect and weed. As was mentioned before, the survey areas are not suited to wheat growing, how effectively to prevent and control of weed growth will be more influential than any other factors, because of the amount of rainfall.

Under this project, increased yield are eyed through systematic efforts to control disease, insect and weed. More specifically, such efforts include weed control, preventive steps for plant lice, green caterpillars and other injurious insects and counter-measures for such diseases as mold and wheat rust.

4) Yield

Practically, the average amount of yield of wheat stands at 1,200 kg per ha in Paraguay. According to previous data and test results, the base and additional dressing with potassium secures yield increases of up to 2,700 kg per ha. As such, partial modification of the present cultivation practices may well bring in production increases.

Table 3-1-17 Wheat Cultivation System (Practice)

Item	Practice cultivation system	Remarks
Main variety	Itapual, 281/60	
Broading	100 ∿ 150 kg/ha	
Fertilizer amount	Compound fertilizer (base fertilizer) 100 kg ∿ 160 kg/ha	N18 P46 K0
Pest control	Not systemized	Individual treatment and removal
Weed control	None	
Yield	1,200 kg/ha	

Table 3-1-18 Wheat Cultivation Experiment

		Experiment 1 (1980)	Experiment 2 (1981)
Experiment plot area		0.03 ha	0.05 ha
Cultivation variety		Itapua 25	Itapua 25
Broading amount		2.7 kg (90 kg/ha)	4.5 kg (90 kg/ha)
Ferti-lizer	Base fertilizer	N40 P70 K35 (component calculations)	N40 P70 K35 (component calculations)
	Additional fertilizer	N20 P35 K15 (component calculations)	None
Weed control		30th day after sowing 2-4-D	30th day after swing 2-4-D
Insect control		None	None
Disease control		2 times for scab, rust	2 times for scab, rust
Yield		2,700 kg/ha	1,800 kg/ha

Table of Basic Farming Unit Prices, 1982
JICA Asuncion Branch

Table 3-1-19 Program Dimension of Wheat Cultivation

Item			Plan summary	Remarks
Cultivated types variety			Itapua 25 (Cardillera)	
Broading amount			90 kg/ha	
Fertilizer	Base fertilizer		140 ~ 150 kg/ha	Compouser (N5, P30, K20)
Fertilizer	Additional fertilizer		30 ~ 40 kg/ha	Urea (N46 P0 K0)
Insect control			Cockroaches, grubs	2 times
Disease control			Scab, rust	1 time
Yield			1,600 kg/ha	
Cropping period			120 ~ 140 days	150 ~ 160 days (Cordillera)
Work Schedule	Sowing period		May 1st ~ May 31st	
Work Schedule	Fertilizer	(Base fertilizer)		At sowing
Work Schedule	Fertilizer	Additional fertilizer	At sprouting (30 ~ 45 days)	
Work Schedule	Harvesting period		Sep. 10th Oct. 10th	

3.1.3 Crop rotation system

(1) Paddy rice-pasture system

More than 90% of rice produced in the world comes from the Asian continent, while North and South Americas account for only less than 10%. The remarkable difference in the production system between Asia and Americas is that in Asia rice is produced in the small-scale labor intensive farming, while in Americas large-scale agricultural management is employed for the production of rice as a cash crop and the economic rationality has always been aimed at in the production for the improvement of labor productivity. It is also true that in many Asian countries certain protection measures have been given to the rice production under the food policy, while in Americas the rice production is usually considered to be a type of industry requiring management with an enterprising spirit. As for the cultivation system, transplanting is the main practice in Asian countries, while in Americas direct seeding in paddy fields and the upland rice production are the generally accepted cultivation methods. In terms of the cultivation method, the rice production types in Americas can be classified into the upland rice production in Brazil and its neighboring countries, direct seeding without inundation in the US except for California and South American countries, and direct seeding with inundation in California.

A study was performed to determine which one of the three cultivation methods, i.e., the direct seeding without inundation, direct seeding with inundation, transplanting, should be applied to the present project. Characteristics of these cultivation methods are listed in the following table.

Table 3-1-20 Comparison of paddy Rice Cultivation Methods

Items	Direct seeding without inundation	Direct seeding with inundation	Transplanting	Remarks
1. Land levelling	High degree of land levelling not required	High degree of land levelling required	Very high degree of land levelling required	Planting machinery is used for transplanting
2. Seeding machinery	Drill	Airplane broadcasting or seeder	Nursery bed, raising of seedling	
3. Seeding method	Both stripe seeding and broadcasting possible	Broadcasting	Stripe seeding	
4. Puddling	No	Yes, partly no	Yes	
5. Initial irrigation water	Peak approached comparatively gradually	Inundating initially, peak at the puddling period	Peak at the time of puddling	Peak irrigation water determined by the length of puddling time
	Initially in the upland field state	Temporarily surface drainage in the initial period, shallow water irrigation	Inundating from the beginning	
6. Weed control	Weeding by inundating not possible in the initial stage	Weeding by inundating not possible in the initial stage	Weeding by inundating from the beginning possible	Weed control of upland field weed at the initial stage
	Weed control for 2∿3 years by crop rotation	Weed control by puddling	Weed control by puddling	Weed control of aquatic and semi-aquatic weeds
7. Red rice control	Difficult to obtain satisfactory results by the seed control only	Probably not possible by the seed control only	Possible by the seed control	The difference of growth stage between the red rice is used when transplanting
8. Continuous cropping	Not advisable for red rice control	Probably not advisable for red rice control	Possible	
9. Required labor	Small	Not small (Increased labor for puddling expected)	Large	
10. Cultivation techniques	Ordinary, similar to the upland crop operations	A little high techniques required (puddling)	High technology required for raising of seedling	Cultivation technique at the initial time of growth period
11. Machineries	Drill	Airplane (rental)	Rice transplanter Facilities for raising of seedling	

The direct seeding method without inundation has been employed in Arkansas which is the major rice producing state in the US, Rio Grande do Sul in Brazil, Corientes in Argentina and others. Most of the rice production in Paraguay has been operated by this method. According to the field investigation, rice fields are used for 2 to 3 years continuously and changed to pasture lands or upland crop fields, which are maintained for 2 years to several decades until they are returned to the paddy rice production again. The reasons for this rotation are considered to be as follows:

1) To conserve soil fertility
2) To facilitate the weed control
3) To control red rice

Change to pasture from paddy fields can facilitate the increase in fertility of land due to the plowing-in of weeds and the accumulation of cattle excrements, thus allowing to decrease the fertilizer input at the time of paddy rice cultivation and at the same time the physical characteristics of soils can be improved by the input of organic materials. Weed in the paddy field and in the upland field are different in species composition. If a paddy field is changed to an upland field, paddy weeds will be replaced by the upland field weeds. In this process, weeds unfavorable for the paddy rice cultivation can be eradicated by the browsing cattle. In this way the eradication of paddy weeds which are unfavorable to the paddy rice, while the paddy field is used as an upland field, can have the same effect as the herbicide and the dosage of herbicide can be decreased. Since this crop rotation has also been employed in the US where the herbicides are available at a comparatively low price, it seems that this system is considerably effective. With regard to red rice, it is a wild variety of rice which has a red surface of kernels. The inclusion of the red rice in the ordinary rice lowers the market price of rice. The employment of crop rotation between the pasture and direct seeding without inundation has been considered to be effective for the control of red rice in the following paddy rice cultivation season because cattle favors it.

The direct seeding with inundation is the cultivation method which has been used mainly in California in the US, where water is ponded after puddling the field and seeds are sprinkled from the airplane. In this case, to facilitate the anchoring of seeds in the field, the field has to have a certain depth of water, which, in turn, requires a high degree of flatness of the field. Although some say that the red rice can be controlled by the puddling of the field before transplanting, no causal relationship was found in California where the red rice has not yet been introduced due to the short history of paddy rice production there. Although there is a possibility for the application, to the proposed area, of the continuous production of paddy rice by the direct seeding with inundation as indicated by the cases in California, the economy of weeding, when the continuous production of rice by the direct seeding with inundation is employed to the project area which is climatically different from California, is not able to be clearly understood.

Although the cultivation method by transplanting has been employed only a few cases in many large-scale paddy rice production operations, it has been used in farms with the operation size of several tens of ha in Japan.

The length of paddy seeding at the time of transplanting is a few cm over 10 cm and the red rice has not sprouted in the puddled field yet. By the ponding after the transplantation, the red rice cannot grow in the field, and by the sufficient seed control the introduction of red rice into the field can be controlled.

The following are the results of examinations of these three types of cultivation methods.

1) Beef-cattle raising in the pasture has been performed in the proposed area and it is not advisable to have a sudden change in the agricultural type in the area by negating the cattle raising.

2) Although it is advisable to employ continuous cropping by transplantation from the view point of red rice control, the introduction of the system seems to be difficult because of the lack of experience in large-scale production by the method and also because of the lack of techniques of transplanting in Paraguay.

3) Answer was not obtained as to whether the continuous cropping by the direct seeding with inundation is advantageous and economical for the red rice control and weed control.

The feasibility for the employment of this method still remains to be determined in the future.

Although there are problems to be examined in the future, the most probable system at present is to introduce, to the proposed area, the paddy rice-pasture rotation system based on the direct seeding without inundation.

There are no data to determine how many years are required to complete the rotation cycle most rationally. In the region where a large-scale paddy rice operation has been practiced, stock farming is usually the main operation of farmers often having huge lands for pasture compared with the area for paddy rice fields and the number of farmers with the experience of returning the field once used as a paddy field back to a paddy field is limited. Therefore, it seems that no experiments were performed.

However, according to the interview with farmers, it was found that farmers had experienced a large decrease in yield by the continuous harvesting of rice for more than 4 years. Therefore, the number of years for paddy rice cultivation was determined to be 3 years and for the pasture following the paddy rice to be 3 years also. There are no data to verify the validity for the operation of a pasture land for 3 years, although the interview with farmers at Carmen del Parana near the survey area did not suggest any problem. Whether it is possible to shorten the period for the pasture land will be examined later.

3.1.4 Other crops

This year, we established the cultivation programs for key crops to be introduced in the survey areas, but additional studies are requested to be made with respect to other crops and those able to be introduced by small-scale agricultural farmers. To these ends, the following conditions should be made.

1) To be labor-intensive and be converted to cash easily
2) To be grown on a small-scale
3) To be free from large initial investment of capital

Also important is how much the crops for self-consumption will take up.

Based on all the data mentioned so far, it is requested to classify in the following year all those crops according to the purpose of cultivation, labor intensity, initial capital investment, irrigation, and so on, and to calculate production costs on an experimental basis for representative crops in order to establish their cultivation management programs.

3.2 Livestock Plan

3.2.1 Grassland utilization plan

Paddy rice is listed up as the major crop for the survey area, but in order to control the difficulty caused by continuous cropping including red rice and weed a three years' rotation system has been established. As another usage of this three years' rotation system, grazing cattle in the pastureland will lead to extermination of wet land weed, intensification of fertility by returning excreta of livestock, and stable management of paddy rice production in the next cycle.

Then, one of the methods to create pastureland is to utilize dry land weed which will grow naturally after the land is allowed to stand after harvesting of paddy rice. However, this method is unfavorable as the basis for a large scale management of cattle which needs stable feed supply, because timing of the natural condition allows only low level utilization from the end of October to the next spring such as a slow initial growing rate of weed and harvesting of paddy rice in the begining of winter.

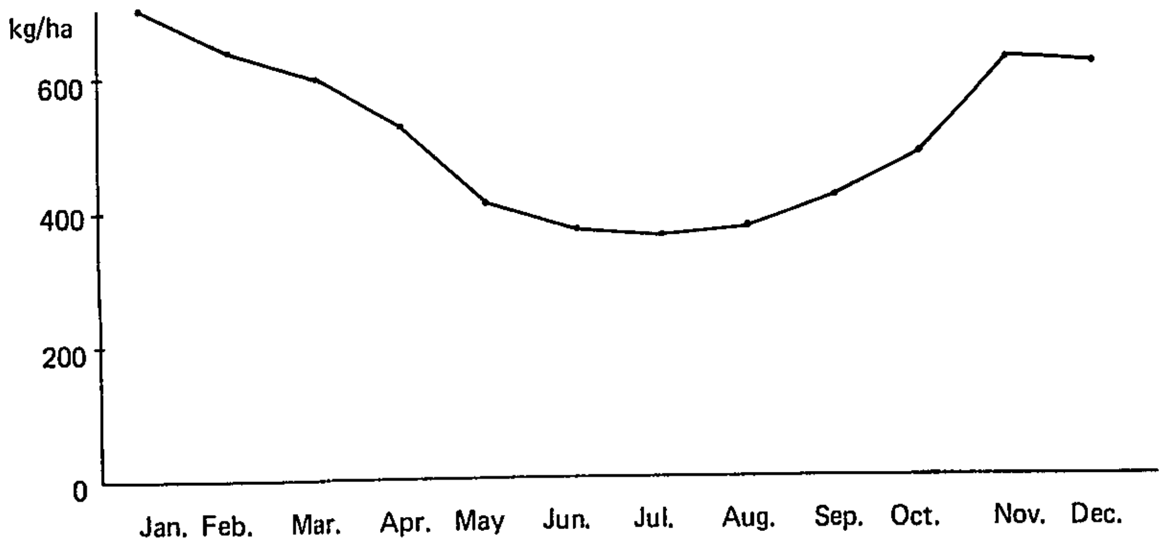


Fig. 3-2-1 Dry Matter Yield by Month of Natural Grassland at Barrerito Experimental Farm (Average for 3 years)

Figure 3-2-1 illustrates a field test result obtained under no fertilizer and no irrigation conditions at the Barrerito Experimental Farm which is located very near the survey area and has similar soil and climate conditions (average values for three years). The values of the bending line are dry matter (D.M.) yield by month, which indicate low productivity in winter from May to September.

The major natural grass species in this field test farm are shown in the Table 3-2-1.

Table 3-2-1

Name in Paraguay	English name	Botanical name
1. Pasto capi-i pé cabayu	Bahia grass	Paspalum notatum
2. Pasto jesuita	Carpet grass	Axonophus coonpresus
3. Capi-i pyta		Andropagon iateralis
4. Capi-i pe-i	Bermuda grass	Cynodon dactylon

Thus, in order to achieve a stable basis for feed supply and to make early utilization/continuous utilization possible, a plan to create improved grassland with seeding of meadow grass and manuring (area) management is made for stable management.

Grass species to be seeded for the improvement of the grassland include Pasto Serina, Costal Bermuda and Buffal, which are used in the Menonita settlement in Chaco region, and gramineous weed such as Panicum, Setaria, Brachiaria, Cynodon and Pennisetum genera and leguminous weed such as Alfalfa, which are investigated by San Lorengo and Barrerito Experimental Farms. The meteorological and soil conditions data obtained at the Barrerito Experimental Farm is used for planning.

Figure 3-2-2, which was obtained at Barrerito under a similar condition with Figure 3-2-1, summarizes in a graph the 3 seasons yields of 4 grass cultivation with higher annual DM yield and wild grass on the basis of the survey data of 10 grass species for three years.

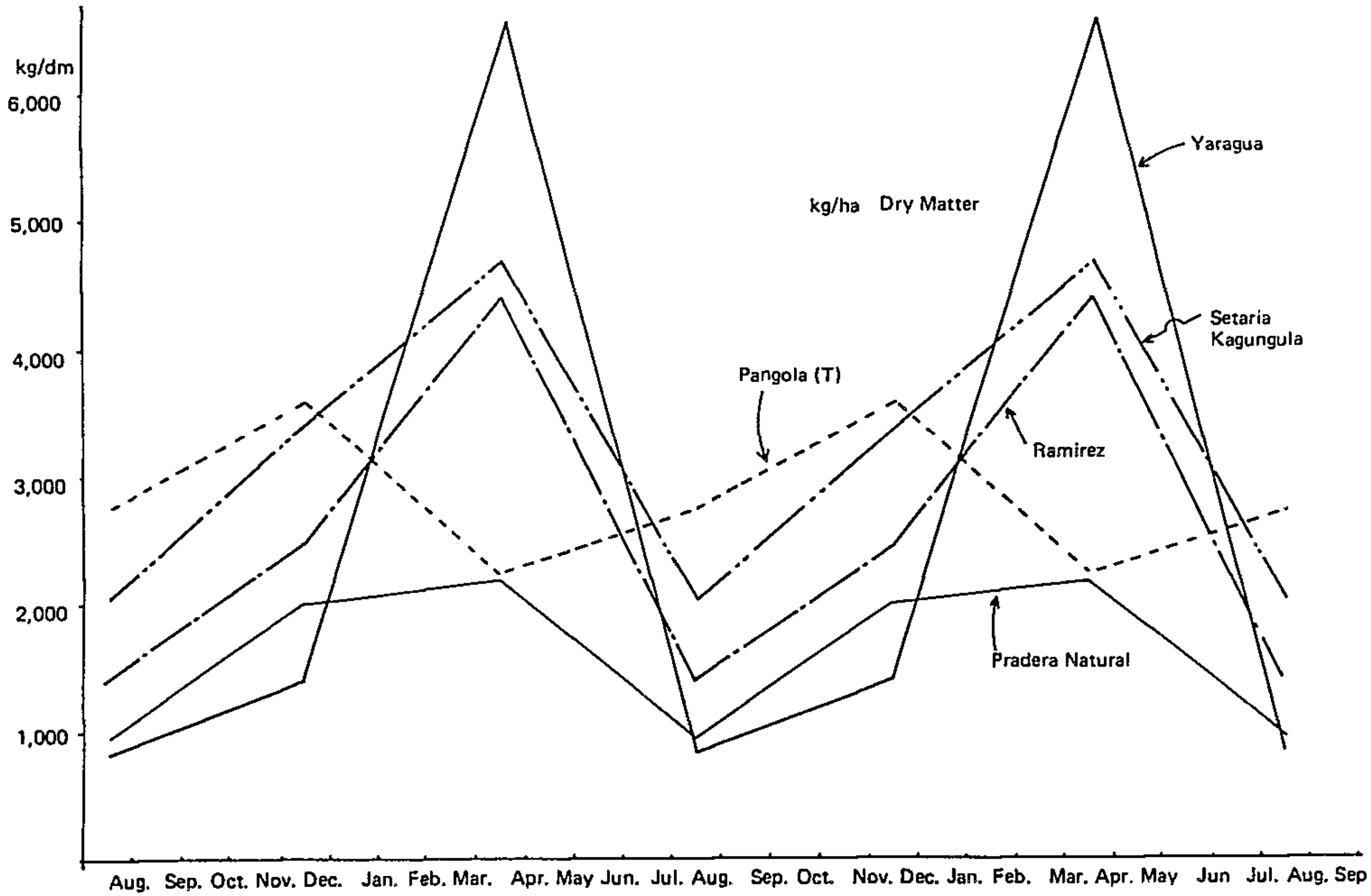


Fig. 3-2-2 Production per Year of Pasture Graph

Table 3-2-2 and Figure 3-2-3 show the fertilizer test data investigated at the San Lorenzo Experimental Farm located near Asuncion. This result indicates an approximately 20% increase in yield of the control section at N : 50 kg. Although it is not suitable to apply directly this result to the survey area, this plan aims at a 20% increase in yield through urea 50 kg/h/year fertilization along with practical use of the characteristics of legumious weed (fixation of atmospheric nitrogen and supply of the nitrogen nutrients to forage grass) after thorough examination of the soil and manuring.

Table 3-2-2 Effect of Fectilizers upon Pasture Grasses at San Lorenzo Experimental Farm (Average for 3 years)

Division	Object region	N: 50kg	N: 100kg	N: 150kg	N: 100, P: 60	N: 100, PK: 60
Pangola	100	115.3	124.2	161.6	146.9	138.6
Buffel	100	120.3	124.9	138.2	168.0	170.3
Costal Bermuda	100	127.8	143.6	175.0	150.0	132.7
Ramirez	100	115.2	140.2	131.4	124.4	136.7
Guinea	100	113.4	109.8	125.4	137.4	138.4
Average	(8,938kg) 100	118.4	128.5	146.3	145.3	143.3

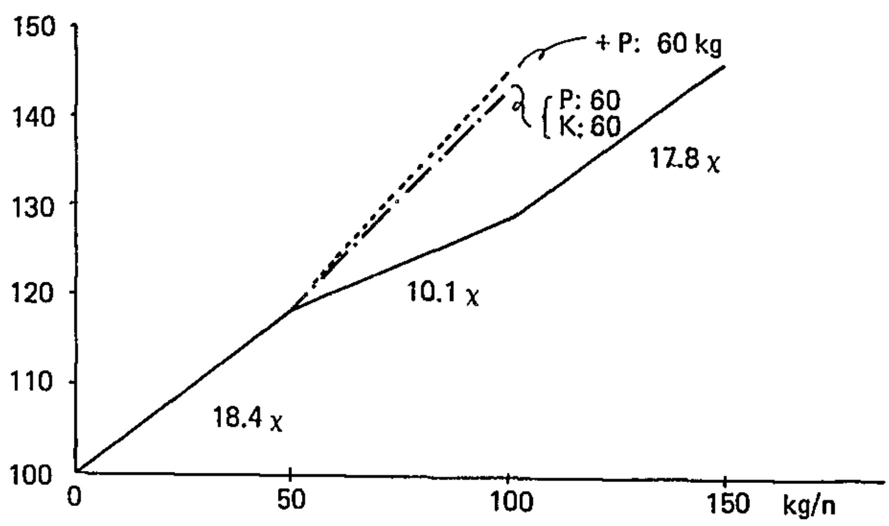


Fig. 3-2-3 Harvest Increase Curve

Figure 3-2-4 summarizes the results of the examination of mixed seeding of two low temperate grasses, Italian Ryegrass and Perennial Ryegrass, with resistance in winter for improving the low yield during winter. This is introduced also for stable and continuous feed supply by facilitating pasturelization after harvesting of paddy rice cultivated in the third years. (Although further detailed investigation is necessary for this plan, theoretically a plan can be made based on data obtained in foreign countries).

Figure 3-2-5 is an illustration of a scheme for the continuous and stable supply from the pastureland during creating new paddy fields by rotation after the harvesting time of paddy rice in the third year.

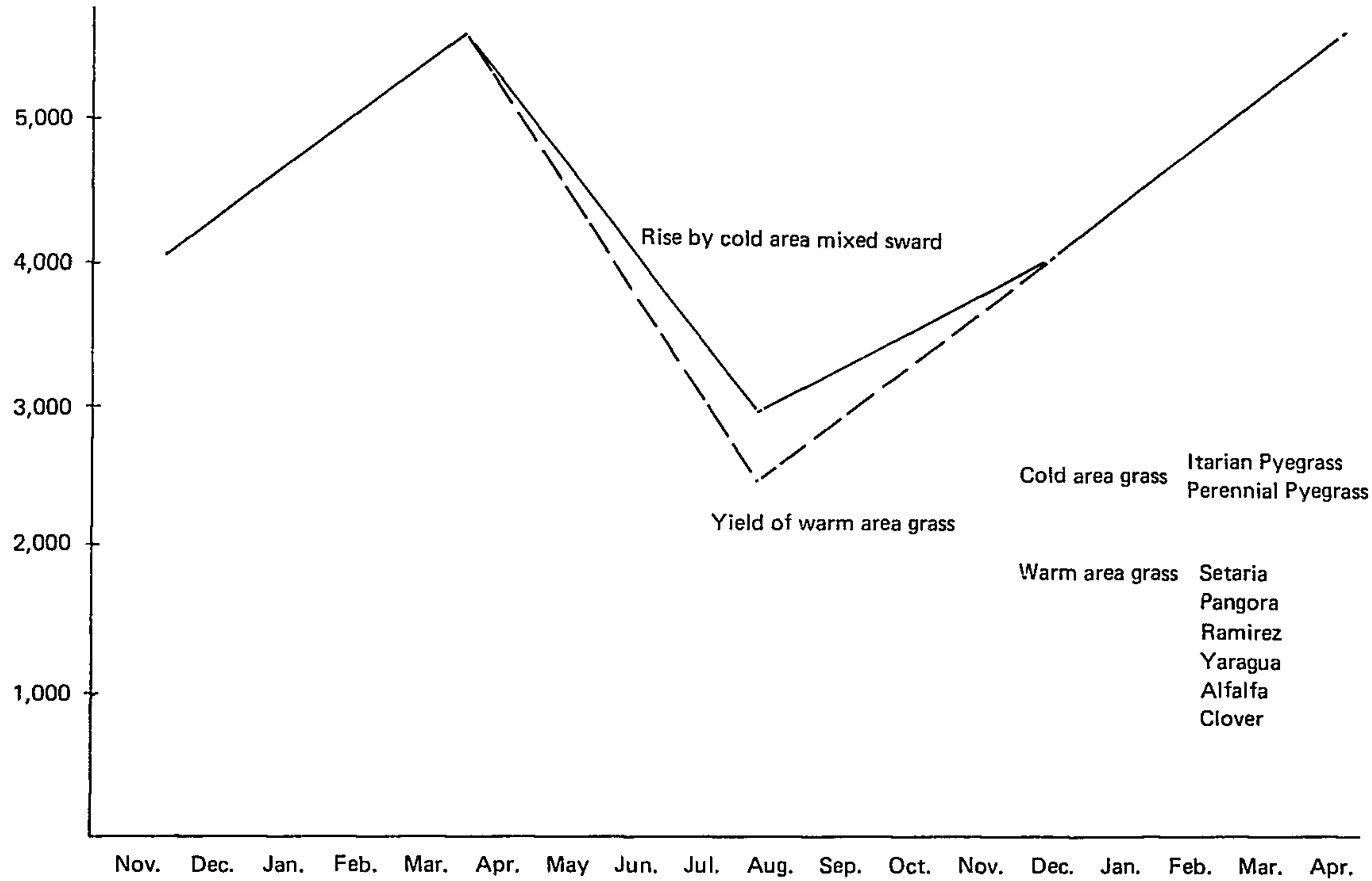
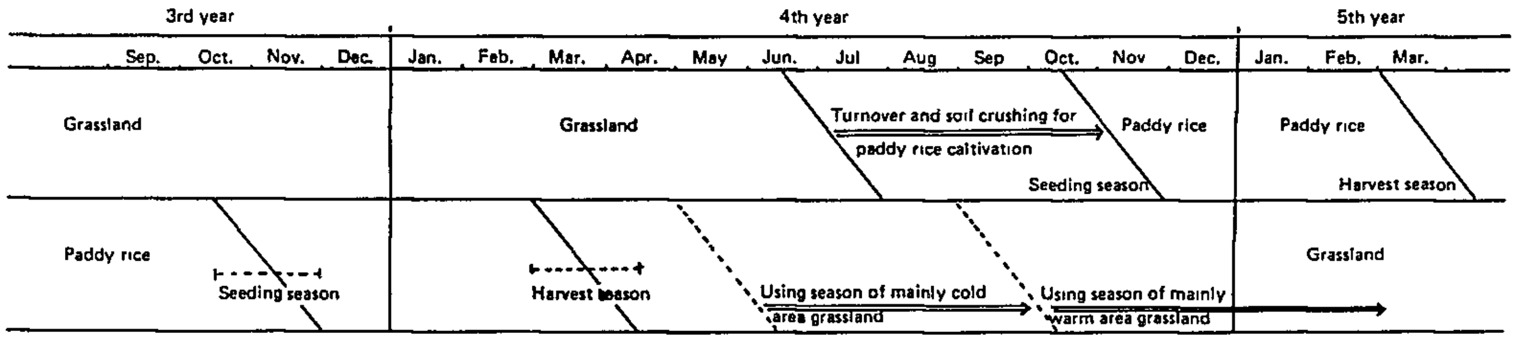


Fig. 3-2-4 Production Curve of Mixed Sward



Seeding grass		
Itarian Ryegrass, Perennial Reyegrass	5 kg	20 kg/Ha
Setaria, Pangora	5 kg	
Ramirez, Yaragua	5 kg	
Alfalfa, Clover	5 kg	

Top dressing is performed in grassland every after using for liverstock (N.50 kg/Ha/year)

Fig. 3-2-5 Paddy Field/Grassland, Preparation of Grassland in 3 Year Rotation System and its Utilization System

Table 3-2-3 DM, TDN and CP Harvests Possible per Ha of Pasture

Division	Harvest			
	Jun. Sep.	Oct. Jan.	Feb. Man	Total
D M	kg (450) 1,800	kg (615) 2,460	kg (855) 3,420	kg (640) 7,680
TDN	(281.3) 1,125	(384.4) 1,537.5	(534.4) 2,137.5	(400) 4,800
C P	(16.5) 198	(22.55) 270.6	(31.35) 376.2	(70.4) 844.8

Note: D M: Dry matter

TDN: Total degestible nutrition

C P: Crude protein

( ) Average monthly values

In summary, the annual and monthly utilizable amounts per ha of the grass DM (Dry Matter) yield and the grass TDN (Total degestible nutrition), which will be attained by the improvement of pastureland and it's utilization plan, are;

DM yield 12,800 kg × 0.6* = 7,680 kg --- monthly average 640 kg

* this number is based on the assumption of 60% of the utilization rate taking account of the loss due to hooves of cattle, the loss of grass which cannot be eaten because of the contamination by excretes, and artificial protection to ensure regeneration.

TDN yield 12,800 kg × 0.6 × 0.625* = 4,800 kg --- monthly average 400 kg

* 0.625, which means the TDN content of weighted mean of each grass, was estimated based on the feed analysis table published by the Asuncion University.

In Figure 3-2-6, a schematic illustration of a plan in which stored roughage is provided during the preharvest months in winter in short supply of an absolute amount of foods, although grazing is maintained as the major activity. This system can establish an annual equalizing feed supply plan, which, then, will facilitate the improvement of nutritional condition of cattle and make planned production possible.

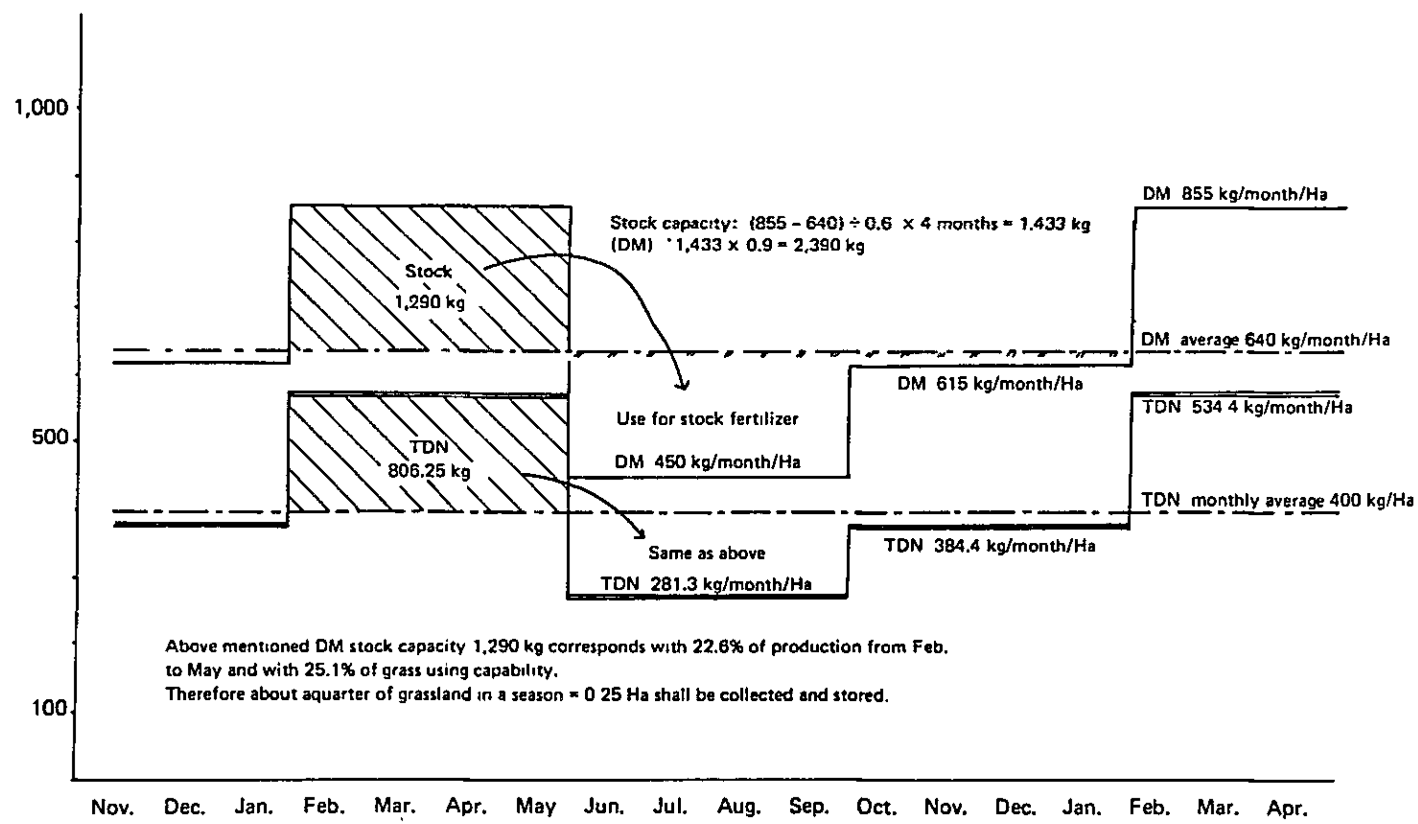


Fig. 3-2-6 System of Use for Livestock and Stock of DM, TDN Using Capability

The same system with this improvement/utilization method will be adopted for the feed basis in the dairy farming plan to be made in the survey area.

Furthermore, problems to be examined and the final goal are summarized as follows.

One of the essential matters in improvement of pastureland is the supply of seed and seedling, almost all of which are currently imported from foreign countries. However, in Paraguay, which has many large areas suitable for seed production under favorable temperature and precipitation conditions, self supply of seed and seedlingwill be possible.

Presently, almost no soil conditioner or fertilizer is used, but in order to improve for good grasslands rationally and to make efficient use of them manure management appropriate to the characteristics of excellent grass cultivate is required. This will need the exploitation of raw materials as well as efficient use of domestic resources.

In making a grassland plan taking account of the above-mentioned matters the effective way is to create mixed seeding grass land consisting of forage grass, as the major grass, and, legimious grass (Alfalfa and clover) to make the most use of the characteristics of grass and the effective use of resources such as fertilizer. In addition, to equalize the imbalance in seasonal production is required.

3.2.2 Beef cattle management plan

Beef cattle rearing in Paraguay is largely still at an extensive stage in which cattle is grazed in a vast natural pastureland. Many problems including varietal improvement of beef cattle, nutritional balance and measures to control diseases and internal/external parasitic diseases remain unresolved. At present a step towards the improvement and the solution is started by SENACSA (Servicio National de Salud Animal) with technical aids from Japan.

The breeding cycle of cattle living in the present natural pasture field is schematically shown in Figure 3-2-7.

However, currently the Ministry of Agriculture and Livestock and the Asuncion University are making much effort in establishing a variety of measures in cooperation, particularly on the regular preventive injections as precautionary measures to control diseases, a precaution to prevent the spread of diseases through strengthening surveylance systems over affected cattle, varietal improvement with artificial insemination, improvement in breeding and productivity by improved nutritional balance. Then, when these efforts produce a result, Paraguay will be able to contribute the world as one of the major beef producing countries.

A scale of the beef cattle management will be determined by the production scale of the principal crop, paddy rice, in the three years' paddy rice-grass rotation system, but a beef cattle management plan as efficient as possible within the range of the scale has to be set to stabilize the multiple management of paddy field and beef cattle.

Figure 3-2-7 was made by the Asuncion University and the Artificial Insemination Center to illustrate schematically the management of the herd by combining the grass growth in a natural pasture with a variety of data relating to beef cattle breeding as the data to promote planning of artificial insemination.

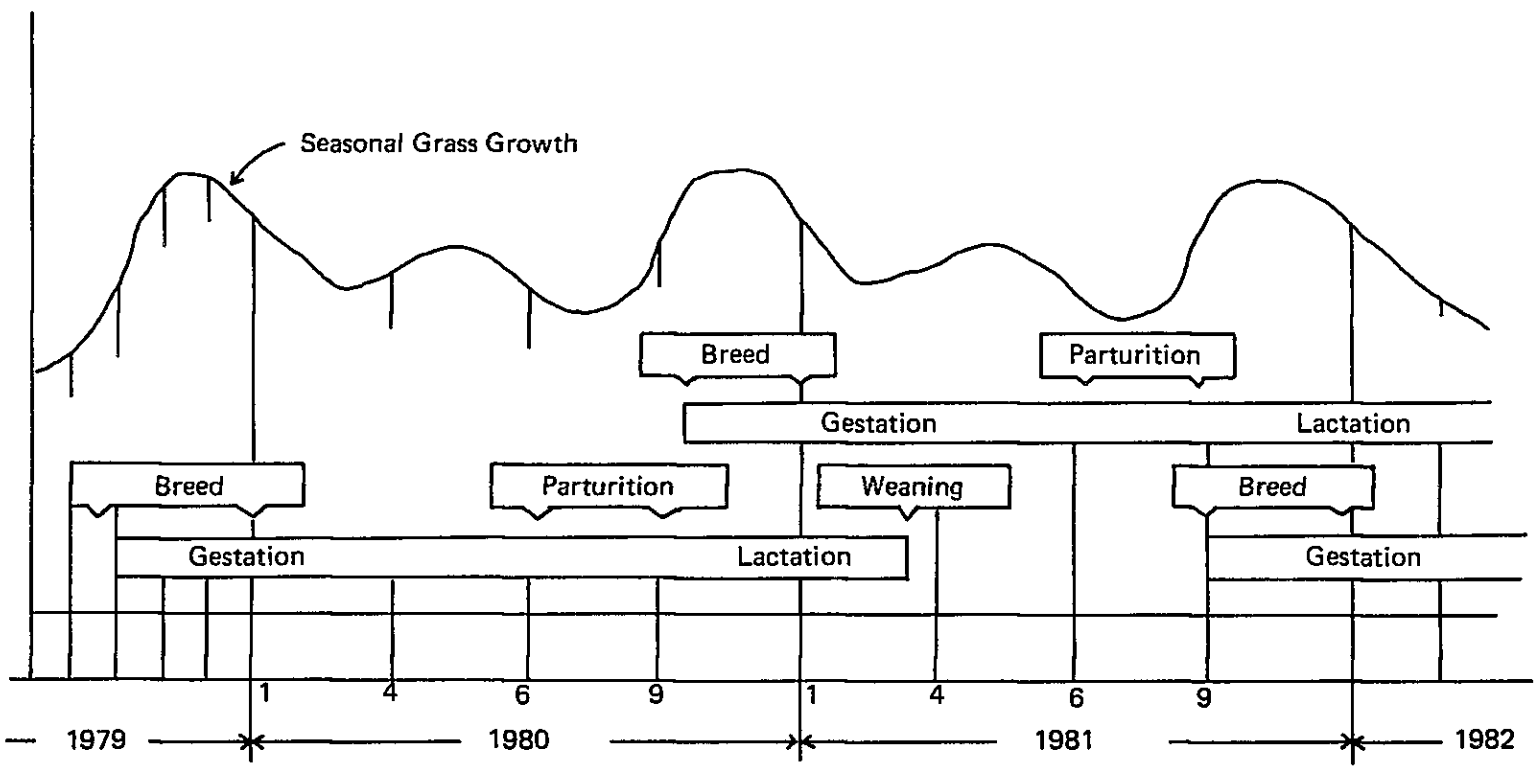


Fig. 3-2-7 Management of the Herd According to the Grass Growth

The usual pattern in Paraguay is one birth every two years, as shown in this figure. This is mainly because the nutritional condition of mother cows depends on the seasonal difference in the productivity of the natural pasture, then their health condition is aggravated during the reoccurence of estrus just after parturition owing to the nutritional imbalance and the resultant anoestrus makes copulation impossible, which is delayed until the next spring (September to December). This means the concentration of estrus and copulation in the spring flash season when the pasture productivity gets higher from spring to summer, while the parturition concentrates from late winter to spring. In addition, since the nutritional condition of the mother cows becomes extremely poor due to nursing of new born calves, estrus and copulation in this season have to be postponed to the next spring flash season, and thus the parturition cycle every two years is formed.

In order to overcome these negative factors, harvesting of grass during the spring flash season and the preparation of bulky feed to be provided during an winter off-season with decreasing grassland productivity for the purpose of improving the nutrition of mother cows should be conducted to establish an efficient beef cattle management plan.

(1) Parameters in the beef cattle management plan

1) Breeding form:

On the basis of the three years' rotation system of paddy field and pastureland consistent management of breeding and fattening is carried out.

Although the present form is based on consistent management, adult cow, calf and feeder cattle are not divided at all. Then, for the purpose of efficient fattening stock cattle is separated for grazing.

2) Breed:

Pure breeds such as Nellor and Brahman at a highly improved stage are crossed systematically for gradual improvement using hybrid of Zebu as the basis.

3) Age for breeding: 21 months after birth

Currently, 30 months of age is usual, but 21 months of age is aimed to promote varietal improvement to bring close the European beef cattle and to build a technical system to facilitate the improvement of nutrition.

4) Weight of adult cow: 400 to 450 kg

Presently, it is around 380 to 400 kg.

5) Parturition interval: 15 months

At present, about 20 to 24 months is common. In some places such as the Menonita settlement in Chaco the improved grassland and the improvement of the nutritional level have resulted in calf production in a 12 ∿ 15 months' cycle. In the light of this fact, an average of the whole management within the region is set at a 15 months' cycle.

6) The life (months): 82 months (the productive life)

At present, the productive life is around 10 years after 3 ∿ 4 parturition, but a cow is abandoned after it finishes 7 months nursing of the sixth parturition.

[{15 months × (6 ∿ 1 parturition)} + 7 months]

The span of life is; {15 months × (6 ∿ 1 parturition)} + 7 months + 30 months = 112 months (months of age for breeding plus gestation period)

7) Raising of regeneration cattle: Self raising (the same as presence)

8) Cross copulation: On the basis of artificial insemination, one bull is alloted to 50 heads in order to clean up unconcepted cows.

Currently, the AI Center produces and provides freezed sperm of European sire, and sub-center has to be set in Ayolas for better use.

9) Accident rate of cattle:

0 ∿ 3 months of age	;	5%
calf (4 ∿ 7 months)	;	3%
rearing cattle (8 ∿ 20 months)	;	2%
stock cattle (8 ∿ 30 months)	;	2%

The present accident rate is approximately 20% up to adult cattle, but the above-mentioned values are set considering the nutritional improvement, the intensification of management and the technical improvement. (The actual record attained at Chaco was around 10%).

10) From the initiation to the completion of fattening (months):
From 8 months of age to about 32 months.

11) Weight at the completion of fattening: 500 kg is aimed

The weight at present is some 400 kg. Cattle has to be competitive with foreign beef for import, which is achieved by the varietal improvement and the improvement of management techniques. The cattle is treated at slaughterhouses near the capital city, Asuncion. The carcass yield is 55%.

12) Feeding standard: Calculated based on the U.S. NRC Standards

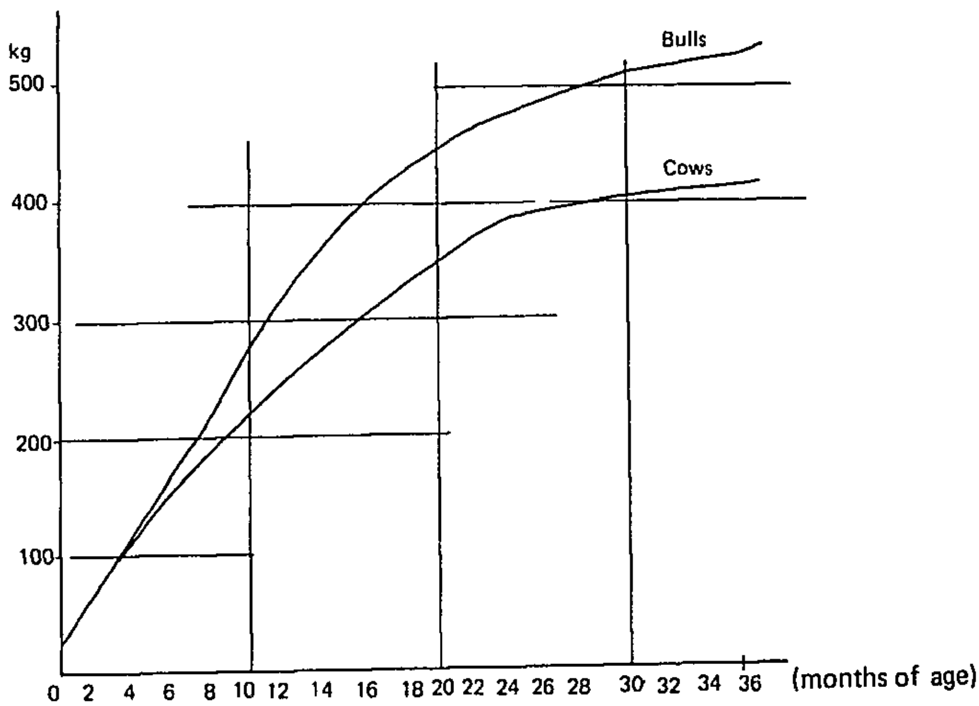


Fig. 3-2-8 Beef Obtained per Animal (by age)

Figure 3-2-8 shows the upper limit and the lower limit in the standard growth of beef cattle. The standard curve in this figure means that the growth within this curve is potentially achieved, provided certain requirements including nutritional level are met.

(2) Beef cattle management plan

Table 3-2-4 illustrates the result of the estimation of the head numbers constituting the herd at each stage such as months of age, nursing and fattening, which are expected at any cross section of the time of a year, when a herd of 100 adult cows (more than 30 months after birth, but just before disuse) is always feeded and they breed claves at a 15 months interval.

On the basis of the head number constituting the herd the annual necessary nutrition values were estimated in accordance with U.S. NRC Standards (National Research Council Feeding Standards) to obtain the annual TDN utilizable amounts by the different scale of management set in the paddy field plan and the head number to be always feeded.

Namely, the estimation of the total annual necessary nutrition of a herd based on 100 adult cows (285.4 head) according to the NRC Standards produces about 580 t. That is (Table 3-2-5), from the following equation;

$$\frac{\text{Annual TDN production by management scale}}{\text{Total necessary nutrition of herd based on 100 adult cows}} \times 100 = \text{Head number of feedable adult cows by management scale}$$

a head number of feedable adult cows by management scale can be obtained.

Based on the percentage of the herd constituents a head number of feedable cows at each stage can be determined, which further leads to the estimation of a number of stock cattle to be shipped annually and a number of abandoned cattle (Table 3-2-7). Similarly, a consignment amount in terms of carcass can be obtained; in a 100 ha scale, stock cattle: 47 head, abandoned cattle: 12 head, and 69 head in total can be shipped, which corresponds to more than 15 tons in terms of carcass.

Table 3-2-4 Component Rate of Cattle (100 head of adult cow)

District		Head	Calculation factor
Calves	0 ∿ 3 month	19.0	100 heads × 12/15 × 3/12 × (1∿5%)
	4 ∿ 7	24.6	" × " × 4/12 × " × (1∿3%)
Rearing cattle	8 ∿ 13	7.4	100 heads × 12/82 × 6/12 ÷ (1∿2%) × (1∿1%)
	14 ∿ 20	8.6	" × " × 7/12 ÷ " × "
Immature cattle	21 ∿ 27	8.7	100 heads × 12/82 ÷ (1∿3%) × 7/12 × (1∿1%)
	28 ∿ 30	3.7	" ×· " ÷ " × 3/12 × "
Adult cow	New-born calves (3 month)	18.3	100 heads × 3 months × (6∿1) ÷ 82 months
	Infant calves (7 month)	51.2	" × 7 month × 6 ÷ 82 months
	Calves (5 month)	30.5	" × 5 month × (6∿1) ÷ 82 months
	Total	100.0	
Type	Cow	2.0	100 heads × 50 heads
	Young bull	0.7	2 × 12/36 months × (30∿7 months)/12
Stock cattle	Initial period (8 month)	37.0	{100 heads × 2/15 × (1∿10%)} − {100 × 12/82 ÷ (1∿8%)} × 8/12 × (1∿1%)
	Middle period (8 month)	37.0	" " " "
	Latter period (8 month)	36.7	" " " " × (1∿1%)
	Total	285.4	

Table 3-2-5 Necessary Nutrition based on N.R.C. Standards
(100 Head of Adult Cow)

District		Normal head	Weight average	TDN necessary		CP necessary		DM necessary	
				Day/head	Year	Day/head	Year	Day/head	Year
			kg	kg	kg	g	kg	kg	kg
Calves	0 ~ 3	19.0	60	1.3	9,015.5	350	2,427.3	2.1	14,563.5
	4 ~ 7	24.6	140	2.3	20,651.7	580	5,207.8	4.4	39,507.6
Rearing cattle	8 ~ 13	7.4	230	3.2	8,643.2	600	1,620.6	7.4	19,987.4
	14 ~ 20	8.6	310	4.0	12,556.0	610	1,914.8	8.8	27,623.2
Immature cattle	21 ~ 27	8.7	360	4.3	13,654.7	620	1,968.8	9.5	30,167.3
	28 ~ 30	3.7	410	4.1	5,537.1	560	756.3	9.0	12,154.5
Adult cow	End of pregnancy	18.3	450	4.1	27,386.0	560	3,740.5	9.2	61,451.4
	Infant calves	51.2	400	7.6	142,028.8	970	18,127.4	14.0	261,632.0
	Calves	30.5	400	4.1	45,643.3	560	6,234.2	9.2	102,419.0
Type	Cow	2.0	650	5.0	3,650.0	980	715.4	12.0	8,760.0
	Young bull	0.7	420	4.7	1,200.9	980	250.4	10.0	2,555.0
Fattening cattle	Initial period	37.0	320	6.0	81,030.0	1,000	13,505.0	10.0	135,050.0
	Middle period	37.0	420	7.5	101,287.5	1,130	15,260.7	11.5	155,307.5
	Latter period	36.7	470	7.8	104,484.9	1,400	18,753.7	13.3	178,160.2
Total		285.4			576,769.6		90,482.9		1,049,428.6

Note. N.R.C. ..... National Research Council

Table 3-2-6 Head Breedable by TDN Obtained from Pasture (by Scale)

		25 ha	50 ha	100 ha	200 ha	500 ha
Pasture TDN (ton)		120	240	480	960	2,400
Mead breedable by TDN Cal-lculation (head)		20.8	41.6	83.2	166.4	416.0
Calves	0 ∿ 3	3.95	7.90	15.80	31.60	79.0
	4 ∿ 7	5.12	10.24	20.48	40.96	102.4
Rearing cattle	8 ∿ 13	1.54	3.08	6.16	12.32	30.8
	14 ∿ 20	1.79	3.58	7.16	14.32	35.8
Immature cattle	21 ∿ 27	1.81	3.62	7.24	14.48	36.2
	28 ∿ 30	0.77	1.54	3.08	6.16	15.4
Adult cow	New-born calves	3.81	7.62	15.24	30.48	76.2
	Infant calves	10.65	21,30	42.60	85.20	213.0
	Calves	6.34	12.68	25,36	50.72	126.8
Type	Cow	0.42	0.84	1.68	3.36	8.4
	Young bull	0.15	0.30	0.60	1.20	3.0
Stock cattle	Initial period	7.70	15.40	30.80	61.60	154.0
	Middle period	7.70	15.40	30.00	61.60	154.0
	Latter period	7.63	15.26	30.52	61.04	152.6
Total		59.38	118.76	237.52	475.04	1,187.6

Table 3-2-7 Product Plan by Scale

		25 ha	50 ha	k00 ha	200 ha	500 ha
Stock cattle	Head	11.8	23.6	47.2	94.4	236.0
	Terms of carcass (kg)	3,245	6,490	12,980	25,960	64,900
Aban-doned cattle	Head	3.15	6.3	12.6	25.2	63.0
	Terms of carcass (kg)	647.5	1,295	2,590	5,180	12,950
Pasture	D M (ton)	192.0	384.0	768.0	1,536.0	3,840.0
	T D N (ton)	120.0	240.0	480.0	960.0	2,400.0
Amount of necessary silage	(ton)	32.25	64.5	129.0	258.0	645.0

[Method of calculation]

Cattle fattening: Grown cows × 12/15 months × (1 - Calf accident rate) - New stock × (1 - Cattle accident rate) = Head of cattle

" (dressed carcass: conversion) No. of cattle fattened × Grown weight(500 kg) × Dressing percentage(55%) = Amount of dressed carcass

Carcasses: Cows × 12/82 months × (1 - Cow accident rate) = 1
Bulls × 12/36 months × (") = 2
1 + 2 = No. of head

" (dressed carcass: conversion) Head of cattle 1 × 400 kg × 50% = 1'
" 2 × 650 kg × 50% = 2'
1' + 2' = Amount of dressed carcass

Pasture
- D M: Productivity/ha(DM: 12.8 t) × Area × Usage rate 60% = Possible usage amount
- TDN: DM possible usage amount × Ratio inc. TDN 62.5% = Possible usage TDN
- Silage: (Peak average DM - Necessary monthly DM) ÷ Usage ratio 60% × Cultivated usage ratio 90% = Amount of stored

(3) Price of beef carcass

According to FAO's statistics the worldwide beef trade in 1981 amounts to 3,200,000 tons of import and a little below 3,400,000 tons of export. The biggest importers in the free nations is the U.S.A.with 540,000 tons, followed by Japan with 120,000 tons.

With respect to exporters,Australia exports 515,000 tons, then New Zealand 230,000 tons, Argentina 220,000 tons, and Canada 60,000 tons. The foreign trade rate to the worldwide carcass production is just a little over 7%.

Furthermore, the FAO's long-range outlook of the supply and demand has reported a stringent market. Based on these conditions, the beef carcass to be produced in the planned region is assumed to be exported to the regular importers such as the U.S.A.

In this case, pricing is set on the basis of the FOB price at Cannon Hill, Brisbane in Australia.

Table 3-2-8 Australian Beef: FOB Price (Yen/kg)

Year	1979	1980	1981	1982	1983	Average
Price (yen)	367	397	331	298	320	342.6

The conversion of the average price shown in the table to U.S. dollars in accordance with T.T.S. of Tokyo Bank yields 342.6 Yen ÷ 235 Yen = 1.46$. The further conversion of this value to Paraguay currency plus 10% distribution margin yields;

$$160 \text{ Gs/US\$} \times 1.46\$ \times (1 \sim 10\%) = 210 \text{ Gs},$$

but abandoned cattle is only for the domestic consumption.

(4) Management plan

Table 3-2-9 shows the result of the proportional estimation of the balance by the scale of management in a year when stable management is achieved.

This plan is made based on labor saving management centering around grazing, in which a technical system to maintain rational and stable management is established by harvesting and storing grass equivalent to 25% of the spring flash season from February to May to cover the shortage in the pastureland yield from June to January.

Table 3-2-9 Estimation of Farm Management Balance for Beef Cattle

(Stable stage)

(unit: 1,000 Gs)

			25 ha	50 ha	100 ha	200 ha	500 ha
Primary production cost		Fattening cattle	681	1,363	2,726	5,452	13,629
		Aged unuseful cattle	78	155	311	622	1,554
		Total	759	1,518	3,037	6,074	15,183
	Material cost	Seed and seeding cost	75	150	300	600	1,500
		Fertilizer cost	114	228	455	910	2,275
		Artificial insemination cost	22	43	86	172	430
		Transportation cost	28	56	111	222	555
		Tax, public fee	21	42	83	166	415
		Fuel, oil cost	59	118	235	470	1,175
		Subtotal	319	637	1,270	2,540	6,350
	Fixed cost	Fence, silo cost	104	209	417	834	2,085
		Machineries cost	131	261	522	1,044	2,610
		Beef cattle depreciation cost	31	61	122	244	610
		Subtotal	266	531	1,061	2,122	5,305
		Total	586	1,168	2,331	4,662	11,655
Rent			10	20	40	80	200
Capital interest			19	37	74	148	369
Secondary production cost			615	1,225	2,445	4,890	12,224
Net benefit			144	293	592	1,184	2,959
(Net benefit ratio) (%)			19.0	19.3	19.5	19.5	19.5

Although the most items in the gross income and production cost vary proportionally according to area or a number of cattle, labor cost is not yet included, since family labor can sufficiently manage from a viewpoint of beef cattle management based on grazing.

Detailed examination of factors other than a technical level of operators, such as difficulty, price and horsepower of introduced machines, and performance, operation efficiency and fuel consumption which depend on soil conditions and the degree of humidity, is further required, but a rough estimation was made in rèference to the price of machines for paddy field and others.

Since the rate of operation of the machines is about 1/4 of the pasture area in the spring flash season and à 10% of annual grass production is harvested for storage, the estimation was made by each area ratio on the assumption of joint use.

Some questions remain in this estimation technique, which will be further examined in the next year, but income and income rate were roughly estimated.

The resultant figures are; in 100 ha management scale, approximately 3,000,000 Gs of gross income, 2,400,000 Gs of production cost, 600,000 Gs of net profit and 20% of profit rate. This is the profit gained only from rearing beef cattles. Compared with some 2,300,000 Gs of net profit by paddy rice per 100 ha, this figure corresponds onl6 to 1/4. However, the introduction of stock rearing is considered to be beneficial in farm management for several reasons; there are a very few problems in the labor allocation in the paddy rice cultivation because of a very extensive method, technically it is required to introduce in the light of weed control, fertility conservation, and countermeasures to prevent red rice, and it brings about certain profit.

3.2.3 Dairy farming management plan

The dairy farming in Paraguay have mainly been conducted in the capital city, Asuncion, and it's neighborhood for the purpose of milk supply. The number of daily stock is rather small, mostly a scale of about 10 head, and assumedly milking per head is 2,000 to 2,500 kg annually. As some problems remain in the quality of milk, rational dairy farming management is necessary by sanitary feeding management and improved milk treatment techniques. Fortunately, the milk price in Paraguay is rather high compared with other prices, so that the price difference makes investment in production facilities and production materials possible.

That is, stable management has been achieved here and there through equipping agricultural machines, preparing roughage storage facilities such as bunker silo, and utilizing them actively, for instance, in the Menonita settlement in Chaco.

Based on the understanding of the above-mentioned state and taking account of the following points, parameters in the dairy farming management are set:

1) In order to cover the roughage shortage during an offseason in winter, an annually equilizing supply system is established by harvesting in a part of the pastureland and preparing stored roughage.

2) Only dairy farming should be managed, and management is set on the basis of a relatively high level of feeding management techniques in Paraguay.

3) Because in Paraguay people have special inclination to raw milk, the distribution range should be within a radius of 100 km centering around Ayolas in the planned region.

4) The improvement of pastureland should be conducted in a similar manner with in case of beef cattle, but the regeneration of the pastureland is carried out every 4 years.

(1) Parameters in the dairy farming management plan

1) Management form:

Only for dairy farming. New born cattle is shipped after about 10 days except calves to be used for regeneration.

2) Breed:

Holstein (will be improved to a breed with hot-weather resistance and a high productivity)

3) Month of age to be used for breeding:

20 months, and at more than 360 kg.

4) The life of cow :

107 months after birth (regenerated after milking in the sixth parturition)

5) Parturition interval:

14 months

6) Milking period:

8 months

7) Raw milk production:

2,720 kg per head of multipara (3,170 kg per head of milking cattle)

8) Cream rate:

3%

9) Crossing:

Artificial insemination

10) Feeding standard:

U.S.'s NRC Standards

11) Growth of calves:

See Figure 3-2-9.

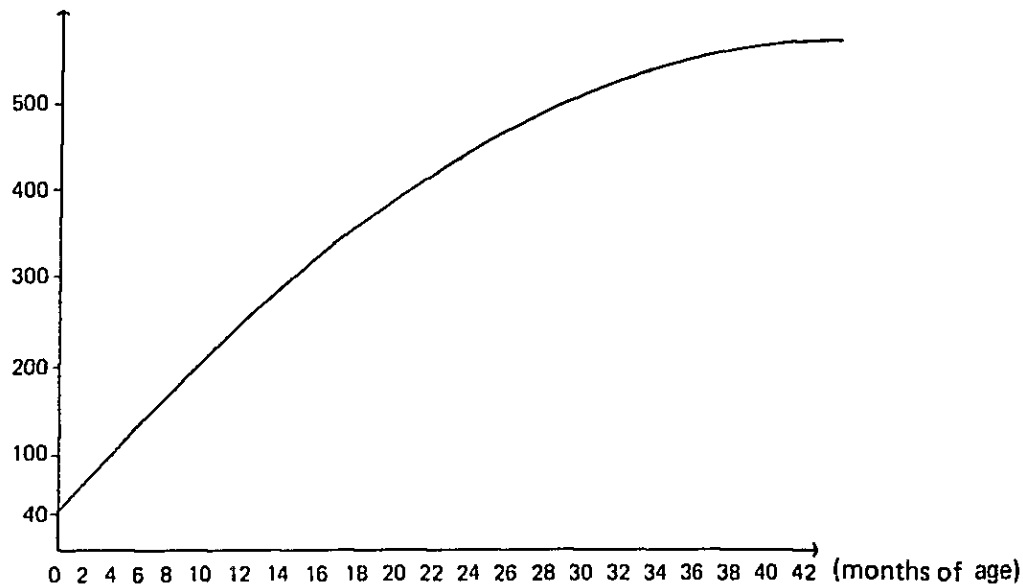


Fig. 3-2-9 Milk Obtained per Cow (by age)

(2) Dairy farming management plan

1) Production plan

The dairy farming plan is based on the same concept with the techniques used for the beef cattle management plan, but there is a production limit due to the qualitative relations including the supply and demand balance of the product, raw milk, freshness as perishable foods and Chahn phenomenon. Therefore, prior to the whole production plan and the individual plans the details of management and the management balance at a scale of 100 ha are estimated.

Table 3-2-10

District		Head	Calculation factor
Calves, cattle	0 ∿ 3 months	4.28	100 heads × 12/78 months ÷ (1∿11%) × (1∿5%) × 3/12 months
	4 ∿ 7	5.31	" × " ÷ " × 0.95 × (1∿3%) × 4/12
	8 ∿ 13	7.88	" × " ÷ " × 0.95 × 0.97 × (1∿1%) × 6/12
	14 ∿ 19	7.80	" × " ÷ " × 0.95 × 0.97 × 0.99 × (1∿1%) × 6/12
Immature cattle	20 ∿ 26	8.98	100 heads × 12/78 months ÷ (1∿11%) × (1∿10%) × (1∿1%) × 7/12
	27 ∿ 29	3.85	" × " ÷ " × " × " × 3/12
Adult cow	Milking period (8)	61.54	100 heads × 6 times birth × 8 months ÷ 78 months
	End of pregnancy period (3)	19.23	" × (6-1) times birth × 3 months ÷ 78 months
	Dry period (2)	19.23	" × (6-1) times birth × 3 months ÷ 78 months
Total		138.10	

Table 3-2-11 Necessary Nutrition based on N.R.C. Standards (100 Head of Adult Cow)

District		Normal head	Average weight	TDN necessary		CP necessary		DM necessary	
				Day/head	Year	Day/head	Year	Day/head	Year
		head	kg	kg	kg	g	kg	kg	kg
Calves, rearing cattle	0 ∿ 3	4.28	75	1.5	2,343.3	245	382.7	2.1	3,280.6
	4 ∿ 7	5.31	150	2.7	5,233.0	295	571.8	4.1	7,946.4
	8 ∿ 13	7.88	220	3.5	10.066.7	345	992.3	5.6	16.106.7
	14 ∿ 19	7.80	300	4.2	11,957.4	620	1,765.1	8.5	24,199.5
Immature cattle	20 ∿ 26	8.98	360	4.6	15,077.4	635	2,081.3	9.5	31,138.2
	27 ∿ 29	3.85	400	7.4	10,398.9	1,150	1,616.0	10.3	14,474.1
Adult cows	Milking period	61.54	500	8.8	196,666.5	1,700	38,185.6	10.5	235,852.1
	End of pregnancy period	19.23	550	6.5	45,623.2	1,130	7,931.4	12.3	86,333.1
	Dry period	19.23	550	3.7	25,970.1	610	4,281.6	8.3	58,257.3
	Total	138.10			324,336.5		57,807.8		477,588.0

Note: N.R.C. ..... National Research Council

Note: Of the necessary annual TDN, 1/3 of the milk fodder (8.8 kg - 3.7 kg = 5.1 kg) supplied is to be concentrated fodder.

∵ 5.1 kg × 365 days × 61.54 heads × 1/3 = 38,185.6 kg

Therefore, the TDN supplied as grain fodder is

324,336.5 - 38,185.6 = 286,150.9 kg

On the assumption of the same plan with beef cattle grass land, 4 years' regeneration and 480 tons of TDN per 100 ha,

480,000 kg ÷ 286,150.9 kg × 100 = 167.7 heads

Thus, 167.7 head of adult cattle can be feeded.

Table 3-2-12 Head of Each Stage

District		Head	Remarks	
Calves, cattle	0 ∿ 3	7.2	4.28 × 1.677	
	4 ∿ 7	8.9	5.31 × "	
	8 ∿ 13	13.2	7.88 × "	
	14 ∿ 19	13.1	7.80 × "	
Immature cattle	20 ∿ 26	15.1	8.98 × 1.677	
	27 ∿ 29	6.5	3.85 × "	
Adult cow	Milking period	103.2	61.54 × 1.677	Total 167.7 heads
	End of pregnancy period	32.2	19.23 × "	
	Dry period	32.3	19.23 × "	
	Total	231.7		

* Calves born are shipped outside after weaning. (The first milk of cows having given birth is unsuitable for human consumption)

Table 3-2-13 Product Plan of Dairy Farming in the 100 ha Scale of Pasture

District	Head	Calculation basis
Calves	103.2	{167.7 heads × 12/14 × (1 ∿ 8%)} - {167.7 × 12/78 ÷ (1 ∿ 11%)}
Abandoned cattle	25.5	167.7 " × 12/78 × (1 ∿ 1%)
Raw milk	456 ton	167.7 " × 2,720 kg = 456,144 = 456 ton

Note: These values were estimated taking account of a 7% incidence of unsuitable milk production caused by difficult delivery, mastitis, bullcellar and acid milk, and a 3% stress incidence caused by hot, discomfort temperature;

Average in Australia and New Zealand in 1981

3,020 kg × (1 ∿ 10%) = 2,718 kg = 2,720 kg.

Although the present mean milking in Paraguay is 2,000 kg to 2,500 kg, the above-mentioned value, 2,720 kg was adopted as the target value, in the very near future, which will be attained by varietal improvement and the improvement of feed and nutritional conditions.

Table 3-2-14 1981, FAO: Production Yearbook

	Australia	New Zealand
Average milking/head	2,910 kg	3,129 kg
Scale/farm	108.2 head	133.0 head

2) Management plan

The balance estimation in the dairy farming management was made on the basis of 100 ha scale management in a stable year similarly to the balance estimation in the beef cattle management.

Table 3-2-15 Estimation of Farm Management Balance for Dairy Cattle

(Stable stage)

(unit: 1,000 Gs)

Division			Amount	Calculation
Gross profit		Calf	516	$103.2^{t} \times 5{,}000^{GS}$
Gross profit		Aged unuseful cattle	892	$22.5^{t} \times 500^{kg}$ 70% 100^{GS}
Gross profit		Milk	22,572	$456{,}000^{kg} \times 55^{GS} \times (1-10\%)$
Gross profit		Total	23,980	
Primary Production cost	Material cost	Seed and seeding cost	300	
Primary Production cost	Material cost	Fertilizer cost	455	
Primary Production cost	Material cost	Feed cost	1,637	$38.2^{ton} \div 70\% \times 30{,}000^{GS} = 1{,}637{,}143$
Primary Production cost	Material cost	Heat, light and water cost	120	$10{,}000^{GS} \times 12$ months
Primary Production cost	Material cost	Aftificial insemination cost	187	$167.7 \times 12/14 \times 1.3^{Time} \times (300+700^{GS}) = 186{,}866$
Primary Production cost	Material cost	Transportation cost	394	$167.7 \times 2{,}350^{GS} = 394{,}095$
Primary Production cost	Material cost	Fuel, oil cost	470	$100^{ha} \times 9{,}407^{GS} \times 1/2 = 470{,}350$
Primary Production cost	Material cost	Miscellaneous	713	20%
Primary Production cost	Material cost	Tax, public fee	168	$167.7 \times 1{,}000^{GS}$
Primary Production cost	Material cost	Subtotal	4,444	
Primary Production cost	Fixed cost	Fence and silo	545	
Primary Production cost	Fixed cost	Milking facilities	930	
Primary Production cost	Fixed cost	Farm machinery	632	
Primary Production cost	Fixed cost	Dairy cattle	3,058	
Primary Production cost	Fixed cost	Subtotal	5,165	
Primary Production cost		Total	9,609	
		Rent	300	$100ha \times 2{,}000GS \times 1.5$
		Capital interest	464	$9{,}609\ (1{,}000GS) \times 0.8 \times 18.1\% \times 1/3$
Secondary production cost			10,373	Net benefit 13,607 (1,000GS) Net benefit ratio (56.7%)

Feeding is mainly based on grazing and the least necessary roughage is stored to achieve a labor-saving and rational management plan as much as possible.

The details of the management balance estimation are; after wet new born calves (calves of 10 days of age just after parturition) drink foremilk (milk up to 10 days after parturition which contains laxative constituents to excrete meconium, and does not fit for human drinking), they are shipped except calves for regeneration, and the estimation is made at the present price value.

Although the price of raw milk was estimated on the basis of the present price, 10% of distribution margin was included taking account of the efforts to establish a long-term stable management plan including the improvement of distribution route and the development of new markets.

As to the production cost section, items dependent on a number of head and an area were estimated in the same manner with the beef cattle management. With respect to the costs of milking facilities, milking equipments and agricultural machines further examination is necessary, but they were roughly estimated on the assumption of a certain scale equivalent to 100 ha pastureland in reference to a variety of data of paddy and upland crops.

Under these conditions the rough estimation of income and income rate was made, but further examination of the individual parts is required.

These results indicate 456 tons of annual raw milk production at the 100 ha scale and approximately 24 million Gs of gross income combined with income from abandoned cattle. Meanwhile, the production cost of about 10 million Gs yields some 14 millions Gs of net profit, a profit rate of 56.7%, which leads to a high level income. Nevertheless, advanced technology and concentrated feeding management required for successful dairy management can not allow any simple decision of management scale based only on the conditions of the land. Namely, 100 ha management needs about 230 head of rearing cattle and 103 head of milking cows, which might cause some difficulties in feeding management taken by a family. In addition, in order to improve the efficiency and to increase feeding cattle very costly investment in facilities is needed, but this is considered to have a too high risk under the present technical level.

From these considerations an about 25 ha scale is considered reasonable as a standard management (58 head of feeding cattle, 26 head of milking cows, and 3,260,000 Gs of net profit). This is almost equal to the net profit of some 2,800,000 Gs from 200 ha paddy rice-stock farming management (paddy rice 100 ha, and grazing 100 ha), and can be said to be a land-intensive agricultural management.

(3) On the limit of raw milk production in the dairy management plan

For estimating the raw milk production limit the population living within the range of raw milk supply and the annual or daily average consumption of raw milk have to be carefully examined for decision. Firstly, a region in which raw milk can be distributed without any change in the quality of milk has to be set to meet the demand limit of raw milk with high national preference. For this purpose the road condition, transportation and pretreatment are examined.

It is considered that it will take a considerably long period before the road network in this survey area is completely paved judging from the present status of road paving and the expected advance of road planning. Also, truck transportation will continue, and the integration with a considerable scale and investment in facilities are needed to apply a pretreatment method, for instance, for long life milk. Thus, an area of a 100 km radius is set centering around Ayolas as a zone in which raw milk can be transported by trucks and the chahn phenomenon (milk solids and water are separated resulting in the degradation of milk quality).

According to the 1980's statistics the population in this area centering around Ayolas is 210,439 persons. However, only about a half of the population will be a target, since in the region with a 100 km radius centering around Ayolas there are some milk producers, although in very small scales, and some farmers producing milk taken from beef cattle such as Criollo for self consumption.

The milk consumption per capita is shown in Appendix. Judging from the consumption basis such as nutrition and calorie per day, they take more than 3,000 Cal per day. Thus, there is no factor which will lead to a drastic increase in milk consumption.

Therefore, the supply limit can be estimated as follows;

Total population living
within a 100 km radius area
near Ayolas ------- 210,439 persons (1982)

The prospective population in 2,000 including an annual population growth of 2.5% is,

$$210{,}439 \text{ persons} \times (1 + 0.025)^{18} = 328{,}213 \text{ persons.}$$

The target amount of annual milk consumption per person (consumption increase : annually 1%) is,

$$75.3 \text{ g} \times 365 \text{ days} \times (1 + 0.01)^{18} = 32.876 \text{ g} \doteqdot 33 \text{ kg}$$

$$328{,}213 \text{ persons} \times 1/2 \times 33 \text{ kg} = 5{,}415{,}514 \text{ kg} \doteqdot 5{,}416 \text{ tons}$$

Thus, the total demand within the region (demand limit) is 5,416 tons.

Based on this production limit (the total demand within Ayolas AREA) the calculation of head of milking cattle necessary to produce this amount yields;

$$5{,}416 \text{ tons} \div 2{,}720 \text{ kg} = 1{,}991 \text{ head of adult cows.}$$

Furthermore, the area of pastureland necessary to feed the 2,000 head of adult cows is;

$$2{,}000 \text{ head} \div 167.7 \text{ head/100 ha} = 1{,}192.6 \text{ ha} \doteqdot 1{,}200 \text{ ha.}$$

Thus, the whole feature of the dairy management plan will be;

Table 3-2-16 Farm Management Plan

Classification	Farm management plan	Remarks
Raw milk supply area	Centering around Ayolas within 100 km	
Target population	164,106 persons	328,213 persons × 1/2
Supply milking per person	33 kg	(anually)
Daily cattle per head		
{Adult cow	2,000 heads	
Cattle	525 heads	
Grassland area	1,200 ha	
Production of grassland (DM)	9,216 ton	DM usable yield 12,800kg × 60% × 1,200ha
Amount of necessary silage (DM)	1,550 ton	
Production of raw milking per year	5,416 ton	
Calculation of agriculture profit	163,284 thousand Gs	13,607thousand Gs/ 100ha × 1,200ha

CHAPTER 4

ECONOMIC AND MANAGEMENT PLAN

4.1 Farming Program

4.1.1 Basic policy for farming program

Paraguay is a sparsely populated country with a land largely exposed to extensive farming. There are vast extent of pasture and wilderness dominates the whole land with the limited exception of agricultural suburban areas. In the agriculturally advanced eastern part, they recently began developing land for farming and raising the soybean, wheat, and rice on a large-scale farming by the use of large agricultural machinery. The both Departments of Itapua and Misiones, where agricultural studies were conducted, are favored by natural conditions with records of highest agricultural production in this country. Itapua, in particular, exceeds other departments in the production of soybean, wheat, paddy rice, and corn, the main agricultural products of Paraguay, contributing to nearly 50% of the national output of soybean, wheat and paddy rice. It is highly expected that the area development will bring about a further increase in the yield of these products in Itapua.

Increase of production by the modern agricultural technique or increase in farm production, one of the four basic objectives of the regional agricultural development program designed for the adjacent area to the Yacyreta Dam, will be attained by the use of large machinery in almost all of these areas. A farming program should in fact represent the practical guideline for the successful initiation of farming in newly developed agricultural land and therefore be well grounded on studies of the intended crop to be raised as well as machinery to be introduced there.

Presently, as about 95% of the area, is possessed by only 100 landowner, (above 200 ha), development will be carried out by these landowners and new immigrants. Farming which is coming forth there will be commenced on a much varying range of scale from large to small depending on the capital power of the developer farmer, with resultant sizes of agricultural income among the individual farmers. A small-scale farmer may take to compensating for his revenue with wages from leisure time working for large-scale farmers.

It is expected, however, that the total income of this small farmer would nevertheless be comparatively lesser than the income of a large farmer. This economic disparity would make it impossible to set single personal income targets universally applicable to all these farmers. Moreover, there has been recommended or proposed on definite income target on which the really practical farming program for a nation or a particular district should be based. Became of this, the plural farming patterns have been established for individual farmers to selectively make application according to the types and size of farming, which also meets the manner in which the Paraguay government wanted things to be done. In addition, in order to confirm further land use etc., it was necessary to make clear the estimated number of participating farmers as classified by the scale of farming. This task of estimation is to be arranged in the year which follows in a joint survey with the Paraguay government.

The whole area to be developed can be broadly divided into two sections; Area B of lower altitude where it is planned to develope an area of paddy field and Area A of higher altitude where the plan is to develope a upland field. The basic structure of the farming pattern for application in the Area B is grounded on rotation system from paddy to other crops (paddy-pasture, 1 : 1), rotated at the interval of three years.

The farming patterns for application in the Area A are designed to comply with the demand of the authorities for increased yield in the soybean and wheat at present. Further study in the years which follows will be concentrated on the crops raised by intensive agriculture.

In these farming patterns, private management is postulated as the basic form of farming with emphasis placed on the efficient utilization of machinery. Our study was extended to the introduction of agricultural machinery of various classes to be privately purchased depending on the size of farming with a separate proposal for the joint purchase of expensive machines such as combines by groups of farmers for jointly use. Since cattle breeding, a conventional form of farming in this country, planned during the three-year grazing ground period of the rotational system in the Area B has nothing in common with the work of paddy field farming during the alternate three-year interval and particularly the form of machinery and labor attributive to it, the budget was estimated as a separate stockbreeding plan. The income from a rotational system should be computed as the average income from the production of beef as well as crop.

Furthermore, necessary measures must be considered such that the cycle of crop rotation can be synchronized among the farmers of the Area B so as to facilitate the execution of individual farming programs. This will be easily achieved as a result of coordination of the cooperative which is to be organized there. The allocation of land to the prospective settlers should be considered in terms of optimization of the unified cycle of crop rotation.

4.1.2 Farming pattern and estimation of balance

The different patterns of farming under the present development plan have been established in light of the following.

(i) Farm mechanization was limited within the scope of technical adaptability to the current stage of development of cultivation systems.

(ii) Farm mechanization was considered as the large-size mechanization integrated work system, based on an organized system of tractors and combines as the nuclei, oriented for efficiency and higher productivity.

(iii) The machine for plowing, harrowing, land leveling, fertilizing, or seeding which would be introduced should be selected to suite the conditions of the site such as soil.

(iv) The combine necessary for harvest, expensive enough for a small-scale farmer to afford on personal fund, should be financed jointly by a group of farmers though farming itself is to be based on the principle of private management.

(v) Consideration of che large plot of paddy field (25 ha) and the layout of the roads would lead to the selection of cropdusting.

As a result of joint studies with Paraguay government, it has been determined that planning would be made out for the time being on the following two farming patterns which are classified according to the scale of management.

Area A

The farming pattern was formulated of raising soybean and wheat raised on five different scales of management classified by the area of upland field; 25, 50, 100, 150 and 200 hectares.

For this farming pattern, it was decided to lay land fallow at the end of three years of growing wheat or soybean for preservation of soil fertility. In practice, this may be achieved by dividing the whole area of upland field into four equal parts, one of the quarters alternately placed in fallow every year while the rest quarters.

Area B

The pattern of paddy field farming was classified as follows according to the scale of management; 25, 50, 100, 150, 250, 400, and 500 hectares of paddy field.

The actual farming area will be twice the area of paddy field as cited above since the form of management in Area B is a crop rotation of paddy field and pasture, 1 : 1.

The farming pattern was established on the basis of the agricultural mechanization plan to be described later in 4.1.3 and management also in 4.1.4 (1). The estimation of yield per unit area was made for the average year following the execution of agricultural land consolidation and improvement of irrigation and drainage systems. In this estimation, reference was made to the yields of typical farms and the results of tests to give the following figures in forecast.

paddy (unhulled)	5,000 kg/ha
soybean	2,000 kg/ha
wheat	1,600 kg/ha

Estimation of the producer price per one kilogram of each crop on the basis of the average producer prices in recent three years gives:

paddy	28.2 Guaranis/kg
soybean	28.0 Guaranis/kg
wheat	40.0 Guaranis/kg

The prices will be studied in next year.

Determination of the unit cost for labor and materials was based on the equivalent of recent years.

Tables 4-1-1 and 4-1-2 and Figs. 4-1-1-(a) and 4-1-1-(b) show the balance of farming of the foregoing two patterns, respectively.

1) Paddy/pasture farming pattern

(i) In paddy farming, classes of 150 ha incur the least expense per hectare while exceed the rest in the amount of revenue per hectare. On the other hand, classes above 150 hectares have the least balance of revenues over costs. This results from the slight change of operating efficiency of the tractors and combines the both classes own.

(ii) A 150-hectare farmer normally barely complete the whole work of harvest from his fields by making the best use of his single piece of combine. This means that a 200-hectare requires two units of combine to harvest his field, increasing production costs. It seems that this is reflected in the higher production costs and lower net profits per unit area of the 200-hectare class compared with the 150-hectare class.

(iii) The results of management seem best when the area of paddy farming is a multiple of 150 hectares, that is, 300 or 600 hectares.

(iv) Management on the farming scale of 100 hectares is apparently unprofitable, with net profits per hectare decreased by 5,300 Gs compared with 150-hectare farmers. 25-hectare farming is handicapped by longer labor time and higher costs for depreciation of machinery and labor mainly because of the smaller size of the tractor, with resultant highest production costs and lowest profits per hectare.

2) Soybean/wheat farming

i) 150-hectare management either of soybean or wheat gives the lowest production costs and highest net profits.

ii) The 200-hectare farmer represents higher production costs and smaller profits compared with the 150-hectare class of farming. This is obviously a result of the additional purchase of a combine to cope with the increased 50 hectares, as indicated by Table 4-1-1-(b), causing a reduction in operating ratio.

(iii) Farming on the scale of either 25 or 50 hectares result in losses. A 25-hectare farmer has larger losses than a 50-hectare farmer, in comparison. This is because they have to go along with a small tractor to farm their relatively smaller area of field, as stated in connection with the small-scale farming of paddy and pasture by rotation.

Table 4-1-1-(a) Summary of Profits by Farming Scales ..... Paddy Rice

Item		50	100	200	300	500	800	1,000
Farming area(ha)		50	100	200	300	500	800	1,000
Paddy Rice (ha)		25	50	100	150	250	400	500
Grazing land (ha)		25	50	100	150	250	400	500
Gross profit (1,000 GS)		3,525	7,050	14,100	21,150	35,250	56,400	70,500
Production Cost per kg(GS)		3,144	5,911	11,830	16,948	28,250	45,204	56,501
Net profit (1,0000 GS)		381	1,139	2,270	4,202	7,000	11,196	13,999
Production cost per kg(GS)		25.2	23.6	23.7	22.6	22.6	22.6	22.6
Yield per ha(kg)		5,000	5,000	5,000	5,000	5,000	5,000	5,000
Producer's price per kg(GS)		28.2	28.2	28.2	28.2	28.2	28.2	28.2
Machinery equipment	Tractor	45 HP 1 unit	90 HP 1 unit	100 HP 1 unit 80 HP 1 unit	120 HP 1 unit 80 HP 1 unit 70 HP 1 unit	120 HP 3 units 80 HP 1 unit	120 HP 4 units 80 HP 3 units	120 HP 6 units 80 HP 2 units
	Combine	95 HP 0.25 unit (for 4 families use)	95 HP 0.5 unit (for 2 families use)	95 HP 1 unit	95 HP 1 unit	95 HP 2 units	95 HP 3 units	95 HP 4 units

Table 4-1-1-(b) Summary of Profits by Farming Scales ..... Soybean-Wheat

Scale (ha) / Item / Crops	25 (Cropping area 18.75)			50 (Cropping area 37.5)			100 (Cropping area 75)			150 (Cropping area 112.5)			200 (Cropping area 150)		
	Soybean	Wheat	Total	Soybean	Wheat	Total	Soybean	Wheat	Total	Soybean	Wheat	Total	Soybean	Wheat	Total
Gross profit (1,000 GS)	1,050	1,200	2,250	2,100	2,400	4,500	4,200	4,800	9,000	6,300	7,200	13,500	8,400	9,600	18,000
Production cost (1,000 GS)	1,117	1,195	2,312	2,104	2,257	4,261	3,969	4,356	5,325	5,548	6,146	11,694	8,011	8,791	16,802
Net profit (1,000 GS)	(-)67	5	(-)62	(-)4	143	139	231	444	675	752	1,054	1,806	389	809	1,198
Production cost per kg (1,000 GS)	-	39.8	-	-	37.6	-	26.5	36.3	-	24.6	34.1	-	26.7	36.6	-
Yield per ha (kg)	2,000	1,600	-	2,000	1,600	-	2,000	1,600	-	2,000	1,600	-	2,000	1,600	-
Producer's price per kg (GS)	28	40	-	28	40	-	28	40	-	28	40	-	28	40	-
Machinery equipment: Tractor	45 HP 1 unit			70 HP 1 unit			70 HP 1 unit 45 HP 1 unit			110 HP 1 unit 70 HP 1 unit			110 HP 1 unit 70 HP 1 unit		
Machinery equipment: Combine	95 HP 0.25 unit (for 4 families use)			95 HP 0.5 Unit (for 2 families use)			95 HP 1 unit			95 HP 1 unit			95 HP 2 units		

Note: Cropping area is 75% for soybean and wheat.

Table 4-1-2-(a) Estimation of Production Costs of Paddy Rice per Ha

(unit : guaranis)

Account items \ Farming area (ha)			25 ha	50 ha	100 ha	150 ha	250 ha	400 ha	500 ha
Gross profit		Prospected yield per ha	5,000 kg	5,000 kg	5,000 kg	5,000 kg	5,000 kg	5,000 kg	5,000 kg
		Crop price per kg	28.2 GS	28.2 GS	28.2 GS	28.2 GS	28.2 GS	28.2 GS	28.2 GS
		Gross profit per ha	141,000 GS	141,000 GS	141,000 GS	141,000 GS	141,000 GS	141,000 GS	141,000 GS
Primary production costs	Materials cost	Seed and seedling cost	10,400	10,400	10,400	10,400	10,400	10,400	10,400
		Fertilizer cost	15,050	15,050	15,050	15,050	15,050	15,050	15,050
		Herbicide cost	2,400	2,400	2,400	2,400	2,400	2,400	2,400
		Pesticide cost	8,850	8,850	8,850	8,850	8,850	8,850	8,850
		Miscellanies	---	---	---	---	---	---	---
		Subtotal	36,700	36,700	36,700	36,700	36,700	36,700	36,700
	Operating costs	Cost of mechanical operation	52,861	48,300	48,414	43,362	43,814	44,016	43,814
		Cost of cropdusting	16,800	16,800	16,800	16,800	16,800	16,800	16,800
		Labor cost	9,070	6,550	6,519	6,574	6,134	5,939	6,134
		Subtotal	78,731	71,650	71,733	66,736	66,748	66,755	66,748
	Total		115,431	108,350	108,433	103,436	103,448	103,455	103,448
Rent			2,000	2,000	2,000	2,000	2,000	2,000	2,000
Cost of water right			1,000	1,000	1,000	1,000	1,000	1,000	1,000
Capital interest			7,313	6,864	6,869	6,553	6,553	6,554	6,553
Secondary costs			125,744	118,214	118,302	112,989	113,001	113,009	113,001
Net profit per hectare			15,256	22,786	22,698	28,011	27,999	27,991	27,999
Ratio of net profit (%)			10.8	16.2	16.1	19.9	19.9	19.9	19.9

Table 4-1-2-(b) Estimation of Production Cost of Soybean per Ha

(unit : guaranis)

Account items \ Scale (ha)			25 ha	50 ha	100 ha	150 ha	200 ha	Remarks
Gross profit	Prospected yield per ha		2,000 kg	2,000 kg	2,000 kg	2,000 kg	2,000 kg	
	Crop price per kg		28 GS	28 GS	28 GS	28 GS	28 GS	
	Gross profit per ha		56,000 GS	56,000 GS	56,000 GS	56,000 GS	56,000 GS	
Primary production costs	Materials cost	Seed and seedling cost	5,200	5,200	5,200	5,200	5,200	
		Fertilizer cost	---	---	---	---	---	
		Herbicide cost	5,000	5,000	5,000	5,000	5,000	
		Pesticide cost	2,760	2,760	2,760	2,760	2,760	
		Miscellanies	---	---	---	---	---	
		Subtotal	12,960	12,960	12,960	12,960	12,960	
	Operating costs	Cost of mechanical operation	36,847	33,547	31,028	28,904	32,505	
		Labor cost	5,285	5,315	4,843	3,570	3,822	
		Subtotal	42,132	38,862	35,871	32,474	36,327	
Total			55,092	51,822	48,831	45,434	49,287	
Rent			1,000	1,000	1,000	1,000	1,000	
Capital interest			3,490	3,283	3,093	2,873	3,122	
Secondary costs			59,582	56,105	52,924	49,312	53,409	
Net profit per hectare			Δ3,582	Δ105	3,076	6,688	2,591	
Ratio of net profit (%)			---	---	5.5	11.9	4.6	

Table 4-1-2-(c) Estimation of Production Cost of Wheat per Ha

(unit : guaranis)

		Scale (ha) / Account items						
Gross profit		Prospected yield per ha	1,600 kg	1,600 kg	1,600 kg	1,600 kg	1,600 kg	
		Crop price per kg	40 GS	40 GS	40 GS	40 GS	40 GS	
		Gross profit per ha	64,000 GS	64,000 GS	64,000 GS	64,000 GS	64,000 GS	
Primary production costs	Materials cost	Primary costs	8,670	8,670	8,670	8,670	8,670	
		Fertilizer cost	9,100	9,100	9,100	9,100	9,100	
		Hebicide cost	1,200	1,200	1,200	1,200	1,200	
		Pesticide cost	2,620	2,620	2,620	2,620	2,620	
		Miscellanies	---	---	---	---	---	
		Subtotal	21,590	21,590	21,590	21,590	21,590	
	Operating costs	Cost of mechanical operation	33,173	30,477	28,145	25,934	29,506	
		Labor cost	4,235	3,570	3,941	2,912	3,080	
		Subtotal	37,408	34,077	32,086	28,846	32,586	
Total			58,998	55,667	53,676	50,436	54,176	
Rent			1,000	1,000	1,000	1,000	1,000	
Capital interest			3,737	3,527	3,400	3,195	3,432	
Secondary cost			63,735	60,194	58,076	54,631	58,608	
Net profit per ha			265	3,806	5,924	9,369	5,392	
Ratio of net profit (%)			0.4	5.9	9.3	14.6	8.4	

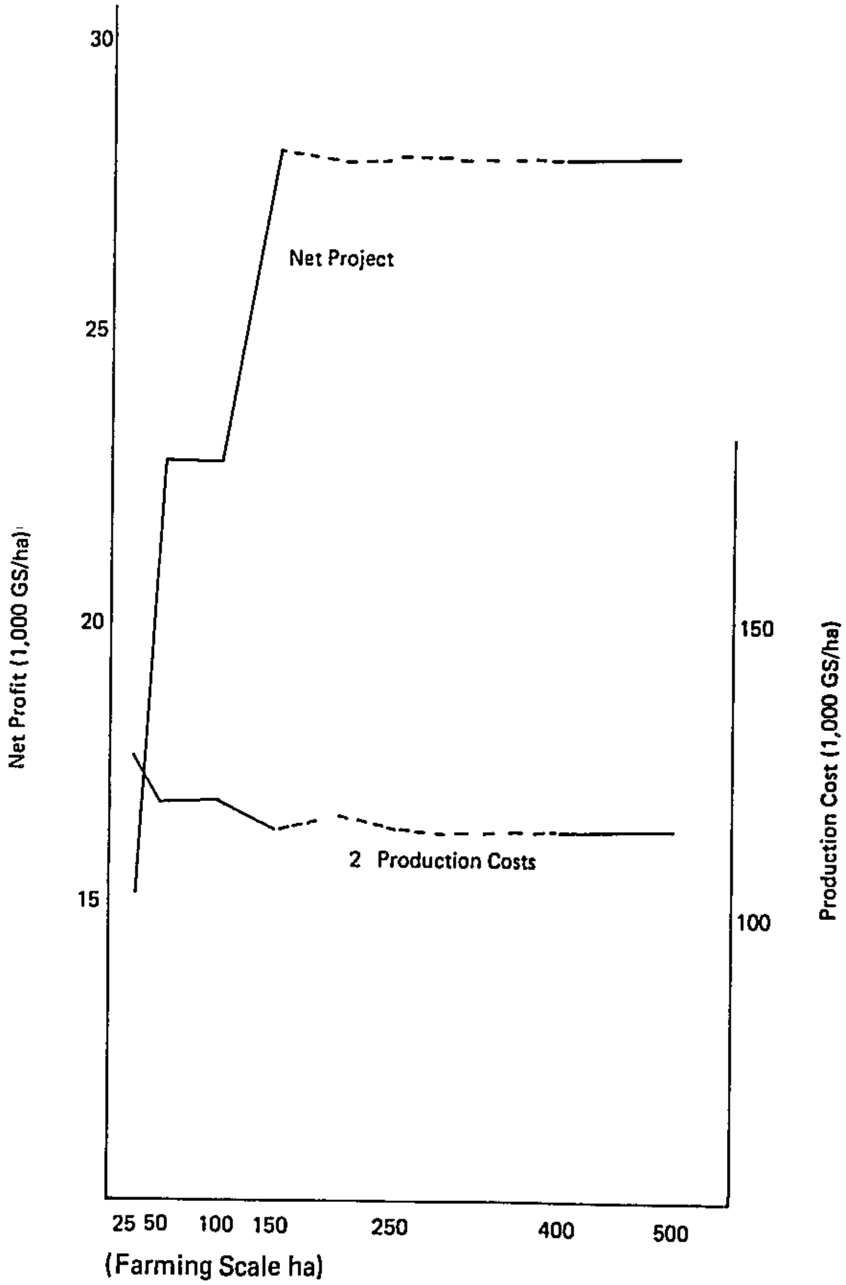


Fig. 4-1-1 (a) The Relation of Farming Scale to Net Profit with Production Cost per Hectare of Paddy Rice Farming

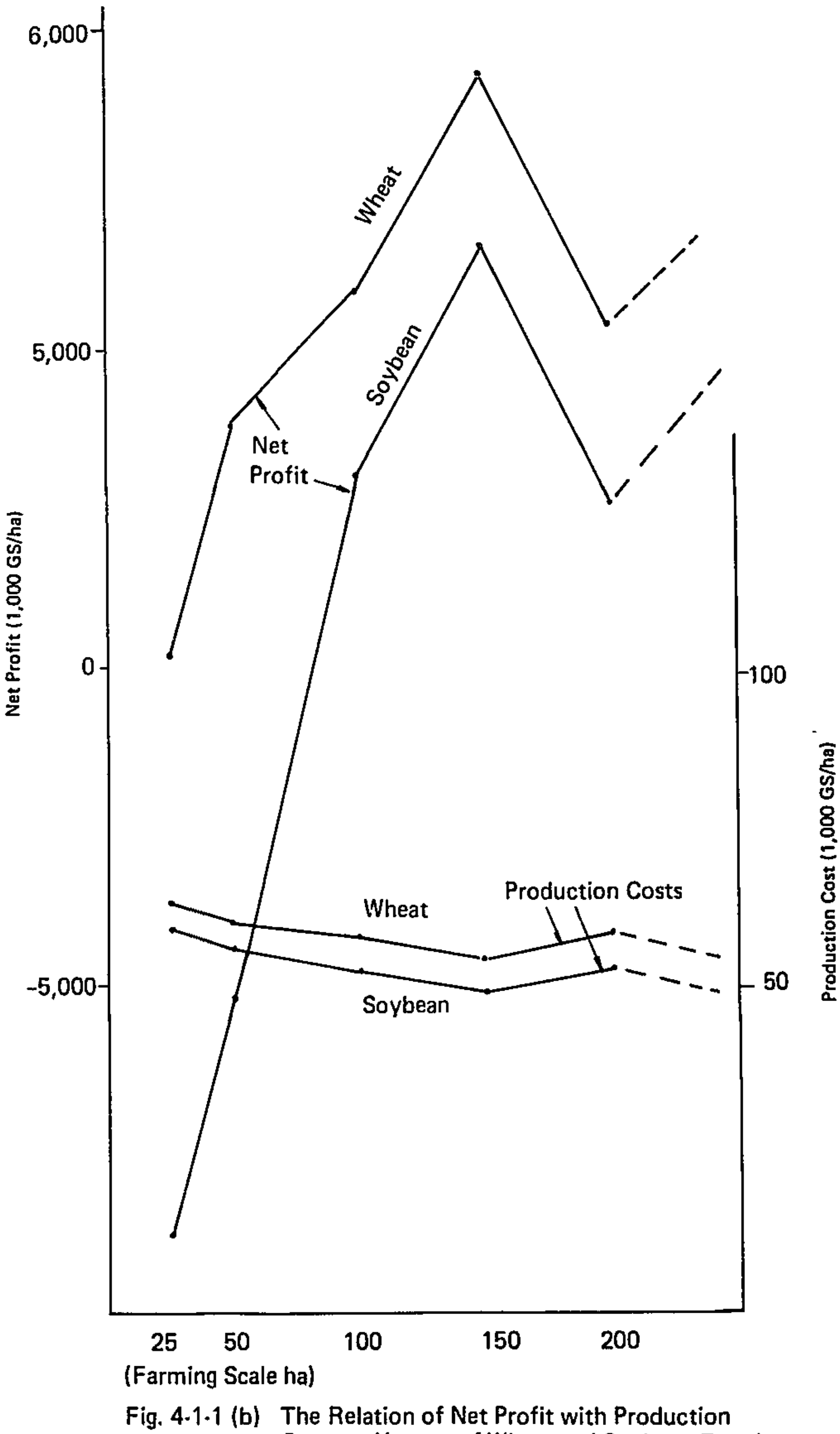


Fig. 4-1-1 (b) The Relation of Net Profit with Production Cost per Hectare of Wheat and Soybean Farming

4.1.3 Plan of mechanization of farming

(1) Basic policy

According to the 1981 reports of the Division de Programacion Agropecuaria y Fovestal, Paraguay has some 6,500 units tractors in 1981 and some 3,000 out of them are in use in Itapua and Misiones. 34% of the tractors are in the range of 60 to 80 HPs and 15% in the range of 80 to 100 HPs, those in the class of 60 ∿ 100 HPs dominate one half of the total number. In addition, the recent trend is a gradual increase in the class of 100 ∿ 110 HPs. The combines has reached a national total of some 520 in 1980, and some 320 units (about 60%) of them are in operation in Itapua and Misiones. Approximately 50% of them range from 90 to 120 HPs.

Itapua and Misiones, main producing centers of soybean and wheat, where so many tractors and combines are being used in mechanized farming which is being accelerated under national projects, are now yielding more and more of these products through efficient use of machinery.

Since the area dominates a very large area, outside the section of land designed for allocation to settlers according to national projects, there is still extra land of ample area which may be developed under different projects. For example, it is possible to introduce a production system based on the utilization of large machinery when the situation of farming along with potential labor available in the neighboring area is taken into consideration. In fact, there are already projects proposed for the rice, soybean and wheat, selected not only to meet the demands for farm products but as crops which suite the natural conditions of the locality. In and around the area, mechanized farming has already been initiated and these examples should be studied for application to those projects designed in the area.

The sowing season of designed crops is generally 30 to 40 days and during this period use of tractors reaches a peak. This led us to determine the number of tractors and their horsepower required to complete all the work of sowing within time. Study of the present status made us to determine the maximum horsepower of 120 HPs for tractors to be introduced.

(2) Requirements for the introduction of agricultural machinery

1) Actual operating hours during the operating period

It is natural to consider the sowing period of a crop when tractors are used at a peak, to study operating hours in the production of soybean, wheat, and rice, respectively. The ratio of possible actual to nominal operating days was computed on the basis of statistical analysis of weather data of the past 10 years. The prospected actual operating days on the average during the sowing season was determined by multiplying the number of days in the season by this ratio. In addition, the prospected daily actual operating hours was set at 70% of the day's nominal working time during the season from interviewing surveys in the field. The results are summarized in Table 4-1-3.

It should be noted that, although the sowing season of soybean is normally 40 days, it was decided to shorten the period to 30 days, so that the transpotation of wheat, the secondary crop to soybean, will not be affected.

2) Capacity of field work of mechanized farming

The capacity of field work is the measure determined by multiplying the scope of given work by the working speed and operation efficiency. Estimation of operating efficiency is based on gyration time, lead time of material supply, and in-field travel time. The results of computation of the capacity of field work in mechanized farming are given in Tables 4-1-4-(a) and 4-1-4-(b).

Table 4-1-3 Possible Actual Operating Time During the Designed Operating Period

	Operating hours	Real operating ratio	Actual operating hours	Sowing Season		Real operating ratio of days	Possible actual working days	Possible actual operating hours
				Period				
Paddy	10 hours	70 %	7.0 hours	10 - 11 days	40 days	60 %	24 days	168
Soybean	10	70	7.0	10 - 11	30	60	18	126
Wheat	10	70	7.0	5 - 6	30	70	20	140

Table 4-1-4-(a) On Farm Working Hours in Paddy Rice Field (hr/ha)

Works (H.P.)	Plowing	Harrowing	Land levelling	Fertilization, seeding	Ridging	Harvesting	Transportation
Tractor 45	3.5	4.5	2.0	2.5	1.5	-	1.5
70	2.5	3.0	1.5	2.0	0.8	-	1.5
80	2.0	2.25	1.0	1.5	0.8	-	1.5
90	1.8	2.1	0.9	1.4	0.8	-	1.5
120	1.25	1.8	0.6	1.1	0.8	-	1.5
Combine 95	-	-	-	-	-	1.5	-

Table 4-1-4-(b) On Farm Working Hours in Upland Field (hr/ha)

Works (H.P.)	Plowing	Subsoil breaking	Harrowing	Fertilization, seeding	Inter-tillage	Weeding	Control	Harvesting	Transportation
Tractor 45	3.5	-	2.0	1.75	2.0	1.0	Soy-bean 4.0 Wheat 3.0	-	Soy-bean 1.0 Wheat 1.25
70	2.5	3.0	1.5	1.5	1.5	0.75	Soy-bean 3.0 Wheat 2.25	-	Soy-bean 1.0 Wheat 1.25
110	1.25	1.5	0.75	1.0	1.0	0.5	Soy-bean 2.0 Wheat 1.5	-	Soy-bean 1.0 Wheat 1.25
Combine 95	-	-	-	-	-	-	-	Soy-bean 1.25 Wheat 1.0	

(3) Computation of the number of machines required

Based on the results of studies of actual operating time and capacity of field work as given in Tables 4-1-4-(a) and (b) and factor of utilization of machinery, the number of required units of the tractor and combine are determined as follows.

Machinery Equipment in Paddy Rice Farming

Machinery \ Scale(ha)		25	50	100	150	250	400	500
Machinery equipment	Tractor	45 HP 1	90 HP 1	100 HP 1 80 HP 1	120 HP 1 80 HP 1 70 HP 1	120 HP 3 80 HP 1	120 HP 4 80 HP 3	120 HP 6 80 HP 2
	Combine	95 HP 0.24 (for 4 families use)	95 HP 0.5 (for 2 families use)	95 HP 1	95 HP 1	95 HP 2	95 HP 3	95 HP 4

Machinery Equipment in Soybean and Wheat Farming

Machinery \ Scale(ha)		25	50	100	150	200
Machinery equipment	Tractor	45 HP 1	70 HP 1	70 HP 1 45 HP 1	110 HP 1 70 HP 1	110 HP 1 70 HP 1
	Combine	95 HP 0.25 (for 4 families use)	95 HP 0.5 (for 2 families use)	95 HP 1	95 HP 1	95 HP 2

(4) Selection of agricultural machinery

1) Tractors

There are two general types of tractors, crawler tractors and wheel tractors, which contribute great assistance to the farming of paddy, soybean and wheat. However, the wheel tractor exceeds in trafficability the crawl tractor in the soil conditions of the survey area. Moreover, the former, while relatively greater in traction losses, is more advantageous in economy, mobility and scope of utilization compared with the latter. As a result, the wheel tractor was selected for use in our survey area. In addition, selection of models was referred to their relative fitness to other machines used in the field.

2) Plows

It was decided to adopt the disk plow as for use with tractors because this type of plow was most universally employed in the vicinity of the survey area. Although a disk plow, compared with bottom plows, less rated in gyration performance and greater in power losses, it is more capable of operation against obstructions such as stones and stumps and deep tillage into hard soil with loaded weights on body, leaving in plowing relatively small granules of soil very easy to break. Furthermore, natives show high levels of skill in handling this type of plow because of its wide spread use and it is more suitable as the plow for application to paddy, soybean and wheat. These facts contributed to selecting the disk plow. Its size was determined with reference to the estimated size of workload depending on the scale of farming.

3) Harrowing and land grading

The disk harrow was selected since it is more common in the survey area. Although a disk harrow is designed for plowing, it is capable of harrowing as well as land grading so that it is suitable for application where the work of plowing tends to leave soil in large lumps. Repeated plying and proper mechanical adjustment would bring a disk harrow to produce greater effects of harrowing and land grading compared with any other type of harrow. Selection of models was based on their relative fitness to farming of paddy, soybean and wheat and on the scale of farming.

4) Land leveler

To insure irrigation, paddy fields require a proper measure of land leveling and to this aim, a land leveler was named and adopted.

This land leveler can perform land leveling without much compacting the soil still loose as a result of harrowing and land grading. Moreover, it permits adjustment to produce different measures of land leveling by means of a hydraulic device with resultant high efficiency, and is judged to give great help in land leveling of paddy fields.

5) Fertilizing and sowing

For use in the sowing and base fertilizer application of paddy, soybean and wheat farming, the grain drill was adopted for efficiency and adaptability to all types of cultivation which is designed for grain drilling, furrowing and rolling. Since this grain drill is originally intended to make grain drills for wheat, when used for soybean, it is to be equipped with a planter. The grain drill has a separate hopper for sowing and fertilizing and, upon plowing, roll the furrows out to completely cover the sown seeds which are prevented from being drifted off or eaten by birds. Nomination of the grain drill is largely depended on its efficiency and double service as for sowing and fertilizing.

6) Subsoiler

Fields of soybean and wheat are subjected to subsoil break down to the designed depth ranging from 45 to 50 cm. To this aim, it was decided to select the subsoiler, which is universally employed in the survey areas. This subsoiler is designed for deep tillage and normally put to use every fourth year for breakup of subsoil so as to prevent the soil from going compact. The models were selected in light of the different scales of farming.

7) Intertillage and weeding

Intertillage and weeding are undertaken in fields of soybean.

The cultivator was decided to be used for intertillage, conducted between the furrows, and weeding during the stages of growth of the soybean. The cultivator provides service normally while the crop is within 30 to 45 cm in height and is found very effective since it is capable of molding, weeding and intertillage simply by adjusting the angle of the blade or change of blades.

8) Additional fertilizing, weeding, and control of insect and disease damage

8)-1 In paddy farming, additional fertilizing, weeding and control of insect disease damage are achieved during the stages of growth of the paddy. Because of the very size and shape of paddy fields, so they are planned to be divided, (each square of some 500 × 500 meters), use of the spray for the purposes of these work from the sides of the field would encounter great difficulty.

A tractor equipped with a sprayer or sprinkler which moves on special wheels in the paddy field would destroy the borders of the paddy field and is therefore not acceptable. These and other limitations led us finally to adopt cropdusting.

8)-2 Selection resulted in adopting the most suitable machine for the weeding and insect disease damage control of soybean and wheat farming.

While taking into account those conventional methods of weeding and control of insect disease damage employed in the survey area, emphasis placed on acceleration of efficient work brought us to adopt the tractor-driven sprayer (boom sprayer) for use in weeding and spraying of agricultural chemicals.

The models of this machine was selected to suite the different size of the designed fields.

9) Combines

While taking for reference those conventional methods of harvesting in paddy, soybean and wheat culture employed in the survey area, consideration of the cultural characteristics of these crops and the weather conditions of the survey area along with the fact that the harvest period of crops is relatively short here, made us to adopt the high-efficiency combine (of standard type). Plans were developed to make the best use of this machine with increased efficiency. The plan for wheat farming was equated with the one for soybean culture since the same model of combine can be used with slight adjustment to treat them.

10) Transportation

The efficient utilization of wheel tractors to be introduced for the transportation of crops (paddy, soybean, wheat) was considered. In addition, study of the features of the designed farm road (ungraveled, 6 meters in width) led us to adopt the farming trailer (of dump-truck type, designed for free-loading) for operation in conjunction with wheel tractors in the transportation of agricultural materials and harvest. The method of harvest planned to enhance the efficiency of operation consists in direct loading of crop just harvested into the trailer through the combine by the field or on the farm road and transporting it to the drying and preparing equipment.