Table 3-28 Useful Palms in the PGC Area

English Name	Brazilian Name	Botanical Name	Use
Babassu palm	Babacu	Orbignya oleifela	Oil
o Oil palm	Dende	Elaeis guineenssis	Oil
o Coconut palm	Cocoteiro	Cocos nucifera	Food, Oil
Macauba palm	Macauba	Acrocomia intumescens	Medicine
Buriti palm	Buriti	Mauritia vinifera	Food, Oil
Assai palm	Acai	Euterpe oleracea	Food
Bacaba palm	Bacaba	Oenocarpus bacaba	Food, Oil
Pupunha palm	Pupunheira	Guiliclma gasipaes	Food
Tucum palm	Tucuma	Astrocaryum vulgare	Food, Textile
o Carnauba wax palm	Carnauba	Copernicia prunifera	Wax
Inaja palm	Inaja	Maximiliana regia	Food, Oil
Coquilla-nut palm	Piacaba	Attalea funifera	Food, Textile, Oil

Note: o = cultivated species

3-2-3 Production Potentials of Crops by Sub-region

Table 3-29 shows the unit yields of the main crops cultivated in Brazil, in comparison with several tropical Asian countries and other main producing countries. In cassava, soybean and sugarcane production, Brazil is around or above the world average, but considerably low compared with the main producing countries; the unit yields of maize and rice are particularly below the world average. However, as mentioned in Section 3-2-2, (8), the distinction between paddy rice and upland rice is not statistically made, and this may be a reason for the gap between Brazil, where almost all upland rice, and other rice producing countries where paddy rice is dominant.

Table 3-30 shows the unit yield by state. As can be seen, the yield of maize in Para, and the yields of cassava, maize, rice and feijao in Maranhao are below the national average, and especially low compared with southern states.

The comparison of unit yields between sub-regions is shown in Figure 3-12; the Castanhal and Balsas sub-regions are below the national average, probably because the crops compared, such as rice, maize, cassava and feijao, are mostly cultivated by small-scale farmers for self-consumption with poor production techniques. Such natural conditions as weather and soil are, therefore, reflected directly in yield. The productivity of these crops cannot be improved substantially in these sub-regions using the conventional varieties and cultivating methods without further technical support such as guidance on fertilization and measures for drought control.

Table 3-29 Unit Yield of Main Crops by Countries

(Unit: kg/ha)

Countries	Cassava	Maize	Soybean	Sugarcane	Paddy Rice
World	9,055	3,370	1,751	56,102	2,855
Brazil	11,968	1,836	1,765	54,888	1,362
Egypt	-	3,782	2,524	83,575	5,411
Ethiopia	-	1,000	-	150,000	-
Kenya	7,901	1,875	-	112,683	4,706
South Africa	-	2,093	1,232	77,086	2,308
Cuba	6,899	1,234	-	47,857	3,186
USA	-	6,898	2,048	88,802	5,462
India	16,803	1,207	833	56,844	2,050
Indonesia	9,718	1,459	891	99,208	3,665
Japan	-	3,000	1,458	66,216	5,629
Malaysia	10,286	1,143	1,600	44,737	2,818
Philippines	11,500	957	889	48,690	2,206
Thailand	17,048	2,156	842	38,750	2,079
Fiji	12,141	2,000	-	51,486	1,800

Source: FAO Production Yearbook, 1981

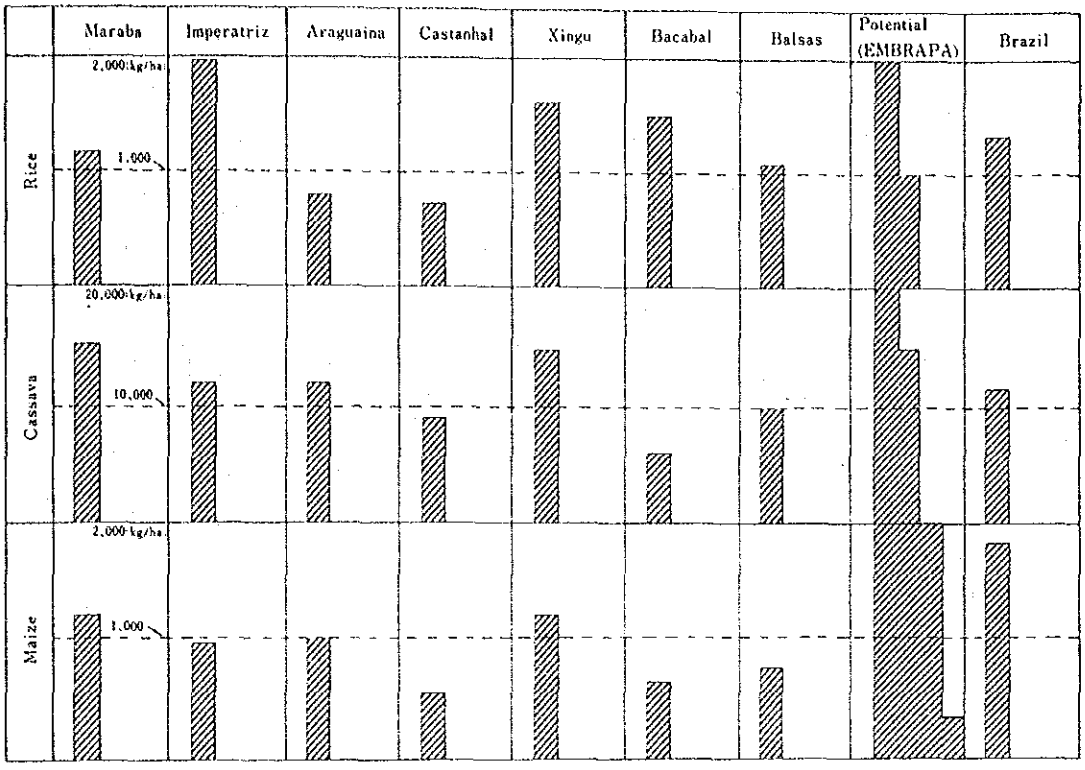
Table 3-30 Domestic Comparison in the Unit Yield of Main Crops

(Unit: kg/ha)

States	Cassava	Maize	Soybean	Sugarcane	Rice	Feijao
Whole Country	11,859	1,833	1,765	55,177	1,349	466
Para	12,349	872	-	48,851	1,109	572
Maranhao	7,990	291	1,696	48,965	672	343
Rondonia	11,859	1,705	-	34,505	1,733	309
Acre	17,539	1,351	-	27,258	1,463	442
Amazonas	14,736	1,300	-	51,987	1,107	1,103
Roraima	13,150	1,075	-	32,000	985	585
Amapa	12,000	495	-	14,492	563	434
Piaui	7,370	165	-	42,998	456	169
Ceara	8,000	180	-	30,000	2,040	180
Rio Grande do Norte	9,140	84	-	38,013	595	94
Paraiba	7,405	122	-	43,289	635	112
Per Nameuco	8,672	224	-	46,069	2,180	179
Alagoas	9,409	435	-	55,699	2,368	283
Sergipe	13,066	297	-	57,518	2,301	180
Bahia	16,000	315	331	43,035	790	359
Minas Gerais	14,821	1,724	1,472	46,417	1,083	521
Espirito Santo	14,500	1,560	-	37,196	1,858	562
Rio de Janeiro	14,411	1,167	-	49,955	2,834	621
Sao Paulo	21,143	2,340	1,901	65,645	1,206	660
Parana	18,745	2,480	2,198	70,712	1,795	669
Santa Catarina	16,758	2,750	1,340	55,224	2,770	870
Rio Grande do Sul	12,338	2,094	1,595	26,765	4,006	600
Mato Grosso do Sul	15,620	1,762	1,733	35,454	1,097	405
Mato Grosso	15,000	1,672	1,873	41,010	1,091	452
Goias	15,000	1,945	1,320	61,770	821	296
Distrito Federal	9,599	1,235	1,670	19,500	740	404

Source: IBGE, Anuario Estatistico do Brasil, 1983

Figure 3-12 Comparison in the Yield of Main Crops between Sub-regions (1981)



As shown in Figure 3-12, on the other hand, the Maraba and Xingu sub-regions have achieved a high production levels compared with the other sub-regions, and this is reflected in the high soil fertility in the sub-regions as discussed in Section 3-2-1. Maize production in all sub-regions is below the national average, requiring technical improvements in varieties and cultivation.

To identify annual trends in the production of the main crops in the PGC Area, comparisons in the unit yields of cassava, maize and rice between Maranhao and Para, and other states, are shown in Table 3-31. It can be seen that there are few fluctuations in the unit yields of cassava from year to year in all states, suggesting the stable production of the PGA Area. The southern states are maintaining virtually stable and high-level yields for maize, while the northern states and the PGC Area have low-level yields with large annual fluctuations. This tendency is even stronger in rice production. It seems therefore that the stabilization of the production of maize and rice in the Area requires technical improvements in crop varieties and cultivation techniques.

Table 3-31 Annual Trends in the Unit Yield of Main Crops

(1) Cassava (Unit: ton/ha)

States	1960	1965	1970	1975	1976	1977	1978	1979	1980	1981	1982
Whole country	13.1	14.3	14.6	12.8	11.9	11.8	11.8	11.8	11.8	11.9	11.3
Maranhao	9.9	10.9	9.1	8.5	8.7	8.8	8.6	8.9	8.9	8.0	7.5
Para	11.4	13.2	10.9	10.1	10.7	10.7	10.7	13.0	12.2	13.2	12.8
Rondonia	19.8	17.7	17.2	21.3	13.3	15.5	13.8	15.9	15.6	17.5	17.4
Acre	20.4	20.7	21.0	13.3	14.0	14.0	15.0	14.0	14.6	14.7	16.0
Amazonas	20.0	26.6	28.6	14.2	12.2	12.0	12.0	12.0	12.0	12.0	12.0
Roraima	39.3	34.6	20.0	10.3	11.1	11.7	12.3	11.3	14.3	13.2	13.8
Amapa	9.5	10.4	11.6	10.0	10.0	10.0	10.0	10.0	10.0	12.3	8.9
Piaui	10.8	11.0	8.1	7.8	8.1	9.0	8.8	8.9	8.0	7.4	8.9
Ceara	13.3	15.6	13.5	10.0	10.0	10.0	9.0	7.0	7.0	8.0	7.8
Rio Grande do Norte	5.7	4.9	6.5	7.9	7.9	8.0	8.3	8.4	9.0	9.1	9.3
Paraiba	11.5	10.7	10.4	8.8	8.6	8.8	9.1	8.4	8.4	7.4	8.2
Pernambuco	9.2	10.1	11.7	10.0	9.6	10.2	10.0	10.4	8.4	8.7	9.5
Alagoas	9.4	9.8	8.3	10.3	9.0	10.3	10.3	10.0	9.1	9.2	10.2
Sergipe	15.5	18.2	17.5	12.0	12.0	11.0	12.9	13.0	13.8	13.1	13.4
Bahia	14.8	15.7	17.8	17.0	15.0	15.0	15.0	16.0	16.0	16.0	12.4
Minas Gerais	16.3	16.0	16.6	16.3	15.8	15.5	15.1	15.0	15.1	14.9	13.4
Espirito Santo	16.4	13.3	16.7	14.0	14.0	14.0	14.0	15.0	15.0	14.5	17.9
Rio de Janeiro	11.5	12.2	12.6	13.5	13.2	14.4	14.3	13.8	14.0	14.4	15.3
Sao Paulo	18.5	19.7	18.8	18.7	20.7	21.7	21.1	19.9	18.5	21.1	20.5
Parana	16.6	23.0	24.0	19.6	18.2	17.7	17.5	18.9	19.7	18.7	19.5
Santa Catarina	16.3	16.1	21.1	16.6	16.1	14.9	15.6	16.7	16.3	16.9	14.4
Rio Grande do Sul	11.0	11.8	12.5	11.9	12.1	11.5	11.9	10.8	11.2	12.3	12.2
Mato Grosso	16.3	17.3	22.8	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Goias	17.4	17.2	17.4	14.0	16.0	14.0	13.8	14.0	14.3	14.3	14.1

Source: Reference [2]

(2) Maize (Unit: kg/ha)

States	1960	1965	1970	1975	1976	1977	1978	1979	1980	1981	1982
Whole country	1,258	1,381	1,442	1,533	1,598	1,429	1,220	1,441	1,779	1,836	1,736
Maranhao	779	843	657	587	582	597	570	567	546	311	549
Para	-	-	-	-	-	-	-	-	-	-	-
Ceara	793	919	302	600	425	660	540	422	240	180	308
Paraiba	799	905	442	553	362	658	517	403	118	124	125
Pernambuco	824	831	506	730	550	797	708	541	825	225	403
Bihia	930	771	945	812	684	675	738	713	672	316	460
Minas Gerais	1,395	1,418	1,431	1,432	1,391	1,524	1,439	1,635	1,725	1,729	1,846
Espirito Santo	911	1,004	1,207	1,130	830	1,260	1,260	1,230	1,348	1,560	1,586
Sao Paulo	1,514	1,685	1,952	1,899	2,180	2,223	1,750	2,160	2,331	2,340	2,550
Parana	1,537	1,655	1,890	1,983	2,208	2,150	1,284	1,968	2,535	2,485	2,385
Santa Catarina	1,869	1,837	1,920	2,241	2,440	2,515	1,579	1,763	2,670	2,750	2,372
Rio Grande do Sul	1,301	1,423	1,374	1,554	1,547	1,602	1,320	1,037	1,699	2,095	1,715
Mato Grosso	1,207	1,364	1,545	1,554	1,523	1,558	1,422	1,527	1,706	1,685	1,725
Goias	1,672	1,740	1,475	1,920	1,860	1,800	1,300	2,120	2,181	1,946	2,180

Souce: Reference [2]

(3) Rice (Unit: ton/ha)

States	1968	1970	1973	1977	1978	1979	1980	1981	1982
Whole country	1.49	1.52	1.50	1.50	1.30	1.39	1.57	1.35	1.62
Maranhao	1.34	1.22	1.28	1.51	1.47	1.25	1.30	0.67	1.35
Para	1.01	0.98	1.12	1.32	1.38	1.54	1.27	1.11	1.27
Rondonia	0.79	0.91	1.69	1.60	1.55	1.64	1.64	1.73	1.70
Acre	1.29	1.24	1.43	1.40	1.40	1.50	1.50	1.46	1.45
Amazonas	1.50	1.51	1.55	1.50	1.50	1.46	1.05	1.11	1.05
Roraima	1.50	1.70	1.00	1.70	1.38	1.41	1.49	0.99	1.18
Amapa	0.82	0.77	0.68	0.90	0.90	0.90	0.91	0.56	1.00
Piaui	1.29	0.69	1.12	1.18	1.01	0.73	0.43	0.46	0.92
Ceara	1.74	0.53	1.43	1.40	1.20	1.11	0.72	2.04	1.19
Rio Grande do Norte	1.06	0.27	1.14	1.24	0.94	0.23	0.17	0.60	0.40
Paraiba	1.56	0.53	1.27	1.03	0.67	0.70	0.50	0.64	0.82
Pernambuco	1.94	1.09	1.82	1.72	1.54	1.63	1.47	2.18	3.49
Alagoas	1.66	1.25	2.19	1.40	1.78	2.20	2.27	2.37	2.10
Sergipe	2.12	1.94	2.30	2.10	2.54	2.63	2.35	2.30	2.76
Bahia	1.82	1.47	1.30	1.20	1.20	1.10	1.40	0.79	0.72
Minas Gerais	1.29	1.33	1.06	0.90	1.02	1.29	1.41	1.08	1.30
Espirito Santo	1.31	1.39	1.58	1.40	1.80	1.40	1.75	1.86	2.36
Rio de Janeiro	1.42	1.50	1.95	1.80	2.30	2.58	2.78	2.83	2.98
Sao Paulo	1.11	1.50	1.14	1.04	0.72	1.02	1.40	1.21	1.50
Parana	0.91	1.28	1.40	1.60	0.55	0.89	1.63	1.80	1.26
Santa Catarina	2.65	2.49	2.07	2.25	2.09	2.21	2.79	2.77	2.61
Rio Grande do Sul	3.36	3.58	3.45	3.72	3.73	3.19	3.83	4.01	4.15
Mato Grosso	1.56	1.92	1.66	1.35	1.25	1.32	1.31	1.09	1.26
Goias	1.45	1.11	1.26	0.80	0.83	1.24	1.23	0.82	1.24

Source: Reference [35], [36] and [37]

The latest achievements by EMBRAPA [32] are shown also in Figure 3-12, indicating the highest levels of productivity by crop in Brazil. It can be seen that EMBRAPA achieved the high yield of 6 tons/ha by using Inca, a variety of upland rice, by undertaking controlled irrigation in Minas Gerais, and also a high yield of 35 tons/ha by use of Juriti, a variety of cassava in Maraba. The variety comparison test undertaken in Minas Gerais recorded the highest yield of maize at 6.4 tons/ha by the variety Agromen 1015. These new data may indicate the production potentials of these crops in Brazil.

Moreover, De Vries et al. [33] estimated the solar energy yield of tropical main crops based on the records of highest yields (see Table 3-32). According to this, cassava has the highest calorific yield, followed by maize, sweet potato and rice. This suggests that these crops are profitable for the tropical region in terms of efficient use of solar energy.

Table 3-32 Solar Energy Yield Based on the High Yield Records of Tropical Main Crops

Crops	ton/ha/yr	Cal/ha/day $\times 10^3$	Areas
Cassava	71	250	Indonesia
Maize	20	200	"
Sweet potato	65	180	"
Rice	26	176	Philippines
Sorghum	16 - 18	140 - 158	Congo
Wheat	12	110	"
Banana	39	80	"

Source: C.A. De Vries et al. 1967. Neth. J. Agr. Sci. 15 : 241-248. [33]

3-2-4 Crop Selection by Sub-region

(1) Standard of environmental adaptation by crop

Crop characteristics and their environmental adaptability (discussed in Section 3-2-2) are summarized in Table 3-33. In this table, eleven crops (numbers 6-16) were assessed on the basis of data recently compiled by EMBRAPA. Five crops (1-5) are according to Nakagawa [24], and four crops (17-20) are according to Nishikawa [27] and other materials. Because the four crops from six to nine are included in reference [24], their optimal rainfalls are also shown.

As shown clearly in the table, the group consisting of coconut palm, oil palm, cacao and Para rubber (hereinafter called Group A) of all perennial tree crops has the minimum of adaptable temperature, 23-24°C, higher than other groups, and the optimal rainfalls are as much as 2,000 mm or more, larger than compared with other groups. The areas whose weather conditions meet these requirements are Af and Am, or $P_{28}d_{2-4}$, $P_{25}d_{4-5}$, and $P_{20}d_5$ zones; in other words, the northern part of Castanhal sub-region and Xingu sub-region.

Among the crops requiring rainfalls of 2,000 mm or less, the group consisting of banana, sugarcane, coffee, rice, cotton, feijao, maize, soybean, sorghum and papaya (hereinafter called Group B), have a minimum of suitable temperature, 15-20°C, and the required monthly rainfall range is 70 to 130 mm with optimal rainfalls of 1,500 mm or more. Thus, this group requires higher temperature range and rainfall level than other crops except the group of tree perennial crops. Besides the above-mentioned Af-Am areas, the Aw or $P_{15}d_6$ and $P_{13}d_6$ zones, i.e., the Imperatriz, Maraba, Araguaina, Bacabal and Balsas sub-regions, are appropriate.

The group consisting of pineapple, castor bean, cassava, groundnuts and cashew tree (hereinafter called Group C) requires lower rainfall than groups A and B, and are strongly resistant to drought. It is adaptable in the Aw or $P_{15}d_6$, $P_{13}d_6$ and $P_{10}d_7$ zones, i.e., Imperatriz, Maraba, Araguaina, Bacabal and Balsas, similar to the second group.

(2) Preliminary crop selection by sub-region

The following points were taken into consideration for crop selection in the PGC Area based on the natural and technical conditions.

(a) Crop selection is considered for each of the sub-regions because the field survey was made sub-regionwise.

(b) The standards for environmental adaptation shown in the previous section were regarded as the principle.

(c) Crop characteristics and technical problems discussed in Section to 3-2-3 are taken into consideration.

Table 3-33 Adaptable Conditions of Natural Environment for Main Crops
- Standards of Environmental Adaptation -

	Crops	(1) Growth Period	(2) Adaptable Temperature	(3) Optimal Temperature	(4) Required Rainfall during Growth	(5) Optimal Rainfall	(6) Average Rainfall Monthly Required	(7) Group
		month	(°C)	(°C)	(mm)	(mm/year)	(mm) = (4)/(1)	
1.	Coconut Palm		21 - 29			>2,400		A
2.	Oil Palm		24 - 30			>2,200		A
3.	Cacao		23 - 30			>2,000		A
4.	Para Rubber		24 - 29			>2,800		A
5.	Banana		16 - 30			>1,800		B
6.	Sugarcane	18	15 - 30	26	1,330 - 1,980	(>1,500)	75 - 110	B
7.	Pineapple	17	20 - 38	29	700 - 970	(>1,500)	40 - 60	C
8.	Coffee	12	17 - 30	20	780 - 1,160	(>1,500)	70 - 100	B
9.	Rice	4	20 - 38	29	400 - 610	(>1,500)	100 - 155	B
10	Cotton	6	20 - 30	25	440 - 670		75 - 110	B
11.	Feijao	3	17 - 30	24	250 - 390		85 - 170	B
12.	Caster Bean	7	20 - 30	25	420 - 630		60 - 90	C
13.	Cassava	23	16 - 38	25	1,060 - 1,590		50 - 70	C
14.	Maize	4	15 - 26	21	330 - 520		85 - 190	B
15.	Soybean	4	18 - 30	24	320 - 510		80 - 130	B
16.	Sorghum	4	15 - 26	21	270 - 420		70 - 105	B
17.	Pepper			26		>2,000		A
18.	Papaya			25		>1,200		B
19.	Groundnut			26		>600		C
20.	Cashew			27		>900		C

Source: 1 - 5 are based on Reference [24].
6 - 16 are based on EMBRAPA's data (1984).
17 - 20 are based on Reference [26]-[31].

(d) Information obtained during the field survey and collected reference materials are referred.

As mentioned in Section 3-2-1, in each of the sub-regions, four crops, namely rice, cassava, maize and feijao, play an essential role in the self-consumption and sales activities of small- and medium-scale farmers. Looking at the characteristics of these four crops in the light of the standards of environmental adaptation, rice, for example, which is suitable to temperatures ranging from 20°C to 28°C, with optimal rainfalls of 1,500 mm or more, is adaptable to all of the seven sub-regions. However, the intensification of cultural techniques such as the countermeasures against drought (except for $P_{28}d_{2-4}$, $P_{25}d_{2-4}$, $P_{25}d_{4-5}$ and $P_{20}d_5$) extension service, breeding and introducing improved varieties, is the prerequisite for increasing rice production in the Area.

Cassava, suited to temperatures ranging from 16°C to 38°C, is strongly resistant to drought, needing monthly rainfall of 50-70 mm monthly; therefore, it is suitable for the whole Area and moreover has high production potentials.

Maize is suitable to temperatures ranging from 15°C to 26°C, requiring monthly rainfall of 85-190 mm. Although it is adaptable in any sub-region, the current production level is low throughout the Area. Countermeasures against drought, use of improved varieties and upgrading the management of cultivation are necessary to raise the production, as in the case of rice.

Suited to temperatures ranging from 17°C to 30°C and monthly rainfalls of 85-170 mm, feijao stands between rice and maize, and can be adapted to any sub-region.

On the other hand, cassava, maize and rice have high potential for efficiently using solar energy, and especially cassava is one of the crops with a highest calorific production level in the tropical region (see Table 3-5). Feijao plays an important role as a source of vegetable protein for the people in this Area.

From these considerations, the four crops of rice, cassava, maize and feijao should be selected as the basic crops for the seven sub-regions.

In the following section, the crops to be discussed in addition to these four essential crops will be examined by sub-region.

(a) Bacabal sub-region

Although this sub-region is classified in Aw (tropical humid savanna zone), the northern area is in fact similar to the coastal, heavy rain climate with annual rainfall of nearly 2,000 mm, whereas in the southern part, with its cerrado vegetation, there is a $P_{10}d_7$ zone with relatively little rain. In the northern part, a large marsh also

extends to the coast. It seems therefore that paddy rice cultivation will become more important in the future by utilizing the marsh and easily-irrigable areas. To complement these four essential crops, the commercial crops belonging to Group A (in Table 3-33), such as Para rubber and cacao, can be cultivated in the aforementioned northern part, where cotton and sugarcane also appear to be adaptable.

On the other hand, in the southern cerrado-type area, the commercial production of soybean is feasible, considering the standards of environmental adaptation and the introduction of Tropical, a new variety adaptable in the low latitude regions.

In the northern suburban areas, tropical vegetables appear to be important.

In this sub-region where babassu palm is concentrated, measures for its intensive or integrated use are required as detailed in Section 3-2-2,(7).

(b) Castanhal sub-region

The northern part of this sub-region belongs to the tropical rain forest climate, or $P_{28}d_{2-4}$ and $P_{25}d_{4-5}$ zones. Accordingly, the perennial crops of Group A such as oil palm, guarana, Para rubber and cacao, which require annual rainfall of 2,000 mm or more, are not only precious adaptable crops but also important commercial crops.

Pepper, which also requires as much rain as 2,000 mm, was the most important commercial crop in the sub-region before the spread of disease, and it may continue to play an important role as a commercial crop in the future, if disease-free areas are chosen, and varieties strongly resistant to blight disease are introduced.

Tropical fruits such as papaya and cupuacu are important as local specialities, and mangosteen, which is cultivated in humid tropical Asia, is highly regarded for its taste and seems to be a promising crop.

The central and southern parts of Castanhal sub-region belong to the tropical monsoon climate, or $P_{20}d_5$ zone. Accordingly, the crops of Group B with optimal rainfall of 1,500 mm, such as sugarcane, cotton, and tobacco, rather than the above-mentioned perennial crops of Group A, are adaptable. In the northern suburban areas, various tropical vegetables are also important.

In addition, such aromatic crops as clove and vanilla cultivated in humid, tropical Asia may be feasible, and for the Af zone in the north starch-producing plants such as sago palm may be considered.

(c) Imperatriz sub-region

This sub-region belongs to the tropical humid savanna climate, or $P_{15}d_6$ zone. Accordingly, Group B, including soybean and sugarcane, is

adaptable to the cerrado areas in the central-southern part, and Para rubber can be expected to be cultivated in the north because it can be favorably protected from serious leaf blight disease due to its dryness during the period of leafing.

(d) Balsas sub-region

This sub-region belongs to the tropical humid savanna climate, or $P_{13}d_6$ zone with relatively low annual rainfall (1,200 mm).

Therefore, the suitable crops are soybean and sugarcane, similar to Imperatriz, and under present conditions, soybean may be preferable in view of the current development of the sub-region.

(e) Araguaina sub-region

This sub-region belongs to the tropical humid savanna climate, or $P_{15}d_6$ zone, generally showing cerrado vegetation. Consequently, in addition to the four basic crops, Groups B and C, including soybean, cotton, sorghum and pineapple, which can meet the environmental adaptation standards and have relatively strong drought-resistance, seem to be adaptable.

(f) Maraba sub-region

Although this sub-region belongs to the tropical humid savanna climate, or $P_{15}d_6$ zone, the soil is highly fertile and the northern and western parts have relatively high rainfall, exceeding 1,500 mm annually. The perennial crops of Group A, for example, Para rubber, cacao and pepper, can be cultivated in this heavy rainfall zone as commercial crops to complement the four basic crops. Pineapple of Group C also seems to be adaptable to the southern cerrado parts which have relatively little rainfall. This sub-region, as the center of the PGC Area, has a population to develop the sub-region that is now remarkably increasing, and the supply of vegetables to this population will become important.

The required measures for the intensive and integrated use of Brazil nuts concentrated in this sub-region are detailed in Section 3-2-2,(j).

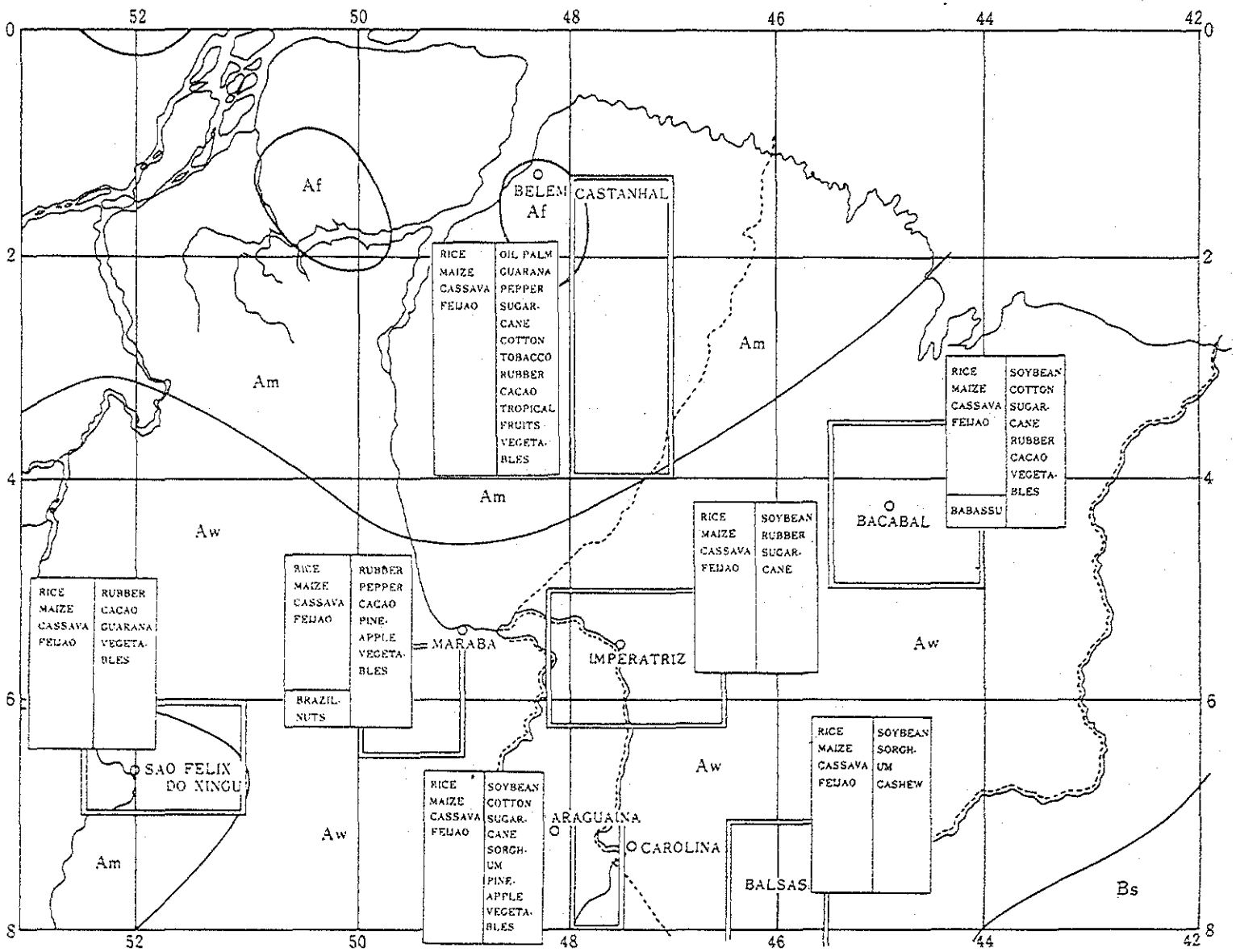
(g) Xingu sub-region

Since this sub-region has much rain, belongs to the tropical monsoon climate, or $P_{20}d_5$ zone, with annual rainfall of more than 2,000 mm, like in Castanhal, the crops of Group A, for example, Para rubber, cacao and guarana seem to be suitable, as in the case of castanhal. For the future development of this sub-region with its abundant forests, the perennial tree crops of Group A are considered to be important because of their role in environmental protection. It is also seems necessary to consider tropical vegetables to be supplied to the adjacent Carajas mining area.

The production of these crops is expected to increase substantially as regional development accelerates, as this sub-region, being rich in fertile soils, has high production potentials.

The conclusions on the preliminary crop selection are summarized in Figure 3-13.

Figure 3-13 Crop Selection by Sub-region Based on Natural and Technical Conditions



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4. FARM STRUCTURE ANALYSIS

4-1 Introduction

This chapter aims to clarify the farm structure of the Greater Carajas Program Area in terms of pattern of land and labor utilization, trends of the production of major crops, size distribution of farm units, and pattern of land-ownership. It is also expected that fact findings with respect to typical cropping pattern of the priority sub-regions as well as the current important issues that farmers in these sub-regions are facing can be obtained from the results of this analysis.

Because the program area is large and consists of many sub-regions which are not homogeneous in terms of farming structure, the study in this chapter is made principally on the basis of each priority sub-region. The analysis is based mainly on the agricultural census data by Brazilian Institute of Geography and Statistics (IBGE) for the years 1970, 1975 and 1980, and records of the discussions and field observations undertaken in Brazil.

This chapter consists of eleven sections including this introduction. Section 4-2 presents a brief review of the previous studies by the Ministry of Agriculture and the Ministry of Home Affairs on the Greater Carajas Program and the Araguaia-Tocantins Basin Integrated Development Plan (PRODIAT). Section 4-3 presents an outline of the farm structure of the PGC Area through comparisons of the whole seven priority sub-regions of the Area with the whole Brazil. Sections 4-4 to 4-10 depict the detailed features of the farm structure of each of the priority sub-regions. Finally, Section 4-11 presents a summary of the farm structure analysis with some fact findings on the cropping patterns and current issues which will be considered in Chapter Seven.

4-2 Review of Previous Studies

In the following a brief review of the previous studies closely related to the farming structure of the PGC Area, as presented in the reports of the Greater Carajas Program and the PRODIAT program will be made.

4-2-1 Greater Carajas Program

The results of the farm structure analysis for the Greater Carajas Program are presented in Section 4-1 (Producao Agropecuaria), Chapter 4 (Aspectos Economicos e Sociais), Volume 1 of the report Programa Grande Carajas Agricola (Versao Preliminar). The section is divided into five subsections: 4-1-1 - Base of Production, 4-1-2 - Means of Production, 4-1-3 - Labor Force, 4-1-4 - Agricultural Production, and 4-1-5 - Livestock. For the purpose of this Study, the following review will be focussed on subsections 4-1-1, 4-1-3, and 4-1-4.

(1) Base of production

Included as the major components of the base of production are agrarian structure, conditions of producers, and land use. The report referred to the irregular and extreme concentration of land to a small number of large-size farm units as the most distinctive feature of the agrarian structure of the program area. It was also mentioned that this concentration of land not only indicated the disparity in land-holding between large farms and small farms, but also represented the principal factor of various chaos occurring in the area with respect to the issue of land-ownership. The conditions of producers were described by the pattern of land-ownership in the States of Goias, Para, and Maranhao, and in the program area of each of these three states as well as in the total program area. For the issue of land use, the report mentioned that in 1975 the total area of non-used arable land and forest land in the program area summed up to 17.6 million hectares, or about 64% of its total land area, indicating that the program area was endowed with high land-resource potential. It was also quoted that in the period 1970-75, the crop area increased by 51% while the total pasture area increased by 32%, and the area of planted pasture alone increased by 144%.

(2) Labor force

The unequal land distribution was said to be the critical explanatory factor of the problem of underemployment existing in the program area. In the period 1970-80, the total number of workers employed in the agricultural and livestock activities of the program area had increased by an annual rate two times larger than the corresponding national average, but the share of agricultural and livestock workers in the total economically active population of the program area declined. It was also mentioned that the average labor-land ratio of the program area declined due to some labor-saving movements like mechanization and substitution of cattle raising for cropping. Besides, the report also quoted that the share of temporary workers in the total employment of the program area was larger than the national average and showed tendency to increase, and there were remarkable signs of seasonality in the pattern of labor utilization in the program area, and specially in the State of Maranhao.

(3) Agricultural production

The present situation and over time changes of agricultural production were analyzed on the basis of the States of Maranhao, Para, and Goias. The report first described the general features of the agricultural production in these three states in terms of shares of perennial crops, annual crops, and extractive products in the total land area as well as the total agricultural production value. The discussions were made on trends in the production and harvest area of rice, cassava, black pepper, feijao, maize, banana, and jute. It was mentioned that the share of extractive products in the total agricultural production was large at Maranhao and Para (12.4% and 8.6%, respectively) and small at Goias (2.2%) in 1980. The report verified

that in 1980 the share of annual crops in the total value of agricultural production in the three states was as high as 81%, and specially for Maranhao and Para, rice and cassava were dominant; the shares of rice, cassava, and maize in the total production value of major annual crops in 1980 were 54%, 23%, and 8.7% at Maranhao, and 17%, 42%, and 6.5% at Para. The trends in the production of some major crops can be summarized as follows:

The report quoted that rice cultivation in the States of Maranhao, Para, and Goias shared 12.2% in terms of production and 18% in terms of area in the national total. It was also said that in the period 1974/76 - 1978/80 the quantity of rice production recorded an annual growth rate of 4.8% for Para, 8.6% for Maranhao, and -3.4% for Goias. The average yield per hectare of rice in these three states was said lower than the national average due mainly to the following factors: cultivated on upland fields, cultivated as a temporary crop before newly-developed land turned to pasture, traditional method of cultivation with traditional varieties and without fertilizers.

In the case of cassava, the quantity of production was estimated at 301 thousand tons for Goias, 1,239 thousand tons for Para and 3,280 thousand tons for Maranhao; both the production quantity and harvest area increased at Maranhao and Para, and declined at Goias in the period 1974/76 - 1978/80.

The maize production at the PGC Area was quoted as of small significance in the total maize production of Brazil, as the share of the State of Maranhao - the area the most important in terms of maize production in the whole PGC Area - in the national maize production was as small as 1.3% in 1980.

The State of Para was referred to as the principal production area of pepper in the whole Brazil, as in 1980 an area of 19 thousand hectares in this state was planted in pepper and contributed to about 90% of the national pepper production. Both the States of Maranhao and Para showed increases in the harvest area and production quantity of this crop in the period 1974/76 - 1978/80.

The report quoted that the production of feijao in the PGC Area was made mainly by small farmers and still held a minor share in the total feijao production of the whole Brazil.

(4) Comments

The study by the Ministry of Agriculture with respect to the farm structure of the PGC Area, as above summarized, presents a useful step toward understanding the Area. Specially, the analysis of the labor force and trends in the production of major products is worthy of reference. However, there still remain some aspects that can be further developed so that a sound development program for the agricultural, forestry, and livestock sectors of the Area can be formulated. Following are those aspects that the Study Team will try to treat more in detail in this chapter.

First, in addition to emphasizing the social aspect of the prevailing extreme disparity in land distribution, as mentioned in the report by the Ministry of Agriculture, it seems desirable that the focus of the farm structure analysis be made on the pattern of land utilization of different farm unit strata in terms of land productivity, types of product, and the purpose of production. A farm structure study in this dimension is supposedly desirable for determining the development potential and perspective of the PGC Area's agricultural, forestry and livestock sectors.

Secondly, as the PGC Area is heterogeneous in the sense that each of its sub-regions has a specific farm structure, there is a need to break down the analysis to sub-regional level. The farm analysis in this chapter will be made principally on a sub-regional basis with the purpose to clarify the special features of each sub-region, reflecting its historical development, its resource endowment, and its infrastructural environment.

Thirdly, it is also desirable that comparisons of the PGC Area with the whole Brazil and other regions be made to identify the standing of the PGC Area in the total Brazilian economy.

4-2-2 PRODIAT

As the study related to the PRODIAT is still in progress and the definition of the coverage of each of its sub-regions differs from that of the Greater Carajas Program, the following review will be focussed on the contents of the study instead of summarizing its results.

The study group of the PRODIAT has planned to conduct a detailed study for each of the selected priority sub-regions (Immediate Program Area: IPA) At the time of the Study Team's visit to Brazil, it was informed that the primary version of an integrated development plan for sub-region Imperatriz was completed. So far as the report on this plan[1] presented, the farm structure is treated sporadically in Subsection 1 (Demographic Aspects), and Subsection 2 (Production Structure) of Chapter III (Socio-Economic Aspects). Included in Subsection 1 are population, migration, and economically active population and employment. The item population presents a description of the structure of population in terms of population shares of the urban and rural sectors in 1970 and 1980. The item migration briefly describes the pattern of migration of the sub-region under study, while the item economically active population and employment explains the shares of the primary, secondary, and tertiary industries in the total economically active population, as well as the number of workers employed in the agricultural, forestry, and livestock sectors. The Subsection 2 consists of six items: general aspects, agriculture, livestock, forestry, agrarian structure, and agricultural services. The item general aspects

1) PRODIAT, API Imperatriz: Plano de Desenvolvimento Integrado (Primeira Versao Interna), 1984.

shows over time changes in the shares of the agricultural and industrial sectors in the sub-regional GDP as well as their production value in constant prices. The item agriculture describes the structure of agricultural production in terms of total land area, number of farm units, and farm size, as well as the production quantity, harvest areas, and yields of rice, maize, feijao, and cassava in 1970 and 1980. The items livestock and forestry briefly discuss the present situation and over time changes of livestock and forest production. The item agrarian structure first summarizes recent developments brought about by improvements in the transportation network of the sub-region under study, and then refers to the agrarian structure of the sub-region with a focus on the pattern of size distribution of farm. The item agricultural services presents a brief discussion of the present situation of technical assistance, storing facilities, rural credit supply, and the implementation of minimum price policy.

As the above-summarized study related to the PRODIAT is on the whole economy of the sub-region, only very limited discussions are made on the farming structure. The study can be appraised for its sub-regional basis, and its detailed treatment of sectoral production.

4-3 The Farm Structure of the Greater Carajas Program Area: An Outline

In this section a brief description of the general features of the PGC Area will be made through comparisons of the major components of the farm structure of the priority sub-regions with those of Brazil. The comparisons seem to reveal the following distinctive features of the PGC Area:

(1) The priority sub-regions are still endowed with large amount of unused arable land and forest area.

(2) The priority sub-regions showed rapid increases in the production of major crops such as rice, maize, feijao and cassava in the period 1970-80; this expansion of production was largely attributable to expansion of cropping areas, although the total cropping area is still small as compared to the pasture area.

(3) The average farm size of the sub-regions was originally small as compared to the Brazilian average, but had been enlarged rapidly and surpassed the Brazilian average in recent years due mainly to increase in the number of large-scale cattle farms. The farm units in the priority sub-regions tend to be distributed more to the small and large size strata, as compared to the pattern of farm-size distribution of the whole Brazil.

(4) The sub-regions have larger percentages of "posseiros" (occupants) in terms of holding area and number of farm units, as compared with the whole Brazil.

(5) The land productivity is generally low and has not shown significant increases in the past.

The above features can be easily understood if one recalls to mind the initial development situation of the sub-regions, as well as expected impacts of public investments made on their infrastructure in the study period. The PGC Area is located far from the major central markets Sao Paulo and Brasilia, and was originally a backward region due to its natural conditions. Because of these reasons, in the area there still existed considerable areas of unsettled land. This existence of unsettled land has induced immigrants from other more populated regions, and explained the high percentage of occupied land areas as well as the rapid expansion of the areas of pasture and major crops. The inflow of immigrants and the rapid expansion of the areas of crops and pasture in the PGC Area were also attributable to the public investments which were made in the region during the last decade. The construction of the Belem-Brasilia and Trans-Amazon highways has substantially shortened the time distances between the priority sub-regions of the PGC Area and the major central markets of Brazil, and has contributed a great deal to stimulating the economic utilization of land in the Area.

4-3-1 Land and Labor Utilization

The most distinctive feature of the pattern of land use in the priority sub-regions is the existence of a large percentage of unused arable land and forest fields, and - on the contrary - the percentage of land used for cropping and cattle raising is relatively small although this percentage has substantially risen due mainly to expansion of planted pasture.

Table 4-1 summarizes the pattern of land use in the priority subregions and the whole Brazil in 1970 and 1980. The figures in Table 4-1 show that, in 1980 an amount of arable land as large as 20% of the total land in the priority sub-regions was not used for economic activities, and forest fields occupied 40% of the total land. On the other hand, the areas of land under perennial crops and annual crops were 0.5% and 4.7%, respectively, while natural and planted pasture shared 35%. It is observed that in the period 1970-80 the percentage of total land used for cropping and cattle raising had increased, but remained smaller than the percentage of land used for cropping and cattle raising of the whole Brazil in 1980. This existence of large percentages of unused arable land and forest fields in these priority sub-regions represents an important aspect of the agricultural development potential of the Area under study.

More detailed investigation of the figures related to cropping and pasture areas in Table 4-1 reveals that, in 1980 the area of annual crops was nine times larger than that of perennial crops, and the area of planted pasture was two times larger than that of natural pasture in the priority sub-regions, as compared to four times and fifty percent, respectively, for the case of the whole Brazil. In other words, compared to the whole Brazil, the cropping pattern in the PGC Area was biased toward annual crops and planted pasture. This seems to reflect the fact that a large number of farm in these sub-regions were small in size and were cultivating rice, maize, feijao, cassava, among other

Table 4-1 Pattern of Land Use in Priority Sub-regions and Brazil (1970, 1980)

	Priority Sub-Regions				Brazil			
	1970		1980		1970		1980	
	(1,000 ha)	(%)	(1,000 ha)	(%)	(1,000 ha)	(%)	(1,000 ha)	(%)
Crops	403.5	4.9	797.6	5.3	33,983.8	12.2	49,104.2	14.2
Perennial	24.9	0.3	81.4	0.5	7,984.1	2.9	10,472.1	3.0
Annual	378.6	4.6	716.2	4.7	25,999.7	9.3	38,632.1	11.2
Pasture	2,421.8	29.6	5,387.4	35.7	154,138.3	55.2	174,499.6	50.6
Natural	1,572.2	19.2	1,862.6	12.3	124,406.2	44.5	113,897.3	33.0
Planted	849.6	10.4	3,524.8	23.4	29,732.3	10.6	60,602.3	17.6
Forest	3,148.1	38.5	6,141.8	40.7	57,881.2	20.7	88,167.7	25.5
Natural	3,140.4	38.4	6,138.8	40.7	56,223.0	20.1	83,152.0	24.1
Planted	7.7	0.1	3.0	0.0	1,658.2	0.6	5,015.7	1.5
Unused	2,205.7	27.0	2,756.9	18.3	33,410.5	12.0	33,416.3	9.7
Unused Arable Land	-	-	1,970.3	13.1	-	-	24,796.6	7.2
Fallow	-	-	786.6	5.2	-	-	8,619.7	2.5
Total	8,179.1	100.0	15,083.7	100.0	279,413.8	100.0	345,187.8	100.0

Source: IBGE, Censo Agropecuario: Brazil, Goias, Maranhao, Para, 1970, 1980.

annual crops, mainly for self-consumption on the one hand, and on the other hand there existed in these sub-regions a considerable number of large-scale cattle farms which were using relatively modern raising techniques. It is also observed that the total area of pasture field in the PGC Area in 1980 was as large as 6.7 times of the cropping area, as compared to 3.5 times in the case of the whole Brazil. This indicates that the production structure of the region presently inclines toward livestock production.

The priority sub-regions under study recorded high growth rates of economically active population which are reflected in the available data on the number of employed workers in the agricultural sectors of these sub-regions in the period 1970-80.

As shown in Table 4-2, the number of employed workers in the agricultural sectors of the priority sub-regions had increased by 39%, or by an annual growth rate of 3.3% in the period. Despite this rapid increase in the number of employed workers, the land-labor ratio had increased from 11.5 ha/person in 1970 to 14.8 ha/person in 1980, due to more rapid increase in the total area of arable land. In the same period, the annual growth rate of employed agricultural workers of the whole Brazil was 1.8% and the average land-labor ratio of the country had slightly declined. The PGC Area represents a region of high growth rate of population, reflecting increasing expectation of its development perspective due to the construction of the Belem-Brasilia highway, the Trans-Amazon highway, and the Carajas railway.

4-3-2 Production of Major Crops

The changes in the structure of agricultural production of the PGC Area can be investigated through examination of the production trends of three major groups of agricultural activities: annual crop, perennial crop, and cattle raising.

Rice, maize, feijao and cassava are the four annual crops which are produced mostly by subsistence farmers in all seven priority sub-regions, and have large shares in the total value added of these sub-regions' agricultural sectors. Except the case of cassava in which both the production quantity and the harvest area have declined from 1975, the production levels of the remaining basic annual crops have substantially increased in the period 1970-80 due mainly to increase in the number of farm units. Compared to the whole Brazil, the priority sub-regions have recorded higher growth rates of production of these crops. It is also observed that, while increases in yield and harvest area were responsible for increases in production in the case of Brazil, the increases in the production of rice, corn and feijao in the priority sub-regions were attributable mainly to expansion of the harvest areas.

As shown in Table 4-3 and Figure 4-1, the production of rice in the priority sub-regions increased from 314 thousand tons (unhulled) in 1970

Table 4-2 Changes in the Land-Labor Ratio of All Priority Sub-regions and Brazil

	Number of Employed Workers in Agriculture[1] (1,000 persons)		Total Arable Land[2] (1,000 ha)		Land-Labor Ratio (ha/person)		Annual Growth Rate of Employment
	1970	1980	1970	1980	1970	1980	(%)
Priority Sub-Regions	436.2	604.9	5,031.0	8,941.6	11.5	14.8	3.3
Brazil	14,681.8	17,423.6	221,532.6	257,020.1	15.1	14.8	1.8

Notes: 1) Number of Employed workers over 14 years old.
2) Sum of crop area, pasture area, unused arable land, and land in fallow.

Source: IBGE, Censo Agropecuario: Brazil, Goias, Maranhao, Para, 1970, 1980.

Table 4-3 Production and Harvest Area of Selected Crops: Priority Sub-regions

	1970		1975		1980	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Banana (1,000 fruits)	5,282	3,544	3,892	4,020	5,648	5,493
Cocoa	39	23	171	103	593	260
Coffee	-	76	-	114	-	248
Orange (1,000 fruits)	-	65,190	-	64,768	-	55,680
Papaya (1,000 fruits)	-	675	-	524	-	37,866
Mango (1,000 fruits)	-	8,209	-	16,149	-	21,646
Rice	222,193	317,043	309,401	448,510	342,990	506,678
	(4,312,134)	(5,271,272)	(5,662,875)	(7,548,930)	(5,712,072)	(8,086,747)
Sugarcane	1,382	26,078	-	14,388	453	14,182
	(1,695,258)	(67,759,180)	(1,860,401)	(79,959,024)	(2,603,292)	(139,584,521)
Feijao	30,182	10,272	27,047	11,230	41,523	16,909
	(4,081,950)	(1,518,844)	(3,895,398)	(1,598,252)	(4,361,467)	(1,732,044)
Cassava	80,816	549,531	84,471	698,767	71,133	632,498
	(1,728,670)	(14,588,768)	(1,307,251)	(11,672,739)	(1,159,260)	(11,050,601)
Maize	161,131	69,907	194,480	85,011	204,151	94,605
	(10,670,188)	(12,770,216)	(10,741,210)	(14,343,556)	(10,964,735)	(15,722,581)
Brazilian Nuts	-	22,397	-	17,683	-	12,553
Oil Palm	-	-	-	-	-	1,713

Notes: 1. In parentheses are corresponding figures of the whole Brazil
2. Araguaina is not included because of lack of data for 1975.

Source: IBGE, Censo Agropecuario: Brazil, Goias, Maranhao, Para, 1970, 1975, 1980.

to 449 thousand tons in 1975 and 507 thousand tons in 1980.[1] This means that during the 1970s the production of rice of these sub-regions had increased by 60%, as compared to a corresponding percentage of 52% in the case of the whole Brazil. However, it is also observed that the average yield of rice in these sub-regions had remained almost constant at 1.45 tons/ha, while the corresponding statistic for the whole Brazil started from a level of 1.22 tons/ha in 1970 and increased to 1.33 tons/ha in 1975 and 1.42 tons/ha in 1980. Thus, the increase in yield had contributed to about 40% of increase in the rice production in the case of the whole Brazil, while it contributed to less than 3% of the increase in rice production of the priority sub-regions. In the case of feijao, the production quantity of all sub-regions increased from a level of 10 thousand tons in 1970 to 16 thousand tons in 1980, with the yield per hectare being 0.34 tons and 0.41 tons, respectively (Table 4-3, Figure 4-2). In the same period, the total production of feijao of the whole Brazil had increased very slightly, from 1.519 million tons to 1.732 million tons. Like in the case of rice, a large portion of increase in the priority sub-regions' feijao production was attributable to the expansion of harvest area. The production of maize in the priority sub-regions increased from 70 thousand tons in 1970 to 85 thousand tons and 95 thousand tons in 1975 and 1980, respectively. In the same period, the quantity of maize production of Brazil had also steadily increased but at a lower growth rate. Here it is also observed that, while the increase in yield was the major explanatory factor of increase in the maize production in the case of the whole Brazil, increase in the harvest area explained most of increase in the maize production quantity of the sub-regions under study (Table 4-3, Figure 4-3). It seems that the low yields of the four basic annual crops in the priority sub-regions have not significantly increased because they are cultivated either by small farmers mainly for self-consumption, or by middle- and large-size farms as transitionary products on newly-developed land before the land is turned to pasture.

The production of sugarcane was declining while soybean, cultivated mainly in sub-region Araguaina (not shown in Table 4-3) presents a new pro-mising commercial annual crops in some priority sub-regions. With respect to perennial crops, the figures in Table 4-3 show that banana, cocoa, coffee, papaya, and mango had recorded increases in production in the period 1970-80, while the production of orange was declining in the same period. Oil palm, which is planted mainly in sub-region Castanhal seems to present a new possibility of agricultural development of the PGC Area.

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1) Araguaina is not included due to lack of data for 1975.

Figure 4-1 Production, Yield and Harvest Area of Rice: Brazil and Priority Sub-Regions (1970: 100)

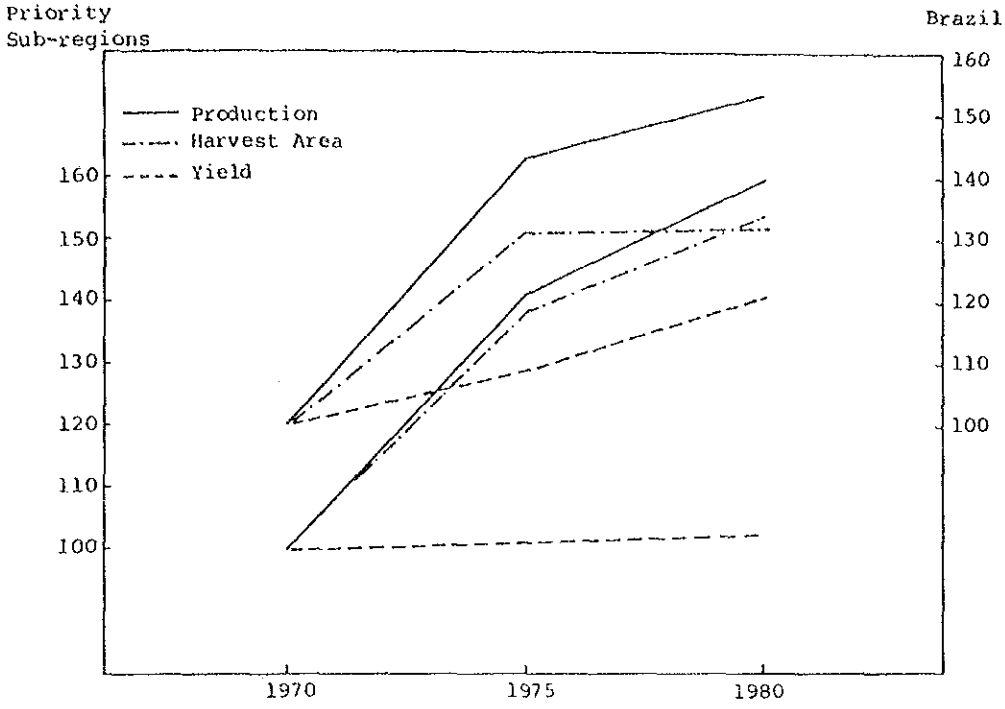


Figure 4-2 Production, Yield and Harvest Area of Feijao: Brazil and Priority Sub-Regions (1970: 100)

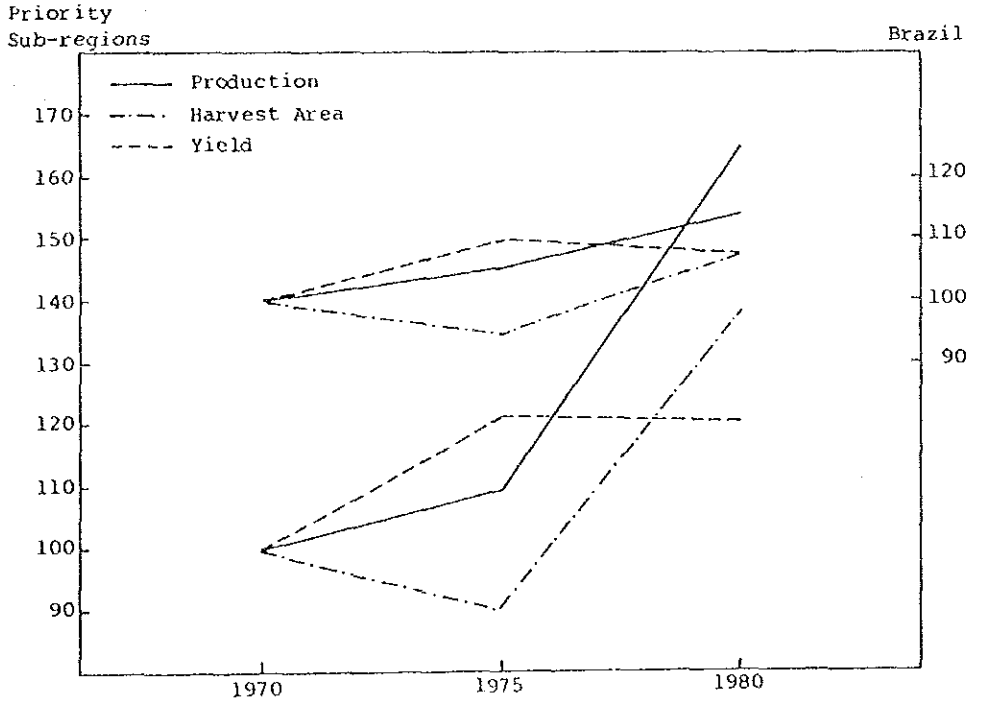
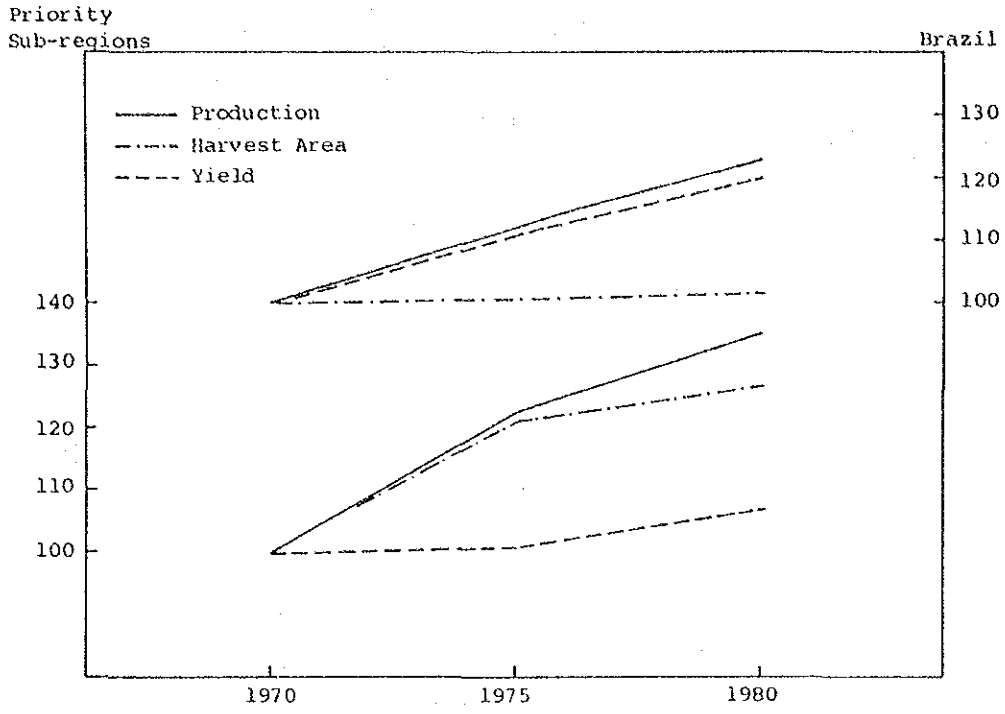


Figure 4-3 Production, Yield and Harvest Area of Maize: Brazil and Priority Sub-Regions (1970: 100)



4-3-3 Size-Distribution of Farm Units

Like in other regions of Brazil, the farm units in the PGC Area range from a low limit of less than one hectare to an upper limit of over ten thousand hectares. However, under these large variances in farm size the farm units in the priority sub-regions seem to show tendency of polarization, in the sense that compared to the pattern of farm size distribution of the whole Brazil, the priority sub-regions show larger percentages of farms ranged in the lower and upper strata, and small percentage of farms in the 10 - 100 ha stratum. It is also observed that the average farm size in the priority sub-regions had increased largely in the 1970s and had surpassed the Brazilian average at the end of this decade.

The farm units in the priority sub-regions in 1980 were first classified into 0 - 10 ha, 10 - 100 ha, 100 - 1,000 ha, 1,000 - 10,000 ha, and over 10,000 ha strata, and then the percentages of farms in these strata were computed for comparison with the size distribution of farm units of the whole Brazil. Table 4-4 and Figure 4-4 show that of the whole 204 thousand farms existing in the seven priority sub-regions, 65 percent were in the 0 - 10 ha stratum, 24 percent in the 10 - 100 ha stratum, 10.1% in the 100 - 1,000 ha stratum, and 1.2% in the over 1,000 ha stratum. The corresponding percentage for the whole Brazil are 50%, 39%, 9.5%, 0.9%, respectively. Thus, the farm units in the priority

Figure 4-4 Size Distribution of Farm Units of Priority Sub-Regions and Brazil

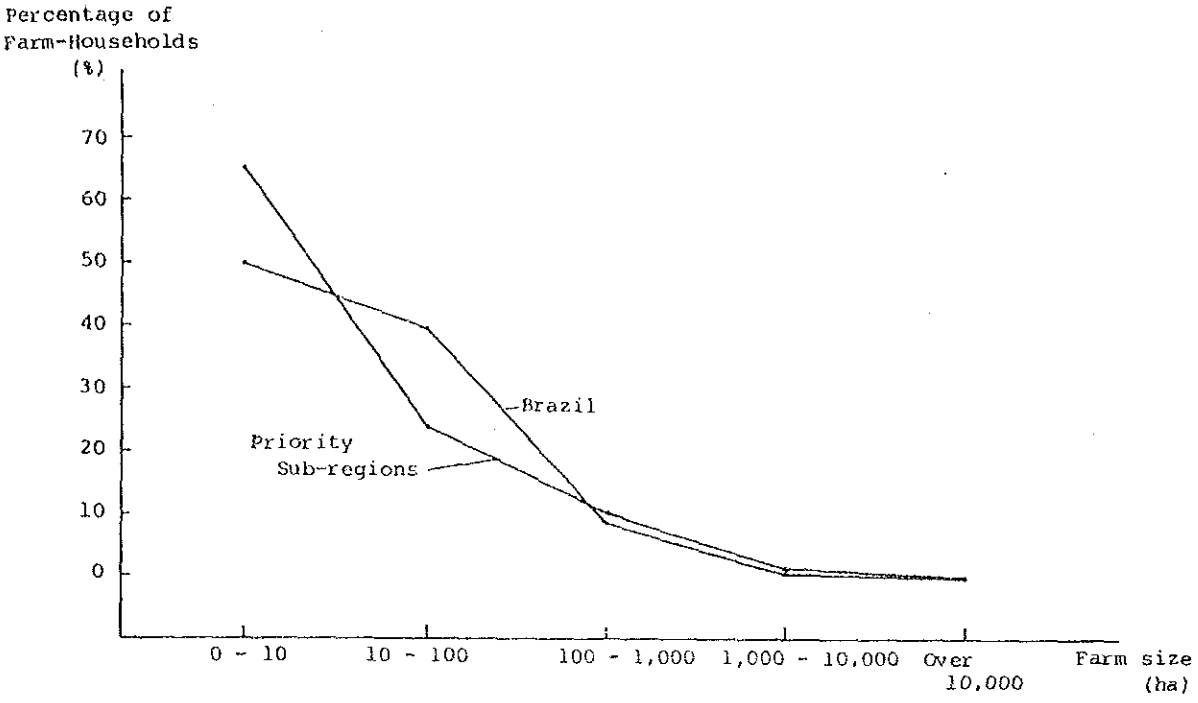


Table 4-4 Farm Size Distribution: Priority Sub-regions and Brazil (1980)

	Priority Sub-Regions		Brazil	
	Number of farms	%	Number of farms	%
0 - 10 ha	132,464	64.8	2,598,019	50.4
10 - 100 ha	48,919	23.9	2,016,774	39.2
100 - 1,000 ha	20,577	10.1	488,521	9.5
1,000 - 10,000 ha	2,146	1.1	45,496	0.9
More than 10,000 ha	127	0.1	2,345	0.0
Total	204,233	100.0	5,151,155	100.0

Sourse: IBGE, Censo Agropecuario, 1980.

sub-regions tend to be distributed more to the small and large strata, as compared to the size distribution pattern of the whole Brazil. The average farm size of the seven sub-regions had increased from 53.0 ha in 1970 to 60.1 ha in 1975 and 76.1 ha in 1980, as compared to 60.0 ha in 1970, 64.9 ha in 1975 and 70.7 ha in 1980 in the case of the whole Brazil.[1] This enlargement of the average farm size of the priority subregions seems to reflect an increase in the number of large-scale cattle farms along the Belem-Brasilia highway.

4-3-4 Pattern of Land-Ownership

With respect to land-ownership, the following two points can be raised as characteristics of the sub-regions under study. First, the sub-regions have large percentage of occupants in both terms of number of farm units and holding area. However, secondly, in the sub-regions a smaller percentage of owners are holding a larger percentage of land area, and on the contrary a larger percentage of tenants are holding a smaller percentage of land area, as compared to the whole Brazil.

Table 4-5 summarizes the pattern of land-ownership in the priority sub-regions and Brazil in 1980. The total number of farm units was classified into owners, tenants, occupants, and administrators, with the category "administrators" standing for either the item "parceiro" (in the case of priority sub-regions) or the item "administrador" (in the case of Brazil). It is observed that 37% of farm units are falling to the category "owners" in the case of the priority sub-regions, as compared to 63% in the case of the whole Brazil. Tenants and occupants share 25% and 37% of the total number of farm units in the priority sub-regions, while in the case of the whole Brazil they are 17% and 16%, respectively. On the other hand, the owners and tenants share 91% and 1.3% of the total holding area in the priority sub-regions, as compared to 59% and 3.8% in the case of the whole Brazil.

4-4 Sub-region Bacabal

Situated in the north-east of the state of Maranhao, sub-region Bacabal includes Pindare zone, Baixada Ocidental Maranhense zone and Mearim zone. The most important cities of the sub-region are Bacabal and Santa Ines. The sub-region is said to be endowed with the most fertile soil of the state of Maranhao and is occupied in the most part by numerous small tenants and occupants who cultivate rice, maize, feijao, cassava, mainly for self-consumption. Sub-region Bacabal is crossed by the Carajas railway which links the area with Sao Luis, the biggest city of the state of Maranhao. The special features of the sub-region's farm structure can be summarized as follows:

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1) Computed from data of IBGE, Censo Agropecuario, 1970, 1975, 1980.

Table 4-5 Land Ownership: Priority Sub-regions and Brazil (1980)

(Unit: %)

	Priority Sub-regions		Brazil	
	Farm household	Area	Farm household	Area
Owners	36.8	90.7	62.7	59.0
Tenants	25.3	1.3	17.3	3.8
Occupants	37.3	7.9	16.5	5.6
Administrators	0.7	0.1	3.5	31.7
Total	100.0	100.0	100.0	100.0

Source: IBGE, Censo Agropecuario, 1980.

(1) The sub-region is an old-settled area where there remains very few forest area; pasture is dominant but the percentage of land used for annual crops is the largest among seven sub-regions under study; the sub-region has relatively small percentage of forest area.

(2) Bacabal is a place of rice cultivation which supplies one third of the total rice production of the state of Maranhao; small farmers are planting maize, feijao and cassava in addition to rice; there exists widespread forest of babassu trees which presents an income source of small farmers and landless workers; the coexistence of small-size subsistence farms and large-size cattle farms is also prominent.

(3) Bacabal is a densely populated area with an average land-labor ratio less than 7 ha/person; the sub-region has the smallest average farm size and the largest percentage of farm units with size smaller than 10 ha.

(4) Tenants and occupants are dominant; the difference in the size of land holding of a small number of owners and a large number of tenants and occupants is specially large.

4-4-1 Land and Labor Utilization

Although cattle raising is also dominant at Bacabal, the pattern of land used in this sub-region is characterized by a high percentage of land used for cropping and low percentage of forest area. The agri-

cultural census data (Table 4-6) show that in 1980 more than 10% of land in this sub-region was used for cropping; this percentage is the largest among the corresponding statistics for the seven sub-regions under study. The percentage of land used for pasture was slightly higher than the average percentage of pasture area of all sub-regions, but the ratio of pasture area to crop area of the sub-region (3.5) was substantially smaller than all sub-regions' average (6.9). The forest area shared 26% of the total area of Bacabal, as compared to 41% in the case of all seven sub-regins. More detailed examination of the data related to land use revealed that annual crops are dominant (10.1% as compared to 0.5% of perennial crops) reflecting the dominance of subsistence farms.

Bacabal is the most populated area of all sub-regions under study. It is estimated that in 1980, 269 thousand persons were employed either as permanent or temporary workers in the agricultural sector, while the total area of arable land in this year was 1,868 thousand hectares. These two figures give an estimate of 6.9 ha/person as the land labor-ratio which is smaller than the ratios of all other sub-regions. However, the figures in Table 4-8 show that, although still small in size at present, the land-labor ratio of sub-region Bacabal tends to increase.

4-4-2 Production of Major Crops

As above mentioned, Bacabal is an area of cattle raising in the sense that the pasture area shared a large percentage of the total land in this sub-region. But relatively speaking, it is the production of annual crops, specially rice, which characterized its farming structure. A large number of subsistence farms are cultivating rice, maize, feijao and cassava on tiny pieces of land mostly for self-consumption. The total production quantity and harvest area of rice at Bacabal had increased steadily from 206 thousand tons and 132 thousand ha in 1970 to 303 thousand tons and 182 thousand ha in 1980. The production quantity and harvest area of maize and feijao had also steadily increased from 1970, with the quantity of production in 1980 being estimated at 42 thousand tons and 8 thousand tons, respectively. The production of cassava had rapidly declined over time but still was at 42 thousand tons in 1980. The sub-region Bacabal is now sharing 30% of the total rice production, 25% of the total maize production, and 20% of the total cassava production in the whole state of Maranhao. Originally sugarcane was planted to some extent in this sub-region, but the production quantity and harvest area of this crop have gradually declined. Banana and mango are the perennial crops commonly planted at Bacabal, but their production and areas are small as compared to the major annual crops (Table 4-9).

The existence of widespread babassu forest is also a special feature of this sub-region, in the sense that this has made Bacabal an important area producing babassu nuts for oil extraction on the one hand, and on the other hand brought about difficulties to the development of new land for cropping and cattle raising. In 1980, Brazil produced 183 thousand tons of babassu nuts (almond) of which 88% were from the state of Maranhao, and 20% from sub-region Bacabal. The production

Table 4-6 Pattern of Land Use by Sub-regions in 1980

(%)

	Crop Area			Pasture Area			Forest Area			Non-used Arable Land
	Perennial	Annual	Total	Natural	Planted	Total	Natural	Planted	Total	
Araguaina	0.5	3.1	3.6	21.7	27.2	48.9	33.2	0.0	33.2	14.4
Maraba	0.3	1.9	2.2	1.0	23.6	24.6	68.6	0.0	68.6	4.7
Xingu	0.2	0.6	0.8	0.0	4.9	4.9	94.1	0.0	94.1	0.2
Castanhal	1.2 (2.9)	4.2 (8.9)	5.4 (11.8)	2.2 (2.2)	20.5 (7.8)	22.7 (10.0)	49.9 (28.1)	0.1 (0.2)	50.0 (28.3)	21.9 (49.9)
Bacabal	0.5	10.1	10.6	9.7	27.5	37.2	25.7	0.0	25.7	26.4
Imperatriz	0.3	6.2	6.5	7.6	27.4	35.0	33.4	0.0	33.4	25.1
Balsas	0.3	5.1	5.4	40.8	8.4	49.2	17.0	0.0	17.0	28.5
Seven Priority Sub-regions	0.5	4.7	5.2	12.3	23.4	35.7	40.7	0.0	40.7	18.3
Brazil	3.0	11.2	14.2	33.0	17.6	50.6	24.1	1.5	25.5	9.7

Notes: In parentheses are percentages of land used for different purposes at Castanhal excluding municipality Paragominas.

Source: IBGE, Censo Agropecuario, 1980.

Table 4-7 Pattern of Land Use by Sub-regions in 1970

(%)

	Crop Area			Pasture Area			Forest Area			Non-used Arable Land
	Perennial	Annual	Total	Natural	Planted	Total	Natural	Planted	Total	
Araguaina	0.2	2.5	2.7	25.4	8.5	33.9	37.8	0.1	37.9	25.5
Maraba	0.1	1.4	1.5	0.0	8.3	8.3	89.7	0.0	89.7	0.3
Xingu	0.8	1.6	2.4	1.6	0.0	1.6	96.1	0.0	96.1	0.0
Castanhal	0.8	4.6	5.4	1.8	9.5	11.3	44.3	0.1	44.4	38.9
Bacabal	0.3	14.6	14.9	8.9	24.2	33.1	11.4	0.0	11.4	40.5
Imperatriz	0.4	7.2	7.6	27.5	14.5	42.0	24.8	0.1	24.9	25.5
Balsas	0.0	1.5	1.5	49.4	2.4	51.8	18.9	0.1	19.0	27.7
Seven Priority Sub-regions	0.3	4.6	4.9	19.2	10.4	29.6	38.4	0.1	38.5	27.0
Brazil	2.9	9.3	12.2	44.5	10.6	55.2	20.1	0.6	20.7	12.0

Source: IBGE, Censo Agropecuario: Brasil, Goias, Maranhao, Para, 1970.

Table 4-8 Changes in the Land-Labor Ratios of Priority Sub-regions

	Number of Employed[1] Workers in Agriculture (1,000 persons)		Total Arable Land[2] (1,000 ha)		Land-Labor Ratio (ha/person)	
	1970	1980	1970	1980	1970	1980
Araguaina	41.8	49.0	1,672.4	2,699.8	40.0	55.1
Maraba	17.0	33.4	108.9	752.2	6.4	22.5
Xingu	0.4	1.5	0.5	24.1	1.3	16.1
Castanhal	104.3 (101.2)	155.8 (141.3)	810.5 (664.9)	1,290.1 (755.8)	7.8 (6.6)	8.3 (5.3)
Bacabal	210.1	269.1	996.5	1,867.8	4.7	6.9
Imperatriz	38.6	66.5	485.1	1,246.3	12.6	18.7
Balsas	24.0	29.6	957.1	1,061.2	39.9	35.9
Seven Sub-regions	436.2	604.9	5,031.0	8,941.6	11.5	14.8
Brazil	14,681.8	17,423.6	221,532.6	257,020.1	15.1	14.8

Notes: 1) Number of employed workers includes employed workers over 14 years old.
2) Total arable land indicates sum of crop area, pasture area, unused arable land, and land in fallow.
1. In parentheses are figures for Bragantina and Salgado (municipality Paragominas is excluded).

Sourc: IBGE, Censo Agropecuario: Brasil, Goias, Maranhas, Para, 1970, 1980.

Table 4-9 Production and Harvest Area of Selected Crops: Bacabal

	1970		1975		1980	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Banana (1,000 fruits)	2,419	1,607	1,454	1,772	1,403	1,989
Coffee	3	2	-	2	-	5
Orange (1,000 fruits)	218	17,526	131	21,490	352	16,592
Papaya (1,000 fruits)	-	58	-	14	-	129
Mango (1,000 fruits)	-	3,890	-	4,670	113	9,168
Pepper	-	-	-	-	-	695
Rice	131,938	206,227	163,693	266,434	181,533	302,927
Sugarcane	864	17,954	-	9,020	290	10,877
Feijao	17,017	4,789	15,942	6,138	23,953	8,329
Cassava	30,077	142,016	27,862	178,511	20,607	148,379
Maize	81,262	27,554	88,936	34,749	104,284	42,126
Babassu	-	31,992	-	32,501	-	37,713

Source: IBGE, Censo Agropecuario: Maranhao, 1970, 1975, 1980.

of babassu at Bacabal showed tendency to increase in quantity in the past, and has contributed a great deal in creating remunerative working opportunities to seasonal unemployed labor in the remote areas (other merits of babassu are explained in Chapter 6). However, as babassu trees have many small nuts, the propagation of this plant is rapid and brings about difficulties to those farmers who try to convert babassu field to cropping or pasture land (Table 4-9).

4-4-3 Size Distribution of Farm Units

Table 4-10 shows the pattern of size distribution of farm units by priority sub-region in 1980, and the average farm size of each priority sub-region in 1970 and 1980. A preliminary investigation of these figures made it clear that the seven priority sub-regions under study showed different patterns of farm-size distribution: a distribution pattern with high percentages of middle-size farms (Figure 4-5), and a distribution pattern with high percentages of small farms (Figure 4-6).

Bacabal has large number of farm units which shares 50% of the total number of farms existing in the priority sub-regions in 1980. The pattern of size distribution of farm units in this sub-region is characterized by an overwhelmingly large percentage of farms of sizes smaller than 10 ha. The figures in Table 4-10 show that the percentage of farms of size smaller than 10 ha at Bacabal in 1980 was 84%, the highest level of all sub-regions. The percentages of farms in the strata 10 - 100 ha, and 100 - 1,000 ha tares in the same year were 11.6% and 3.8%, respectively, while farms of size larger than 10,000 ha shared only 0.2%. The pattern of size distribution of farm units at Bacabal, as presented in Figure 4-6, is similar to that of Castanhal, Imperatriz and Balsas, and contrastive to that of Araguaina, Maraba and Xingu (Figure 4-5).

4-4-4 Pattern of Land-Ownership

It is observed that the available data related to the seven priority sub-regions revealed a general tendency that the smaller the average farm size and the older the time of settlement, the larger is the percentage of tenants, with Castanhal being an exception (Figure 4-7). This tendency is prominent in the case of Bacabal where in 1980 the average farm size was 26 ha, the smallest level among all sub-regions, and the percentage of tenants in terms of number of farm units was the largest of all sub-regions. In the same year, the percen-tages of owners and occupants were 19% and 40%, respectively, in terms of number of farm units (Table 4-11). However, the figures in Table 4-12 show that the total holding area under the category "owners" was as large as 91.6%, as compared to 2.6% for tenants and 5.6% for occupants. More detailed examination of the holding areas under these groups of farmers revealed that the average farm size was 122 ha for owner-farmers, 1.7 ha for tenant-farmers, and 3.5 ha for occupants.

An interview with a group of farmers at Alto Alegre zone situated

Table 4-10 Size Distribution of Farm Units by Sub-region in 1980

	Number of Farm Units	Size Distribution					Average Farm Size (ha)	
		0 - 10 ha	10 - 100 ha	100 - 1,000 ha	1,000 - 10,000 ha	More than 10,000 ha	1970	1980
Araguaina	16,491	15.7	40.8	39.4	4.0	0.2	194	254
Maraba	6,579	2.8	39.2	51.9	5.6	0.5	210	373
Xingu	283	0.7	19.1	70.3	8.1	1.8	102	1,578
Castanhal	46,091 (43,060)	51.7 (55.1)	44.3 (42.3)	3.2 (2.5)	0.7 (0.1)	0.1 (0.0)	45 (19)	58 (26)
Imperatriz	23,344	59.1	25.7	14.1	1.1	0.0	49	81
Bacabal	101,857	84.4	11.6	3.8	0.2	0.0	13	26
Balsas	9,588	63.9	13.7	19.3	3.0	0.1	176	137
Seven Priority Sub-regions	204,233	64.8	23.9	10.1	1.1	0.1	53	76
Brazil	5,151,155	50.4	39.2	9.5	0.9	0.0	60	71

Note: In parentheses are the corresponding statistics for Bragantina and Salgado.

Source: IBGE, Censo Agropecuario: Brasil, Goias, Maranhao, Para, 1970, 1980.

Figure 4-5 Farm-Size Distribution: Araguaina, Maraba, Xingu

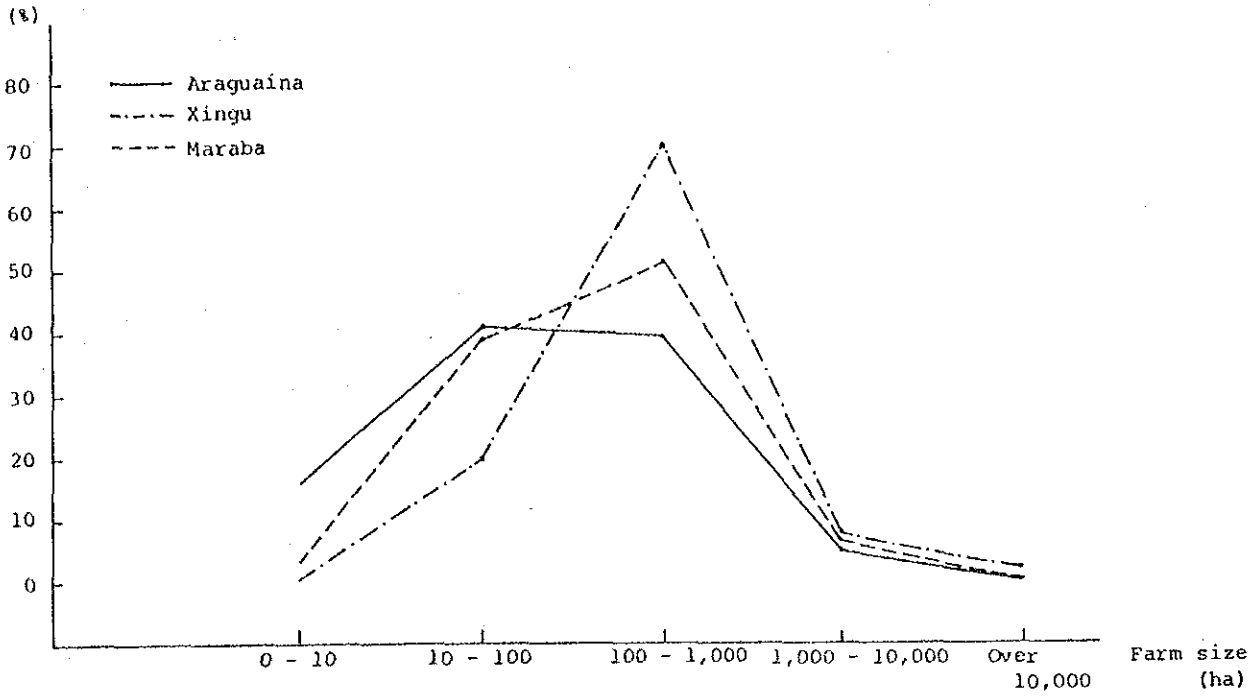


Figure 4-6 Farm-Size Distribution: Castanhal, Imperatriz, Bacabal, Balsas

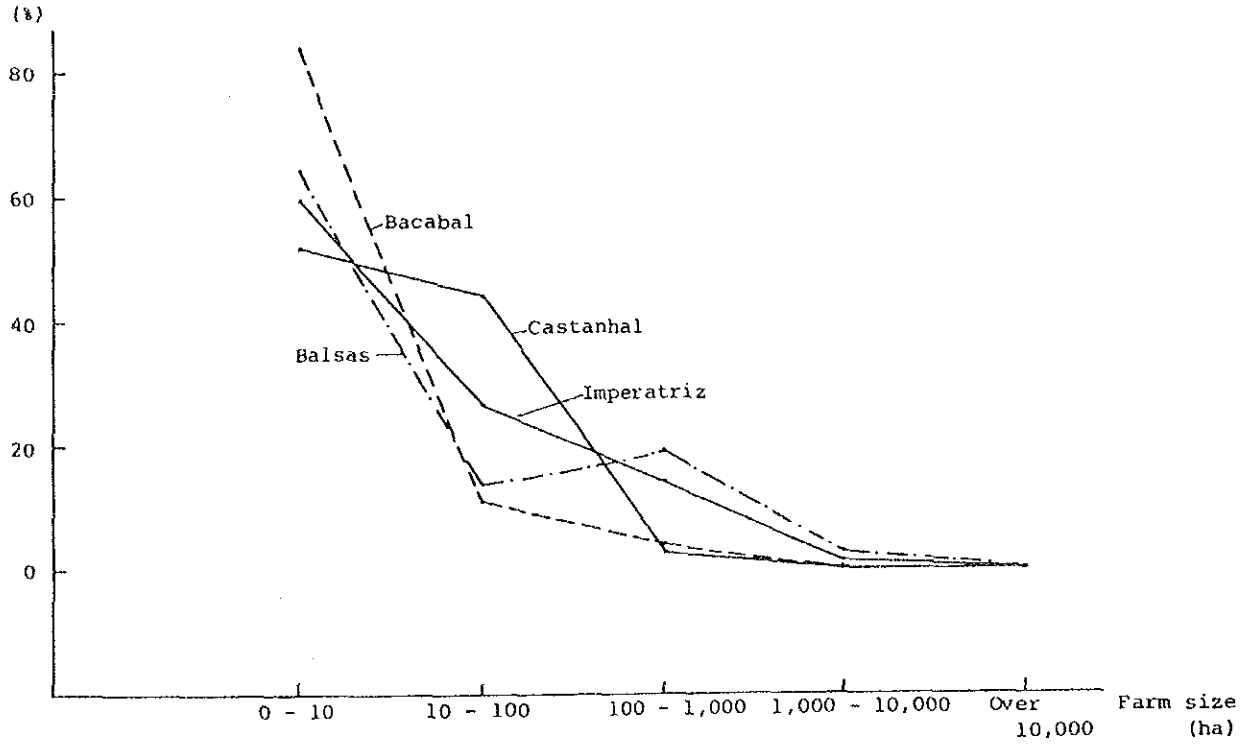


Table 4-11 Pattern of Land Ownership by Sub-region: Number of Farm Units (1980)

(%)

	Owners	Tenants	Occupants	Administrators	Total
Araguaina	75.4	5.8	18.2	0.6	100.0
Maraba	75.6	0.3	23.8	0.3	100.0
Xingu	3.9	0.4	95.8	0.0	100.0
Castanhal	56.4	4.2	38.6	0.8	100.0
Bacabal	19.2	39.7	40.5	0.6	100.0
Imperatriz	45.1	25.7	28.2	1.0	100.0
Balsas	30.6	25.1	43.1	1.2	100.0
Seven Sub-regions	37.1	25.5	36.7	0.7	100.0
Brazil	62.7	17.3	16.5	3.5	100.0

Source: IBGE, Censo Agropecuario, 1980.

Table 4-12 Pattern of Land Ownership by Sub-region: Total Holding Area (1980)

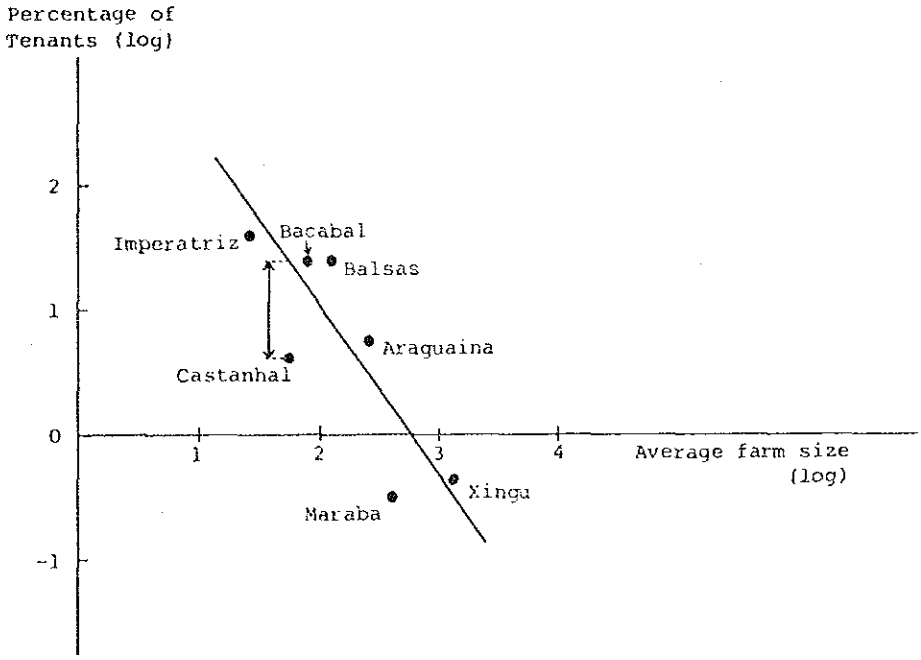
(%)

	Owners	Tenants	Occupants	Administrators	Total
Araguaina	88.6	0.3	11.0	0.1	100.0
Maraba	91.6	0.4	8.0	0.1	100.0
Xingu	64.5	16.1	19.4	0.0	100.0
Castanhal	90.6	0.3	9.0	0.1	100.0
Bacabal	91.6	2.6	5.6	0.2	100.0
Imperatriz	96.7	1.1	2.2	0.1	100.0
Balsas	94.8	0.3	4.8	0.1	100.0
Seven Sub-regions	90.7	1.3	7.9	0.1	100.0
Brazil	59.0	3.8	5.6	31.7	100.0

Source: IBGE, Censo Agropecuario, 1980.

close to Santa Ines made it clear that the land in the surroundings was held by eleven landowners, of whom ten did not possess official ownership-titles issued by either the central government or the government of the state of Maranhao, and all farmers responding to the interview were sharetenants who paid one fifth of their harvest (in the case of rice cultivation) to the landowners. These tenant-farmers, who originally came to this area in search for unoccupied land, have decided to settle down in this region as share-tenants because they thought there remained very few unoccupied land in the nearby regions. Another group of farmers in the neighborhood of Bacabal city informed that the share-cropping system with a share rate of 20% was also dominant in this area. Because of land constraint, neither the shifting cultivation nor the land rotation system with land put in fallow were practiced by these tenant-farmers. Most of them planted rice, maize, feijao and cassava on a land area of 2 - 5 ha without using chemical fertilizers.

Figure 4-7 Correlation between Farm-Size and Percentage of Tenants



4-5 Sub-region Castanhal

Sub-region Castanhal is situated at the north of the state of Para, including Bragantina zone, Salgado zone and municipality Paragominas of the Guajarina zone. The sub-region is known as the area the most populated of the state of Para with numerous small- and medium-size farms

cultivating rice, maize, cassava, and fruits as well as pepper, oil palm and other perennial crops by using non-traditional technologies. The special features of the sub-region's farm structure can be summarized as follows:

(1) The sub-region has high percentage of land used for cropping; the pasture area and forest area are relatively small (excluding municipality Paragominas) while the area of non-used arable land is large.

(2) Pepper and fruits such as papaya and melon are the major market-oriented products which are produced by the sub-region's advanced farmers; oil palm recently came to the picture as a promising perennial crop to be cultivated by medium-size farms; rice, maize, cassava and feijao are also the annual crops commonly cultivated by small-size farms in this sub-region.

(3) The average farm size was estimated at 58 ha for the whole sub-region and at 26 ha if municipality Paragominas is exclu-ded; the pattern of size distribution of farm units is characterized by high percentages of small-size strata.

(4) The sub-region has larger percentage of owners and and smaller percentage of tenants as compared to the pattern of land ownership of similar sub-regions Bacabal, Imperatriz and Balsas.

4-5-1 Land and Labor Utilization

The inclusion of municipality Paragominas in sub-region Castanhal makes this sub-region heterogeneous in terms of farming structure. The pattern of land use of the whole sub-region Castanhal is not significantly different from those of other sub-regions, but the pattern of land use in the Bragantina zone and Salgado zone seems to reveal remarkable contrasts, due to the fact that these two zones are densely populated while municipality Paragominas is a backward area with abundant undeveloped land.

The figures in Table 4-6 show that in 1980, for the whole sub-region Castanhal, 50% of the total land were forest area, 28% were used for cropping and cattle raising, and 22% were non-used arable land; the pasture area was 4.2 times of the cropping area. Thus, compared to the corresponding figures for all seven priority sub-regions, it can be said that the whole sub-region Castanhal is presently less active in livestock and has larger forest area, but these features are not prominent. On the other hand, the figures for Bragantina and Salgado show that, in the same year, 28% of land were forest area, 22% were used for cropping and 50% were unused arable land; the pasture area was smaller than the cropping area. Thus, Bragantina and Salgado are crop-oriented zones with less forest area and more unused arable land, although the percentage of pasture area is increasing. These findings are consistent to the prevailing opinion that cropping is dominant and most cattle farms are of medium-size at Bragantina and Salgado.

Castanhal is a populated sub-region with relatively unfavorable land endowment. The figures in Table 4-8 show that the number of temporary and permanent workers in the agricultural sector of the whole sub-region was 104 thousand in 1970 and 156 thousand in 1980. On the other hand, the total area of arable land of the whole sub-region increased from 810 thousand hectares to 1,290 thousand hectares in the same period. Consequently, the land-labor ratio of the whole sub-region increased from 7.8 ha/person in 1970 to 8.3 ha/person in 1980. This ratio in 1980 was slightly larger than that of Bacabal and smaller than those of all other sub-regions in the same year. This labor-intensive characteristic appears clearer in the land-labor ratio of Bragantina and Salgado which show a decline from 6.6 ha/person in 1970 to 5.3 ha/person in 1980.

4-5-2 Production of Major Crops

The recent changes in the structure of production of sub-region Castanhal can be summarized in the following four points: (1) upward shift of the production of fruits to meet the increasing demand of the urban markets, (2) a decline in the production of major cereals like rice and maize, (3) the dominance of pepper as a source of cash income of some groups of small farms, (4) the emergence of oil palm as a new promising crop for advanced medium-size farms.

The major fruits produced at Castanhal are banana, orange, papaya, mango and melon. The production of banana and mango tended to decline while the production of papaya and melon showed big jumps in the 1970s. The production of papaya has increased partly because of upward shift of its demand at the major urban markets like Belem, Brasilia and Sao Paulo, and partly because of the success in introducing the Hawaiian variety which is suitable to the natural conditions of this sub-region and to the taste of consumers. However, it is informed that the major fruits produced at Castanhal are now facing strong competition from other regions located closer to the main markets.

Rice, maize, feijao and cassava are also the major annual crops cultivated by small farms at Castanhal. But, here the harvest areas of rice and maize are smaller than that of cassava, and their production quantity shows tendency to decline. The figures in Table 4-13 show that the production quantity and harvest area of rice declined from 31 thousand tons and 37 thousand hectares in 1970 to 19 thousand tons and 27 thousand hectares in 1980. In the same period, the production quantity and the harvest area of maize declined from 19 thousand tons and 38 thousand hectares to 17 thousand tons and 32 thousand hectares. The production quantity and harvest area of cassava also tended to decline but still remained at 454 thousand tons and 47 thousand hectares in 1980. The harvest area of feijao is relatively small at Castanhal. The overall tendency to decline in the harvest areas of subsistence crops seems to due to a substitution of commercial crops for these crops in the study period.

Table 4-13 Production and Harvest Area of Selected Crops: Castanhal

	1970		1975		1980	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Banana (1,000 fruits)	858	525	589	478	506	374
Cocoa	24	18	167	102	498	223
Coffee	102	64	101	100	196	175
Orange (1,000 fruits)	481	29,578	117	10,632	182	9,879
Papaya (1,000 fruits)	-	326	-	271	1,183	37,439
Mango (1,000 fruits)	-	211	-	1,563	27	2,906
Pepper	-	5,362	5,719	12,688	9,498	18,621
Rice	33,593	25,090	37,377	30,729	26,551	19,454
Sugarcane	61	966	116	2,043	64	1,311
Feijao	7,010	3,085	4,905	2,207	7,939	4,662
Cassava	41,243	352,914	51,734	481,254	46,748	453,622
Maize	34,953	18,714	38,435	19,125	32,412	17,348
Brazil Nuts	-	12	-	24	-	53
Melon (1,000 fruits)	-	515	-	1,482	-	-
Oil Palm	-	-	-	-	-	1,713

Source: IBGE, Censo Agropecuario: Para, 1970, 1975, 1980.

In 1980, the total production of pepper (Pimenta do reino) of the whole Brazil was 63.7 thousand tons, of which 94% were produced in the state of Para and 80% were produced in the sub-region Castanhal. The production quantity of pepper at Castanhal which was only 5.4 thousand tons in 1970 jumped up to 12.7 thousand tons in 1975 and 18.6 thousand tons in 1980. It is informed that pepper at Castanhal is produced mainly by Japanese-origin farmers of relatively small size of planted area. Recently, pepper has lost its past impetus, because of various diseases, but presently still remains one of the major commercial crops of farmers in this sub-region.

The cultivation of oil palm, which appeared in the statistics of Agricultural Census from 1980 with a total production of 1.7 thousand tons, is still limited to a small number of farms located close to the DENPASA oil mill at Castanhal city. But there is a widespread opinion among the advanced farmers in this sub-region to expand the areas of oil palm in response to recent favorable changes in its market prices, and for the suitability of oil palm to the natural conditions of Castanhal, farmers' technical accumulation, and recent signs of recession in the production of other cash crops. An interview undertaken with those farmers at Castanhal made it clear that the availability of financial sources for initial investment seems to be crucial in strengthening the cultivation of oil palm in this sub-region.

4-5-3 Size Distribution of Farm Units

As presented in Table 4-10, the average farm size of the whole sub-region Castanhal was 45 ha in 1970 and 58 ha in 1980. The average farm size of Bragantina zone and Salgado zone was 19 ha in 1970 and 26 ha in 1980. Thus, on the average the farm size of the whole sub-region Castanhal is smaller than the farm sizes of Araguaina, Maraba, Xingu, Imperatriz and Balsas but as large as twice of the farm size of the most populated sub-region Bacabal of the state of Maranhao; however the average farm size of Bragantina and Salgado is exactly the same as that of Bacabal.

The special feature of the size distribution of farm units at Castanhal is large percentages of farms in the small-size strata. As shown in Table 4-10, of 46,091 farm units existing in 1980 at Castanhal 52% had size smaller than 10 ha and 96% had size smaller than 100 ha; the percentage of farms with size larger than 100 ha was as smaller as 4%. This pattern is more prominent in the size distribution of farm units at Bragantina zone and Salgado zone where the cropping activity is prevailing. The size distribution of farm units at Castanhal is similar to that of Imperatriz, Bacabal and Balsas, and different from that of Araguaina, Maraba, and Xingu (Figure 4-5 and Figure 4-6).

4-5-4 Pattern of Land-Ownership

The special feature of the pattern of land ownership at sub-region Castanhal is a small percentage of tenants as compared to other sub-

regions with similar pattern of size distribution. Generally speaking, the smaller is the average farm size the larger is the percentage of tenants because land has rental value only when it becomes scarce. This can be verified in Figure 4-7 which shows the relationship of the percentages of tenants in the total number of farm units and the average farm sizes of the seven priority sub-regions under study. It is verified that sub-region Castanhal which has an average farm size comparable to that of Bacabal, Imperatriz and Balsas, has a percentage of tenants less than 5%, as compared to 40% for Bacabal, 26% for Imperatriz, and 25% for Balsas.

In terms of number of farm units, owners shared 56.4%, tenants shared 4.2%, and occupants shared 39.6% in 1980 (Table 4-11). On the other hand, in terms of holding area, the percentages of these three categories in the same year are 90.6%, 0.3%, and 9.0%, respectively (Table 4-12). Thus, although sub-region Castanhal is similar to sub-region Bacabal in the sense that both are prevailed by small-size farms, the former (specially Bragantina and Salgado zones) differs from the latter in that the majority of small-and middle-size farms at Castanhal are owner-farms which use high cultivation technology and tend to produce more commercial crops.

4-6 Sub-region Imperatriz

Sub-region Imperatriz is situated in the south-east of the state of Maranhao. The sub-region covers the cities Imperatriz, Joao Lisboa, Acailandia, Porto Franco, and Amarante do Maranhao with the southern and western borders adjoining sub-regions Araguaina and Maraba. Imperatriz was selected as a priority sub-region of the Greater Carajas Program for its strategic importance in terms of location and natural resources. The city Imperatriz is the second largest city in the state of Maranhao with calmness and relatively well-organized administrative and transport networks. The sub-region is crossed north to south by the Belem-Brasilia highway, and east to west by the Carajas railway; these transport infrastructures and the Tocantins river play an important role in connecting the economic activities of this sub-region with the major economic centers of the country. The sub-region is endowed with rich forest resources and has high potential in rubber and sugarcane cultivation as well as in livestock development. The special features of sub-region Imperatriz's farm structure can be summarized as follows;

(1) The pattern of land utilization of the sub-region is very close to the average of all seven sub-regions under study.

(2) Although not as much as at Araguaina, Maraba and Xingu, cattle raising is the most important economic activity; rice, maize, feijao and cassava are also the basic annual crops cultivated by small farmers in this sub-region; the major fruits produced in this sub-region tended to increase both production quantity and harvest areas; the production of sugarcane tended to decline.

(3) The average farm size had almost doubled in the 1970s and attained

81 ha in 1980; the pattern of size distribution of this sub-region is characterized by large percentages of farms in the small-size strata.

(4) The sub-region presents an old-settled area where the percentage of occupants is small and, on the contrary, the percentage of small size tenants is relatively large.

4-6-1 Land and Labor Utilization

Generally speaking, the allocation of land among different economic activities in this sub-region is very close to the pattern of average land use of the seven priority sub-regions under study. Table 4-6 shows that in 1980 the percentages of land used for crops and pasture were 6.5% and 35.0%, as compared to the corresponding statistics for all seven sub-regions of 5.2% and 35.7%. However, the sub-region has less forest area (33.4% as compared to 40.7% and more unused arable land (25.1% as compared to 18.3%. This seems to reflect the fact that the sub-region has relatively large area of annual crops (6.2% as compared to 0.3% of perennial crops) which are commonly cultivated in a land rotation system with long period of fallow. Comparisons of the figures in Table 4-6 with those in Table 4-7 reveal that the percentage of land used for cropping and cattle raising declined while the percentage of forest area increased in the period 1970-80 (although the areas of all of these categories had substantially enlarged).

The total arable land, which is defined as the sum of crop area, pasture area, unused arable land and land in follow, jumped from 485 thousand hectares in 1970 to 1,246 thousand hectares in 1980, while the number of employed workers in the agricultural sector was estimated at 39 thousand in 1970 and 67 thousand in 1980. Consequently, the land-labor ratio increased from 12.6 ha/person to 18.7 ha/person and ranked fourth after Araguaina, Balsas and Maraba in 1980 (Table 4-8).

4-6-2 Production of Major Crops

Cattle raising is the most important activity in this sub-region, although the ratio of pasture area to cropping area is smaller than those at Maraba and Araguaina (1980). Rice, maize, feijao and cassava are also the principle annual crops cultivated by numerous subsistence farmers at Imperatriz. The figures in Table 4-14 show that the production quantity and harvest area of the two cereals (rice and maize) increased sharply in the period 1970-75 and remained almost constant in the period 1975-80; on the other hand, cassava declined sharply in the former period and remained almost constant in the latter. The quantity of rice production at Imperatriz was estimated at 109 thousand tons and was ranked second after Bacabal among the seven priority sub-regions under study. Feijao also showed tendency to increase in production. Although the statistics related to the production of soybeans still did not appear in the IBGE census in 1980, there was informed a movement among farmers toward planting this product in this sub-region.

Table 4-14 Production and Harvest Area of Selected Crops: Imperatriz

	1970		1975		1980	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Banana (1,000 fruits)	908	634	816	845	1,721	1,521
Coffee	12	10	-	7	-	17
Orange (1,000 fruits)	79	12,805	63	20,832	133	20,691
Papaya (1,000 fruits)	-	266	-	221	-	175
Mango (1,000 fruits)	-	4,032	-	8,916	70	8,032
Pepper	-	-	-	6	-	114
Rice	34,785	57,627	61,484	105,727	69,260	109,310
Sugarcane	192	2,698	-	1,646	31	396
Feijao	4,009	1,280	3,520	1,740	4,751	2,027
Cassava	5,556	22,335	2,354	15,293	1,963	14,732
Maize	28,054	9,711	38,442	17,559	38,533	18,352
Babassu	-	2,370	-	2,219	-	1,431

Source: IBGE, Censo Agropecuario: Maranhao, 1970, 1975, 1980.

The major perennial crops planted at Imperatriz are banana, orange, and mango. Banana showed substantial increases in both production quantity and harvest area in the period 1970-80. Imperatriz is also an area of natural babassu forest; the production of babassu in this sub-region had gradually declined in the past. There are no data on the production of rubber, the product referred to as suitable to the meteorological conditions of this sub-region. Experimentation tests undertaken by EMBRAPA showed that sugarcane cultivation is suitable to the natural conditions at Imperatriz and, consequently, the crop was once expected to be a substitute for pasture and a means to promote the alcohol manufacturing industry in this region.[1] However, the agricultural census data show that the production of sugarcane at Imperatriz which was estimated at 2,700 tons in 1970 declined to 400 tons in 1980.

4-6-3 Size Distribution of Farm Units

Although situated close to Araguaina and Maraba, the farm structure of Imperatriz is different from that of these two sub-regions and, instead, similar to the farm structure of Castanhal, Bacabal and Balsas. The average farm size at Imperatriz was estimated at 49 ha in 1970 and 81 ha in 1980. The sub-region's farm size in 1980 was relatively small as compared to that of Xingu, Maraba, Araguaina and Balsas, and is slightly larger than the average farm size of the whole seven priority sub-regions under study. The pattern of size distribution of farm units at Imperatriz is similar to the average size distribution of all seven sub-regions, with an exception in that Imperatriz has slightly smaller percentage of farms in the stratum 0 - 10 ha and larger percentage of farmers in the stratum 100 - 1,000 ha. Table 4-10 shows that in 1980, of the total 23,344 farm units existing at Imperatriz, 59% had size smaller than 10 ha, 26% were of the size 10 - 100 ha, and 15% had size larger than 100 ha, as compared to the corresponding percentages of 65%, 24% and 11% for all seven priority sub-regions. The pattern of farm-size distribution of Imperatriz is presented in Figure 4-6.

4-6-4 Pattern of Land-Ownership

Compared to the neighbor sub-region Maraba, Imperatriz is an old-settled area which has rather stable agrarian structure. The stability of Imperatriz's agrarian structure seems to be also attributable to the existence of the most important executive unit of Araguaia-Tocantins Lands Executive Group (GETAT) in this sub-region.

As an old-settled area where the average farm size is not large, the rental value of land at Imperatriz is thought to be significantly positive and, thus, the sub-region has the conditions for the development of the owner-tenant relationship. The figures in Table 4-11 show

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1) Ministry of Agriculture, Programa Grande Carajas: Agricola (Versao Preliminar) Vol. 3.

that, in terms of number of farm units, about 26% of farms in the sub-region were classified under the category "tenants" as compared to 45% as owners and 28% as occupants. The percentage of owners was larger and that of occupants was smaller at Imperatriz, as compared to the other sub-regions in the state of Maranhao. In terms of holding area, the category "owners" shared 96.7% while the categories "tenants" and "occupants" shared only 1.1% and 2.2% in 1980 (Table 4-12).

4-7 Sub-region Balsas

The sub-region Balsas is situated in the south-west of the state of Maranhao and includes three districts (municipios) of Chapados do Sul Maranhense zone and two districts of Baixo Balsas zone as its coverage area. The sub-region was originally an area of extensive cattle raising and began to attract the inflow of crop producers very recently. The sub-region is principally a savanna area where the population density is relatively low; the shortage of labor and insufficiency of transport network to link the sub-region with the Belem-Brasilia highway and the Carajas railway present the major bottle-necks of its development at this moment. Soybeans, which began to be planted at Balsas in the recent years, seems to indicate a possibility of the sub-region's development in the future. The special feature of the farm structure of this sub-region can be summarized as follows:

(1) Very few forest areas exist at Balsas because the major part of this sub-region is savanna; about 50% of the total land area is under pasture, and natural pasture is dominant reflecting the widespread traditional cattle raising system in this sub-region.

(2) Rice, maize, feijao and cassava are also commonly cultivated by the majority of subsistence farmers for self-consumption; soybeans began to be planted recently in some limited land area.

(3) Balsas is a backward region of the state of Maranhao with an average farm size estimated at 137 ha and ranked fourth after Xingu, Araguaina and Maraba among the seven sub-regions under study; the pattern of size distribution of farm units shows signs of polarization.

(4) The sub-region has relatively large percentages of tenants and occupants, and relatively small percentage of owner-farmers.

4-7-1 Land and Labor Utilization

Balsas was originally an area of beef production, and cropping activities were introduced to the sub-region very recently. Because of this, it is observed that the percentage of land used for cropping has increased rapidly although the percentage of pasture area (specially of natural pasture) still remains high. In addition, there exists rela-

tively small percentage of forest area, reflecting the dominant savanna characteristics of the natural conditions of this sub-region.

The figures in Table 4-7 show that in 1970, the percentage of land under forest at Balsas was 19% or about one half of the percentage of forest area of all seven priority sub-regions. The percentages of land areas under crops and pasture in the same year were 1.5% and 51.8%, respectively, as compared to 4.9% and 29.6% for all seven sub-regions. These figures seem to reflect the fact that Balsas was originally a cattle raising sub-region, and there existed very few forest area. When it comes to 1980 (Table 4-6), the percentage of cropping area jumped up to 5.4% while the percentage of pasture area declined slightly to 49.2%. Thus, it is observed that there was a tendency of increase in cropping activities in the 1970s at Balsas, but cattle raising still remained dominant at the end of this decade. The other special features of land use in this sub-region are a high percentage of land used for annual crops as compared to perennial crops, and a high percentage of area under natural pasture as compared to planted pasture. This seems to reveal the following aspects of the farming structure of this sub-region: tendency of newly-established agricultural producers to cultivate annual crops for both self-consumption and sale, and the dominance of previously-settled cattle farms using traditional raising techniques.

As above mentioned, the population density of Balsas is rather low. This is reflected in a high land-labor ratio of this sub-region. Table 4-10 shows that, in the period 1970-80, the number of employed workers in the agricultural sector increased from 24 thousand to 30 thousand, and the area of total arable land increased from 957 thousand hectares to 1,061 thousand hectares. Consequently, the land-labor ratio of this sub-region declined from 40 ha/person in 1970 to 36 ha/person in 1980. The land-labor ratio estimated for Balsas in 1980 is ranked second after Araguaina among the seven priority sub-regions under study.

4-7-2 Production of Major Crops

Rice, maize, feijao and cassava are also the major annual crops cultivated by the majority of small-size farms at Balsas. Of these four basic annual crops, rice presently shares the largest harvest area and has shown tendency of rapid increases in both the production quantity and harvest area. Maize and feijao indicate a decline in the period 1970-75 and an increase in the period 1975-80 in their production and harvest area, while cassava had declined steadily throughout the period 1970-80. Table 4-15 shows that the total production of rice had doubled in the period 1970-80 due to increase in its harvest area. In 1980, the production quantity and harvest area of rice were estimated at 38 thousand tons (unhulled paddy) and 35 thousand hectares.

The major perennial crops planted at Balsas are banana, orange, and mango. However, the quantity of production and the harvest areas of these crops are very small as compared to annual crops. Babassu nuts are also collected for sale in this sub-region, but the quantity of

Table 4-15 Production and Harvest Area of Selected Crops: Balsas

	1970		1975		1980	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Banana (1,000 fruits)	301	141	137	95	119	99
Coffee	-	-	-	-	-	1
Orange (1,000 fruits)	19	4,954	18	7,346	32	5,001
Papaya (1,000 fruits)	-	24	-	1	-	7
Mango (1,000 fruits)	-	76	24	164	-	334
Rice	10,628	16,362	15,425	14,119	34,662	36,748
Sugarcane	260	4,434	-	1,618	59	1,321
Feijao	1,731	794	516	215	1,462	418
Cassava	1,784	7,356	527	2,731	361	2,209
Maize	8,308	5,399	6,671	3,325	8,826	3,309
Babassu	-	328	-	202	-	205

Source: IBGE, Censo Agropecuario: Maranhao, 1970, 1975, 1980.

collected nuts each year in this sub-region is small as compared to Bacabal, Araguaina and Imperatriz.

It is informed that the favorable changes in the price of soybeans in the past and the availability of EMBRAPA's new soybean variety "Tropical" have stimulated the cultivation of this crop among the advanced farmers in this sub-region in the past several years. Unfortunately, the series of IBGE Agricultural Census does not provide data related to the production of this crop at Balsas for further study.

4-7-3 Size Distribution of Farm Units

The average farm size at Balsas declined from 176 ha in 1970 to 137 ha in 1980, and presently is ranked fourth after Xingu, Maraba, and Imperatriz (Table 4-10). The total number of farm units was estimated at 9,588 in 1980. Of this total 63.9% were classified in the 0 - 100 ha stratum, 19.3% in the 100 - 1,000 ha stratum, and 3.1% in the strata of over 1,000 ha. Thus, compared to the figures related to the size distribution of farm units at Castanhal, Imperatriz, and Bacabal, it can be said that the pattern of farm-size distribution at Balsas has relatively large percentage of farms with small size (0 - 10 hectares), small percentage of farms the small-medium size (10 - 100 hectares) and large percentages of farms in the medium- and large-size strata. This difference is clearly depicted by Figure 4-6 in which the size distribution curve of Balsas shows a convexity at the stratum 100 - 1,000 hectares. This characteristic of Balsas' pattern of size distribution can be explained by the above-mentioned historical developments in the farming structure of this region: the inflow of numerous immigrants to the region as small producers of annual crops, and the existence of a considerable number of previously-settled large-size cattle farms.

4-7-4 Pattern of Land-Ownership

The pattern of land-ownership at sub-region Balsas is characterized by large percentages of tenants and occupants, and a small percentage of owners. In 1980, in terms of percentage in the total number of farm units, owner-farmers shared 31%, tenants shared 25% and occupants shared 43%. On the other hand, in terms of percentage in the total holding area, owner-farmers shared 94.8% while tenants and occupants shared 0.3% and 4.8% respectively. From these figures, it can be inferred that the differences in farm size between owner-farmers and tenants or occupants are large. In fact, the average farm size was estimated at 424 ha for owner-farmers as compared to 1.9 ha for tenants and 15.2 ha for occupants in 1980.

4-8 Sub-region Araguaina

Araguaina presents the only one sub-region of the state of Goias which is included in the Greated Carajas Program. The sub-region is

situated at the extreme north of the state of Goias and between the two rivers Araguaia and Tocantins. The construction of the Belem-Brasilia and Trans-Amazon highways which cross the center of the sub-region has brought about dynamic changes in the demographic and economic structure of the sub-regions in recent years. Araguaina has a relatively long history of land settlement, and most of its land is flat, as compared to Maraba and Imperatriz. The special features of the farm structure of Araguaina can be summarized as follows:

(1) Araguaina is among the sub-regions with large percentage of land used for cattle raising; there exist relatively small percentages of forest areas and unused arable land in the sub-region.

(2) Like in other sub-regions of the PGC Area, rice, maize, feijao and cassava are the four basic annual crops which are produced by small- and middle-size farms mainly for self-consumption; the production of rice and maize had tendency to increase while that of feijao and casava tended to decline in the period 1970-80.

(3) For large-scale commercial farms, cattle raising is the most important income source in this sub-region, but the emergence of soybeans in the recent years seems to indicate a new possibility of the sub-region's agricultural development.

(4) The average farm size of Araguaina had increased from 194 ha in 1970 to 254 ha in 1980 due mainly to increase in the number of large-scale cattle farms; the majority of the sub-region's farm units are distributed to the middle-size strata.

(5) The sub-region's pattern of land ownership is characterized by large percentages of the categories "owners" in terms of number of farm-households and holding area.

4-8-1 Land and Labor Utilization

The most distinctive feature of the sub-region's pattern of land utilization is a high percentage of land under pasture and, on the contrary, small a percentage of land used for cropping.

Table 4-6 summarizes the pattern of land utilization by priority sub-region in 1980. It is observed that almost 50% of land was used for cattle raising (natural and planted pasture areas) while the cropping area shared less than 4% in Araguaina. The percentages of forest area and unused arable land were 33% and 14%, respectively. These figures imply that Araguaina is a cattle raising region, as the area under pasture was 14 times larger than the cropping area, as compared to the corresponding figures of 6.9 times and 3.5 times for all priority sub-regions and the whole Brazil. On the other hand, reflecting the sub-region's long history of settlement its percentages of unused arable land and forest area are relatively low and close to the national averages. Comparisons of the figures for 1980 (Table 4-6) to those for 1970 (Table 4-7) reveal that during the period 1970-80

there were increases in the percentages of land used for cropping and pasture, and declines in the percentages of forest area and unused arable land.

The number of temporary and permanent workers employed in the agricultural sector of the sub-region Araguaina had increased from 41.8 thousand persons in 1970 to 49 thousand persons in 1980 (Table 4-8). In the same period, the total arable land had increased from 1,672.4 thousand hectares to 2,699.8 thousand hectares. These figures imply that the average land-labor ratio of he sub-region had increased from 40 ha/person in 1970 to 55 ha/person in 1980. Thus, Araguaina can be regarded as the sub-region the most favorable in terms of land-labor ratio among the seven priority sub-regions under study, although the average farm size (as referred to below) is smaller than those of Xingu and Maraba. This land-labor ratio seems to be attributable to the dominance of large-scale cattle farms in this sub-region.

4-8-2 Production of Major Crops

The quantity of production and the harvest areas of major crops planted in sub-region Araguaina in 1970 and 1980 are presented on Table 4-16. Of the total cropping area in 1980, 85% were planted in annual crops and 15% in perennial crops. The four subsistence crops rice, maize, feijao, and cassava shared over 80% of the total area of annual crops in the same year, while the shares of rice and maize were 50% and 25%, respectively. With respect to perennial crops, farmers in this sub-region are cultivating banana, coffee, orange and mango, and others. The planted area of banana alone shared 25% of the total planted area of perennial crops in 1980.

The production and harvest area of rice, the most important annual crop at Araguaina, in 1980 were 69 thousand tons and 62 thousand hectares, respectively, as compared to 51 thousand tons and 41 thousand hectares in 1970. In the same period, the production of maize increased by 10% while the production level of feijao declined by 15%. Cassava showed substantial reduction in terms of harvest area and production in the same period. With regard to perennial crops, it is observed that the production of coffee and orange declined and that of banana, papaya and mango increased.

Araguaina is also a sub-region of babassu trees, although the production quantity of babassu in this sub-region is small as compared with Bacabal and tends to decline. Soybean, with the production quantity and harvest area still as small as 5 tons and 10 ha in 1980, presents a promising commercial crop in the future. The emergence of soybean in recent years seemed to have been attributable to the following two factors: the appearance of a new variety named "tropical" suitable to the natural conditions of the area, and favorable changes of the relative price of this product in the domestic and international markets. Recently, soybean producers have faced difficulties in expanding the area of this product because of financial constraints.

The prices of soybeans in the domestic and international markets in the period 1970~80 are as follows:[1)]

	1970	1972	1974	1976	1978	1980
International Market (CIF, Rotterdam US$/ton)	117	140	277	231	268	297
Domestic Market (Real price index)	100	108	105	113	173	156

Table 4-16 Production and Harvest Area of Selected Crops: Araguaina

	1970		1980	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Banana (1,000 fruits)	1,621	1,171	5,065	3,346
Coffee	53	42	41	30
Orange (1,000 fruits)	126	15,405	79	11,889
Papaya (1,000 fruits)	-	15	-	186
Mango (1,000 fruits)	-	0	14	1,829
Rice	40,647	51,241	61,690	69,264
Sugarcane	213	5,099	74	1,364
Feijao	7,176	2,476	6,842	2,136
Cassava	7,194	44,901	2,622	18,301
Maize	27,213	16,400	30,903	18,143
Babassu	-	3,495	-	3,223
Soybean	-	-	10	5

Source: IBGE, Censo Agropecuario : Goias, 1970, 1980.

1) Prices of soybean are based on Agricultural Economics Institution (Sao Paulo), Prognostico 1975-76, 1981-82. The real domestic price index was derived by dividing the annual average prices of soybean by the general price index which was obtained from EMBRAPA, Informacoes e Indices Basicos da Economia Brasileira, 1983.

4-8-3 Size Distribution of Farm Units

The average farm size of Araguaina had increased from 194 ha in 1970 to 254 ha in 1980, and is now ranking third after Xingu and Maraba among the priority sub-regions under study. The figures in Table 4-10 show that, of 16,491 farm units existing in Araguaina in 1980, 16% had total area smaller than 10 ha, and 80% of farmers had total area ranking from 10 to 1,000 ha. The pattern of size distribution of farmers in Araguaina is, thus, similar to that of Maraba and Xingu, and different from that of Castanhal, Imperatriz, Bacabal and Balsas where farm units are distributed more to the small size strata.

4-8-4 Pattern of Land-Ownership

It is observed from Table 4-11 and Table 4-12 that the percentage of farms under the category "owners" is relatively high in terms of number of farm units; 75% of farmers in Araguaina were owner farmers and only 6% were tenant farmers, as compared to the corresponding averages of all priority sub-regions of 37% and 25%, respectively. However, in terms of total holding area, the percentage of land under the category "owner" is 89%, a level relatively low compared to Maraba, Castanhal, Bacabal, Imperatriz, and Balsas; on the other hand, the figures under the category "occupant" shows smaller percentage in terms of farm units and higher percentage in terms of holding area. This seems to indicate that the average farm size of occupants in Araguaina is relatively large.

4-9 Sub-region Maraba

Maraba is situated at the south-east of the state of Para and represents one of the most important sub-regions from the point of view of the development strategy of the Greater Carajas Program, due to its favorable location. The sub-region Maraba is crossed over by the two rivers Araguaia and Tocantins and is the site of the Tucurui hydro-electric dam. The construction of the Trans-Amazon highway and the Carajas railway as well as the discover of mining resources have brought about to that sub-region various dynamic changes in the past and made it an area where the most striking signs of development are taking place. Besides being a region of large-scale cattle raising, Maraba also presents an area where the major official settlement projects are being implemented, and there arise many disputes on the issue of land ownership. The special features of sub-region Maraba's farm structure can be summarized as follows:

(1) The percentage and absolute area of land used for cropping and cattle raising had largely increased in the period 1970-80, although forest areas and unused arable land still substantially remain in this sub-regions; land used for cattle raising is relatively large as compared to cropping area.

(2) Rice, maize, feijao and cassava are also the basic annual crops

cultivated by the sub-region's small- and medium-size farms; the first three crops show tendency to increases in production while the last crop tends to decline; shifting cultivation is widely practiced in the sub-region.

(3) The average farm size of sub-region Maraba in 1980 was 374 ha and ranked second after Xingu among the seven priority sub-regions under study; the pattern of size distribution of farm units in the sub-region is characterized by large percentages of middle- and large-size farms (100 - 1,000 ha).

(4) The category "owners" occupies virtually large shares in terms of number of farm units and holding area, while occupants share considerable percentage in terms of farm units and relatively small percentage in terms of holding area; Maraba is presently a spot of disputes on the issue of land ownership because there still exists large amount of unsettled land (including forest areas) and there is increasing expectation of its development possibility along with the construction of the Carajas railway.

4-9-1 Land and Labor Utilization

The most distinctive feature of the pattern of land use at sub-region Maraba is the remaining high percentage of land area under natural forest. In 1980, nearly 70% of the total land at Maraba were under natural forest, and the percentage of total land used for cropping and pasture was less than 25% while in 1970 the forest area and land for cropping and pasture were 90% and 10%, respectively. Through these figures, it can be said that in the last decade there was rapid progress in the utilization of natural forest land at Maraba for cropping and specially cattle raising, but there is still large room at present for expansion of land for these two activities. In 1980, the percentage of land under pasture was 11 times of that used for cropping, and most of pasture in the sub-region was planted. This seems to indicate that cattle raising is the dominant activity and most of cattle farms in the sub-region are using modern raising techniques

In the period 1970-80, the number of employed workers in the sub-region's agricultural sector had doubled and the total area of arable land had increased by seven times. As a result, the land-labor ratio had increased from 6.4 ha/person in 1970 to 22.5 ha/person in 1980, as compared to the corresponding figure of 14.8 ha/person for all seven sub-regions and for the whole Brazil.

This seems to reflect increase in the importance of cattle raising in this sub-region in the last decade.

4-9-2 Production of Major Crops

Rice, maize, feijao and cassava are the basic annual crops cultivated by subsistence farmers in Maraba. It was observed during the

Table 4-17 Production and Harvest Area of Selected Crops: Maraba

	1970		1975		1980	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Banana (1,000 fruits)	741	604	861	807	1,818	1,428
Cocoa	15	5	4	1	93	34
Coffee	3	0	101	5	47	15
Orange (1,000 fruits)	2	312	39	1,463	55	3,290
Papaya (1,000 fruits)	-	1	-	17	8	36
Mango (1,000 fruits)	-	-	-	836	16	973
Papper	-	-	-	-	19	20
Rice	11,191	11,687	31,169	31,271	29,977	36,896
Sugarcane	5	26	5	55	5	50
Feijao	412	324	2,154	926	3,292	1,377
Cassava	2,060	23,985	1,889	20,047	1,369	12,987
Maize	8,450	5,503	21,816	10,059	19,570	12,906
Brazil Nuts	-	22,068	-	17,498	-	11,728

Source: IBGE, Censo Agropecuario: Para, 1970, 1975, 1980.

field observations that farmers burned each year 3 to ten hectares of primary or secondary forest for planting the above four crops without fertilizers and with very simple agricultural tools. It is informed that usually farmers leave behind the land and move to other places after the first harvest of the annual crops. But there are also cases where, instead of moving to other places, farmers adopt a pattern of land rotation which includes either a long period of fallow immediately after the harvest of the annual crops or several years of pasture before the fallow period. The production quantity and harvest area of rice tripled in the period 1970-80. Feijao and maize also recorded increases in their production and harvested area while cassava showed substantial declines.

The major perennial crops cultivated at Maraba are banana, cocoa, coffee, orange and pepper. Banana has the largest harvest area among these perennial crops and had shown considerable increases in both production quantity and harvest area in the period 1970-80. Cocoa and pepper which began to strengthen their production and harvest area around 1980 seem to present new sources of cash incomes of farmers in this sub-region. Maraba is also an area producing Brazil nuts, an important source of foreign exchanges earning of Brazil. The production of Brazil nuts at Maraba was estimated at 22 thousand tons in 1970 and 12 thousand tons in 1980.

4-9-3 Size Distribution of Farm Units

The average farm size of sub-region Maraba had increased from 210 ha in 1970 to 374 ha in 1980 and is now ranked second after Xingu among the priority sub-regions under study. The size distribution of farm units at Maraba in 1980, as presented in Table 4-10 and Figure 4-5, shows 40% and 52% of farmers in the strata 10 - 100 ha and 100 - 1,000 ha, respectively, the percentage of farms with size smaller than 10 ha is 3% compared to 65% for all priority sub-regions, and 52%, 59%, 84% and 64% for Castanhal, Imperatriz, Bacabal, and Balsas. Figure 4-5 and Figure 4-6 show that the pattern of size distribution of farm units at Maraba is similar to that of Araguaina and Xingu, and contrastive to that of the other sub-regions.

4-9-4 Pattern of Land-Ownership

Maraba is a development frontier of the PGC Area and of the whole Brazil. Improvement in the transport infrastructure of this sub-region (the construction of the Trans-Amazon highway and the Carajas railway), together with government's tax policy and the exploitation of mining resources, has increased expectation on its development possibility and stimulated investors from the South to come and turn unused arable land and forest area into large-scale cattle farms. On the other hand, the existence of large areas of unused land in this sub-region has also induced small farmers and landless workers in the surrounding populated regions to come and search for new land for settlement. It is informed that in the past these movements had brought about many

conflicts between previously settled farmers and newcomers, and finally obliged the central government to establish the executive group GETAT. Although the establishment of GETAT has gradually reduced this tension, the problems of land ownership still remain presently a hot issue in this sub-region.

As a newly-settled area of abundant land, the percentage of tenants at Maraba is very small; most of farmers and holding areas in this sub-region are classified under the categories "owners" and "occupants".

4-10 Sub-region Xingu

Xingu is the most remote area among the seven priority sub-regions under study. Interests on the development of this sub-region began to arise very recently along with the prospect of the construction of the Carajas railway with a terminal station located about 100 km from the center of the region. Agricultural planners and private investors have been also interested in Xingu for the belief that there exist in this sub-region substantial areas of high quality land suitable for the plantation of rubber, cocoa and guarana. The special features of sub-region Xingu's farm structure can be summarized as follows:

(1) The sub-region is a backward area with most of land being under natural forest; the total area of land used for cropping and cattle raising is still very small.

(2) The percentage of land under pasture is high as compared with land used for cropping, but the proportion of these two is not as high as all sub-regions' average; rice, maize, feijao and cassava are also the basic annual crops cultivated by small- and medium-size farms in the sub-region mainly for self-consumption.

(3) Xingu has the largest average farm size among the seven sub-regions study; the pattern of size distribution of farm units in this sub-region is characterized by large percentages of farms in the middle- and large-size strata.

(4) The number of farm units and the holding area under the category "owners" are small while the category "occupants" is relatively large in both terms of farm units and holding area.

4-10-1 Land and Labor Utilization

Compared to the whole Brazil, the PGC Area is a region where there still exist large areas of natural forest and unused arable land. This characteristic of land use is specially prominent in sub-region Xingu where the Agricultural Census in 1980 shows that 94% of the sub-region's total area was under forest, and the total cropping and pasture area shared only 6%.

The statistics available for the year 1980 do not indicate that

cattle raising was specially dominant at Xingu as compared to other sub-regions under study (ratio of pasture area to cropping area was 6 : 1 for Xingu and 6.9 : 1 for all seven sub-regions), but it is observed that most of the forest area which was turned into agricultural land in the period 1970-80 was used for pasture, as the percentage of cropping area declined from 2.4% in 1970 to 0.8% in 1980 while the percentage of pasture area increased from 1.6% in 1970 to 4.9% in 1980.

Because of this increase in the area of pasture, it is predicted that the ratio of pasture land to cropping land at Xingu will continue to increase in the future. It is also observed that all pasture at Xingu is planted, reflecting the likely fact that cattle farms in this sub-region are newly established and using relatively modern techniques.

The number of employed workers in the agricultural sector of sub-region Xingu increased rapidly from 400 persons in 1970 to 1,500 persons in 1980. In the same period, the total arable land increased from 500 ha to 24,100 ha. These figures mean that the land-labor ratio of the sub-region had increased from 1.3 ha/person in 1970 to 16.1 ha/person in 1980. Thus, the available data show that the land-labor ratio of sub-region Xingu in 1980 was larger than those of Castanhal and Bacabal and smaller than those of the other sub-regions. This seems to be due to the fact that, although the average farm size estimated on the basis of total holding area of Xingu (as referred to below) is the largest among the sub-regions, the area of arable land of each farm at this sub-region is relatively small.

4-10-2 Production of Major Crops

All economic activities at Xingu are still very limited, showing that the sub-region is a new area where substantial development will take place in the years ahead. The data from the Agricultural Census in 1980 show that the total area of land used for annual crops in this sub-region was 2,370 ha[1)], of which 74% were planted in the four basic crops rice, maize, feijao and cassava. The production quantity and harvest area of rice in 1980 were 1,343 tons and 1,007 ha respectively, as compared to 50 tons and 58 ha in 1970. The production quantity and harvest area of maize and feijao in 1980 were also still very limited but substantially larger than the corresponding level recorded for 1970. Like in other sub-regions, cassava also shows ten-dency to decline in both production and harvest area in this sub-region.

The major perennial crops cultivated at Xingu are banana and coffee with the harvest areas being 81 ha and 12 ha, respectively, in 1980. Besides, cocoa, orange, papaya and mango are also cultivated, but their harvest areas are still very small. Xingu is also an area producing Brazil nuts; the sub-region's production quantity of this production tends to increase but is still at low level as compared to

1) IBGE, Censo Agropecuario: Para, 1980

Table 4-18 Production and Harvest Area of Selected Crops: Xingu

	1970		1975		1980	
	Area (ha)	Production (ton)	Area (ha)	Production (ton)	Area (ha)	Production (ton)
Banana (1,000 fruits)	55	33	35	23	81	82
Cocoa	-	-	-	-	2	3
Coffee	-	-	-	-	12	35
Orange (1,000 fruits)	1	15	-	6	3	227
Mango (1,000 fruits)	-	-	-	-	3	233
Papaya (1,000 fruits)	-	-	-	-	1	80
Rice	58	50	253	230	1,007	1,343
Sugarcane	-	-	-	6	4	227
Feijao	3	0	10	4	126	96
Cassava	96	925	105	931	85	569
Maize	104	79	180	194	526	564
Brazil Nuts	-	-	-	161	-	772

Source: IBGE, Censo Agropecuario: Para, 1970, 1975, 1980.

sub-region Maraba. There are no data on the production of rubber, the perennial crop referred to as promising to this sub-region.

4-10-3 Size Distribution of Farm Units

In 1980, the sub-region Xingu had 283 farm units in total with an average farm size of 1,578 ha. This average size was ranked first among the sub-regions, 4.2 times larger than the second largest average farm size (Maraba) and 60 times larger than the smallest average farm size (Bacabal). The special feature of the size distribution pattern of farm units at Xingu is large percentages of farms of medium- and large-size. Table 4-10 shows that in 1980, 70% of farm units were in the stratum 100 - 1,000 ha and 10% of farm units had size larger than 1,000 ha, while the percentage of farms with size smaller than 10 ha was as small as 20%. The pattern of size distribution of farms at Xingu is similar to those of Maraba and Araguaina, and shows remarkable contrasts with those of the other sub-regions (Figures 4-5 and 4-6).

4-10-4 Pattern of Land-Ownership

The pattern of land ownership in sub-region Xingu shows remarkable differences with that of other regions. In 1980, of 283 farm units existing at Xingu eleven were owners, one was tenant and the remaining were occupants. The percentages of owners and tenants in terms of number of farm units were small while the percentage of occupants was large. In terms of total holding area, owner-farmers shared 64.5% tenants shared 16.1%, and occupants shared 19.4%. More in detail, eleven owners held 287,971 ha (average holding area per farm: 26,180 ha), one tenant held 72,000 ha (average holding area per farm: 72,000 ha) and two hundreds seventy one occupants held 86,717 ha (average holding area per farm: 320 ha) in 1980[1].

4-11 Summary and Fact Findings

In order to clarify the structure of farming of the PGC Area, we began this chapter by a brief review of the similar previous studies related to the Greater Carajas Program itself (by the Ministry of Agriculture) and the PRODIAT program (by the Ministry of Interior). The review made it clear that these studies presented a useful step toward understanding the farm structure of the region, but for their different purposes they still do not fully depict the special features of the region's farm structure. We then proceeded to make an outline of the farm structure of the PGC Area by comparing the pattern of land and labor utilization, trends of production and harvest area of selected crops, size distribution of farm units, and pattern of land-ownership of all seven priority sub-regions of the PGC Area with the corresponding components of the farm structure of the whole Brazil. Finally, a

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1) IBGE, Censo Agropecuario: Para, 1980, p. 172.

detailed analysis was undertaken for each of the seven priority sub-regions. Following are the major fact findings of the farm structure analysis in this chapter:

(1) The PGC Area has undergone a process of rapid agricultural development through expansion of cropping and pasture land. The comparison of the trend of production of the major agricultural products between these sub-regions and the whole Brazil revealed that the quantities of production of the selected crops and cattle (see Chapter 8) at the sub-regions under study showed higher rates of increase, due mainly to expansion of their areas. This high pace of agricultural development, based on the use of unsettled land, was attributable to the existence of vast areas of unused arable land and forest in this region, as well as to the public investments made on its transport infrastructure in the past decade.

(2) Despite rapid increases in the areas of cropping and pasture, the priority sub-regions of the PGC Area are still endowed with large percentages of unused arable land and forest areas. The figures obtained from the agricultural census of IBGE showed that in 1980 about 60% of the total area of these sub-regions were not used for cropping or pasture, as compared to a percentage of 35% in the case of the whole Brazil. This high percentage of undeveloped land existing in these sub-regions indicates their high development potential, and explains the underlying reason of the land-using method of cropping and cattle raising commonly practiced in these sub-regions.

(3) The PGC Area is a beef-production-oriented region where the ratio of pasture area to cropping area is substantially high as compared to the national average. It was also verified that most of the pasture fields in those sub-regions such as Maraba, Araguaina and Xingu are planted, reflecting the fact that most of cattle farms in these sub-regions are newly-established and using relatively modern raising techniques.

(4) Rice, maize, feijao and cassava are cultivated by the majority of small- and medium-size farms in all sub-regions mainly for self-consumption. However, the cropping system of these four subsistence crops varies from one sub-region to another. It was informed that the three cropping systems commonly practiced are shifting cultivation, land rotation system, and sedentary cropping system. The first and second systems of cropping were informed to be practiced by farmers at less populated sub-regions like Maraba and Araguaina, while the third system was found common to farmers at the densely populated zones of Bacabal.

(5) The major agricultural products of the PGC Area can be classified into the following three categories: (i) four basic subsistence crops: rice, maize, cassava and feijao, (ii) extractive products: babassu and Brazil nuts, and (iii) commercial crops: melon, soybeans (annual), pepper, papaya, coffee, cocoa, orange, etc.

(perennial). The harvest areas of perennial crops are very small as compared to these of the four basic subsistence crops. Pepper has been an important source of cash income of advanced farmers in the Area. Although still small in terms of production quantity and harvest area, oil palm and soybean have emerged as two new commercial crops. Oil palm, which is considered suitable to the meteorological characteristics of sub-region Castanhal, began to be planted by some advanced farmers in this sub-region at the end of the 1970s. Soybean was first planted in this region also at the end of the 1970s by farmers at Araguaina, Imperatriz and Balsas as a substitute for pasture. The emergence of soybean was said to be due to the availability of a new soybean variety named "tropical" suitable to the natural conditions of these sub-regions.

(6) The average farm size of all seven priority sub-regions under study began with a level below the national average in 1970, increased rapidly and surpassed the national average at the end of the 1970s. The pattern of size distribution of farm units in these sub-regions is characterized by larger percentages of farm units in the small- and large-size strata and a smaller percentage of farms in the medium-size strata, as compared to the pattern of farm-size distribution of the whole Brazil. This seems to be due to the following two respects: (i) the region consists of a small-size sub-regions group composed of Bacabal, Castanhal, Imperatriz and Balsas, and a large-size group composed of Xingu, Maraba, and Araguaina, and (ii) the coexistence of small-size subsistence farms and large-size commercial farms (mainly cattle raising) in each sub-region.

(7) The PGC Area has larger percentage of occupants (posseiros) and smaller percentage of owner-farmers as compared to the whole Brazil. The existence of large number of occupants seems to reflect the fact that the PGC Area possesses new areas where the land-ownership system is still not strictly established.

5. INSTITUTIONAL SYSTEM RELATED TO AGRICULTURE

Needless to say, the type of land utilization and selection of crops in a given area depend primarily on the natural conditions, distance from markets, existing infrastructures and other physical conditions of the area. At the same time, institutional and organizational conditions related to agriculture in the area also exert considerable impacts.

Hence, this Chapter deals with some institutional aspects which seem to be relevant to the agricultural development of the PGC Area, and examines th system to be considered in crop selection, together with the institutional improvements which may help realizing the development potential of the Area.

5-1 Agricultural Land System

5-1-1 The Land Statute

The land system in Brazil began with the Sesmania during the Portuguese colonial era in the mid-sixteenth century. Although there have been changes in the system over several centuries, large-scale farms (fazenda) have remained the dominant form of agriculture.

After World War II, land identification (public or private land) was legislated, but it was not until the establishment of the military government in 1964 that farmland policy was considered to be of national importance.

The Land Statute which was enacted in 1964 stipulated the Agrarian Reform to be a series of measures "to improve land distribution in order to raise productivity, based on the principles of social justice." The aim was to gradually diminish large farms (latifundio) and mini farms, and thus promote middle- and small-size farms.

Concerning the situation in 1960 prior to the enactment of the Land Statute, as shown in Table 5-1, large farms (1,000 ha or more), accounting for about 1% of the total number of all farms, held 44% of the total farmland area, while mini farms (less than 10 ha), accounting for 44.8% of all farms, held less than 2.4% of the total area.

Although the reform to reduce the number of large holders was made in part by the expropriation and re-distribution of large farms in the states of Sao Paulo and Parana, in the early 1970s, the situation nationwide remains little changed. Reform has made little progress because of delays in land certification (due to complications discussed later in this chapter) in the northern and northeastern parts of the country.

Table 5-1 Number of Farms by Size

(1) Number

(Unit: 1,000)

	1960		1970		1980	
	Number	(%)	Number	(%)	Number	(%)
Less than 10 ha	1,495	44.8	2,520	51.2	2,603	50.4
10- 100 ha	1,491	44.7	1,934	39.3	2,016	39.0
100- 1,000 ha	315	9.4	414	8.4	489	9.5
1,000-10,000 ha	31	0.9	35	0.7	46	0.9
More than 10,000 ha	1.5	0.1	1.4	0.03	2.4	0.05
Unknown	4	0.1	18	0.4	11	0.2
Total	3,338	100	4,924	100	5,168	100

(2) Areas

(Unit: 1,000 ha)

	1960		1970		1980	
	Number	(%)	Number	(%)	Number	(%)
Less than 10 ha	5,952	2.4	9,083	3.1	8,995	2.4
10- 100 ha	47,566	19.0	60,069	20.4	64,456	17.4
100- 1,000 ha	86,028	34.4	108,743	37.0	126,936	34.3
1,000-10,000 ha	71,421	28.6	80,059	27.2	105,656	28.6
More than 10,000 ha	38,893	15.6	36,190	12.3	63,545	17.2
Unknown	-	-	-	-	-	-
Total	249,826	100	294,145	100	369,588	100

Source: IBGE

A comparison between 1960 and 1980 in Table 5-1, shows that the percentage of super-farms (10,000 ha or more) decreased in number (from 0.1% to 0.05%), but increased in area (from 15.6% to 17.2%). The percentage of mini-farms showed no change in area (2.4%), but increased in number (from 44.8% to 50.4%). This suggests that farms are being divided into two extremes -- super-farms which are becoming much larger in unit area and mini-farms which are becoming much smaller.

5-1-2 Land Certification

The greatest difficulty in effecting agrarian reform lies in the fact that land ownership and occupancy are not clearly defined. There are various types of land ownership: e.g. ownership which originated from the old Sesmania; ownership registered at a church; successive changes in ownership under a legal system which has undergone several changes, and owners holding forged certificates. It is said that less than half of the farms in the country have legally guaranteed rights of ownership. The first step of the Agrarian Reform, therefore, is to clarify the complex land holding and to certify ownership. The federal government is responsible for this procedure for the land under federal jurisdiction, and state governments are responsible for their respective territories under the land statute.

The jurisdiction of the federal government has consisted of the federal territories, coastal areas and the national boundary (66 km wide) under the Constitution of 1891. In 1974, a 100 km wide areas on both sides of the national highways was added to the jurisdiction of the federal government.

The executive organization of the federal government responsible for jurisdiction is the Institute for Land Settlement and Agrarian Reform (INCRA), but in the special development district, another organization (GETAT) is carrying out the task.

Land certification in the area of jurisdiction of the state governments is carried out by the state agencies, but in some states it is conducted jointly by INCRA and the state, under special agreements. At present, INCRA has such agreements with 14 states.

The identification and granting of ownership in the areas of the federal jurisdiction are based on the following standards. For state governments, too, similar standards have been adopted, though some state laws contain additional or modified provisions.

(1) People who obtained ownership prior to enactment of the Land Statute are guaranteed ownership; (2) those who have land with area exceeding certain limit but do not farm it, may have the unused portions expropriated for use as public land; (3) those who have been living for one year or more on land whose ownership has not been determined, are permitted to occupy the land for four years, and after that ownership may be granted depending on how the land is being used; and (4) those who have occupied land belonging to

someone else may be accorded rights to the land unless the owner files a claim within one year.

The final step in the above described procedures is the registration of land which has been identified or for which ownership has been granted, and the issuance of a land certificate. The number of land certificates issued after the enactment of the Land Statute totaled about 900,000 in the area of jurisdiction of the federal and state governments, and is expected to reach one million in 1984.

5-1-3 Special Programs and Projects Related to the Land Reform

(1) PROTERRA

This program is designed to promote agrarian reform under the Land Statute. That is, part of the land of large estates will be granted to farm workers or will be broken up into mini-farms. The areas covered at present are three states (Pernambuco, Paraiba and Ceara) where the concentration of large farms is a salient feature.

This program started in 1972, and although its implementation was undertaken in the face of pressure and resistance by vested landholders, it has recently begun to make progress; in 1983, a survey of an area three times larger (slightly more than 500 km in total along the boundaries) than the previous year was carried out, and by the end of the year, the number of ownership rights granted exceeded 6,000.

(2) POLONORDESTE

POLONORDESTE, which was developed in 1975 and has been assisted by the World Bank since 1981, is one of the federal special programs for regional development. An important element of POLONORDESTE is agrarian reform to allow granting of ownership to 100,000-200,000 families. By 1983, ownership was granted to 3,657 families, which is below the target, but the numbers are expected to increase gradually in the future, since the survey, the determination of boundaries, and the identification of ownership have been carried out on schedule.

5-1-4 Settlement Projects

The Brazilian settlement project began with the collective resettlement of immigrants from overseas on undeveloped land. In 1812, immigrants from the Azores Islands (Portuguese) settle for the first time in Espirito Santo. Then, Swiss immigrants settled in Bahia and Rio de Janeiro in 1819, and Germans settled in Rio Grande do Sul in 1824. Immigration from overseas, which flourished in the 19th century, was induced by the demand for labor on coffee plantations, whereas the settlement projects played a role in creating independent farms.

Immigration from abroad began to decrease in the 1920s, and the resettlement of Brazilians came to dominate. The settlement projects in previous years were mainly on a state or private corporate basis, but the federal government began to develop these projects in 1938, when the Land and Settlement Department (DTC) was set up in the Ministry of Agriculture. The DTC later developed into the present INCRA through several reorganizations.

The DTC initially carried out the projects in states such as Goias, Mato Grosso, Maranhao (Barra do Corda District), Para (Monte Alegre District), Amazonas and Parana, but in the 1970s great importance was attached to the national integration program (PIN) and the Amazon settlement project administered by PROTERRA. In addition, the settlement projects along the Trans-Amazon highway began to be emphasized. As a result, the organizations established by the federal government for developing specific regions, e.g. the San Francisco River Development Corporation (CODEVASF), the Superintendency for Development of Nordeste (SUDENE) and the GETAT incorporated the settlement projects into their regional development plans.

Families who were settled under the official settlement projects and the number of such projects by region are shown in Tables 5-2 and 5-3. The northern section of the country accounts for the largest percentage.

In addition to the above-mentioned official settlement projects, INCRA launched in 1980 the Rapid Settlement Projects under which settlers are given land expropriated by the government from large landowners or illegal occupiers. The advantage of this project is that the cost is low and the settlers can begin production at once because the land settled (unlike ordinary settlement) is already under cultivation and has been provided with an infrastructure. The totals for these cases and the land areas involved are not included in the tables listed above.

Beside official settlement projects, there are private projects: the ratio of the official projects and private in number is estimated at 8 to 2. Some private projects are being undertaken by cooperatives. One example is the Cotia Central Society of Agricultural Cooperatives which is operating at several places throughout the country (Refer to Section 5-4-4).

Although comprehensive statistics concerning the settlement projects are not available, the settlers involved in the projects, official and private, totalled about 160,000 families (including one-man family) by 1983, and of these, about 130,000 families were involved in official projects, of which 38,000 were involved in the Rapid Settlement Project.

Table 5-2 Number and Areas of Official Settlement Projects

Great Region	Number of Projects	Area (1,000 ha)
North	25	10,664.2
Northeast	14	683.7
Central-West	07	764.3
Southeast	05	56.6
South	03	20.6
Brazil	54	12,189.4

Source: INCRA, Official Settlement in Brazil, 1984

Table 5-3 Families Settled Under the Official Settlement Projects

Great Region	Families Settled						
	Up to 1978	1979	1980	1981	1982	1983	Total
North	26,477	2,645	8,831	4,668	7,799	10,040	60,460
Northeast	8,128	1,225	1,184	1,824	1,601	1,569	15,531
Central-West	640	-	-	776	447	646	2,509
Southeast	522	11	-	275	75	190	1,073
South	146	-	-	200	227	-	573
Brazil	35,913	3,881	10,015	7,743	10,149	12,445	80,146

Source: INCRA, Official Settlement in Brazil, 1984

5-1-5 Actual Land Use and Settlement Under the Control of GETAT

As mentioned in Section 2-4-3 of Part II, Araguaia-Tocantins Lands Executive Group (GETAT) is an executive organization for integrated development of an area of about 4.5 million ha covering the basins of Araguaia and Tocantins rivers. The GETAT's integrated development policy is concerned with the development of the physical infrastructure, educational facilities (school construction), and sanitation (the extermination of malaria and yellow fever). In addition, handling of land-related problems is an important task. These land-related problems have been especially complicated in the area around the confluence of the two rivers. Therefore GETAT became the temporarily responsible agency for the period of 1980 to 1985 for the implementation of integrated development in these regions.

In the project regions, GETAT has carried out surveys and has issued certificates of ownership for land presently occupied. The people occupying the land are granted ownership of an area three times larger than the area of land they presently cultivate. Half the land granted must be preserved as forest. If the total area of land to be granted is less than 50 ha, the figure may be raised to 50 ha. The settlers apply for rights of ownership under the guidance of the GETAT and obtain the land certificate.

Since the establishment of GETAT, 45,000 land certificates have been issued. In terms of size, the areas average 100-200 ha (the area cultivated being one third that size) in most cases, and crops such as rice and cassava are being cultivated. For pastures, the areas involve total 500-3,000 ha in many cases (permission is required from the Federal Senate for an area of 3,000 ha or more). GETAT attaches great importance to fostering the private ownership of farms with an area of 100 ha or less.

In the settlement districts, after the occupied land is certified as private land as a result of the survey of the region, land suitable for agriculture and pasturage is selected from the remaining unoccupied land, and allocated to new settlers.

Looking at the progress of the Carajas Settlement Project made by GETAT, District I (86,000 ha) is reserved as forest, District III (85,000 ha) was completely settled in 1983 (520 families), and settlement of District II (240,000 ha) is now under way. When the Study Team visited the site in September 1984, 1,502 people (742 families and individual settlers combined) settled there, and it is planned that 1,600 persons will have settled by the end of 1985 (when the GETAT program will be terminated).

With regard to land allocated to settlers, the settlement site is mainly devoted to agriculture, and a standard of 50 ha per family (including one-man family) has been adopted, but near the central part of the district (Nucleo), a standard of 25 ha has been adopted to allow more intensive agriculture operations. A Nucleo, which is located respectively in Districts II and III, has public facilities and an

office of extension service.

Settlers are initially provided by GETAT with 0.5 ha of cleared land, housing materials, six months legal minimum wages, and food for one month. These are supplied on credit base with two year grace period, and must be repaid within five years. This credit, however, is almost a gratuity under the present inflation, since the annual interest rate is only 6%.

5-1-6 The Situation Concerning Farmlands in Maranhao

As the state of Maranhao, which occupies a large part of the PGC Area, is one of the most problematic states of the country in regard to land possession, the present situation and problems in the state is analized hereunder based on the data collected during the field survey of the Study Team.

The complexity of land ownership in Maranhao has a long historical background, but disputes on land ownership had not been significant before the 1960s, because most of the land had remained unexploited. The opening of highways, such as Teresina-Sao Luis and Belem-Brasilia, and the plan for the Carajas railroad induced the influx of settlers, squatters and land speculators. They rapidly brought about land disputes in the state. The development of mining ventures also had impact on the land problems.

The private and public land areas in the state of Maranhao are shown in Table 5-4, and as noted in the table, private land includes disputed land (more than one owner, boundary problems, etc). The land which the state government has designated as disputed land totals 3.46 million ha. In addition, many other areas have not been certified in terms of ownership. The largest area of designated land in dispute is the Pindare Farm which occupies an area of 1.17 million ha extending to the provinces of Moncao and Amarante.

The areas and numbers of farms (according to size and type) are shown in Table 5-5. The total of these areas exceeds that of private areas as shown in the Table 5-4. This is probably due to the fact that many farms are located on public and uncertified lands. The areas referred to here are those which are occupied (including both cultivated and un-cultivated areas). As shown in the Table 5-5, the concentration of land into large farms is a remarkable feature of this state.

Land certification as well as settlement in the state are entrusted to the Maranhao Land and Settlement Agency (ITERMA), but many projects are being carried out jointly with INCRA.

The largest project for land certification is the one under way in Mealim and Pindare (northwestern part) in cooperation with INCRA, SUDENE and the World Bank. This project seeks to identify an area of 1.2 million ha, to requisition an area of 140,000 ha, and to issue 12,500 certificates of ownership. Up to 1984, an area of 586,000 ha has been

Table 5-4 Private and Public Land in Maranhao

Total	Private area	Public area	Unidentified area
32,461,600 ha	26,666,591 ha	5,795,009 ha	
100%	82.14%	17.86%	

Note: Private areas include disputed land.

Source: State of Maranhao/INCRA, 1984.

Table 5-5 Agricultural Land Areas in Maranhao by Size of Farms

Size (ha)	Number	Total Area (ha)
Less than 10	11,263	48,824
10- 25	11,443	189,365
25- 50	18,310	630,415
50- 100	24,723	1,561,302
100- 500	33,366	6,663,145
500- 1,000	5,669	3,805,173
1,000-10,000	4,765	10,436,594
Over 10,000	217	7,105,493
Total	109,756	30,441,314

Source: State of Maranhao/INCRA, 1984.

identified, an area of 156,000 ha has been requisitioned, and 1,147 certificates of ownership have been issued.

In this district, certification of ownership is combined with the settlement project. The combined cultivation of such crops as rice, pepper, fruit (oranges), beef cattle, and rubber is sought. The district is equipped with an experimental agricultural station for Brazilian Agricultural Research Enterprise (EMBRAPA), a pilot field for Agricultural Research Enterprise of Maranhao (EMAPA), a pepper processing plant, a rubber tree nursery and a rice seed plots. An agricultural cooperative is also being organized.

5-1-7 Land System and Greater Carajas Development

(1) Urgent Need for Land Certification

It seems that the current land problem in Brazil is very similar to the problems which occurred in the U.S.A. in the 19th century.

When the U.S.A. was formed in 1778, 13 states entrusted the handling of undeveloped land (non-private land) to the federal government, and states which later joined the Union followed this precedent. It took nearly a century of years for the federal gevernment to dispose of the vast land. The disposal comprised of sales or granting to private individuals or corporations, transfer to the states and reservation as federal public land. The disposition of land by the federal government made up one of main subjects of American history in the 19th century. In particular, the dispute on the fundamental policy for the disposition of land between Jefferson, who advocated family farms, and Hamilton, who advocated large farming estates, is one of the greatest issues in American history. Today, Jefferson is called "the father of American democracy", because the self-owned family farms which he advocated formed the basis for democracy in the U.S.A.

Another notable point in the process of land disposition in the U.S.A. is that many areas were reserved as public lands to protect the natural environment.

Confirmation and grant of private land ownership were based principally on the occupancy of undeveloped land. The General Pre-Emption Act of 1841 codified this principle and procedures. Creation of family farm on undeveloped land was promoted by the Homestead Act of 1862. This process took several decades, during which the government had to deal with many difficult problems such as the handling of old certificates of ownership, the checking of forged certificates, and the preventing of land speculators from aquiring homestead lands.

The nationwide cadastral survey, which the newly-born central government of modern Japan conducted after the Meiji Restoration, took three years (1874-1876), even though Japan is one twenty-third the size of Brazil. Land taxes based on the survey became the single most

important source of revenue of the new government, for the development of the national economy.

Looking at the current situation of the land system in Brazil, in comparison with the American and Japanese experiences, we realize that the establishment of the basic principles for land policy and the early implementation of land surveys and land identification are urgently needed.

Land identification work is now in progress in the Greater Carajas Program Area. Unlike the U.S.A. in the 19th century, this work will not take such a long period as a century, because of the use of modern technology such as aerial survey and computerization of data processing. Neverthless, it will take still considerable period of years to complete over the whole area of the Greater Carajas Program. It seems necesary, therefore, to carry out early and intensive work of land certification in the priority areas or selected pilot areas. Especially in the areas where plantation of tree crops such as rubber and oil palm is planned, undisputable land ownership is the pre-requisite because long term investment is necessary for planting tree crops.

(2) Environmental Protection and Development

It is said that the destruction of the Great Amazonian forest, the largest tropical rain forest left on earth, has an effect on global climate, and its protection is of great concern to the world as well as to Brazil.

As previously mentioned, the Land Statute of Brazil stipulates the rational use of land and "the protection of natural resources". The federal forest regulations also contain strict provisions concerning the protection of nature. During our survey, however, we witnessed that steep mountainsides and the crests of hills not suitable for agricultural use or pasturage had been burned off.

As in the U.S.A. in the 19th century, the Statute provides ownership on the basis of occupancy of undeveloped land. However, once the land is privately owned, it is difficult to restrict the type of operations undertaken in order to protect the environment. For this reason, the federal government reserved considerable amount of land as public lands. About one third of the land is presently reserved as public land in the form of national forests, national parks, wild life sanctuaries, and public pastures.

Even the U.S.A., which took the cautious protection of the land into account in the previous century, has been faced with problems of soil erosion and desertification in recent years. It must be fully kept in mind that these risks are greater in the tropical zone than in the temperate zone. Therefore more care must be taken to protect the environment in developing the PGC Area than was required in the U.S.A.

In order to preserve as much natural forest as possible, higher productivity from the area already opened or planned for development is required. Therefore productivity is a key element in the selection of crops and locations for agricultural development projects.

In this connection, the type of shifting cultivation practiced in the PGC Area is a problem both from conservation and productivity point of view. The present practice is said to result in natural destruction and concentration of land into large and extensive pasture of low productivity. However, the traditional type of shifting cultivation (long-term rotation with 10 - 20 years cycle) practiced for centuries in the tropical areas in Southeast Asia is now revaluated because of its advantage of preserving natural ecology and of low cost agricultural production without fertilizers and other inputs. Consideration might be given to adoption of a controlled shifting and rotating system in which farmers are given the right to use public lands every few years under a long-term and carefully-controlled plan.

5-2 Agriculture-Related Tax System

5-2-1 Characteristics of the Brazilian Tax System

Taxes are the main source of revenue for the treasury, accounting for 77% of all federal revenues in 1982.

Taxes in Brazil consist of federal, state and local taxes. Most federal revenues are generated by the income tax (corporate and personal) accounting for 39% of tax revenues, and the second largest amount of tax revenue is generated by the industrial commodity tax and the financial transaction tax. In terms of state taxes, the Marketing Tax (ICM) is most important, generating the largest amount of state tax revenue. According to statistics for 1982, the total federal tax revenue was Cr$4,197.278 billion while the total for the ICM taxes of all states was Cr$2,467.820 billion. The ICM is significantly related to the marketing of agricultural products.

One of the characteristics of the Brazilian tax system is that tax policy is used to achieve several objectives. This is true in all countries, but it seems that more importance is attached to it in Brazil.

The "tied revenue (Receita Vinculada)", for example, assigns the use of taxes such as the industrial commodity tax, the single consumption tax and the regional development fund. In view of the fact, however, that this system interferes with flexibility of financial policy, it has been gradually abolished since 1982.

Regarding the income tax, a variety of tax reduction is granted as incentives to projects which are considered to be of national importance. In particular, companies which undertake development projects in the Amazon and northeastern region of the country are given very pre-

ferential treatment.

5-2-2 Farmland Tax

The federal tax on farmland is the Rural Property Tax (ITR), 80% of which is refunded to the states.

The ITR is a very small source of tax revenues, accounting for only 0.016% of federal tax revenues in 1983. This tax is used, in terms of national policy, to promote rational and efficient land use rather than as a source of revenue.

Taxation of farmlands had been the state or province taxes until the Land Statute was established in 1965, when it became a federal tax under the control of INCRA. The fundamental provisions for levying and collection are provided for in the Land Statute. This tax therefore has served as a means of agrarian reform since 1965.

Taxation is based on the declaration from owners and occupants of lands, these declarations being entered in the land register. The taxable amount is calculated using a standardized value, based on the district and land use (perennial and annual crops, pasture or forest), and various types of tax reductions, exemptions, and additions are made. Exemption is applicable for lands of less than 20 ha which are being cultivated by an individual family.

The tax on land used "properly" or "efficiently" may be reduced by 45%, and a reduction of 90% may be made if the land is used both properly and efficiently. This reduction is applicable to any land regardless of size. Corporate farms which receive the 90% reduction total approximately 400,000.

On the other hand, unexploited land is levied twice (the first year), three times (the second year) and four times (in the following years) of the cultivated land.

In the implementation of farmland tax, 4.1 million cases were recorded by 1983. Owners and occupants must register, and an investigation is not conducted to determine whether the ownership or occupancy is legal or not. The rate of registration by occupants of land is high since people working the land wish to have their occupancy verified.

The registration is handled by a computer at the Tax Department in INCRA's headquarters. In 1983, 4.8 million cases were handled of which about 2 million cases were eligible for exemptions. Tax was notified to the remaining 2.8 million cases, totaling about Cr$150 billion.

The rate of collection of land tax is low, 40% for the country as a whole. The southern part of the country shows a high rate of collection, while the northern and northeastern parts show a low rate. The rate in 1983 was 20% in the state of Maranhao and 5.5% in the state of Para.

In general, small- and medium-sized farms reportedly have better tax payment records than large farms.

Although the farmland tax is designed to raise land productivity rather than to gain revenue, the effect of the tax is minimal because the amount of tax per area is very small. Obtaining positive results may require the imposition of higher taxes on unproductive land use, as well as more efficient collection of the tax, which at present is extremely low. In order to raise the rate of collection, the responsibility and power of state governments to collect the tax might well be enlarged, since 80% of the collected tax is returned to the states. During our field surveys, we found many check points (Posto Fiscal) for collection of the distribution tax located on the highways. This seems to indicate that each state is very eager to collect the tax (ICM) as it is their main source of revenue.

It is expected that the farmland tax could be effectively used for its initial purpose in line with land identification as mentioned in the previous section, because this tax has an impact on land use and crop selection.

Since land tax, if effectively used, will exert impact on the land use, selection of crops and managerial type of agriculture, the effective use thereof combined with the land certification program is expected.

5-3 Rural Credit and Price Support

5-3-1 Rural Credit System

(1) Main points of the rural credit system

In the reform of the banking system in 1964, immediately after the establishment of the military regime, the Monetary Council (CMN) and the Central Bank were established. CMN is the supreme decision-making organization for determining financial policy, and the Central Bank is the competent institution for implementing the policy. In the new financial system, a Rural Credit System (SNCR) was established under the Rural Credit Law in November, 1965. It was after this that the current agricultural credit system was instituted and great emphasis was placed on agricultural development policy.

The mainstays of the SNCR are concessional loans for agricultural and livestock farm production, agro-industry, and agricultural product marketing, and obligatory lending for agriculture by commercial banks.

Concessional loans provided under SNCR are classified broadly into two categories -- general loans and special program loans. General loans include production-cost loans, fixed-property loans, and merchandise loans (EGF for price support mentioned later). Production-cost loans are the most numerous and account for the highest monetary

value. In the figures for 1982, production-cost loans accounted for 80.3% of total number of loan contracts and 68.4% of the total amount loaned; fixed-property loans 15.5% and 9.6%; merchandise loans 4.2% and 21.9% respectively (Source: IBGE, Brazilian Statistical Yearbook 1982).

The special program loan is a loan for a special development project conducted by the federal or state governments. It is a concessional loan for particular projects or regions, such as the Agriculture Insurance Program (PROAGRO), Warehouse Program (PROMAZEM), National Alcohol Program (PROALCOOL), and the Program for Integrated Area Development of Nordeste (POLONORDESTE).

Under the obligatory lending system, commercial banks and other lending institution participating in SNCR are required to allocate certain percentage of their lending resources to agriculture loan at the concessional term or to deposit that portion of the resource to the Agriculture Fund (FUNDAGRI) of the Central Bank.

(2) Changes in the implementation of the SNCR

From the start of SNCR to the mid-1970s, the use of rural credit spread rapidly throughout the country. The changes in the proportion of rural credit to total agricultural production value indicate the growth of rural credit during this period. Before the launching of SNCR, the proportion was only about 10%; in 1970 it was 71%; and in 1975 it was as high as 105%.

However, with the first oil crisis in 1973 as a turning point, the Brazilian economy experienced a recurrence of inflation, and a deterioration in the national balance of payments. Thus, it became impossible to continue issuing liberal agricultural loans as it had during the "miracle growth" period. The system was also criticized for allowing loans to be used for other purposes. It was said that during the period when the number of loans was expanding, lending was biased towards large-scale farms.

Under these circumstances, beginning in the latter half of the 1970s, loans were gradually tightened by raising the interest rates and cutting down the loan limit to individual borrowers. Since the second oil crisis in 1979, there has been a further tightening of funds.

As for interest rates, nominal interest was gradually increased, but was still far lower than the open market rate (35% in the northern and northeastern regions, 45% in other regions). Under the pressure of runaway inflation, the actual interest rate was nearly zero. Therefore, in 1983, although the nominal interest was determined to be as low as 3%, ORTN (the price of national bonds with value modification) was applied to the principal, resulting in a substantial increase in the actual interest rate. However, it was decided that the revised value should not be applied at one time, but should be applied gra-

dually through 1985 (see table below).

Rate of Application of Value Modification
for Agricultural Production Loans

	1983	1984	1985
North, Northeast Regions	ORTN x 70%	ORTN x 90%	
Other Regions	ORTN x 85%	ORTN x 95%	ORTN x 100%

This tight-money policy was implemented not only for general loans, but also for special program loans. Particularly since 1982, the number of projects which were covered by the special program loans decreased considerably. The financial resources for special program's SNCR loans were cut off except for only a few projects such as the Marsh Development Program (PROVARZEAS) and Cerrado Agricultural Development Program (PRODECER).

As a result of this restrictive monetary policy, the proportion of agricultural loans to support agricultural production value declined to 20% in 1982 from the above-mentioned peak of 105% in 1975.

In parallel with the decrease of subsidized loan from the public fund, the obligatory loan by commercial banks was increased in order to utilize more private funds for agriculture. The system of progressive rate of obligation was adopted, i.e., larger banks were required to allocate higher proportion of their loan resources to agriculture. The obligatory rate which was about 10% at the beginning of SNCR was raised to 10% - 55% as shown in Table 5-6.

Table 5-6 The Rate of Bank Obligated Agricultural Loans

	Total value of transaction	Percentage to be loaned to agriculture
a)	Under 130,000/MVR	10%
b)	From 130,000/MVR To 350,000/MVR	20%
c)	From 350,000/MVR To 100,000,000/MVR	30%
d)	From 1,000,000,000/MVR To 3,000,000,000/MVR	40%
e)	From 3,000,000,000/MVR To 5,000,000,000/MVR	45%
f)	Over 5,000,000,000/MVR	55%

Source: Central Bank Resolution No. 904, April 5, 1984.

(3) Loan policy to promote small-scale farms and improve productivity

Although SNCR aims to aid small-scale farmers from the outset, its critics claimed that loans were biased towards the large farms during the 1970s. During the tight-money policy period, SNCR secured loans for small-scale farms by reducing the amount of money available for large-scale farms.

Higher ceilings on loans are set for small-scale farmers than that for large-scale farmers for production cost loans. The limit rate in 1982-83 for mini- and small-scale farms was 90% of the basic cost value (VBC), 60% for medium-scale farms, and 40% for large-scale farms (in the northern and northeastern regions, 100% for mini- and small-scale farms, 70% for medium-scale farms, and 50% for large-scale farms). For 1984-85, it was decided, as a part of the tight-money policy, to lower the limit rates, as well as to reclassify the three categories of small-, medium-, and large-scale farms into two categories and to set the limit rate by type of crop (The limit rate in northern and northeastern Brazil had not been determined at the time of this Study)[1] (Table 5-7).

As a means of increasing productivity through the provision of loans, the basic cost value (VBC) are determined on the basis of productivity, because highly productive farms require greater investment in materials and labor.

The VBC is determined by region. The VBC (1983-84) which applies to the state of Maranhao, occupying most of the Greater Carajas Program Area is indicated in Table 5-8. As shown in this table, the VBC varies widely with the yield per hectare. Differences are greatest for cotton; the VBC for farms with the highest yields (over 1,800 kg/ha) is 12.5 times as much as the VBC for farms with the lowest yields (under 150 kg/ha), and for feijao, 6.9 times as much. For cassava, the VBC is higher for farms which raise two crops a year.

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1) The scale of a farm is determined in two ways: by acreage and by production. The farmland tax is based on acreage and loans are based on the amount of production. The sizes of farms are classified by production using the following guidelines:

Mini farms	Annual production under 200 MVR
Small-scale farms	from 200 to 600 MVR
Medium-scale farms	from 600 to 3,000 MVR
Large-scale farms	over 3,000 MVR

For 1984-85, farm scale is classified into two categories: small farms producing less than 2,000 MVR and large farms producing over 2,000 MVR.

Table 5-7 Limit Rates for Production Cost Loans (1984-85)

Crops	Producers	
	Mini and Small-scale Farms	Medium- and Large-scale Farms
Cotton	60% of VBC	40% of VBC
Ground nut	80% "	60% "
Upland rice	80% "	60% "
Paddy rice	80% "	60% "
Feijao	80% "	60% "
Cassava	80% "	60% "
Maize	80% "	60% "
Soybean	60% "	40% "
Millet	80% "	60% "
Others	60% "	40% "

Source: The Central Bank Resolution No. 940, August 13, 1984

(4) Agricultural credit in the northern and northeastern regions

Under the loan policy, the northern and northeastern regions receive preferential treatment in terms of the loan ceilings and interest rates. However the amount of loans to these regions is considerably lower than in other regions. Concerning agricultural loans by region and state in 1980, the year when the last agricultural census was taken, as shown in Table 5-9(A), the northern and northeastern regions accounted for 13.7% of the total. The fact that 55% of all farms in Brazil are located in these regions indicates that an extremely small proportion of farms in the northern and northeastern regions are benefitting from the Rural Credit System (SNCR). Table 5-9(B) indicates the relationship between the amount of loans and the number of farms by region. By dividing the total value of loans by the number of farms, it can be seen that the average loan on a nationwide basis totalled Cr$129,000; the average for the northeastern region totalled Cr$45,000; for Para, Cr$41,000; for Maranhao, Cr$23,000. In Para, loans are made mostly to livestock farms, while in Maranhao they are made to farms producing crops.

5-3-2 Price Support System

Although prices in Brazil are basically determined through the market price mechanism, a price support system which is an important part of agricultural policy has been implemented for staple products to stabilize the producers' incomes and encourage farm production.

Table 5-8 Basic Cost Value (VBC) 1983 - 84
(Applies to the three states of Maranhao, Piaui, and Bahia)

Crops	Yield (kg/ha)		VBC
	From	to	Cr$/ha
Cotton	-	150	22,700
	151	200	25,300
	201	250	32,900
	251	300	35,200
	301	400	56,000
	401	600	88,800
	601	800	123,000
	801	1,100	151,100
	1,101	1,400	201,000
	1,401	1,800	237,200
	above	1,800	283,900
Upland rice	-	1,000	56,200
	1,001	1,300	74,200
	1,301	1,600	95,700
	above	1,600	114,700
Irrigated rice	-	2,000	118,500
	2,001	3,000	140,800
	3,001	4,000	171,400
	above	4,000	214,100
Feijao	-	200	19,600
	201	300	24,400
	301	400	34,000
	401	500	43,400
	501	700	66,700
	701	900	96,500
	above	900	136,300
Irrigation Feijao	-	1,200	149,900
	1,201	1,500	167,900
	above	1,500	185,000
Maize	-	300	11,300
	301	500	15,700
	501	700	22,600
	701	900	30,500
	901	1,200	45,300
	1,201	1,500	58,200
	1,501	1,900	74,200
	above	1,900	90,700
Cassava (Single-crop)	-	2,500	23,400
	2,501	5,000	42,500
	5,001	7,500	56,400
	7,501	10,000	68,200
	10,001	12,500	79,100
	12,501	15,000	89,800
	15,001	20,000	115,200
	20,001	25,000	130,600
	above	25,000	151,800
Cassava (Double-crop)	-	2,500	35,400
	2,501	5,000	59,700
	5,001	7,500	80,900
	7,501	10,000	99,400
	10,001	12,500	115,200
	12,501	15,000	129,800
	15,001	20,000	165,200
	20,001	25,000	185,500
	above	25,000	216,900

Source: CFP, Informativo Sunop, Ano 11 - No. 18.

Table 5-9(A) Agricultural Loans by Region and State (SNCR of 1980)

(Unit: Cr$ million)

Regions	Agriculture				Stock Raising				Total
	Production Costs	Sales Costs	Invest-ment	Total	Production Costs	Sales Costs	Invest-ment	Total	
South	(147,821)	(77,077)	(19,194)	(244,092)	(15,657)	(18,905)	(12,047)	(46,610)	(290,703)
Rio Grande do Sul	63,663	35,279	8,869	107,812	7,500	9,085	5,832	22,418	130,230
Parama	72,012	35,805	7,730	115,567	3,907	5,620	3,802	13,329	128,876
Santa Catarina	12,146	5,993	2,595	20,733	4,251	4,200	2,413	10,864	31,597
Southeast	(140,869)	(49,811)	(29,977)	(220,656)	(19,311)	(27,369)	(17,673)	(64,353)	(285,009)
Sao Paulo	87,267	40,612	16,865	144,804	9,999	12,832	6,334	29,165	173,968
Minas Gerais	44,295	5,568	9,378	59,241	6,816	8,563	8,800	24,179	83,420
Rio de Janeiro	3,906	3,118	1,035	8,059	1,545	4,916	1,668	8,129	16,187
Espirito Santo	5,401	453	2,698	8,553	951	1,059	871	2,881	11,433
Northeast	(67,191)	(16,234)	(26,626)	(110,051)	(5,570)	(1,176)	(21,826)	(28,572)	(138,623)
Bahia	20,477	3,890	6,385	30,752	1,766	783	5,727	8,277	39,029
Pernambuco	12,057	2,217	3,761	18,035	1,029	295	3,996	5,321	23,356
Ceara	5,406	5,300	4,801	15,507	1,087	26	3,046	4,160	19,666
Alagoas	8,246	884	3,394	12,523	193	14	1,526	1,733	14,256
Maranhao	9,440	439	1,776	11,655	256	23	554	833	12,488
Paraiba	3,088	1,875	2,396	7,358	353	1	1,598	1,952	9,311
Rio Grande do Norte	3,120	1,069	2,213	6,502	325	4	1,670	1,998	8,500
Piani	3,700	263	1,450	5,413	200	14	1,520	1,734	7,148
Sergipe	1,557	296	452	2,304	361	15	2,187	2,564	4,868
Central-west	(43,714)	(11,691)	(14,094)	(69,499)	(4,237)	(4,937)	(6,663)	(15,837)	(85,336)
Goias	20,677	5,263	4,735	30,674	2,514	2,445	3,735	8,694	39,368
Mato Grosso do Sul	12,799	3,419	3,895	20,114	1,042	1,702	1,365	4,109	24,223
Mato Grosso	9,334	2,730	4,905	30,674	2,514	2,445	3,735	8,694	39,368
Brasilia	905	279	559	1,734	128	123	435	687	2,430
North	(12,869)	(2,013)	(7,804)	(22,686)	(984)	(74)	(1,983)	(3,041)	(25,727)
Para	6,068	1,448	1,665	9,181	749	59	1,240	2,048	11,229
Amazonas	4,969	487	2,774	8,230	149	15	354	517	8,747
Rondonia	798	35	2,559	3,392	20	-	105	125	3,518
Acre	623	17	559	1,199	35	-	67	102	1,301
Roraima	364	23	217	604	22	-	169	191	794
Amapa	46	3	31	80	9	-	48		57
Total	412,463	156,825	97,696	666,984	45,759	52,462	60,193	158,414	825,398

Table 5-9(B) Distribution of SNCR Loans by Region, and Average Amount of Loan for One Farm

Region	Total Amount of Loans (%)	Ratio of Number of Farms (%)	Average Amount of Loan per Farm (Unit Cr$1,000)
South	36.6	22.1	213
Southeast	33.0	17.2	247
Central-west	10.4	5.1	259
Northeast	16.6	47.4	45
North	3.4	7.9	55
Total	100.0	100.0	
Maranhao	1.7	9.6	23
Para	1.3	4.3	41

This system has a long history, and has undergone amendments since it was instituted in 1943 patterned after the Commodity Credit Corporation (CCC) in the U.S.A. The existing system, known as Government Price Support Program (PGPM), is based on DL-79 for which relevant laws and regulations were written in 1966.

Crops covered by PGPM are listed in the table for minimum prices (see Table 5-10). For coffee, sugar (including sugarcane) and wheat, which are staple products not covered by the PGPM, pricing policy is implemented by other organizations and by other means.

PGPM is implemented by two measures -- government acquisition at a minimum price and government loans secured by the value of the products.

(1) Government acquisition (AGF)

AGF is a system in which the government purchases products at a predetermined minimum price. Producers deposit their products in a warehouse, designated by the banks, where they undergo authorized inspection and grading. Producers then submit the warehouse bond and certificate of grading to the bank, and receive the set price as payment.

The government purchases not only from producers but also from traders. Where a trader is a seller, he must prove that he purchased the crops from the producer at a price not lower than the minimum price. For cassava, silkworm cocoon, and grapes, included among the crops covered by the AGF, only processed goods (cassava flour, cassava starch, raw silk, wine, and grape juice) are purchased. A producer of

Table 5-10 Minimum Price for Summer Crops (1984-85)

Products	Unit	Minimum price (Cr$)	Period of Revising Price
Cotton	15 kg	12,000	Aug. 84 - Apr. 85
Upland - Rice	50 kg	18,000	Aug. 84 - Apr. 85
- Paddy	50 kg	21,400	Aug. 84 - Apr. 85
Feijao	60 kg	54,200	Aug. 84 - Dec. 84
Maize	60 kg	13,000	Aug. 84 - Apr. 85
Soybean	60 kg	20,000	Aug. 84 - Apr. 85
Cassava	1 t	51,800	Aug. 84 - Apr. 85
Peanut with shell	25 kg	15,000	Aug. 84 - Dec. 85
Castorseed	60 kg	20,600	Aug. 84 - Apr. 85
Sorghum	60 kg	11,000	Aug. 84 - Apr. 85
Cashew nuts	1 kg	700	
Camauba wax	1 kg	1,100	
Sunflowerseed	40 kg	12,000	Aug. 84 - Dec. 84
Jute and malvaceae	1 kg	670	Aug. 84 - Apr. 85
Ramie	1 kg	800	
Silk (Silkworm)	1 kg	3,500	
Sisal	1 kg	380	
Buckwheat	1 kg	244	Aug. 84 - Dec. 84
Jute seed	1 kg	1,157	Aug. 84 - Apr. 85
Seed potato	30 kg	15,000	Aug. 84 - Nov. 84
Soybean seed	1 kg	467	Aug. 84 - Apr. 85
Cotton seed	1 kg	240	Aug. 84 - Apr. 85

Source: Ministry of Agriculture Announcement, Aug. 16, 1984.

the processed goods must prove that he purchased the raw materials at a price not lower than the minimum price.

The government's acquisition price (minimum price) is determined prior to the commencement of planting. This price is revised by adjusting to fluctuations in the national consumer price index (INPC) each month during the period between the setting of the price and the harvest. The date for setting the basic prices varies between the southern and the northern Brazil; in the former it is made in August, and in the latter in December.

The set minimum prices for summer crops (which applies to the south) in 1984-85, determined in August, 1984, are indicated in Table 5-10.

(2) Government loans for price support (EGF)

The EGF is a system in which short-term loans are issued on collateral of the products, so that the producer can delay selling in order to obtain a better price, thus prevent the decline of market price due to the hasty sale of the products after harvest. The period of the loans varies according to the type of produce from 30 to 240 days. A trader or processor can accept this loan, but he must show proof that he purchased the products (raw materials, in the case of a processor) from farmers at a price not lower than the minimum price.

There are two types of loans in the EGF system, and a producer can choose either one: option and non-option loans. In the former, the producer can sell the products to the government, if he cannot sell on the open market, due to unfavorable market conditions during the period of the loan -- this is called the option system. In the other system the producer must repay the loan and redeem the security (the produce) when the period expires -- this is called the non-option system. In the latter system, the producer may store the secured produce in his own warehouse. Borrowing is relatively easy, since it does not require official grading of the produce used to secure the loan, although the loan is limited to 80% of the set minimum price.

In addition to these two systems, there is a special system known as the Pre-EGF used for the purpose of encouraging the marketing activity of cooperative associations. In this system, funds to be used as payment for the products collected from the members are loaned to the associations. The terms and conditions of EGF and Pre-EGF loans are also concessional.

The volume and the value of AGF and EGF for 1983-84 (as of May 1984) are shown in Table 5-11. Rice is the most important product in terms of AGF and EGF followed by soybean, feijao and maize. Government acquisition (AGF) was not made for soybean, because market price was higher than the minimum price through the period.

Table 5-11 AGF and EGF Volume and Value (1984)
(Total as of May 11)

Products		(ton)	(Cr$ million)
Cotton	AGF		9
	EGF	103,282	43,646
Rice	AGF	340,410	72,932
	EGF	136,571	54,664
Feijao	AGF	42,520	15,202
	EGF	71,714	25,123
Meize	AGF	3,280	350
	EGF	158,162	20,991
Soybean	AGF	-	-
	EGF	434,980	52,763
Others	AGF	-	1,254
	EGF	-	23,869
Total	AGF	-	89,747
	EGF	-	221,056

Source: CFP, Informativo Sunop, Ano 11 - No. 18.

5-3-3 Credit and Price Policy in Relation to the Agricultural Development in Greater Carajas Program Area

(1) Rural credit (SNCR)

Rapid expansion of rural credit starting in the latter half of 1960s was impressive. This credit expansion was made possible by the "miracurous growth" of the national economy of Brazil. It is also noted that the banking system of the country had been fairly well established when SNCR started, and the existed bank network could be utilized as the agencies for SNCR loans. This was another factor which enabled the rapid expansion of rural credit. This situation was different from developing countries in Southeast Asia. In these countries, except for the Philippines, lack or inmaturity of local banking institutions was the bottleneck for expanding rural credit. In the Philippines, local banks had existed for doing business with large landowners originated from the Spanish regime.

As previously mentioned, in the northern and northeastern regions, which includes the Greater Carajas Program Area, very few farms enjoy the benefits of the SNCR. One reason is that banking net-

works, which implement SNCR, are not numerous in this area, so that farmers cannot easily utilize them. In addition, there was the problem of timing -- from the latter half of the 1960s to the first half of the 1970s, the period of expansion of the SNCR, owners of small- and medium-scale farms in this area had little need for funds. In the mid-1970s, when production of commodity crops began to increase, the SNCR was decreased by the tight-money policy.

In consideration of these factors, with a view to the development of agriculture in the Greater Carajas Program Area, concessionary measures for specified areas must be introduced, in combination with a policy of encouraging owners of small- and medium-scale farms, and improving productivity in the SNCR. In addition, means must be devised to provide easier access to the SNCR for owners of small- and medium-scale farms.

(2) Price support (PGPM)

Pricing policy is an effective means of increasing production by setting the minimum price (AGF price) of certain products. For example, the acreage devoted to maize increased by 23% and production by 13% in 1981-82 due chiefly to the favorable AGF price for maize. At the same time, however, medium- and large-scale farmers changed from growing soybean to producing maize. This means that pricing policy has a great effect on the selection of crops.

Since support prices are determined for regional groups, operation of the support price system in combination with the encouragement of preferential crops in various region will aid regional development. In this case, as in the SNCR case described above, a method is required to facilitate easier access to PGPM for small and medium farmers. In remote regions where access to financial organizations (price support agencies) is difficult, Production Credit Board (CFP) has established temporary branch offices during the harvest season for the convenience of farmers. According to information obtained during the field survey, the mere fact that a branch office had been opened prevented a decline in price.

(3) Regional agricultural development in cooperation with the SNCR and PGPM

It has been noted that the SNCR and PGPM are being successfully implemented in a comprehensive manner. However, in recent years, emphasis has gradually been shifted to pricing policy, due to the financial condition of the nation.

Since loan and pricing policies function differently, pricing policy cannot replace all functions of the loan policy. For example, as described above, SNCR gives preferencial treatment to small-scale farmers in respect of VBC and interest, as mentioned before, but it is difficult to separate the products of small farms from those of large farms in setting minimum prices. Likewise, a higher VBC is applied to loans for highly productive farms, but it is difficult to

provide preferential treatment in terms of price according to the productivity of the producers.

Policy in the 1970s stressed the subsidized loans, but now that they have been reduced, other types of incentives must be considered, for example, a method of direct subsidy (goods in kind or purchase cost) for the production in specific project areas, such as settlement areas. The most effective means for regional development seems to be by a "package deal", combining loan, pricing, subsidy, and the extension service.

5-4 Agricultural Cooperatives

5-4-1 Basic Law Concerning Cooperatives

Agricultural cooperatives in Brazil were organized under the Cooperative Association Act legislated prior to the war. Since 1964, when the military regime came into power, the activities of agricultural cooperatives have been encouraged as a part of rural development efforts.

The current basic law concerning cooperatives is the Cooperative Law of 1971. Under this law, the federal agency responsible for supervising and controlling the cooperatives is the National Institute of Colonization and Agrarian Reform (INCRA), but the mixed agricultural cooperatives, which conducts credit operations, are under the control of the Central Bank, as are the credit cooperatives. The housing cooperatives are under the control of the Housing Bank.

5-4-2 Type and Number of Cooperatives

Cooperatives in Brazil are classified into three organizations: single cooperatives, federations, and central cooperatives. At the same time, they are classified into six sectors: production, consumption, rural electrification and telephones, education, housing, labor (not labor union), and credit.

The cooperatives are formed after approval by the authorities concerned. The number of cooperatives classified by the type of business and by state at the end of 1981, 1982, and 1983 is indicated in Table 5-12. The number of cooperatives at the end of 1983 totalled 2,811; 1,452 cooperatives out of 2,811 were related to agriculture (hereinafter called "agricultural cooperative"); and 433 out of 1,452 are related to agro-industry.

Under the Cooperative Law, cooperatives which are not in operation for a specified number of years shall have their registration revoked, but they can exist until their registration is cancelled. Thus, there are considerable number of non-operating cooperatives.

Table 5-12 Number of Cooperatives by Type of Business and by State (On Approval Basis)(As of December 31, each year)

State	Year	Total	Industry's Type							
			Production			Consumption	Stock-Farming	Education	Rural Electrification	Others
			Animal	Mineral	Vegetable					
BRASIL	1981	2,700	196	9	223	374	974	268	281	375
	1982	2,781	198	11	233	381	1,018	272	278	390
	1983	2,811	192	11	241	382	1,019	246	278	442
Rondonia	1981	7	-	-	-	2	5	-	-	-
	1982	6	-	-	-	1	5	-	-	-
	1983	9	-	-	-	2	6	-	-	1
Acre	1981	10	-	-	-	-	10	-	-	-
	1982	10	-	-	-	-	10	-	-	-
	1983	10	-	-	-	-	10	-	-	-
Amazonas	1981	29	4	-	3	2	16	1	-	3
	1982	29	3	-	3	2	17	1	-	3
	1983	25	1	-	2	1	17	1	-	3
Roraima	1981	5	1	-	-	1	3	-	-	-
	1982	7	2	-	-	1	4	-	-	-
	1983	9	2	-	-	2	5	-	-	-
Para	1981	48	5	1	-	3	23	9	-	7
	1982	48	3	1	-	3	23	9	-	9
	1983	51	3	1	1	4	22	10	-	10
Amapa	1981	6	1	-	-	-	4	1	-	-
	1982	5	1	-	-	-	3	1	-	-
	1983	5	1	-	-	-	3	1	-	-
Maranhao	1981	56	7	-	2	2	24	2	14	5
	1982	63	6	-	2	2	33	2	13	5
	1983	67	4	1	2	2	37	2	13	6
Piaui	1981	40	4	1	1	1	19	1	7	6
	1982	42	4	1	1	1	21	1	7	6
	1983	47	4	1	2	1	23	1	8	7
Ceara	1981	81	3	-	4	2	48	1	14	9
	1982	82	3	-	5	1	47	1	14	11
	1983	86	3	-	5	1	50	-	14	13
Rio Grande do Norte	1981	63	2	3	-	2	36	-	5	15
	1982	70	3	4	-	2	37	-	8	16
	1983	76	3	4	1	3	38	1	8	18
Paraiba	1981	70	1	-	1	4	44	2	9	9
	1982	74	2	-	1	4	45	2	10	10
	1983	82	2	-	1	4	49	2	11	13
Pernambuco	1981	142	5	-	3	3	70	32	19	10
	1982	154	6	-	5	3	76	32	19	13
	1983	149	6	-	5	3	78	21	18	18
Alagoas	1981	39	-	-	1	2	8	19	5	4
	1982	42	-	-	1	3	9	19	5	5
	1983	43	1	-	1	3	9	19	5	5
Sergipe	1981	22	1	-	1	2	11	1	3	3
	1982	22	1	-	1	2	11	1	3	3
	1983	20	1	-	2	1	10	-	3	3
Bahia	1981	128	9	1	6	7	59	19	15	12
	1982	136	12	1	7	7	62	26	13	8
	1983	146	13	-	8	8	61	30	12	14
Minas Gerais	1981	323	24	-	20	58	149	10	33	29
	1982	343	25	-	20	61	164	11	31	31
	1983	337	24	-	19	63	161	8	31	31
Espirito Santo	1981	38	8	-	8	7	9	3	-	3
	1982	40	8	-	9	7	9	3	-	4
	1983	40	8	-	10	7	9	-	-	6
Rio de Janeiro	1981	139	19	1	10	24	40	7	7	31
	1982	145	20	1	10	25	43	7	7	32
	1983	151	20	1	11	24	40	7	7	41
Sao Paulo	1981	487	37	1	46	109	115	24	33	122
	1982	478	33	1	46	108	112	24	33	121
	1983	482	34	1	46	110	111	24	33	123
Parana	1981	262	10	-	20	16	50	124	22	20
	1982	268	11	-	24	20	50	120	21	22
	1983	273	11	-	26	20	50	114	20	32
Santa Catarina	1981	144	6	-	10	21	48	6	40	13
	1982	144	6	-	10	21	47	6	40	14
	1983	143	5	-	10	22	47	3	40	16
Rio Grande do Sul	1981	367	35	1	75	82	95	3	20	56
	1982	356	35	1	74	77	91	3	18	57
	1983	342	33	1	74	71	85	1	18	59
Mato Grosso do Sul	1981	39	7	-	3	2	14	-	6	7
	1982	42	7	-	3	4	14	-	6	8
	1983	38	6	-	3	4	11	-	6	8
Mato Grosso	1981	43	2	-	5	4	24	1	4	3
	1982	51	2	-	7	5	28	1	5	3
	1983	52	2	-	8	4	28	-	5	5
Goias	1981	94	4	-	4	10	46	2	23	5
	1982	105	4	1	4	12	54	2	23	5
	1983	109	4	1	4	13	56	1	24	6
Distrito Federal	1981	10	1	-	-	8	4	-	2	3
	1982	19	1	-	-	9	3	-	2	4
	1983	19	1	-	-	9	3	-	2	4

Source: Ministery of Agriculture, INCRA.