of beef production. On the other hand, when the effective interest rate is reduced to 5%, the B/C ratio rises to 1.30, widening the profitability differentials between these two activities and indicating that the profitability of soybean production, which requires much funding, depends heavily on the interest rate.

(6) Impact of the rate of tax on sales

The impact of the rate of tax on sales can be assessed by comparing Case 5 and Case 6 in Table 7-7. The impacts are examined in the cases in which the tax rate is more than 8% (Case 5), and less than 8% (Case 6).

In Case 5 the IRR and the B/C ratio are 5% and 0.87 respectively, indicating a redution in investment efficiency compared with the basic case. Especially, the B/C ratio of less than one makes the investment itself questionable. In Case 6, in which the IRR and the B/C ratio are lifted to 25% and 1.36 by a reduction of the tax rate to 6%, investment efficiency improves substantially. Thus, changes in the tax rate have a direct and considerable influence on the production of soybean.

7-2-3 Medium-Scale Perennial Crop Farm Model

In order to examine the various issues farmers face when they grow perennial crops which are expected to become commercial crops in the future, this section will presents an analysis of oil palm cultivation. The model farm is one in which oil palm is planted on 200 ha of purchased land. According to the data obtained during the field observations at sub-region Castanhal, the first harvest of oil palm takes place at the 5th year after the seedlings are planted with a yield of 5 tons per hectare. The yield gradually increases and attains its peak at the 8th year with a level of 20 tons per hectare. This level is maintained for about ten years and gradually declines thereafter.

The costs of oil palm cultivation can be separated into investment costs that are incurred during the first four years and production costs incurred from the 5th year (see Table 7-8 and Table 7-9). Investment expenditures in the first year involve the costs for land acquisition, land preparation, and for the purchase of nursery trees and fertilizers, totaling Cr$2,430,000/ha. For the period from the second to the fourth year, when there is no land acquisition or preparation, the expenditures are as follows: Cr$684,000/ha in the second and third years, and Cr$926,000/ha in the fourth year. Annual costs from the fifth year comprise the cost of such materials as fertilizers and pesticides, and the cost of labor required for collection and transportation.

(1) Cost-benefit analysis

Given that the conditions concerning cultivation techniques, fund procurement and processing facilities are satisfactory, whether a farmer has the willingness to be engaged in oil palm cultivation depends on the profitability of oil palm production.

Here, again the internal rate of return (IRR) and the B/C ratio are used as profitability criteria.

$$(1) \quad \sum_{t=1}^{30} Bt/(1 + IRR)^t = \sum_{t=1}^{30} \sum_{i} Cit/(1 + IRR)^t$$

$$(2) \quad B/C = \frac{\sum_{t=5}^{30} \sum_{i} (Bt - Cit)/(1 + R)^t}{\sum_{t=1}^{4} \sum_{i} Cit/(1 + R)^t}$$

where, Cit : Cost of item i at year t
Bt : Benefit at year t
IRR : Internal rate of return
R : Effective interest rate (= 10%)

Substituting the data from Table 7-8 and 7-9 for the variables in the above equations one obtains an IRR of 18% and a B/C ratio of 2.16 (Basic Case in Table 7-10). These results show that, given the current prices and other present conditions, the profitability of oil palm cultivation as an agricultural business is considerably high, and for this reason many farmers in the Castanhal sub-region are showing great interest in oil palm cultivation.

Table 7-8 Investment Costs of Oil Palm Farm Model

(Unit: Cr$1,000/ha)

	1st year	2nd year	3rd year	4th year
Land Acquisition	300	-	-	-
Land Preparation	696	-	-	-
Nursery Trees	750	-	-	-
Fertilizers & Others	512	532	532	742
Labor	172	152	152	184
Total	2,430	684	684	926

Source: Data provided by Cooperativa Agricola Mista Paraense (1984)

Table 7-9 Cost and Benefit Structure of Oil Palm Model: 5th - 30th Years

Year	Benefits		Costs (Cr$1,000/ha)			
			Labor		Fertilizers and Others	Total
	Yield (ton/ha)	Production Value (Cr$1,000/ha)	Fertilizer & Pesticide Application	Collection and Transportation		
5	5	850	152	160	746	1,058
6	10	1,700	152	320	746	1,218
7	15	2,550	152	480	746	1,378
8 - 17	20	3,400	152	640	746	1,538
18	19	3,230	152	608	746	1,506
19	18	3,060	152	576	746	1,474
20	17	2,890	152	544	746	1,442
21	16	2,720	152	512	746	1,410
22	15	2,550	152	480	746	1,378
23	14	2,380	152	448	746	1,346
24	13	2,210	152	416	746	1,314
25	12	2,040	152	384	746	1,282
26	11	1,870	152	352	746	1,250
27	10	1,700	152	320	746	1,218
28	9	1,530	152	288	746	1,186
29	8	1,360	152	256	746	1,154
30	7	1,190	152	224	746	1,122

Note: Labor costs for collection and transportation were assumed to be in proportion to yield.

Source: Cooperativa Agricola Mista Paraense (1983)

Table 7-10 Results of Cost-Benefit Analysis of Oil Palm Farm Model (Financial Analysis)

	Assumptions	IRR	B/C
Basic Case	Prevailing price in 1983	18%	2.16
Case 1	Price decreased by 20%	11%	1.25
Case 2	Price increased by 20%	22%	3.06

(2) Technical and financial factors in oil palm cultivation

From the analysis outlined in the previous sub-section it is apparent that oil palm production can substantially raise the income of farmers. Let us now examine the impacts of technical and financial factors on the formation of oil palm producing areas.

As seen in Table 7-8 and Table 7-9, there observe two special features in the cost structure of oil palm production. First, a large amount of investment is required and returns on capital cannot be expected in the first four years. Secondly the seedlings are expensive and, thus, improvements in the marketing system and cultivation techniques of nursery trees are necessary to reduce farmers' financial burden.

The total investment cost over the first four years amounts to as much as Cr$4,724,000/ha, and therefore the total cost for establishing an oil palm farm of 200 ha is estimated at Cr$944 million. Even if the effective interest rate is 0%, the break-even point, where initial investment is completely recovered, comes in the ninth year. Thus, the availability of long-term soft loan seems to be a precondition for oil palm production.

The seedling cost of Cr$750,000/ha accounts for 30% of the total cost in the first year. Since most of the nursery trees are imported from Africa, there are problems for solving with respect to the distribution network and procurement of enough nursery trees to meet local demand. Therefore, it seems essential that, in addition to improvements in the marketing and processing facilities of oil palm product, technical and institutional improvements be made so that farmers can produce nursery trees themselves.

(3) Oil palm cultivation and processing and market conditions

The high profitability projection drawn from the cost-benefit analysis described previously was calculated on the assumption that all the collected oil palm bunches are sold to a local oil mill at a market price of Cr$170,000/ton. Although careful attention should be paid to trends in world's demand and supply of oil palm, in considering the present situation of the world market of oil palm and its substitutability with other oils, it is not reasonable to be pessimistic about the future of oil palm. The crucial element in the success of oil palm production is the existence of an oil mill of sufficient capacity near the farm site. As mentioned in Chapter 6, oil palm bunches should be treated within twenty-four hours after harvesting. If the producer price declines by 20% due to limited crushing capacity, the IRR and B/C of oil palm production will decrease to 11% and 1.25 respectively. These results indicate the importance of the existence and crushing capacity of oil mills in oil palm cultivation.

7-2-4 *Land Rotation Farm Model*

An analytical model of the shifting cultivation system in which a farmer cuts and burns forests and grows crops two or three years before moving to another place is difficult to construct because there is no limitation in land area. This section will be focused on the so-called land rotation system which is considered a transitionary state between the shifting cultivation and the sedentary cultivation systems, and examine the conditions for its continuation and transition to the sedentary cultivation system.

Results of the model analysis can be summarized as follows: (i) for farmers with a vast land area, poor cultivation techniques and limited labor availability, it is more profitable to adopt the land rotation system than the sedentary cultivation system which requires soil fertility maintenance by applying fertilizers and other inputs; (ii) the transition from the land rotation to the sedentary cultivation system requires changes in the land-labor ratio, lower input prices, and improvements in sedentary cultivation techniques; and (iii) in order to promote farmers' settlement, it seems effective to provide farmers with technical and financial support for planting profitable perennial crops in addition to food crops for self-consumption.

(1) Objective function and constraints

The concern of the farmer in this model is the selection of the types of products and the method of production which satisfy the objectives of self-consumption food supply and cash income maximization. The activities are rice under shifting cultivation system, cattle raising under shifting cultivation system, rice under sedentary cultivation system, cattle raising under sedentary cultivation system, and a perennial crop.

Objective function:

$$Z = X_1(P_S Y_S) + X_2(P_B Y_B) + X_3(P_S - F_S)Y'_S + X_4(P_B - F_B)Y'_B + X_5 P_p - CP_S \quad \ldots\ldots\ldots (1)$$

Constraints:

$$15X_1 + X_3 + X_4 + X_5 \leq A \quad \ldots\ldots\ldots (2)$$

$$X_2 - 5X_1 \leq 0 \quad \ldots\ldots\ldots (3)$$

$$b_1X_1 + b_3X_3 \leq B1 \quad \ldots\ldots\ldots (4)$$

$$b_2X_2 + b_4X_4 + b_5X_5 \leq B2 \quad \ldots\ldots\ldots (5)$$

$$X_1Y_S + X_3Y'_S \geq C \quad \ldots\ldots\ldots (6)$$

$$dX_5 \leq D \quad \ldots\ldots\ldots (7)$$

where, X_1 : Rice area under the land rotation system (ha)
X_2 : Pasture area under the land rotation system (ha)
X_3 : Rice area under the sedentary system (ha)
X_4 : Pasture area under the sedentary system (ha)
X_5 : Perennial crop area (ha)
P_S : Unit price of rice (Cr$1,000/ton)
P_B : Unit price of cattle (Cr$1,000/head)
P_p : Profit of the perennial crop per unit of area (Cr$1,000/ha)
Y_S : Yield of rice under the land rotation system (ton/ha)
Y_b : Pasture productivity under the land rotation system (head/ha)
Y'_S: Yield of rice under the sedentary system (ton/ha)
Y'_B: Pasture productivity under the sedentary system (head/ha)
F_S : Current input cost of rice cultivation per unit of area (Cr$1,000/ha)
F_B : Current input cost per unit of pasture area (Cr$1,000/ha)
A : Total arable land area (ha)
B_1 : Labor availability in Season I (labor-days)
B_2 : Labor availability in Season II (labor-days)
C : Quantity of rice for self-consumption (ton)
D : Funds available (Cr$million)
b_1, b_2, b_3, b_4, b_5: Labor coefficients of each crop (labor-days/ha)
d : Investment per unit of area, necessary for the perennial crop (Cr$1,000,000)

The above model contains the following assumptions: (i) the land rotation period is 15 years, and the area where rice was once grown is

used as pasture for 5 years; and (ii) rice and pasture under the sedentary cultivation system require fertilizers and other inputs to maintain soil fertility; they also require more labor than the rotation system.

(2) Necessary conditions for the continuation of the land rotation system

Table 7-11 shows the technical coefficients and various restrictive conditions of the model.

Rice under shifting cultivation system is cultivated without inputs except labor, and the yield per hectare was assumed to be 1.2 tons. Rice under sedentary cultivation system requires inputs for maintaining soil fertility and more labor in order to yield 1.2 tons per hectare. Through beef activity under shifting cultivation the farmer can sell 1/4 head of cattle annually per 1 ha of natural pasture. In the sedentary cultivation the beef production provides 1/2 head of cattle for sale per year per hectare of improved pasture, but requires current inputs and more family labor to maintain soil fertility. With 2.5 persons of family labor, a maximum of 100 labor-days are available during the planting and harvesting periods of rice, and 333 labor-days is for the rest of the year. Since data on perennial crops were not available except for oil palm, we will use the case of oil palm as an example. The assumption is that the farmer owns 100 ha of land, of which 50 ha are forest and the remaining 50 ha are available for cultivation.1)

As shown in the linear programming solutions (see Table 7-12), all the available area of land is used for rice and pasture under the land rotation system, and other activities (rice and pasture under sedentary cultivation system, and perennial crop) are not entering the farmer's cropping pattern. The yearly production of rice and beef are 4.0 tons and 4.16 head respectively. Subtracting 1.28 tons for self-consumption, the balance of 2.72 tons of rice for sale together with the beef cattle production yields a cash income of Cr$1,513,000 per year.

(3) Impact of labor endowment

As described in Chapter 4, the production of food crops for self-consumption differs between the sub-regions in the PGC Area. In the sub-regions where land is abundant such as Maraba and Araguaina, the practice of shifting cultivation and land rotation is widespread, while sedentary agriculture is dominant in sub-region Bacabal where land is scarce. The LP solutions obtained by gradually increasing the labor endowment are shown in Figure 7-3. As the amount of available labor increases, the areas devoted to rice and pasture under the land rotation system decrease, while the areas of rice and pasture under

1) It is assumed that the farmer buys a two-year old calf and sells it to the market after fattening it for two years.

Table 7-11 Basic Assumptions for the Land Rotation Farm Model

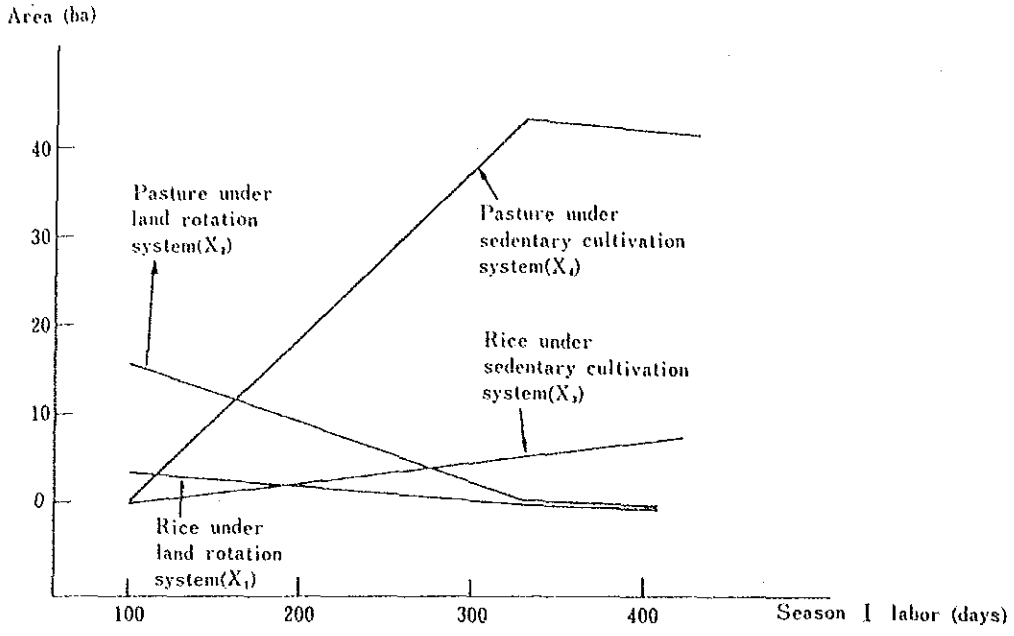
	Symbol	Value
Unit price of rice	P_S	Cr$250,000/ton
Unit price of beef cattle	P_B	Cr$200,000/head
Profit per unit area of perennial crop	P_P	Cr$850,000/ha
Current input cost per unit area of rice under sedentary cultivation system	F_S	Cr$70,000/ha
Current input cost per unit area of pasture under sedentary cultivation system	F_B	Cr$140,000/ha
Yield of rice under land rotation system	Y_S	1.2 tons/ha
Cattle sold per unit area of pasture under land rotation system	Y_B	0.25 head/ha
Yield of rice under sedentary cultivation system	Y'_S	1.2 tons/ha
Cattle sold per unit area of pasture under sedentary cultivation system	Y'_B	0.5 head/ha
Labor coefficient of rice under land rotation in Season 1	b_1	30 days/ha
Labor coefficient of rice under sedentary cultivation in Season 1	b_3	20 days/ha
Labor coefficient of pasture under land rotation in Season 2	b_2	50 days/ha
Labor coefficient of pasture under sedentary cultivation in Season 2	b_4	25 days/ha
Labor coefficient of perennial crop in Season 2	b_5	10 days/ha
Investment per unit area of perennial crop	d	Cr$4,124,000/ha
Area of arable land	A	50 ha
Labor endowment in Season 1	B_1	100 days
Labor endowment in Season 2	B_2	333 days
Quantity of rice for self-consumption	C	1.28 tons
Investment capital available	D	Cr$0.0

Source: Based on the records of interviews with farmers in the PGC Area during the field observations.

Table 7-12 LP Solutions of the Land Rotation Farm Model

	Rice			Beef			Perennial Crop	Total
	Land Rotation System (X_1)	Sedentary System (X_3)	Total	Land Rotation System (X_2)	Sedentary System (X_4)	Total	(X_5)	
Area (ha)	3.33	0	3.33	16.65	0	16.65	0	
Production Quantity (ton or head)	4.0	0	4.0	4.16	0	4.16	0	
Self-Consumption (ton or head)			1.28			0	0	
Quantity of Sale (ton or head)			2.72			4.16	0	
Income (Cr$1,000)			680.0			832.5	0	1,512.5

Figure 7-3 Impact of Labor Endowment on the Cropping Pattern



the sedentary cultivation system increase. This can be explained in the following way. When labor is in short supply, the farmer adopts the land rotation system because there is enough land to absorb his family labor, even though forests are burned yearly and the rotation period is long. When there is abundant family labor, however, land-saving sedentary cultivation is preferable.

(4) Impact of current input prices

In the land rotation system land is left fallow for long periods in order to restore soil fertility, and thus fertilizers and other current inputs are not necessary. In the sedentary cultivation system, on the other hand, soil fertility is maintained by applying compost and chemical fertilizer instead of leaving the land fallow. Consequently, the level of fertilizer and other current input prices can be considered an important factor in deciding whether to continue the land rotation system. This can be confirmed by comparing the linear programming solutions obtained from varying the current input price.

Figure 7-4 shows the cropping patterns corresponding to different current input prices. The areas under the sedentary cultivation system are very limited at the initial current input price, and most of the land is used for rice and pasture under the land rotation system. As the input price declines, the areas of rice and pasture under land rotation decrease and those of rice and pasture under the sedentary cultivation system increase. The results of this simulation imply that reducing current input prices will stimulate a shift of farming from land rotation to sedentary cultivation.

Figure 7-4 Impact of Current Prices on the Cropping Pattern

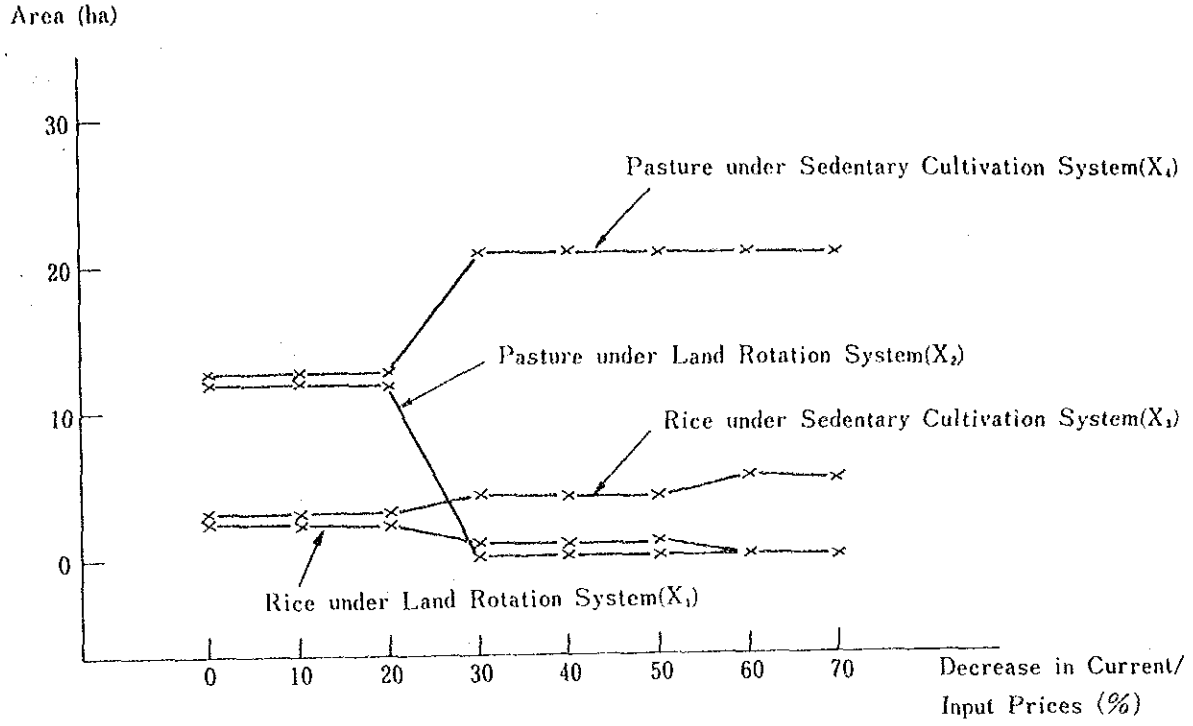
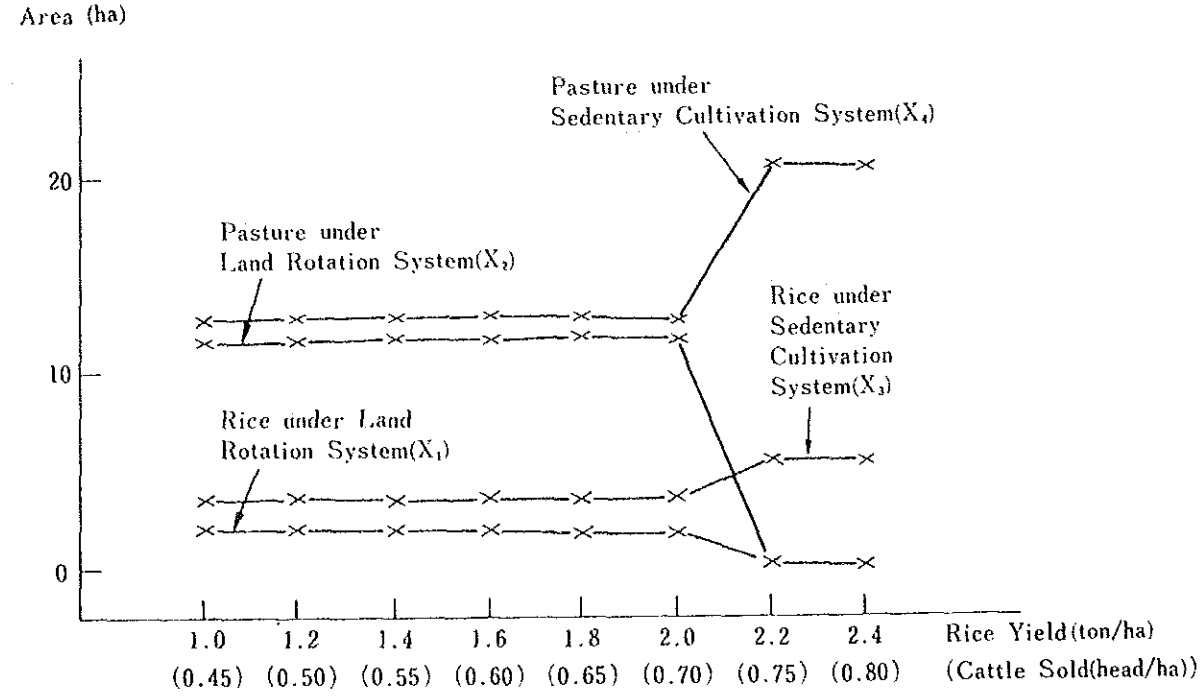


Figure 7-5 Impact of Technical Changes on the Cropping Pattern



(5) Impact of changes in production technologies

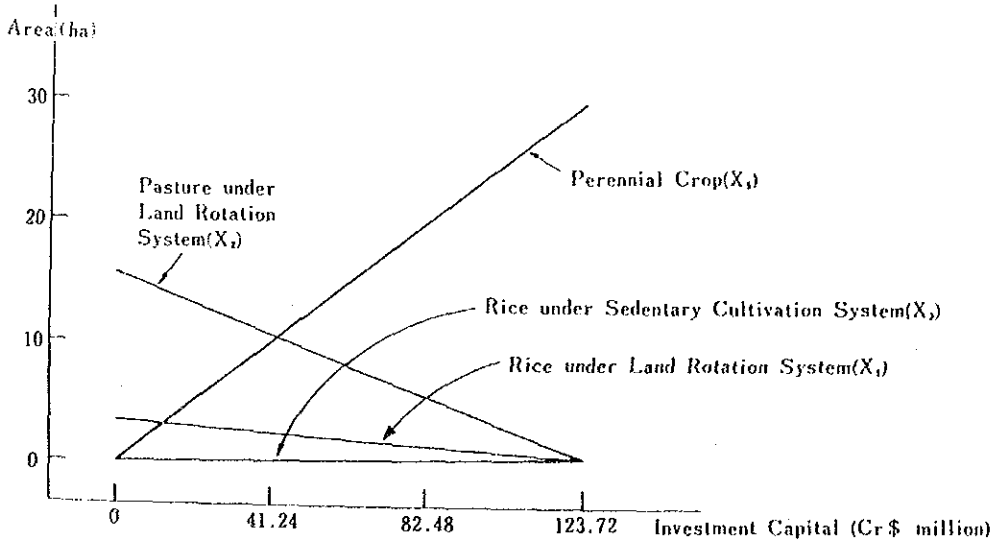
Improvements in the production technologies of the sedentary cultivation system also work towards promoting this method of cultivation. By varying the land productivities of rice and pasture under the sedentary cultivation system, one obtains the corresponding cropping patterns as shown in Figure 7-5. It is observed that, as the technical level related to the sedentary cultivation is improved, the farmer tends to switch to this system. Under the assumptions of the model, however, the areas of rice and pasture under the sedentary cultivation system do not exceed 5.14 ha and 21.6 ha, respectively, even when those under land rotation become zero. In order to use all the 50 ha of land, the farm has to use hired labor in addition to its family members.

(6) Introduction of perennial crop

In order to raise the efficiency of land utilization and increase farm incomes, it seems also effective to encourage farmers to plant perennial crops of high profitability. To introduce perennial crops, subsistence farmers need to have knowledge on cultivation techniques and access to investment funds. Since it is difficult to accurately distinguish these two factors (technology and credit) in a simple model, an investment capital restriction was incorporated into the model as a proxy variable for these factors to assess their impacts on the cropping pattern.

The perennial crop (oil palm) in the model will produce a profit of as much as Cr$850,000/ha but, on the other hand, will require an investment of as large as Cr$4,120,000/ha. As shown in Figure 7-6, as the amount of capital available increases, the planted area of the perennial crop rises, reducing the areas of rice and pasture under land rotation.

Figure 7-6 Impact of Investment Capital Availability on the Cropping Pattern
(Season I labor: 100 days; Season II labor: 333 days)



7-3 Preliminary Crop Selection on the Basis of Social and Economic Conditions and Necessary Conditions for Agricultural Development

7-3-1 Basic Views

The selection of crops for certain specific regions is to search for a combination of crops which (1) is consistent to the aims of agricultural development in the region, as well as to the objectives of farm units which are the core of agricultural production, (2) under the current situation and foreseeable changes of the various conditions surrounding the agricultural sector and farmers, and (3) various attributes of crop with respect to cultivation and marketing.

Regarding (1), based on the Inception Report and the survey results, the following points are to be emphasized in crop selection. The crop should be that which can:

(i) realize the potential of the enormous land resources -- the biggest asset of the Area -- as possible,

(ii) help raise the living standards of small-scale farmers, who constitute the majority of farmers in this Area, and help settle down shifting farmers,

(iii) be developed as a commercial crop suitable for the utilization of the Area's, and

(iv) contribute to environmental conservation.

Accordingly, bearing the above objectives in mind we reviewed the priority crops for each sub-region in terms of the interrelationship of the characteristics of each region and of each crop. Tentative selection of suitable crops based on natural and technical conditions has already been undertaken in Chapter 3. The examination in this section was conducted on the basis of the study results of development potentials in Part II, the studies on social and economic conditions discussed in Chapters 4 to 6, and farm management analysis, that is, a study on individual farms and the related circumstances done in the second section of this Chapter.

It goes without saying that for selecting the specific crops suitable for production in the sub-regions of the Area in terms of social and economic conditions, still more factors and information are necessary. For this reason, this section outlines a method for selecting crops, rather than stating what crops are concretely suitable. This section will look at:

(1) The characteristics of each sub-region,

(2) The characteristics of the main crops, and

(3) The preliminary selection of suitable crops for each sub-region.

7-3-2 Major Socio-Economic Features of the Sub-regions

Since the features of each sub-region are related to the period in which agricultural development was active, they will be described in the order of date of settlement and in consideration of social and economic conditions necessary for agricultural production. Based on the study on the Area's development potentials in Part II and the study results mentioned up to the previous chapter, the main items examined here are the present availability of land for cultivation, land-ownership, average size of farm units, labor endowment, levels of production techniques, access to markets, and infrastructure conditions. (See Figure 7-7 for location and main transport infrastructures of the sub-regions).

(1) Bacabal

Compared with the six other sub-regions, settlement occurred relatively early, so Bacabal has the least amount of undeveloped arable land. The present cultivated land is divided into small lots and the average farm size is the smallest in the PGC Area. The percentage of owner-farmers is smallest after the Xingu sub-region, while that of tenant farmers and occupants (Posseiro) is the largest after Xingu and Balsas.

Municipalities with relatively high population densities in the Area are concentrated around this sub-region, making it the sub-region with largest potential labor force. In fact, the land-labor ratio is the smallest in this sub-region.

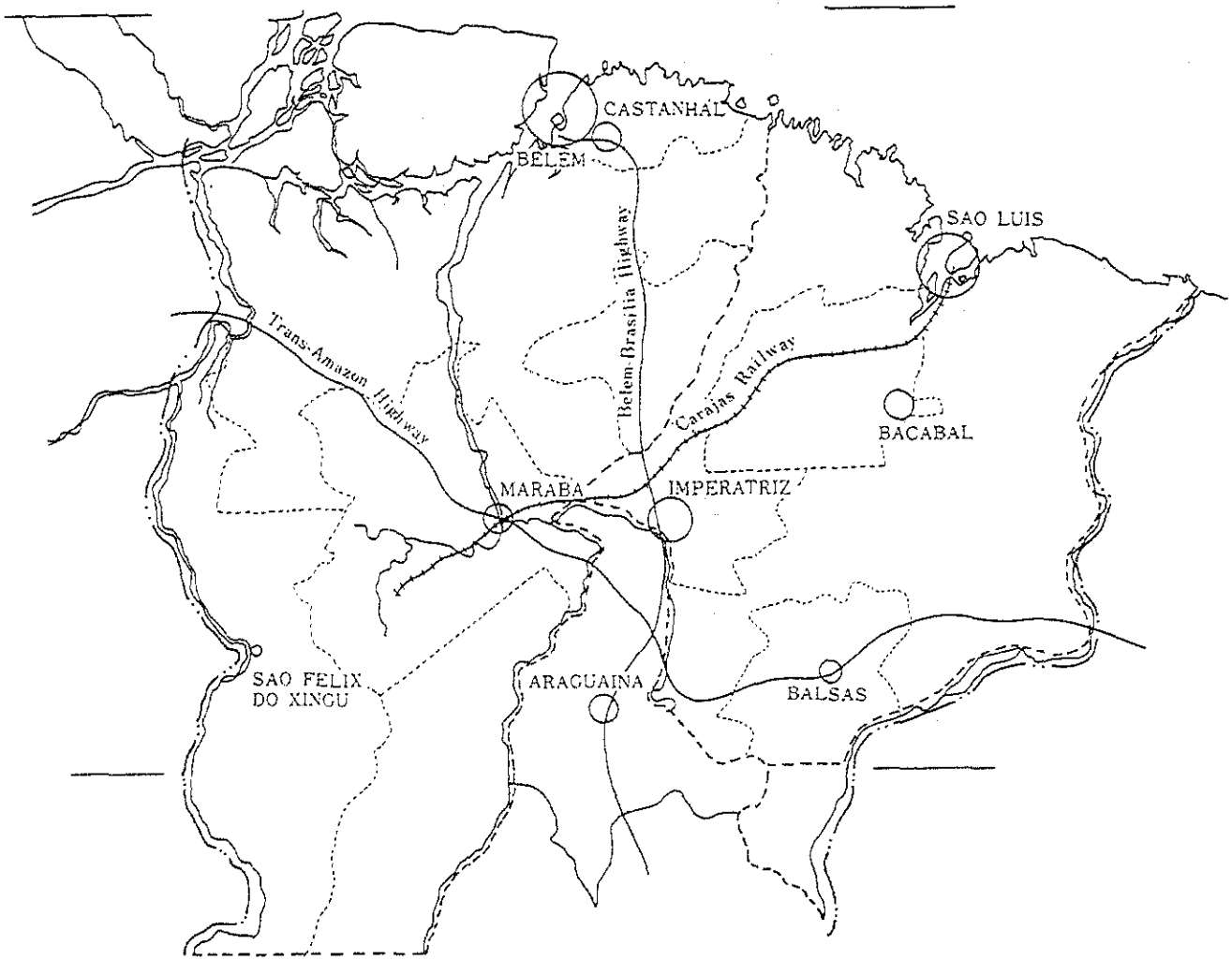
Because the percentage of owner-farmers and average farm size are comparatively small in this sub-region, the percentage of mini farmers is large. Most of these mini farmers are producing food for self-consumption, and obtaining income by collecting babassu. Therefore, few of them are engaged in the type of modern agriculture that requires many inputs at this stage, and their technological levels are generally low.

Like the Castanhal sub-region, infrastructure in this sub-region is relatively well-structured. Since the impact of the opening of the Carajas Railway on this region is beginning to appear, the capacity to introduce new production techniques is greater because of the improved means of communication.

As for access to markets, Sao Luis, which is the local market for Bacabal, is close-by, and exporting will be possible by shipping from the Sao Luis Port, thereby giving Bacabal the advantage over inland sub-regions.

In addition, Sao Luis has a large mill for processing babassu, so it can be said that Bacabal, like Castanhal, is well-suited to the processing of farm produce.

Figure 7-7 Major Local Markets and Transport Infrastructure of the PGC Area



Note: ◯ indicates market size.

(2) Castanhal

This sub-region includes the districts of Salgado (micro-region) and Bragantina, which constitute the suburbs of Belem, and also the municipalities of Paragominas and Peixe-Boi, which make up the district of Guajarina. Since there are big differences in the conditions of production between the former and the latter, they are discussed separately.

In the Salgado and Bragantina districts, like in the Bacabal sub-region, settlement occurred relatively early, and the average farm size is small. Population is concentrated in and around Belem, and the land-labor ratio in these two districts is as small as in the Bacabal sub-region.

What differs from Bacabal is that the percentage of owner-farmers is the largest after the Maraba and Araguaina sub-regions, and the farmers' production techniques seem generally high because commercial crops which require cultivation techniques for example, pepper and choice tropical fruits are being produced. Agricultural cooperatives are advanced in some parts, and even medium- and small-scale farmers are well-vessed in production techniques. Since this sub-region has a large percentage of owner-farmers, capital-raising ability, including suitability for receiving loans, seems to be relatively high. This is reflected in the long history of pepper production, as well as in the increasing production levels of oil palm; both are perennial crops whose returns on investment require much time.

In terms of infrastructure, the suburbs of Belem have a well-developed road network and the Belem-Brasilia highway, which links these districts with major domestic markets. In addition, the districts can use the Tocantins river and the Belem port, although it is not modern for export; the districts are therefore have the advantage of well-established infrastructure. Belem, which is relatively densely populated, is in the district and has good access to domestic and foreign markets, so it can be said that, concerning markets, the districts are best-suited to commercial farm production. The districts have considerable number of processing mills in Belem, although their number is still not sufficient.

On the other hand, the Guajarina district, incorporating the central municipality of Paragominas, has been developed since the Belem-Brasilia highway opened in the 1960s, and is featured by the large number of pasture areas.

(3) Imperatriz

Development began in this sub-region when the Belem-Brasilia highway was opened, and centered mainly on the city of Imperatriz. In the 1970s, especially, big stock breeders from central and southern Brazil, including the state of Goias, and small producers from Maranhao and other northeastern states moved in, increasing the region's population markedly. Imperatriz now, has the third largest

population behind the Bacabal and Castanhal sub-regions. Accordingly, average farm size is the smallest after these two sub-regions and the land-labor ratio is relatively small.

One special feature of this sub-region, although not as marked as those of Balsas, is a polarization between large farmers, mainly beef producers, equipped with capital and technology, and small-scale farmers including occupants. Many of the former are those from the central and south (mainly from Goias), engaged in large-scale stock farming along the highway where infrastructure is relatively well-established. Recently grain cultivation with large machinery has begun, encouraging several agricultural cooperatives to improve their organizational structure, and these have become the forerunners in commercial farm production typical of the central and southern type. On the other hand, the latter are typical small-scale farmers that can be seen throughout the PGC area, producing mainly for self-consumption at great distances from the highway where the standard of feeder roads is very poor.

In terms of infrastructure, the main land route is the Belem-Brasilia highway by which access to the major domestic markets is secured for the present, although feeder roads are not in satisfactory condition. Since the opening of the Carajas Railway is considered to make transportation to Sao Luis via Acailandia more convenient, this sub-region will be favorably located to local markets, mainly Sao Luis, as well as to foreign markets. There are high population concentrations in Imperatriz, so it can be said that there is a good potential market in the sub-region.

(4) Balsas

This sub-region is similar to Imperatriz in terms of farm structure. The percentage of owner-farmers is relatively small and that of occupants large, while the ratio of land-to-labor is highest after Araguaina partly because much of the land is natural pasture areas with low population densities. Reflecting the above features, the difference in farm size between large- and small-scale farms in this sub-region is as large as in Bacabal.[1)]

Balsas is in a favorable situation when compared with Xingu, in terms of infrastructure and market access for it has a road network, even though it is below the level of state roads, and transportation within the state and access to northeastern Brazil is now secured. However, main trunk roads such as Belem-Brasilia highway are a long way off, and the sub-region is not likely to benefit simply from the opening of Carajas Railway. It will therefore become important to upgrade the infrastructure that is connected to these trunk roads.

1) Although there are no data available on the distribution of farms by size of cultivated area, according to a study using the data on size distribution of owned area of IBGE, the Gini coefficient of Balsas is highest in the seven sub-regions after Bacabal (Ministry of Agriculture, Programa Grande Carajas Agricola (Versao Preliminar)).

Much of the sub-region is of the flat Cerrado type, having many advantages for mechanized agriculture.

(5) Araguaina

Settlement occurred earlier than the Maraba sub-region, but the development of agricultural land is still in progress. The average farm size is relatively large, there are many middle- and large-scale farms doing stock breeding, many independent farmers and few occupants, and the proportion of land to labor is high. Among the seven sub-regions, Araguaina has the highest land-labor ratio, and the largest average farm size after Xingu and Maraba. Like in other sub-region, large-scale farmers tend to own their own land, so the proportion of owner-farmers is the highest after Maraba, while that of occupants is the lowest.

Since there is already a high percentage of large-scale cattle farms and still more are coming in from the south, the technological potentials appear to be large. For the development of large-scale crop production, however, there are other requirements such as the existence of nearby markets (including processing sites). Araguaina has the advantage of being the nearest sub-region to the central markets of Brazil because of the Belem-Brasilia highway.

Different from Maraba, stock farmers in Araguaina can convert to crop production because it is located in the northern tip of the flat cerrado zone.

(6) Maraba

Maraba and Araguaina have many common characteristics in terms of farming structure. However, since the population has rapidly increased recently as a result of the extraction of iron and gold from mines in Carajas, and construction of mine-linking roads and the Carajas Railway, accelerating the introduction of cultivation in the bordering areas, agriculture in the sub-region is in a state of flux. Maraba has the same land ownership problems as Imperatriz and Araguaina, but the inflow of population was so marked that attention has been paid to agricultural problems associated with disputed land ownership. Moreover, the ecology has been destroyed not only by frequent shifting cultivation but also by the use of the land rotation system. Therefore, it can be said that reform of this production system, along with improvements in large-scale land development is one of the tasks in agricultural development of this sub-region.

This sub-region is expected to have considerable advantages in terms of infrastructure as a result of the opening of the Carajas Railway and access to local markets, mainly Sao Luis, and to foreign markets by way of Sao Luis. Although a waterway to Belem via Tucurui is available, most of the roads, except for the paved road connecting to the Carajas Mine, are impassable during the rainy season. So the transport infrastructure in this sub-region still requires upgrading.

(7) Xingu

Except for the private agricultural settlement program, "Tucuma Project", there are no conspicuous economic activities in progress, reflecting the backwardness of this sub-region. Average farm size is the largest of the seven sub-regions, but the proportion of occupants is also large, supposedly because the figure includes natives undertaking shifting cultivation for self-consumption in the vast virgin forests, along with ordinary farmers who are settled and engaged in village.

Concerning transportation and market access, the sub-region is not very well favored, compared with other sub-regions.

7-3-3 Socio-Economic Characteristics of Main Crops

Reflecting the variety of natural conditions present in the PGC Area, the number of crops that can be grown in the Area is extremely large, making it difficult to review the characteristics of all of them. Therefore, we will deal with the crops considered most suited to the natural and technical conditions (Chapter 3) and examine their characteristics in relation to land, labor, capital, technology, the necessity of processing, and also freight bearing capability. As many of these crops represent some crop categories, the results of the following discussion can be used as indicators, to some degree, when planning the introduction of other crops able to be grown in each sub-region from the point of view of the natural conditions.

Maize, cassava, rice and feijao are most often grown by small-scale farmers mainly for their own consumption, so these items will be called "staple food crops" and be examined separately from crops grown for commercial purposes. However, considering that rice and maize are produced in some districts by mechanized large-scale operation, they will also be treated in the section "Commercial Crops".

(1) Staple food crops

This group comprises maize, cassava, rice and feijao. All of them have features in common. First, if cultivation methods are not limited the cultivation of these crops can be suited to any scale according to capital availability and technical level. Secondly, the production of these crops does not necessarily require intensive use of capital, technology and labor. Thirdly, transformational processing is unnecessary immediately after harvesting or even if it is necessary, simple facilities, like those used for cassava, are sufficient. Finally, prices per unit weight of these crops are low, reducing their freight bearing capability.

(2) Commercial Crops

(i) Perennial Crops

Included are oil palm, Para rubber, pepper, cacao, and guarana, all of which have common characteristics. When compared with short-term crops and vegetables, the time between planting and harvesting is long so it takes several years for investment returns to appear. Technology levels and labor intensiveness are generally high, although not as high as those for choice fruits or vegetables.

Para rubber and oil palm are typical crops for which returns on investment do not appear for several years. Since it is essential for these two items to be processed immediately after harvesting, investment in cultivation techniques as well as in processing is necessary. For this reason, the minimum land area of cultivation in a district will be quite large, compared with pepper or guarana.

Pepper and guarana, on the other hand, make profits even if they are grown on small-scale. However, cultivation requires high levels of technology and tends to be labor-intensive. Since the yield of both crops is affected by weather, and output fluctuates widely from year to year, better fertilizing techniques are needed to stabilize output. Both are favored specialities of the Area. Unit price is therefore relatively high, and freight bearing capability is as high as that of babassu and Brazil nut.

(ii) Short-term crops

These crops can be divided into two groups: annual crops such as soybean, rice, maize, cotton[1] and tobacco, and such short-term crops as sugarcane, which need 1 - 2 years from planting till harvesting and can be utilized for a few years after that. Investment in the latter naturally takes a longer time to be recovered.

In order to grow soybean, rice and maize for commercial purposes, consideration must be given to the competition with other regions, especially with the central and southern regions. Accordingly, production will be of a medium- or large-scale, capital-intensive type, using machinery and a large amount of input such as fertilizer. Although these three items do not need to be processed immediately after harvesting, their freight bearing capability is small, as already mentioned, so distance from the market and the level of infrastructure greatly influence individual production and also the establishment of production areas.

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1) Cotton is originally a perennial tree; this woody plant type is cultivated in the areas of northeastern Brazil but its quality is poor. Therefore, only the herbaceous plant-type cotton will be discussed here because of potential of being able to be produced in good quality in the Area.

Since cotton and tobacco can bear profits even if they are grown on a small-scale, they have the advantage of being able to be produced by small-scale farmers as commercial crops. However, a high level of production techniques and a large amount of labor are required for cultivation. Labor is needed mostly at the time of harvest. In the case of tobacco, especially, the work carried out from the harvest to preparation (drying) is considered to affect the quality of tobacco a great deal, and fertilization needs to be adjusted to the nature of soil: tobacco cultivation techniques are thus intensive in general. Since tobacco is a luxury and fairly expensive, its freight bearing capability will be large when compared with grain.

Sugarcane can be grown either on a small- or large-scale, depending on availability of capital and levels of production technique, but competition with the central and southern regions is extremely keen. In order to be competitive, large-scale cultivation using machinery should be chosen. Since sugarcane needs to be processed within a certain time after being harvested, and the raw sugarcane's freight bearing capacity is small, processing facilities in the production areas are essential.

(iii) Extractive products

Although research and experiments have been done on the cultivation techniques of babassu and Brazil nut, there have been no cases of commercial cultivation of these crops yet. These two products have the advantage of being specialties of the PGC Area. Accordingly, unit price is among the highest of the crops dealt with in this study, and freight bearing capability is large. On the other hand, they are gathered from native trees, and nuts should be removed from shells by man to make them commercial, requiring relative large amounts of labor.

(iv) Tropical fruits

Tropical fruits can be roughly divided into two types: choice fruits eaten raw such as papaya and melon, and those processed such as passion fruit and orange. This division by use which is based partially on the inherent characteristics of these crops, aims to facilitate the discussion on impact of the Area's social and economic conditions such as distance to major domestic markets on the production of these crops.

These crops, especially the former, require high-level management know-how for successful cultivation, harvesting and subsequent packing, thereby making the production process considerably labor-intensive. Choice fruits are usually specialty products, with a high unit price and large freight bearing capability. Passion fruit and orange have small freight bearing capability, so the existence of a nearby market will be an important consideration in designating production areas.

(v) Vegetables

Like the above choice fruits, relatively high levels of techniques are needed during the whole labor-intensive process of production. Since small-scale cultivation is possible, vegetables are the most advantageous commercial crops for small farmers with certain level of technology. However, it is difficult for many vegetable crops to be preserved for long periods under natural conditions, and their freight bearing capability is small; therefore, production sites near a market, preferably in the suburbs of a big city, will be advantageous.

7-3-4 Preliminary Selection of Suitable Crops on the Basis of Social and Economic Conditions and Necessary Conditions for Development

In light of the previously-described charactristics of each sub-region and of each crop, the crops considered suitable for each sub-region and the conditions necessary for cultivating them will now be postulated. When selecting crops, those considered impossible or very difficult to be grown in each sub-region, based on the crop selection viewed from natural and technical conditions in Chapter 3, were excluded from the discussion.

(1) Bacabal

As this sub-region has large number of small-scale farmers, a large potential labor force, the Sao Luis market nearby, and a comparatively good infrastructure, the small-scale cultivation of crops like vegetables that require little capital and high labor-intensity and do not incur large transportation costs, will be suitable. Vegetables, however, need relatively high production techniques compared with maize and rice, the crops grown by most small-scale farmers in this region; therefore improvement on the technical side is a precondition of development.

Babassu, which needs much labor for gathering and shell cracking, has the advantage of being a specialty because there are many concentrations of babassu trees in the region, making its utilization very important. It is desired that its competitiveness should be strengthened further by the modernization of crushing facilities and the application of integrated utilization techniques.

Although the production of maize, rice, cassava and feijao grown mainly for self-consumption in this sub-region does not necessarily have an advantage over that of other regions, cultivation is possible even for small-scale farmers, who do have insufficient capital and technology; so they will continue to be important crops for many such farmers in the sub-region. Nevertheless, in order to make them more advantageous in the future for these small-scale farmers, it will become necessary to raise the commercial rates of these crops through improvements in marketing, including the setting up of simple processing facilities. Since there are many occupants among these farmers,

it is urgent to work out measures to improve the situation of land ownership in order to stabilize production.

Furthermore, this sub-region has the natural conditions that will enable Para rubber, cacao, soybean, sugarcane and cotton to become suitable crops. However, in order to realize this, improvements in capital availability, production techniques, processing and marketing will be essential.

(2) Castanhal

This sub-region has many middle- and large-scale farmers with much experience in commercial production, and the technical levels are generally higher than the other six regions. In addition, agricultural organizations (cooperatives), infrastructure and markets are comparatively well-established, so the cultivation of humid tropical crops, climatically very suited to the subregion and which tend to be specialties, is considered advantageous compared with production in other sub-regions. Crops suitable for this sub-region are oil palm, pepper, guarana, cacao, cotton, tobacco, tropical fruits and vegetables. Among them, oil palm (palm oil), pepper, guarana, and choice fruits, which are specialty items and have large freight bearing capability, will be very competitive in major domestic markets, which are concentrated in central and southern Brazil, and in foreign markets, depending on the future situation concerning cultivation techniques, processing and financing.

Primary processing in the production area is indispensable for Para rubber and sugarcane, so improvement on the processing side as well as procurement of capital are future tasks. Although there is a possibility of large-scale cultivation of sugarcane in Guajarina district, where there are still comparatively vast uncultivated areas, competition with the more efficient producing areas in the central and southern regions is fierce, so establishing a production area will depend on the circumstances of processing and the related industries, and trends in alcohol demand and petroleum markets.

(3) Imperatriz

The great bulk of agricultural production in this sub-region is carried out by medium- and large-scale farmers, who have comparatively favorable conditions, as well as typical small-scale farmers, such as those found in the Bacabal sub-region. The former, mostly producers from central and southern Brazil, have adequate capital resources and technology and are well able to organize themselves. They have access to well-established infrastructure, because they usually occupy the land along the Belem-Brasilia highway. Taking advantage of these circumstances, mechanized large-scale grain production of soybean, maize and rice, for example, will be worthwhile. As far as market access is concerned, prospects are good because the Carajas Railway will be opened in the near future. However, these crops with small freight bearing capability are grown near the major markets in the southern regions more productively. Consequently, it will be reasonable to

expand production in this sub-region by aiming at selling to the north and the northeast.

Small farmers, most of whom have come from other parts of the state or from northeastern Brazil, are deficient in capital, technology and organizational ability and usually farm in areas with poor-standard infrastructure. For those farmers, like those in Bacabal, the cultivation of rice, maize, feijao and cassava for self-consumption and partial commercialization is preferable, even though they are not as profitable as those produced in other regions or produced by medium- or large-scale farmers within the sub-region. If levels of technology are raised and improvements in marketing made, vegetable production for urban markets in the sub-region, such as the city of Imperatriz, will be possible if the relatively abundant labor is utilized.

There is potential for Para rubber production in the northern part of the sub-region and sugarcane production throughout the whole sub-region. Like Castanhal, however, in order to become a production area, it is necessary to solve the problems of capital, technology, processing facilities, and markets for primary processed products.

(4) Balsas

Since producers in this sub-region and those in Imperatriz have certain characteristics in common, the same thing can be said about medium-, large-, and small-scale farmers in this sub-region as those in Imperatriz.

However, there is still much flat land suitable for mechanized, large-scale cultivation compared with Imperatriz. Unlike Maraba where the growing stock of forests is dense and land is generally undulating, Balsas is rich in flat natural grasslands and open forests, meaning that cultivation costs per unit area would be less. There is strong potential of changing the uncultivated land of cerrado type into agricultural land suitable for mechanized farming. Soybean production has already brought good results. Compared with Imperatriz, however, infrastructure is of a low standard, so in order to increase production in the future its improvement is an important task.

(5) Araguaina

There is a high proportion of medium- and large-scale farmers in this sub-region. At present, these producers are engaged mainly in cattle raising, but they have large amounts of accumulated capital and technology compared with those in the other six sub-regions, and thus there is the possibility of converting into crop cultivation. If they do, mechanized, large-scale production of soybean, rice and maize, which are suited by the topography and cerrado-type climate, will be fully possible. Moreover, if the problems surrounding the processing facilities and marketing are solved, sugarcane could also be a suitable crop.

As seen in the case of Imperatriz, however, these crops compete fiercely with those produced in the existing production areas in central and southern Brazil. If the crops are sold in the present major domestic markets, they will not be competitive because transportation costs are too high, so for the time being, there is no choice but to sell in markets within the sub-region or in those in the north and the northeast. As development of the cerrado areas proceeds in the future, production is expected to expand, taking advantage of the relatively low price of land. The establishment of new processing facilities is likely to shift the major markets northwards. When this happens, this subregion, which is the most southern of the seven sub-regions, will have the advantage of easy access to domestic markets. Whatever happens, trends will be closely related to the northward movement of agricultural development. For small farmers who exist in the northwestern part of this sub-region in relatively large numbers the same thing can be said as for those in Imperatriz.

(6) Maraba

The farm structure of this sub-region resembles that of Araguaina in many ways. As far as infrastructure is concerned, exploitation of mines has facilitated improvement in railways and trunk roads, making favorable the production of grain, with its comparatively small freight bearing capability. However, when such natural conditions as topography and weather are taken into consideration, mechanized, large-scale grain production is considered difficult in many parts, compared with Imperatriz, Balsas and Araguaina.

Agricultural development in this sub-region is under way at the present time. Although there are many aspects to consider in the process of large-scale development of pasturelands in the context of environmental conservation, attempts to immobilize small-scale farmers who are engaged in shifting cultivation so as to prevent environmental destruction are also important. A transitionary pattern of shifting cultivation is land rotation system operated in a predetermined place, but the settlement rate is generally low because of the absence of crops that will stabilize the operation by these small-scale farmers. As a countermeasure, therefore, the introduction of perennial crops such as rubber, cacao and pepper, which are considered suited to the climate of the region, is desirable. These crops, however, require large investment and a high degree of technology, so various support policies, incorporating establishment of land ownership, will be necessary. The levels of production techniques for maize, and rice, which have been cultivated mainly for self-consumption, are considered low compared with those of small-scale farmers in the more developed sub-regions in the PGC Area such as Bacabal and Castanhal. Measures to improve production techniques for these staple food crops are also important. If the overall technical level is raised, vegetable production aiming at local markets, which have been expanding by the exploitation of mines, is considered possible.

Brazil nut in this sub-region, like that of babassu in Bacabal, can have the advantage of being a specialty of the region, and become

an important product especially for local residents who have no other source of income.

(7) Xingu

Development has only recently begun in this sub-region, and drastic changes in the agricultural structure in the near future are not foreseeable. The various conditions necessary for successful agricultural production such as infrastructure are not well-established at present, so considerable improvements in these will be necessary for this sub-region to be productive. Judging from the present circumstances, the introduction of such perennial crops as rubber and cacao is considered appropriate, in terms of need to settle local residents and preserve the natural environment. Since this sub-region has more rainfall than Maraba, it is considered suitable for the cultivation of humid tropical perennial crops such as oil palm and guarana. If the necessary conditions for production such as capital, technology and infrastructure are improved in the future, it may be possible to develop it into a special production area of perennial crops, taking advantage of the natural potential of the sub-region.

Depending on the development of the Carajas Mine area and the condition of infrastructure that leads into the area, there is a possibility that this sub-region can become a vegetable production area, considering the favorable natural conditions such as the rich soil.

For reference, the above discussion is summarized in Table 7-13.

Table 7-13 Suitable Crops on the Basis of Social and Economic Conditions by Sub-region (Tentative)

	Sub-region						
	Bacabal	Castanhal	Imperatriz	Balsas	Araguaina	Maraba	Xingu
Staple Food Crops							
Maize	o	o	o	o	o	o	o
Cassava	o	o	o	o	o	o	o
Rice	o	o	o	o	o	o	o
Feijao	o	o	o	o	o	o	o
Commercial Crops							
Perennial Crops							
Oil Palm		o					Δ
Para Rubber	Δ	Δ	Δ			Δ	Δ
Pepper		o				Δ	Δ
Cacao	Δ	o				Δ	Δ
Guarana		o					Δ
Short-Term Crops							
Soybean	Δ		o	o	o		
Maize	Δ		o	o	o		
Rice	Δ		o	o	o		
Cotton	Δ	o	Δ		Δ		
Tobacco		o					
Sugarcane	Δ	Δ	Δ		Δ		
Extractive Crops							
Babassu	o		Δ		Δ		
Brazil nut						o	
Vegetable and Fruits							
Tropical Fruits		o	Δ		Δ	Δ	
Vegetables	o	o	Δ	Δ	Δ	Δ	Δ

Notes:
1. The above crops are limited to those under the coverage of in this study and considered suitable in terms of natural and technical conditions.
2. This table is produced from limited data, and should only be considered to indicate general tendencies.
3. Δ indicates that there are many aspects of the crop to be improved before it can be regarded as suitable.

8. LIVESTOCK (BEEF PRODUCTION) DEVELOPMENT

8-1 Introduction

Brazil occupies a very high position with regard to cattle raising, with the current number of cattle almost equal to the human population of this vast nation. Compared with other advanced beef-producing countries, however, beef production levels are much lower in Brazil because of the small ratio of the number of cattle slaughtered to the number raised, a characteristic which sometimes produces shortages in the domestic supply of beef.

In 1970, the cattle population of Brazil was 96,576,000 head; this had increased to 118,971,000 by 1980 with an annual growth rate of 2.17%. The population increased annually until 1976, when it reached 107,349,000, and thereafter declined slightly to 106,943,000 in 1978 when it resumed its upward trend which is continuing.

Regarding the cattle population by region, the southeastern region registered 35,126,000 head in 1980 (29.5% of the national figure), the west central region, 33,673,000 head (28.3%) and the southern region 24,609,000 head (20.7%). These three regions accounted for 78.5% of the total national population.

The major cattle-raising states, based on the number of cattle in 1980 are Minas Gerais with 19,615,000 head (16.5%), Goias with 16,454,000 head (13.8%), Rio Grande do Sul 14,082,000 head (11.8%), Sao Paulo 11,867,000 head (10.0%) and Mato Grosso do Sul 11,704,000 head (9.8%). These five states possessed over 50% of the national total.

Of the three states involved in the Greater Carajas Program Area (PGC Area), Goias, of which the northern area is partly included in the Program, is the nation's second largest producer of cattle as mentioned above, but the other two states, Para and Maranhao, occupy a lower portion with the cattle population of each being around two million and accounting for about two percent of the national total. The cattle population in these areas, however, has been showing a steady increase since 1975 as compared with the slowing trend in the more developed southeastern region.

The cattle raising in Brazil is mainly for beef production, and the number of milking cows kept in 1980 was 16,513,000 head or only 14% of the total number of cattle. The amount of milk produced annually is 11,162,000 kilo liters, suggesting a very small average amount of milk produced per head of dairy cattle. It is presumed therefore that, aside from the areas adjacent to the large milk-consuming cities such as Sao Paulo and Rio de Janeiro, milk production mostly comes from cows of dual purpose herds. Thus, cattle raising in Brazil is usually regarded as being almost wholly confined to the production of beef.

Regarding the trend of beef production, the output reached the record of 2,309,000 tons in 1978, but thereafter declined slightly

before recovering in 1982 to 2,385,000 tons, a level slightly exceeding the production in 1978.

Despite an increase in the number of cattle slaughtered in 1983, beef production registered a fall from the previous year because of the reduced average weight of dressed carcasses per head of cattle (240 kg from a bull and 179 kg from a cow and heifer) as a result of the increased number of cows slaughtered.

Meat production in Brazil is composed of beef, 56%, chicken, 28%, pork, 15% and others (horse meat, mutton, etc.) 1% (in 1982). Although the production of chicken has been increasing rapidly in recent years, beef still holds the leading position.

The individual shares of the number of cattle slaughtered of the three states involved in the PGC Area are 0.9% of the national figure in Para, 1.7% in Maranhao and 10% in Goias respectively, which are even further below their shares of the number of cattle raised. This is because Goias exports large numbers of fattened cattle to other states and countries for slaughtering, while the slaughter rates at the states of Para and Maranhao are below the national average.

Until 1978, with the annual beef consumption per capita being a little more than 20 kg, the domestic demand for beef averaged about 2,200,000 tons per year. In 1978 and 1979, the domestic production failed to meet local demand, and imports of beef increased remarkably to the 130,000 - 140,000 tons (dressed carcasses). As a result, the export of beef decreased and the quantities exported and imported during 1978 were almost equal. In 1979, beef exports declined further, and the balance in the domestic supply and demand was maintained by imports.

Considerable changes have been observed in the meat consumption structure of Brazil in the past few years due mainly to the deterioration of the domestic economy and the growth of the broiler industry. The annual per capita consumption of beef has been gradually decreasing since 1977 when the highest per capita consumption of 20 kg was recorded. The recent per capita consumption is estimated at 16 kg for 1983, and 14 kg for 1984. As the consumption of meat as a whole has not changed so much, the reduced portion of beef consumption is considered to have been due to a substitution of chicken for beef in Brazil's domestic meat consumption.

Such changes in the domestic demand, coupled with a recovery in beef production, have led to a downward trend in imports since 1980. Imports decreased to 23,000 tons in 1982 when beef production recovered to a level exceeding that of 1978.

In the meantime, beef exports have increased rapidly since 1980, reaching 361,000 tons in 1982 when most of the raw meat component for export being provided by domestic production.

The recent upturn in exports has been caused by decreased demand in the domestic market, as mentioned above, rather than by the expansion in

domestic production. Thus the local supply and demand conditions contribute significantly to the annual fluctuations in beef exports and imports.

A feature of beef exports from Brazil is the relatively high proportion of processed beef, such as canned beef and cooked beef, compared with table beef which is usually frozen or chilled. This is mainly attributable to the preventive restraints imposed by disease-free countries under the international sanitary regulations which state that beef imports from countries affected by foot-and-mouth disease are not acceptable unless the beef is processed by heating as preventive measure against the major infectious disease.

There follows an account of the importance of beef cattle production in relation to agriculture and national land utilization.

The total area of land owned or used (including leased and occupied land) by the occupational categories "agriculture and animal husbandry" and "animal husbandry" is 364,854,000 ha (as of 1980), of which 197,997,000 ha (54%) are owned or utilized by those raising cattle. Also, of these 364,854,000 ha, 57,724,000 ha are used as arable land (including permanent, short term and idle farming lands) while 174,500,000 ha are either natural or improved pasture.

Some portions of the pasture are used for raising horses and sheep but the greater area is presumed being utilized for cattle raising on the basis of the livestock numbers by types of animal.

The fact that 51% of the utilized land area (arable lands, pasture land and forest) is occupied by pasture most of which are used for cattle raising, and in particular beef cattle, indicates the importance of beef cattle production in the national economy.

Beef cattle is the major product of the liverstock sector of each of the three states related to the PGC Area. The percentage of cattle in the total production of livestock (such as cattle, buffalo, horses - including donkeys and mules, pigs, sheep, goats, chicken and rabbits) represents 79% in the state of Para, 73% in Maranhao and 94% in Goias (as against the national average of 85%), showing the overwhelmingly high position of cattle in animal husbandry.

Regarding other livestock products, 42% of the national total of buffalo are raised in the state of Para, where buffalo account for 10% of the livestock production. In Maranhao, pigs account for 10% of the livestock production.

Grass feeding, rather than grain feeding, is characteristic of the Brazilian animal husbandry where the proportion of grass-fed livestock is as high as 93%. Chicken and pigs raising is dependent on grain feed and concentrated in the country's southern and southeastern regions which are rich in feed supply and adjacent to large consumer markets. In these regions, poultry production accounts for 68%, and pig production, 74%, of the national total.

The marketing and feed supply conditions explain the reasons by which the liverstock industry of the three states related to the PGC is restricted to cattle.

Both beef cattle and dairy cattle are included in the cattle production statistics of Brazilian Institute of Geography and Statistics (IBGE). In both Para and Maranhao, it is presumed that a large proportion of cattle is raised mainly for the purpose of producing beef, with milk as a side product, since the percentage of dairy cattle in the number of cattle raised is as low as 9.5%, as compared to the national average of 14%. The milk production per head of dairy cattle is also very low. In Goias, the proportion of dairy cattle, at 16%, is higher than the national average, but the rate of milk production per head is almost the same as it is in Para and Maranhao. Therefore, in these three states cattle are considered to be raised mainly for the purpose of producing beef.

Consideration of factors such as domestic beef supply and demand conditions, the need for export promotion, land utilization and the present state of animal husbandry, suggests that it is appropriate to select beef cattle production as a strategic element in the development planning of the PGC Area. However, it should be noted that, despite the large number of cattle being raised and the vast land area available, shortages in the domestic supply of beef still occur from time to time, albeit usually for only short periods.

These shortcomings are considered attributable not only to the low productivity of both land and livestock but also to poor pasture management techniques.

Whether the recent changes in the meat consumption structure, decline in beef consumption and substitution of chicken meat for beef, should be viewed as the beginning of diversification in meat consumption which is already proceeding in the developed countries, or, should be regarded as a temporary self-defensive reaction by consumers to the deterioration of economic conditions, is a question requiring further long-term study.

Even on the assumption that the per capita beef consumption will remain at the present level in Brazil, the overall national consumption is expected to increase, since it is estimated that the nation's population will reach 179 million in the year 2000. In order to secure a domestic supply sufficient to meet the increasing local demand, therefore, the improvement of productivity is a matter of great importance. Although the PGC Area is a vast undeveloped region with high development potential, it has the characteristics of an underdeveloped area even in the production of beef cattle which is regarded as a traditional industry in the nation's agriculture.

In the following discussion about the present position of beef production in the PGC Area, it should be noted that the description for each sub-region is confined to some specific items on which the relevant data are available. There seem to be no great fundamental differences

for each sub-region in the other items for the study related to beef cattle production, except grass production which, being influenced by local climatic and soil conditions, extends from the tropical humid type to the Cerrado type. For the other items, the study will be qualitative and restricted to descriptions of the general conditions of the PGC Area.

8-2 The Present Position of Beef Production in the PGC Area

8-2-1 Changes in the Number of Beef Cattle Raised

As mentioned above, the number of cattle raised in the three states related to the PGC Area is still at a low level, especially in Para and Maranhao with 2,800,000 and 2,900,000 head respectively (as of 1981) representing 2.3% and 2.4% of the national total. However, the number of cattle raised in these states has shown a remarkable increase in the past several years (Table 8-1).

While there is an almost stable or downward tendency in the number of cattle raised in the southern region, which was the largest cattle-raising area occupying 36% of the nation's total number of cattle as of 1970, the number of cattle raised in Goias has shown a very high growth registering the nation's highest growth rate at 73% for the past ten years.

Although the number of cattle raised in 1975 decreased below the level in 1970, Para shows a growth rate of 65% for the past ten years, and the growth of the last few years is particularly remarkable.

In Maranhao, although the number cattle raised in 1975 was 25% below the level in 1970, the growth rate in the past five years was 59% (1975 to 1980). However, the rate of increase for the past ten years still stands at 20%, a level slightly lower than the national average, because of the decline in the number of cattle raised during the first half of the 1970s.

The following factors can be cited as the reasons why the number of cattle raised in these three states has been increasing remarkably in contrast to the slowdown of growth in the developed southern regions:

(1) Construction and improvement of the transportation network

The development of farm land is closely related to the situation of the transportation network. Shifting cultivation spread through the tropical rain forests along the main rivers, and the endless belts of grassland seen along the Belem-Brasilia high-way running through the PGC Area are examples of the expansion of farm land development resulted from improvements in transportation.

The construction of the main roads such as Belem-Brasilia, Cuiaba-Rondonia and Trans-Amazon, has stimulated immigration from the

Table 8-1 Changes in the Number of Cattle Raised by Region

(1,000 head)

Region	State	1970	1975	1980	1981	'75/'70 (1970=100)	'80/'75 (1975=100)	'80/'70 (1970=100)
North		2,266 2.3%	2,113 2.1%	3,688 3.1%	4,168 3.4%	93	175	163
	Para	1,459 1.5	1,430 1.4	2,412 2.0	2,810 2.3	98	169	165
Northeast		20,354 21.1	18,297 17.8	21,876 18.4	22,136 18.2	90	120	108
	Maranhao	2,365 2.4	1,783 1.7	2,836 2.4	2,906 2.4	75	159	120
Southeast		35,137 36.4	35,586 34.7	35,126 29.5	35,045 28.8	101	99	100
South		19,284 20.0	21,669 21.1	24,609 20.7	24,838 20.4	112	114	128
Central-west		19,535 20.2	24,866 24.3	33,673 28.3	35,598 29.2	127	135	172
	Goias	9,522 9.9	12,884 12.6	16,454 13.8	17,087 14.0	135	128	173
Brazil		96,576 100.0	102,532 100.0	118,971 100.0	121,785 100.0	106	116	123

Source: IBGE, Censo Agropecuario, and Anuario Estatistico do Brasil 1983

central-west and southern regions to the northern and northeastern regions and facilitated the development of new farm land in this area.

(2) Low land prices

It was pointed out by some cattle raising farmers that the low land prices in Para and Maranhao have stimulated the movement of people from the central-west and southern regions to these states. There are many instances of people selling whole or part of their present land to acquire a larger area (sometimes several times larger) in these states, as a means of expanding their farming scale. The establishment of a second stock farm is often easier in the north and northeast than expanding operations in the central-west or southern regions.

(3) Incentives given by the Superintendency for the Development of Amazonia (SUDAM)

In addition to the factors mentioned in (1) and (2), the incentives given by SUDAM also contribute to accelerating the establishment of new beef-cattle farms in the PGC Area.

It has been a distinctive trend in recent years that the share of liverstock projects, particularly for production of beef cattle, in the total number of projects approved by SUDAM is high, and the tendency of concentration of these projects in the state of Mato Grosso and the southern part of Para.

(4) Expectation brought about by the PGC

A small number of entrepreneurs rich in capital and foresight, have begun to raise cattle beef in the PGC Area, taking into account such factors as improvements in the transport network, marketing facilities, increase in population, and the potential for the region to become a beef-exporting base through improvement of port facilities.

8-2-2 Type and Size of Beef Cattle Farms

According to the 1980 Agricultural Census, the types of beef cattle farms are classified into seven categories as shown in Table 8-2.

The data included in the Agricultural Census are not sufficient for the analysis of operation scale, because they were compiled from the farmers' reports. For example, the statistics for land use classified by scale and indicated by cattle numbers, were obtained from less than 50% of the nation's total number of cattle raisers, and some reporters failed to distinguish between dairy cattle and beef cattle.

It is seemingly that the national figures of these statistics are of some practical use, while the state and sub-region breakdowns cannot be expected because of data shortcomings.

Table 8-2 Numbers of Informants and Beef Cattle by Type of Operation

Type of Operation	No. of Informants	No. of Cattle (head)	No. of Cattle per Informant (head)
Breeding	535,680 (43.3%)	20,524,263 (23.5%)	38
Rearing	264,942 (21.4%)	10,109,983 (11.6%)	38
Fattening	103,413 (8.4%)	11,513,298 (13.2%)	111
Breeding and Rearing	210,712 (17.0%)	21,018,056 (24.1%)	100
Breeding and Fattening	28,136 (2.3%)	3,314,786 (3.8%)	117
Rearing and Fattening	22,129 (1.8%)	4,183,924 (4.8%)	189
Breeding, Rearing and Fattening	72,156 (5.8%)	16,641,367 (19.0%)	231
Total	1,237,168 (100%)	87,305,677 (100%)	71

Source: IBGE, Censo Agropecuario, 1980

The figures shown Table 8-2, judging from the nationwide number of cattle raised, can probably be regarded as representing the number of cattle raised according to the different types of beef-cattle raising operations in Brazil as a whole.

Assuming that there is no significant difference between the number of informants and the number of producers, then it can be said that the number of producers under the category "breeding" occupies the highest percentage (43%) in terms of number of farms. Regarding the type of farms, 25% of producers are engaged in combined rearing and fattening in addition to breeding. Therefore, the beef cattle producers who are producing calves by raising cattle for reproduction purposes, account for 68% of the total number of raisers, and the producers engaged only in rearing and fattening represent 32%, of which 21% are rearing and 8% fattening, exclusively. The number of producers conducting integrated operations from breeding to fattening is rather small with a percentage of 6%.

Regarding the number of beef cattle classified by operation type, the producers engaged only in breeding and rearing have the smallest number of cattle per farm, 38 head, while those conducting integrated operations have the largest average number of cattle, 231 head. The producers engaged in two combined types of operations, out of the basic categories, have larger numbers of cattle per farm, as compared with those with single type operations. The breeding producers share 43% of the total number of producers but account for only 24% of the total number of cattle, while the integrated-type producers, account for only 6% of producers and share 19% of the total number of cattle.

With regard to the special features of beef cattle raising in the three states related to the PGC Area the percentage of producers of the breeding type in Para is the highest (45%) and those of the breeding and rearing type account for 25%. Thus, these two types of producers make up 70% of the total. Besides, more than half (52%) of the total number of cattle raised in Para are kept by these two types of producers. Further, the percentage of integrated-type producers engaged in all three kinds of operation, is 8% in Para, a high level as compared to the other states. The percentage of number of cattle raised by these producers is also very high (27%). This indicates a high concentration of cattle raising to large-scale cattle farms.

In all types of operation, in the state of Para the average number of cattle raised per farm is at a high level, and the scale of cattle raising is much larger than the national average but smaller than that in the state of Goias which is one of the principal beef-cattle producing regions of Brazil. This tendency is noticeable particularly in the type of operation combined with fattening.

In the state of Maranhao, the percentage of breeding producers is the largest (44%), showing a similarity with the national trend, and the breeding and rearing operation accounts for 21%, with the two types occupying 65% as in Para. Those producers who are not engaged in fattening operations show a high percentage, 84%, and their total number of cattle raised account for 68%, the highest proportion among the three states related to the PGC Area (59% in Para and 65% in Goias). The producers engaged in integrated operations share 8% in terms of number of farms and 21% in terms of number of cattle, levels higher than the national averages. In Maranhao, cattle are concentrated to reproduction and rearing farms, and the number of cattle raised per farm under the fattening category is relatively small. In all types of operation the number of cattle raised per farm is low. Even the integrated operations, which are regarded as the largest in scale, keep an average number of cattle as small as 88 head.

In the state of Goias, the breeding producers account for 50 % in terms of number of producers, and 30% in terms of number of cattle. The number of producers concentrating on breeding or rearing represent 90% of the total cattle farms. The percentage of fattening farms and those of reproduction or rearing combined with fattening accounts for only 10% in terms of number of farms, but the number of cattle raised in these

farms share 35% of the total, suggesting that the size of fattening farms is also large in the state of Goias. large scale in "fattening" operations. All types of cattle farms in Goias are of much larger scale compared to those in Para and Maranhao. The breeding category, the smallest, has an average size of 96 head, and the size becomes larger as the purpose of cattle raising changes from rearing to fattening. The sizes of fattening farms are especially large, with the pure fattening farms having an average of 545 head, the integrated breeding rearing and fattening farms 640 head, and the rearing and fattening farms 818 head (Table 8-3).

A detailed analysis of the structure of beef cattle raising is difficult to be undertaken because the available statistics include both cattle for meat and milk. However, as of the total number of cattle (118,085,872 head), the percentage of beef cattle can be estimated at 80%, of which 74% is exclusively for beef production and 6% for both milk and beef production. Therefore, a rough picture of the beef cattle raising structure can be obtained through analysis of the available data.

The cattle raising farms in Brazil can be divided into two groups - a large number of small-scale cattle raisers and a small number of large-scale cattle raisers. About one half of the cattle raisers have less than 10 head per farm, 68% raise not more than 20 head, with as many as 84% retaining not more than 50 head. The aggregate number of cattle held by such small-scale raisers who share 84% of the total number of cattle raisers occupies only 20% of the nation's total number of cattle (Table 8-4).

In contrast, 40% of the nation's total number of cattle are kept by producers raising more than 500 head each, and the over 1,000 head class of producers are raising 27% of the total number of cattle. The over 500 head class of producers number about 36,000, accounting for only 1.5% of the national total.

Such a cattle raising structure offers a very difficult problem in taking measures to promote beef cattle production and stable beef supply and demand. It should be noted that some of the difficulties related to this issue cannot be dealt with satisfactorily simply by economic policy.

8-2-3 Present Conditions and Possible Improvements of Pasture

The area of pasture land in Brazil is estimated at 174,502,000 ha (as of 1980), or equivalent to 51% of the nation's arable land area and for exceeding the areas of crops and forest. Regionally, the pasture land occupies 25.0% in the southeastern region, 38.8% in the central-west region and 12.2% in the southern region. The area of pasture in these three regions shares 76.0% of the nation's total area of pasture. The area of pasture in the northeastern region accounts for 19.6%, and that in the northern region accounts for only 4.4% of the nation's total (Table 8-5).

Table 8-3 Proportions of Producers and Beef Cattle Raised Classified by Operation Type, with Average Number of Cattle Raised (1980)

Operation Type	Brazil			Para			Maranhao			Goias		
	No. of Producers	No. of Cattle	Av. No. of Cattle per Producer	No. of Producers	No. of Cattle	Av. No. of Cattle per Producer	No. of Producers	No. of Cattle	Av. No. of Cattle per Producer	No. of Producers	No. of Cattle	Av. No. of Cattle per Producer
	%	%	head	%	%	head	%	%	head	%	%	head
Breeding	43.3	23.5	38	44.6	19.2	48	43.7	22.2	16	50.4	29.6	96
Rearing	29.5	11.6	38	15.1	7.2	5	19.2	10.0	17	14.1	10.8	124
Fattening	8.3	13.2	112	4.6	5.2	131	4.8	5.4	37	4.3	14.5	545
Breeding and Rearing	17.1	24.1	100	24.5	33.0	150	21.1	36.1	56	25.8	24.3	153
Breeding and Fattening	2.3	3.8	118	2.1	4.6	228	2.3	2.9	42	0.9	2.7	496
Rearing and Fattening	1.8	4.8	190	1.1	4.1	515	1.3	3.0	73	1.0	5.1	818
Breading, Rearing and Fattening	5.8	19.1	231	8.1	26.6	370	7.5	20.5	88	3.3	13.0	640
Total	100.0	100.0	71	100.0	100.0	115	100.0	100.0	33	100.0	100.0	163

Source: IBGE, Censo Agropecuario 1980

Table 8-4 Numbers of Informants and Cattle Classified by Scale of Operation

Operation Scale (No. of head)	Informants		Cattle Raised	
	Number	%	Number	%
- 10	1,219,222	49.2	5,414,552	4.5
10 - 20	471,852	19.0	6,336,342	5.4
20 - 50	394,777	15.9	12,045,947	10.2
50 - 100	181,678	7.3	12,483,570	10.6
100 - 200	106,071	4.3	14,523,798	12.3
200 - 500	67,872	2.7	20,520,823	17.4
500 - 1,000	21,900	0.9	14,986,045	12.7
1,000 - 2,000	9,493	0.4	12,873,747	10.9
2,000 -	4,787	0.2	18,901,078	16.0
Total	2,477,652	100.0	118,085,872	100.0

Source: IBGE, Censo Agropecuario 1980

Table 8-5 Area of Pasture and Number of Cattle Raised by Region (1980)

Region	Area of Pasture		No. of Cattle Raised		Pasture Area per Head (ha)
	Area (ha)	%	Head (1,000)	%	
North	7,722,487	4.4	3,688	3.1	2.09
Para	4,513,420	2.6	2,412	2.0	1.87
Northeast	34,158,706	19.6	21,876	18.4	1.56
Maranhao	4,849,106	2.8	2,836	2.4	1.71
Southeast	43,639,266	25.0	35,126	29.5	1.24
South	21,313,458	12.2	24,609	20.7	0.87
Central-west	67,665,720	38.8	33,673	28.3	2.01
Goias	31,422,129	18.0	16,454	13.8	1.91
Brazil	174,501,641	100	118,971	100	1.47

Source: IBGE, Censo Agropecuario 1980

Although it is not proper to simply compare the existing area of pasture with the number of cattle raised, since pasture is also used for raising horses, sheep and goats, it is possible to draw a regional trend in the relationship between the pasture area and the number of cattle in considering the very high proportion of cattle in the total number of animals raised on pasture land.

The endowment pasture seems to be in proportion with the distribution of cattle raised except for certain regions which will be referred to later.

The number of cattle raised per unit of pasture area is large in the southern and southeastern regions, and small in the northern and central-west regions.

Although an absolute conclusion cannot be made because the degree of improvement and the management of pasture have considerable influences on the productivity of pasture land, the productivity of pasture land in the northern region seems inferior to that in the southern and southeastern regions. In other words, this indicates that in the northern region there is room for substantial increase in the number of cattle raised even within the existing area of pasture.

The present conditions of pasture land in the three priority sub-regions Maraba, Imperatriz and Araguaina are shown in Table 8-6.

A common feature of the three sub-regions is that the area of pasture shows an extremely high proportion in the so-called agricultural land (cropping and pasture), namely 85% in Maraba, 86% in Araguaina and 76% in Imperatriz. In Maraba and Araguaina, more than 65% of the total land area is occupied by forests, suggesting great future prospects of agricultural land development. On the other hand, Imperatiz shows a higher proportion of cropping area (over 10%) in the total area of land in use, and the proportion of unused lands is conspicuously high, compared to the other two sub-regions.

As regards the progress in developing improved pasture, the ratio of area of improved pasture in Brazil is 35%, and the remaining 65% area is natural pasture (Table 8-7). While the ratio of improved pasture in the advanced state of Sao Paulo is high, at 69%, the natural pasture area accounts for 60 to 70% in the major beef cattle producing regions of south, southeast and central-west, where the ratio of improved pasture is generally at a low level. On the contrary, in Para, which is less developed in beef cattle production with the number of cattle raised being small (about 2% of the national total) the improved pasture area accounts for over 60%. In the state of Maranhao, with almost the same share in the number of beef cattle, less than 50% of the pasture area are under improved pasture.

In the sub-regions Maraba and Imperatriz, most of the pasture area is under improved pasture, accounting for as much as 96% and 78% respectively. It is seemingly that such a high degree of improved pasture development is attributable not only to the dominance of forests before

Table 8-6 Existing Conditions of Pastureland in Sub-Regions

	Total Area (ha)	Pasturelands (ha)			Arable Lands (ha)	Forests (ha)	Land not in Use (ha)
		Total	Natural	Improved			
Para	20,448,422	4,513,420	1,711,731	2,801,689	1,798,596	11,075,809	2,076,021
	100%	22.1			8.8	54.2	10.2
		(100)	(37.9)	(62.1)			
Maraba	2,430,553	589,177	24,058	565,119	100,664	1,641,615	62,622
	100%	24.2			4.2	67.5	2.6
		(100)	(4.1)	(95.9)			
Maranhao	15,134,237	4,849,106	2,690,740	2,158,366	2,482,837	3,438,493	3,810,430
	100%	32.0			16.4	22.7	25.2
		(100)	(55.5)	(44.5)			
Imperatriz	1,894,850	653,478	141,621	511,857	211,514	623,857	381,274
	100%	34.5			11.2	32.9	20.1
		(100)	(21.7)	(78.4)			
Goias	47,853,028	31,422,129	20,578,467	10,343,662	3,922,756	6,967,255	2,960,905
	100%	65.7			8.2	14.6	6.2
		(100)	(65.5)	(34.5)			
Araguaina	4,194,598	1,974,098	875,981	1,098,117	318,286	2,739,769	407,983
	100%	47.1			7.6	65.3	9.7
		(100)	(44.4)	(55.6)			
Brazil	364,854,421	174,501,641	113,899,357	60,602,284	57,723,959	88,167,703	24,796,570
	100%	47.8			15.8	24.2	6.8
		(100)	(65.3)	(34.7)			

Note: 1. The sum of the areas with specified land use does not coincide with the total area which includes land unsuitable for use.
2. The figures in parentheses in the column "Pasturelands" indicate the ratios to total area of pasture lands.

Source: IBGE, Censo Agropecuario 1980

Table 8-7 Progress in Development of Improved Pasturelands (Proportion of Improved Pasturelands in the Total Area of Pasture), as of 1980

(Unit: %)

	Natural Pasture	Improved Pasture
Brazil	65.3	34.7
North	51.2	48.8
Para	37.9	62.1
Maraba	4.1	95.9
Northeast	69.8	30.3
Maranhao	55.5	44.5
Imperatriz	21.7	78.4
Southeast	62.9	37.1
South	73.6	26.4
Central-west	63.5	36.5
Goias	65.5	34.5
Araguaina	44.4	55.6

Source: IBGE, Censo Agropecuario 1980

the land development, but also to the establishment of cattle farms with sufficient funds and technology of new settlers from other regions.

Regarding the size distribution of pasture land, the 100 to 500 ha class represents a quarter of the total area of pasture, and the 1,000 ha or less class accounts for over 50%. The remaining less than 50% are classes of 1,000 - 2,000 ha, 2,000 - 5,000 ha and more than 5,000 ha, representing 12%, 14% and 22% respectively.

With regard to the three states related to the PGC Area, 44% of the pasture land in Para are occupied by farm units of size over 5,000 ha, with the over 10,000 ha stratum occupying one third of the total pasture area, showing a very high concentration of pasture land in the large-scale strata. As mentioned above, this seems to be results of the recently promoted entrance of new cattle raisers to the PGC Area, especially the south of Para, from other regions.

The situation in Maranhao is different. The over 5,000 ha strata holds 18% of the total pasture area, a level lower than the national average, and the area occupied by the 1,000 ha or less strata accounts for 52%, a rate equal to the national average.

In the state of Goias, the proportion of the pasture area held by the 1,000 ha or less strata is 46%, a level lower than the national average, while the over 5,000 ha strata hold a share almost equal to the national average, and the middle-size strata share slightly exceeds the national average (Table 8-8).

Table 8-8 Pastureland Proportions by Scale in Area

(Unit: %)

Scale in Area	Brazil		Para		Maranhao		Goias	
- 100 ha	14.0		8.9		10.2		5.9	
100 - 500	24.9	51.9	16.5	33.0	27.1	52.1	24.6	45.6
500 - 1,000	13.0		7.6		14.8		15.1	
1,000 - 2,000	12.4		8.3		14.0		15.6	
2,000 - 5,000	14.0		14.9		16.3		17.4	
5,000 - 10,000	7.3		10.8		8.8		7.7	
10,000 -	14.4		33.0		8.8		13.7	

Source: IBGE, Censo Agropecuario 1980

8-2-4 Pasture Utilization

The PGC Area can be classified into two sub-areas according to climatic conditions. The greater part of the Area falls in the humid tropical zone which includes the region with a radius of several hundred kilometers centering on Belem and the basin of the main stream of the Amazon river. This sub-area is of low elevation and almost flat where the temperature is high with much rain, and the dry season is short. Although rainfall varies seasonally there is some rain even during the dry season. On the other hand, the eastern side of a line drawn from Sao Luis, the state capital of Maranhao, to Imperatriz and the region southeast of Imperatiz, belong to the semi-dry tropical climate zone. The character of rainfall here is similar to that of the central plateau of Brazil. Rainfall from June to September is slight.

The soil of the PGC Area is broadly classified into two groups: the alluvial soil zone containing much clay in the basin of the Amazon river, and the sandy soil zone produced by weathering of paleozoic strata rocks, with topographical features including hilly semi-plains, which connect with the central plateau. The former belongs to the humid tropical climatic zone and the latter to the semi-dry tropical climatic zone.

While the hot and humid climate promotes dense vegetation, the soil contains relatively small amounts of organic substances because they dissolve quickly under such moist climatic conditions, and the layer of this soil is only a few centimeters thick. Such a tendency is conspicuous, especially in the semi-dry zone, because of the sandy soil and the influence of the dry season.

The humid tropical zone, mostly covered by deep forests under these climate and soil conditions, lacks natural pasture suitable for feeding livestock. Thus, it would require development of new pasture land suitable for beef cattle raising.

In the semi-dry region, mostly composed of cerrado type shrub zones, the natural pasture is of extremely low productivity with one head of beef cattle requiring five to ten hectares of pasture area and the fattening of cattle being absolutely impossible. Therefore, improvement of these pasture lands is necessary to bring them into production. There has been a tendency in recent years to establish pastures on land where rice and soybeans were previously produced, for the purposes of stabilizing farm management and maintaining the soil productivity. Those cattle farms which depend mainly on natural pasture are usually of the breeding and rearing type and survive by selling calves and cattle. Fattening is usually conducted on the improved pasture.

The development of improved pastureland in this Area was initiated at the beginning of the 1970s. Encouraged by the extremely low land prices compared with those of southern states and also by the Government's policy of promoting development in the southeast Amazon region through the incentive schemes of SUDENE/SUDAM, large stock farmers from the southern states in association with various enterprises, have actively participated in pastureland development projects. Relatively easy capital accumulation and the modest labour needs of cattle operations provided further incentives.

Regional cattle farm operations, including deforestation and the development of pastureland, were planned from the beginning. However, around Imperatriz and in the northern area of Goias, on the other hand, there were instances in which the medium scale production of grains (rice and soybeans) for several years preceded the conversion to pasture-land.

The development of pasture lands in the forest zone begins with the cutting down and extraction of useful trees, after which the remaining shrubs are cleared by hand, and, in the dry season the lands are burnt. Big unusable trees are left as they are, and seeding is done by hand or

from an aircraft. The grass seeds, falling in thick fertilizing ash, germinate and grow easily. This seeding method is considered the most economical way to develop pasture land in this region.

The pastoral development of the shrub and clear forest zones in the cerrado region is much easier than in the forest zone. It is generally considered advisable for soil preservation, to leave strips of natural woods 5 m to 10 m wide at intervals of 200 m to 300 m along the contour lines.

The felled trees are burnt after drying and the remaining unburnt logs are piled up by bulldozers, in ridges along the contour lines, for reburning. Thereafter, the land is levelled and cultivated by tractors before grass seed is sown. The investment in the machinery and equipment for such a method of preparation is, needless to say, an excessive burden for medium- and small-scale farmers. Thus they have to engage specialized contractors, or open up the woods themselves by hand or using a small tractor as is done in the forest zone. This method is usually inefficient and uneconomic.

There is no standard pattern established as yet, for the development method for the PGC Area.

Regarding the species of grass, mainly Panicum maximum (Caloniao) and Brachiaria humidicola (Quicuio) are used at present. P. maximum is generally used in relatively fertile regions and B. humidicola in less fertile regions along with Brachiaria decumbens. These species are all gramineous plants and legume has seldom been introduced so far.

Legume such as Stylosantes, Centrosema and Calopagonium are considered viable but there are difficulties for the whole Brazil in developing pasture land with combinations of grass and legume because of soil conditions. Also the overwhelming superiority of the gramineous plants is a common problem throughout the country. Therefore, it is considered essential to develop and establish the technology of creating and managing such combined-species pasture land.

The cattle farms which we visited in the survey had large- and medium-scale pastures. Probably because they are relatively advanced farms, the grazing blocks are all small with an area of 100 to 200 ha each, and adopting a small-lot rotation system. There are no large grazing blocks of 1,000 to 2,000 ha such as are seen in the southern states.

Since the greater part of the PGC Area falls in humid tropical climatic zone, the short dry season offers a great benefit to pasture operations. In the semi-dry climatic region, southeast of Imperatriz, however, the shortage of grass for pasturage during the dry season is a considerable problem requiring countermeasures. Depending on regional conditions, measures to provide silage or other feed to cattle during dry season should be considered.

A common problem among cattle farms in the Area is the management of pasture utilization. After development of pastures, the useless

trees grow quickly under the conditions of high-temperature and high-rainfall, and retard the growth of the grass.

In the early stages of pastureland development, young trees, unless they are cut away every two or three years, sprout and grow vigorously to recreate the forest in several years. To promote pasture establishment, grazing should be suspended for one year after tree lopping. Such measures are often neglected for financial reasons as well as shortages in machinery and manpower. This is a serious problem in need of solution.

In addition, as a result of successive over-stocking there are many cases of low productivity pasture land. Because of the relatively high price of fertilizers compared with that of cattle, such extremely low productivity has been brought about by pasturing for many years without applying any fertilizer. If this situation is to be eliminated, it is necessary to implement planned pasturing and suspend the grazing from time to time. It will also be necessary to consider land revival measures such as the rotation of pasture land with cropping land.

Under the present circumstances, the average stocking capacity of pasture land is one head of adult cattle per hectare, but an improvement in the management of pasture land could raise the stocking capacity to two head per hectare.

8-2-5 The Breeds of Cattle Raised and Their Character

The cattle raised in the PGC Area are of the Zebu group, of which the overwhelming majority are of the Nelore breed.

The climate in the Area has higher temperature and humidity than the inland areas of the states of Sao Paulo and Mato Grosso do Sul, but the Zebu-group cattle appear to be adaptable to the new climatic conditions.

The Nelore breed is popular almost all over the nation north of Parana and Sao Paulo. With a sensitive nature, it has a white, beautiful shape and long limbs. Its fattening capacity is high among the tropical breeds, with a high carcass ratio. Also, it shows a low rate of difficult deliveries and is suited to the management conditions of natural pasture, being strong and growing well even in rough conditions.

The Zebu-group of cattle, however, is a late-maturing type compared with the European breeds, to which it has considerably inferior fattening capacity. A steer raised under northern pasturing conditions needs four or five years to grow to 450 or 500 kg.

Although the European breeds are not suited to tropical and semi-tropical conditions, the hybridized breeds such as Canchim and Santa Gertrudis are increasing in number in Sao Paulo and other states. These cattle, although unsuitable for natural pasture, show early growth, a

high level of fattening capacity on improved pasture. The period up to the time of slaughtering can be shortened by about one year. Canchim cattle have been raised on a trial basis in the vicinity of Sao Luis, but it is not yet clear whether the breed is fully adaptable to the Area. Experts are of the opinion that there will be no problem in raising this breed as long as it is on the improved pasture.

Although no official records are available on the growth characteristics of each breed in the region, the growth of the Zebu-group in the Area appears to be at the almost same level as in Sao Paulo. It can be assumed, therefore, that for the present, the major emphasis will be placed on the Nelore breed. In addition, it is generally considered advisable that, along with the improvement of cattle raising management techniques, crossbreeding with European breeds be gradually introduced.

In any event, the Region's greatest problem in the raising of beef cattle lies in the low productivity due to delayed progress in the development of cattle raising management techniques rather than the question of breed.

Table 8-9 Beef Cattle Fattening Test Results
(in 1982, at Sertaozinho Experimental Station)

(Unit: kg)

No. of Cattle Tested	Breed	Weight, 392 days from birth			Increase in Weight during the Test Period (112 days)		
		Max.	Av.	Min.	Max.	Av.	Min.
42	Canchim	479	350.0	260	143	90.1	34
49	Sta. Gertrudes	462	343.2	257	132	96.5	58
19	Indobrasil	399	328.8	257	114	86.4	62
95	Nelore	365	296.5	238	113	77.8	31
53	Guzera	344	280.7	234	97	75.8	55
29	Zir	312	249.1	200	86	63.4	37

Notes:
1. The top 10 head showing the highest weight include 6 head of Canchim breed and 4 head of Gertrudes breed.
2. The Cattle tested were born during Sept.-Oct., 1981. The weight was measured 28 days after birth and 112 days thereafter.
3. In addition to pasturing, the cattle tested were fully fed with sugarcane and soiled grass (such as Coloniao) mixed with concentrate.

Table 8-10 Growing Weight of Zebu-group Cattle Classified by Breed (at Sertaozinho Experimental Station in the State of Sao Paulo)

(Unit: kg)

Age	Gir		Nelore		Guzera		Indo-Brazil	
	Male	Female	Male	Female	Male	Female	Male	Female
at birth	24.6	23.8	29.8	24.8	29.1	28.0	30.0	28.6
1 month	47.0	44.2	49.5	46.3	47.9	47.0	52.1	48.4
3 months	80.5	77.4	88.5	83.8	87.5	83.1	88.2	85.1
6 months	142.3	139.2	148.4	150.2	165.3	151.3	166.5	156.8
9 months	181.8	171.5	186.9	178.0	204.0	197.6	206.1	288.2
12 months	177.8	165.4	178.6	180.9	205.7	190.7	201.0	188.2
15 months	202.0	181.5	199.4	208.2	230.0	206.1	227.8	210.6
18 months	232.0	226.4	247.5	253.9	280.0	254.3	279.4	257.1
24 months	272.4	256.0	289.2	278.0	324.0	270.9	315.1	284.5
36 months	362.1	314.3	374.9	361.2	420.0	361.5	408.8	354.5
48 months	410.7	367.7	462.6	421.6	490.0	430.7	504.0	426.0

8-2-6 Cattle Raising Technology

The following are the technological conditions in the beef cattle raising in Brazil, classified by the principal types of operation:

(1) Fattening Operations

In terms of profitability, the operations specializing in fattening are the most lucrative. Therefore, specialized fattening operations are viable on cattle farms which are capable of purchasing easily the feeder stock (mainly two-year-old male calves) for fattening, and which hold fertile pastureland with good quality of grass favored by cattle. The fattening farm buys male calves of two to two and a half years of age (weighing 300 to 350 kg) and raises them on the pasture land for one year or one and a half years to grow to the weight of 450 to 500 kg before shipping to the slaughter house. In such a case, the cattle raising is totally dependent on improved pasture. Currently the recommended grass species is Panicum Maximum

which is highly productive, is much favored by cattle, and promotes a high fattening efficiency.

(2) Breeding Operations

In the regions which are not favored by good transport communications and in the case of pasture lands, natural or improved, of low fertility, the cattle farms are mostly specializing in breeding and rearing operations because of the difficulties with fattening. In the breeding and rearing operations, many defects are noticeable in the management of cattle raising, such as the inferior quality of bulls, insufficient nutrition or low mineral content in feed. Inevitably the result is poor breeding performance, low profitability, and further aggravation of the vicious circle of poor management.

In recent years, however, the pasture land improvement has been in progress in the areas of low fertility through the introduction of better species of grass, and the use of better method of pasture, such as the adoption of the small grazing block system.

(3) Integrated Operations

Integrating from breeding to fattening, although of lower profitability compared with specialized fattening, can be said to be a safe and sound undertaking. On the cattle farm rich in good quality grass on fertile land, profitability can be enhanced by strengthening the fattening operations through the purchase of feeder stock. Large-scale cattle farms are mostly engaged in such integrated operations.

The low productivity which characterizes beef production, not only in the PGC Area but also throughout Brazil, is attributed to the too extensive ways of management techniques as well as a dependence on the year-round pasturing.

A report of a research center of EMBRAPA at Campo Grande (Centro Nacional de Pesquisa de Gado de Corte) points out that there are a large number of factors hindering the productive raising of beef cattle:

(a) Improper nutrition of cattle in the dry season.

(b) Poor knowledge of nutritive value of feed.

(c) Technological defects in the economical and rational approach to the development and management of pasture lands.

(d) Poor knowledge of controlling useless trees and about damage from disease and noxious insects.

(e) Shortage of nutrients.

(f) Poor knowledge of the techniques of herd management and economics.

(g) Lack of knowledge about the infectious diseases of cattle, parasites and breeding problems.

(h) Improper distribution of cattle, beef and by-products.

(i) Diversity and vastness of the ecological, social and economic conditions.

Since most of these defects are related to the cattle raising technology, much better productivity is expected to be achieved by technological improvement.

In the PGC Area, a new region in the beef cattle industry, the pasture management systems of large companies, with capable technical staff, are fairly advanced to be equaled to those in use in the southern states. On the other hand, extensive management is seen in some newly opened cattle farms, and there are many cases of outdated technology and poor management on the older medium-and small-scale cattle farms.

Beef production based on cattle raising operation with whole year grazing has, generally speaking, several operational advantages and is capable of producing beef at low cost. However, any advantage can be negated by poor management techniques.

8-3 The Distribution and Slaughter of Beef Cattle

8-3-1 Distribution of Live Cattle

As already described, there are various types of beef cattle operation, namely the basic types: (1) breeding, (2) rearing and (3) fattening, plus combinations such as (4) breeding and rearing, (5) breeding and fattening, (6) rearing and fattening and (7) breeding, rearing and fattening. Accordingly, live cattle on distribution are broadly classified into calves, rearing cattle and fattening cattle.

From the number of beef cattle in the Agricultural Census by type of operation, age of cattle and by sex, it is assumed that, the movement of cattle from breeding to rearing and fattening operations starts at the weanling calf stage, and 70 to 80% of cattle produced by breeding operation move to rearing or fattening operations at the age of one or two years, the majority going to the former.

In the breeding operations, the number of cattle raised is relatively small. And because the first calving age is considerably high and the delivers interval is long, the proportion of the breeding stock in the number of cattle kept inevitably becomes high. For this reason the producers are obliged to sell off calves early, retaining only stock for breeding, under the restraints of limited stocking capacity.

In the rearing operation, calves are usually raised as feeder stock

before being transferred to fattening, but sometimes weanling calves go direct to fattening operations. This is presumed to be a reflection of the flexible operational policy by fattening producers to cope with fluctuations in supply and demand, and market prices of rearing cattle.

Cattle are traded through direct transactions between producers or through brokers. Fattening and "rearing and fattening" operations are generally of large-scale, and they purchase the feeder stock through brokers, after indicating to the latter the required time of purchase, number and weight of cattle and an idea of price, or purchase by direct transactions with other large-scale raising operations.

The integrated cattle farms engaged in breeding, rearing and fattening operations, being of large-scale, mostly appear to be placing emphasis on fattening operations. In these operations, a substantial portion of the required feeder stock is purchased outside, while the remainder is produced internally.

In the distribution market of feeder stock for fattening purposes in Brazil, in terms of the types of operations, the supply of feeder stock is apparently made comes from the breeding and rearing producers, which account for more than 80% of the nation's total number of beef cattle producers (based on the number of reporters in the Agricultural Census of 1980), to the fattening producers equivalent to less than 20% of the nation's total.

The unbalanced structure of feeder cattle supply in which cattle are being distributed from a large number of relatively small-scale breeding producers to a small number of large-scale fattening producers, with the pasture land raising producers existing in-between, creates various problems.

In transactions cattle are assessed in the following three ways: (1) by measuring the weight of each animal, (2) by the visual estimation of weight and (3) based on the weight of a dressed carcass after slaughtering.

Any of these assessment methods may be used according to the time of the transaction and the supply-demand conditions. The method in item (1) above is adopted when supply and demand conditions are stable, method (3) is adopted in a "buyer's market", under easy supply-demand conditions and method (2) at the off-season when the supply-demand situation becomes stringent creating a "seller's market".

Often beef processers have their expert personnel travel around to purchase cattle directly from producers or producers sell direct to slaughter houses or through brokers.

In the PGC Area, except for the state of Goias, there are few Government supervised and licensed slaughter houses and the number of cattle slaughtered is relatively small. The reasons are the small number of beef cattle raised, currently around the two million mark, and the distance from the large consumer markets of the south. For this

reason, the prices paid by the slaughter houses are lower than those paid in the southeastern region. At the time of our survey (in September 1984), the price paid by meat processors in Sao Paulo was Cr$3,666/kg of dressed carcass, delivered at cattle farm, while it was Cr$2,230/kg (ex. slaughter house) in Belem and Cr$3,000 (ex. slaughter house) in Imperatriz.

In addition, in the event of transportation costs being borne by the producer, the net earnings of the producer go down further. The transportation costs, at the time of our survey, were Cr$550/km for the trucking of 20 head, and therefore the transportation for a maximum length of 400 km to the slaughter house in Imperatriz cost Cr$11,000 per head. Furthermore, a marketing tax (ICM) is imposed on raw cattle, at the rate of 17% for marketing within the state and 12% for marketing outside of the state, and also a 2.5% equivalent is levied as a contribution to the Agricultural Welfare Fund (FUNRURAL).

In the planning of beef cattle production in the PGC Area, it is necessary to consider the measures for the improvement of productivity and the rationalization of management methods to compensate for such price differentials. Also for marketing purposes, it will be necessary to study how slaughter houses can be established in the production areas and how the road network can be improved.

8-3-2 The Movement of Cattle to Other States

The annual number of cattle moving beyond the boundaries of states is 3,165,000 head of cattle for slaughtering and 1,415,000 head of cattle for rearing, fattening and breeding, totaling 4,580,000 head in 1982 (Live Stock Hygiene Statistics).

Under the regulations aiming at preventing the spread of infectious diseases such as foot-and-mouth disease, equine infectious anaemia, hog ocholera and Newcastle disease, the movement between states of livestock vulnerable to these diseases is required to be authorized by certificates issued by Federal or state government veterinary officials.

Of the total or 8,772,000 head of cattle slaughtered in 1982 at slaughter houses under the supervision of Federal Government meat inspectors, 36% had moved across state boundaries.

The principal destinations of the cattle for slaughtering are Sao Paulo (49%), Minas Gerais (16%) and Parana (13%), with these three states accounting for 78% of the total number of cattle moving across state boundaries.

The major states exporting cattle to other states are Mato Grasso do Sul (30%), Goias (29%) and Minas Gerais (15%), with these three central-west states accounting for 74% of the total number of cattle transferred.

Accordingly, it can be said that the movement of cattle is mainly from the central-west region to the southeast and south regions where the large consumer markets and overseas export facilities exist.

The number of cattle (for slaughtering) moved into and out of three states related to the PGC Area is as shown in Table 8-13.

Both Para and Maranhao show a small number of cattle moved in and out for slaughtering, indicating basically, almost balanced supply and demand conditions within each state although there is some shortfall in Para and a slight excess in the number of cattle moved out of Maranhao.

Table 8-11 Number of Cattle Moved for Slaughtering Classified by Principal Destination

Ranking	Destination	Number of Cattle (head)	(%)
1	Sao Paulo	1,539,272	48.6
2	Minas Gerais	491,797	15.5
3	Parana	405,652	12.8
4	Rio Grande do Sul	135,253	4.3
5	Santa Catarina	121,398	3.8
	Sub-total	2,693,372	85.0
	Brazil	3,164,592	100

Source: Boletim de Defesa Sanitaria Animal

Table 8-12 Number of Cattle Moved for Slaughtering Classified by Principal States of Origin

Ranking	State of origin	Number of Cattle (head)	(%)
1	Mato Grosso do Sul	947,496	29.9
2	Goias	904,443	28.6
3	Minas Gerais	463,155	14.6
4	Sao Paulo	272,120	8.6
5	Rio Grande do Sul	186,180	5.9
	Sub-total	2,773,394	87.6
	Brazil	3,164,592	100

Source: Boletim de Defesa Sanitaria Animal

Table 8-13 Movement of Cattle for Slaughtering into and out of the States Related to the PGC Area

(Unit: head)

	No. of Cattle Moved in (A)	No. of Cattle Moved out (B)	(B)-(A)
Para	28,482	15,525	-12,957
Maranhao	12,663	19,480	6,817
Goias	32,976	904,443	871,467

Source: Boletim de Defesa Sanitaria Animal

8-3-3 Slaughter Houses

As of 1982, there were 229 slaughter houses, of which 179 had cold-storage facilities. Compared with 1970 when there were 37 slaughter houses without cold storage (matadouro) and 82 slaughter houses with cold storage (matadouro frigorifico), the number has increased greatly during the period of little more than 10 years.

The hygienic inspection of meat, although it is now under centralized control by the Federal Government, was once administered in three stages at Federal Government, state government and municipal governments level. In those days, except for the slaughter houses supervised by the Federal Government, slaughtering facilities were outdated, mainly due to each of funds, and sanitary arrangements were not always adequate.

In the 1970s, the Government took policy measures to promote the modernization of slaughtering facilities under a system of low-interest financing from government funds.

The government standards regulating the construction and internal facilities of slaughter houses, as well as the controls on the handling of cattle and dressed meat are very strict and at a modern level.

The present annual capacity of slaughter houses meeting government standards is said to be 11 million to 12 million head, greatly in excess of the number of cattle slaughtered in 1982.

Thus, the modernization of slaughter houses has given rise to several new problems, such as (1) a low rate of operation compared with the capacity, (2) since small-scale and sub-standard slaughtering facilities often do not have government approval, a considerable number of cattle for local consumption were slaughtered without going through inspection by the Federal Government, and (3) businesses are refraining from setting up small-scale slaughter houses in low-consumption areas to cater for local demand, because there are no economical advantages.

In addition, the supply of dressed carcasses to remote low consumption areas is affected by restrictions on transportation conditions, and retail prices become higher when refrigerator trucks are used.

In view of the reasons cited in (2) and (3) above, it is presumed that a number of cattle are slaughtered without inspection by the Federal Government authorities.

In a simple comparison between the number of cattle slaughtered and the amount of beef production for 1982 which were published in the Meat Inspection Statistics and the Annual Statistics of Brazil (by IBGE) respectively, the total number of cattle slaughtered amounts to 11,658,642 head while the number of beef cattle slaughtered under the supervision of the Federal Government stands at 8,771,754 head, accounting for 75% of the total number of cattle slaughtered. Also, the proportion of beef production in the former figure is 2,396,642 tons, while it is 1,912,961 tons in the latter, representing 80% of the total amount of beef produced.

It is presumed, therefore, that 25% (about 2,887,000 head) of cattle slaughtered and 20% (about 484,000 tons) of beef produced are being consumed without undergoing inspection by the Federal Government authorities.

The number of cattle slaughtered and the amount of beef produced by region in Brazil are as shown in Table 8-14. According to the table, 50% and 25% of the number of cattle slaughtered under the inspection and supervision of the Federal Government were produced by the southeastern region and southern region, respectively, and the northern and northeastern regions account for only 7%.

Regarding the three states related to the P.G.C. Area, the number of cattle slaughtered and the amount of beef produced in Para and Maranhao represent only about one per cent respectively as is shown below in Table 8-15.

Table 8-14 Number of Cattle Slaughtered and Beef Production by Region (1982)

	North	Northeast	Southeast	South	Central-west	Total
Number of Slaughtered	132,653 1.5	466,484 5.3	4,444,326 50.7	2,184,479 24.9	1,543,812 17.6	8,771,754 100%
Carcasses Produced (tons)	26,410 1.4	95,475 5.0	987,422 51.6	471,184 24.6	332,470 17.4	1,912,961 100%

Source: Boletim Animal de Estatistica 1982

Table 8-15 Number of Cattle Slaughtered and Beef Production in the States Related to the PGC Area (1982)

	Para	Maranhao	Goias	Brazil
Number of Slaughtered	87,712 1.0	160,078 1.8	880,144 10.0	8,771,754 100%
Carcasses Produced (tons)	18,140 1.0	32,637 1.7	181,757 9.5	1,912,961 100%

Source: Boletim Animal de Estatistica 1982

8-4 The Present Situation of Research in Brazil and Targets for Improvement in Beef Cattle Production

The technological problems in promoting the beef cattle production have already been indicated in the report, "Programa Grande Carajas Agricola". In the field observations, although the period and scope of survey were very limited, many factors were observed which might act as deterrents to the promotion of beef cattle production.

They are as follows; (1) the amount and quality of the pasture in the natural pasture lands, (2) seasonal variations in pasture production, especially the remarkable decrease in pasture production during the dry season, (3) low stocking capacity and the deterioration of pasture quality attributable to poor management methods, (4) loss in livestock caused both by poor nutrition and by improper management of cattle raising, (5) be lated first calf birth and low calf production rate, (6) long time period prior to slaughtering, low slaughter rate and low dressing percentage, and so on.

There follows, a brief reference to the results of researches conducted by experimental and research institutions to solve some of the problems mentioned above and which have proved effective at the experimental stage. Also mentioned are some new beef production systems which technology-extension service organizations are trying to apply to existing operations.

8-4-1 The Qualitative and Quantitative Improvement of Pasture

In the development of pasture by deforestation, the slash-and-burn method which is widely applied, allows the maintenance of soil fertility for only the first one or two years, thereafter over the next three years soil fertility of pasture managed by the traditional methods

declines to below natural fertility levels, with the deterioration accelerating year by year.

Similarly, coarse development and management of pasture cause a rapid decline of soil fertility to lower than the pre-deforestation level of fertility, while more appropriate development and management (of stocking rates and fertilization) of pasture with suitable species of grass can retard the decline of fertility keeping it above the pre-deforestation level.

According to research, the stocking rate during the high grass-production period for one or two years after slash-and-burn, has a great influence on the amount of grass produced in the subsequent period. If the number of grazing cattle is one or two head per hectare, the growth of grass can be maintained over a long period of time, but the grazing of three to five head per hectare, would be overstocking, which results in a rapid fall in soil fertility in and after the sixth year after clearing. To minimize the risk of soil erosion before the establishment of pastureland, it is suggested that one or two kinds of grain are first planted and grass seeds sown between the ridges. In this way the development cost of pasture can be covered by the proceeds from grain production. The researchers of Tropical-humid Agriculture Research Center (CPATU)/EMBRAPA suggest maize as a suitable kind of grain. It is also recommended that the use of bulldozers be minimized in large-scale pasture development because they remove the fertile surface soil and also harden the ground.

8-4-2 Species of Grass

Selection of suitable species of grass meeting the regional conditions is very important to ensure the maintenance and improvement of grazing capacity of the pasture land.

Although Panicum maximum and Hyparrhenia rufa have been used as traditional species of grass in the Amazon region, both species have a limited adaptability to declining soil fertility, with yields falling sharply year by year compared with Brachiaria humidicola and Brachiaria decumbens.

The researchers of CPATU/EMBRAPA (Belem) suggest Panicum maximum and Hyparrhenia rufa as the species of grass adaptable to the humid tropical region and also recommend Brachiaria humidicola as the species suitable for extending pasture durability or for substitution for Panicum maximum which cannot be maintained when the soil fertility dwindles.

Besides, the EMGOPA Experimental Station (Araguaina) is also taking up the question of declining productivity of Panicum maximum and is conducting research on the re-activation of pasture by mixed seeding with Brachiaria as a countermeasure for declining productivity.

The researchers of Cerrado Agriculture Research Center (CPAC)/ EMBRAPA cite Brachiaria (B. decumbens, B. humidicola and B. ruziziensis) and Hyparrhenia rufa as the species suitable for the Cerrado region. It is said that although Hyparrhenia rufa was once the most popular species, the planting area of Brachiaria has been increasing sharply since 1978, and that one third of the area of each sown pasture is occupied by these two species of grass (while CPATU/EMBRAPA regards Brachiaria decumbens as not adaptable to the humid tropical region because of its vulnerability to blights, the same species is most widespread in the cerrado region).

Also, it is said that in this region, Andropogen gayanus Var. bisquamulatus and Planaltina are increasing their importance as adaptable species as a result of their selection by CPAC/EMBRAPA in 1980.

The introduction of leguminous grass will improve the nutrition of animal through its high protein content and will enhance the quality of the true grasses by fixing nitrogen in the soil.

The selection of species of legume adaptable to tropical zones is an important matter not only for Brazil, but also for other tropical countries, and relevant research has been going on since 1978 by CIAT and other institutions. In Stage I of a research project conducted by CPAC, 50 species were tested for their adaptability to factory such as soil, climate, disease and blight, seed production potential, productivity, and nutritive value, and seven key species were selected (Table 8-16). In Stage II, a grazing test was conducted on the pasture where leguminous species had been introduced, and it was shown that cattle of AU 450 kg can be raised at an annual average stocking rate of 1.2 AU/ha (0.7 AU/ha in dry season and 2.11 AU/ha in rainy season). In Stage III, the seeds of the selected adaptable species will be reproduced and provide to seed-producing companies.

At present, Servico de Producao de Sementes, which is engaged in the reproduction and propagation of good-quality seeds, supplies only Andropogen gayanus Var. bisquamalatus as the breeding-purpose seed of grass which was selected by CPAC/EMBRAPA, and it is not yet handling the supply of leguminous species. The researchers of EMBRAPA point out, that even if a leguminous species adaptable to tropical regions is found, the spread of such species will require careful management. CPAC/EMBRAPA, which is conducting the research jointly with CIAT, appears to be obtaining good results in its efforts to find adaptable species.

8-4-3 The Re-Activation of Pasture Lands

As mentioned before, the conventional way of pasture management brings about an accelerated decline in grazing capacity along with the decrease in grass production, resulting finally in a return of the pasture to forest. For the promotion of beef cattle production, it is a problem of great importance to take measures to prevent the deterioration of already developed pasture lands.

Table 8-16 Summary of the General Characteristics of <Key> Species and Others Evaluated at CPAC

General or Species	Climatic Adaptation	Soil Adaptation	Productivity and Vigour	Persistence	Nutritive value	Pest & Disease Tolerance	Seed Production Potential
Key Species							
Stylosanthes guianensis	++	++	++	+	+	+	+
Stylosanthes capitata	++	++	++	++	+	+	++
Stylosanthes macrocephala	++	++	++	++	+	++	++
Stylosanthes viscosa	++	++	++	++	+	+	+
Zornia brasiliensis	++	++	++	++	+	+	+
Centrosema macrocarpum	++	++	++	++	+	++	+
Centrosema brasilianum	++	++	++	+	+	+	+
Other Species							
Calopogonium spp.	++	++	+	+	+	++	++
Galactia spp.	++	++	-	-	+	++	-
Macropotilium/Vigna spp.	++	-	-		+	++	+
Pueraria/Teramnus spp.	++	-	-		+	++	+
Leucaena leucocephala	++	-	-		+	++	++
Aeschynomene spp.	++	++	-			-	++
Desmodium spp.	+	++	-			-	-
Desmodium ovalifolium	-	++	-	-	-	-	-

Note: ++ Excellent; + Good; - Poor; Blanks represent unknowns.

Source: D. Thomas et al, Pasture Development in the Tropical Savanna Region of Brazil

Several investigations have been made into ways of improving both the amount and quality of roughage, and into the prevention of pasture deterioration.

CPAC/EMBRAPA conducted a grazing test at stocking rates of 1.0 AU/ha (AU=400 kg) and 1.4 AU/ha respectively on a pasture of grasses (Brachiaria ruziziensis) which was fertilized with N_2 at the rate of 40 kg/ha. In the test, the weight of cattle increased by 50 kg/ha annually in the case of 1.0 AU and by 100 kg/ha in the case of 1.4 AU, a better result than that of another test of pasture of mixed grass and legume.

Research on the relationship between stocking rate, grass production, and increase in cattle weight, has revealed that on pasture of Brachiaria decumbens, grazing at the rate of one head per ha in dry season and two head in rainy season either maintains the weight of cattle or increases it by 450 g per day, without causing deterioration of the pasture.

The above tests have demonstrated how effectiveness of pasture land fertilization and controlled grazing in maintaining and extending the grass life and cattle growth.

Finally, another idea for improving the quality of roughage was stimulated by the difficulties of using legume in tropical regions. To supplement nutrition by crude feed rich in protein, it is suggested that belts of legume could be set up as "protein banks" in a pasture of true grasses. Alternatively, leguminous trees (Leucaena) could be planted around natural pasture land, as feed trees. Leucaena is adaptable to acid soil and its leaves are said to contain 25 to 50% crude protein.

8-4-4 The Beef Cattle Production System

The low level of beef cattle production in Brazil is an undeniable fact at present. EMBRAPA/EMATER are presently making efforts to improve conditions by establishing model beef production systems in each region.

Table 8-17 shows a comparison of various production factors in the beef production system in the three sub-regions of Maraba (Para), Imperatriz (Maranhao) and Araguina (northern part of Goias) which have high priority in the PGC. Also compared is Paragominas which is considered to be at a relatively higher technical level than the other three sub-regions.

As can be seen at a glance, the technical level of beef cattle production is generally low and also there are substantial regional differences.

Although the table does not indicate the years in which the goals for improvement are to be reached, Paragominas seems likely to attain the goals while the other sub-regions will apparently have difficulties in doing so unless exceptional efforts are exerted.

It goes without saying that since the beef cattle production has

Table 8-17 Production Technique Factors in Beef Production System

	Northern Part of Goias		Maraba		Imperatriz		Paragominas	
	Present	Goal	Present	Goal	Present	Goal	Present	Goal
Grazing Capacity	-	-	0.8AU/ha	1.25AU/ha	0.6AU/ha	1.0AU/ha	1.0AU/ha	1.5AU/ha
Production Rate	45%	65%	65%	75%	60%	70%	70%	75%
Death Rate								
One year old	9%	5%	12%	10%	8%	5%	6%	5%
One to two years old	5%	3%	6%	5%	-	-	3%	2%
Two to three years old	3.5%	2%	3%	2%	-	-	2%	2%
Adult	3%	2%			-	-		
Sales Rate of Cattle	13.4%	22.7%	-	20%	7%	15%	15%	20%
Age of First Birth	3.75 yrs.	3 yrs.	-	-	-	-	3.5 yrs.	3.0-3.5 yrs.
Age of Cattle Slaughtered	4 yrs.	3.5 yrs.	3.5-4 yrs.	3-3.5 yrs.	3.5 yrs.	3 yrs.	3 yrs.	2.5-3 yrs.
Weight of Cattle Slaughtered	-	-	350 kg	450 kg	300 kg	350 kg	400 kg	400-430 kg

its foundation on land, it is greatly affected by natural conditions. However, it was felt in our field observations that there were great differentials in the beef cattle productivity among the producers irrespective of the scale of operations and of regional conditions.

Among the cattle farms of medium or larger scale which seem to have been opened recently, some pasture lands were seen to be already deteriorating while adjacent pastures were rich in grazing capacity under appropriate pasture land management, indicating the importance of adequate management methods.

It is also considered quite essential to induce the producers with poor capital and technology resources to make the most of the outcome of experiments and research and also to encourage them to strive for the improvement of the technical factors previously indicated.

Although EMATER is carrying out its activities in a positive manner, these activities promoting the spread of technical improvements should be pushed forward more vigorously. Also special consideration should be given to a proper financing systems for beef cattle production in view of its long conception period.

8-5 The Potential of Beef Cattle Production and Matters to be Taken into Consideration in the Promotion of Beef Cattle Production

In the foregoing descriptions about the present conditions of beef cattle production in the PGC Area, reference has been made to the problems hindering the promotion of beef cattle production. Although there are some technical problems inherent in the Area related to specific natural conditions, the other questions should be considered from the national point of view.

Regarding the factors arising from natural conditions, even measures taken elsewhere may resultantly benefit the PGC Area since there are some other regions with the same or similar conditions as those of the Area.

Discussed below is the potential for beef cattle production should it be taken up as one of the strategic items in the development of the PGC Area. Also considered are the matters to be taken into account in the promotion of beef cattle production.

8-5-1 The Importance of Beef Cattle in Regional Development

On the premise that there will be no significant increase in labor available in the Area, beef cattle which requires a relatively small labor force compared with other production systems could be the appropriate stimulus for the development of this vast area.

The land utilization in the Area is presently centered on the pasture lands and beef cattle raising. In view of the market conditions

for agricultural and livestock products, transportation conditions, relatively low land prices and the shortage of skilled agricultural labor, the current move from agricultural production into beef cattle production is considered a reflection of the actual conditions of the Area.

As has already been indicated, animals other than beef cattle are raised on the pasture lands, they include dairy cattle, sheep, goats and horses. Dairy cattle raising, where it is exclusively devoted to the supply of milk for drinking, encounters serious restraints due to location such as distance from the consuming market, and poor infrastructure such as water supply, electricity and roads which are required for production and distribution because of the product being liable to deteriorate in quality in a short period of time.

With regard to sheep and goats which have a traditional place in the local diet, the need for their production and thus the related promotive measures —— except where production is for small scale home consumption purposes —— should be considered in the light of the domestic demand.

The beef supply and demand situation in Brazil becomes stringent at times because of low productivity on the supply side. Measures for the improvement of efficiency in beef cattle production are required on a national basis and the promotion of beef cattle production is essential to ensure stable domestic supply.

Furthermore, when looking at the long-range possibilities for the international beef supply and demand situation, a nation with vast agricultural lands will become very important.

In the case of Brazil, however, the countries to which it can export its beef are limited at present because it is affected by foot-and-mouth disease, an international serious infectious disease.

Foot-and-mouth disease is an epidemic that is very difficult to control as may be seen from the fact that the disease is always extant even in economically advanced West European countries. The idea of making a foot-and-mouth disease-free zone in the PGC Area, will be an important plan.

Taking into consideration domestic beef supply - demand conditions, the long-range international beef supply - demand situation, the development needs of the vast land area, and other conditions, beef cattle production is regarded as one of the important industries in the promotion of development in the PGC Area.

In order to ensure stable development in beef cattle production, however, the following points will need careful consideration.

8-5-2 Target for Beef Production

The meat consumption structure in Brazil has recently been showing substantial changes.

Since the beginning of the 1980s, the production and consumption of chicken-meat has been rapidly increasing. The annual consumption of chicken-meat per capita increased from 2.3 kg in 1970 to 10.1 kg in 1980. Meanwhile, the annual consumption of beef had increased year by year upto 1977 when the per capita consumption reached 20.1 kg accounting for 60% of the total meat consumption (beef, pork and chicken). In 1982, however, it went down to 16 kg with its share in the meat consumption declining to 47%.

Meat consumption generally has also been decreasing since 1983, and that of chicken is levelling off or decreasing slightly while the downturn in beef consumption is remarkable. Until 1982, while beef consumption had been on a downward trend, the consumption of meat had been increasing slightly because of the grawth in chicken consumption.

Such changes in the meat consumption structure are presumably attributable to the declining purchasing power of consumers resulting from the deteriorated domestic economy, which encouraged the substitution of beef with chicken. However, since such a situation can also be regarded as a phenomenon indicating the beginning of diversified meat consumption rather than a temporary economic symptom, a careful long-range study of the meat consumption structure will be required.

The major portion of chicken production costs is occupied by the expense of feed, and it is a special feature of the broiler industry that production can be expanded rapidly if favored by the feed conditions and a good consumer market.

Bazil is rich in soybean meal which is protein feed, and if the supply of maize increases in future, there will be a great potential for increased chicken production. It is, therefore, necessary to study the prospects of future domestic production of grain feed and the details and scale of meat consumption.

Beef cattle production in Brazil requires considerable improvement in matters of production efficiency. The present number of beef cattle raised indicates a potential for considerable expansion of production if improvements are made. In addition, it will be necessary to determine a comprehensive projection of beef supply and demand including the local demand and export outlook in connection with the expected increase in the supply quantity of beef resulting from the development of the PGC Area.

It seems that no official projection has so far been made by the Brazilian Government on the supply and demand for beef. According to a forecast made by National Council of the Beef Cattle Industry (CNPC), a private institution, the number of cattle raised in the year 2000 is predicted at 1.37 times more than that in 1983 while the meat produc-

tion is forecast to increase markedly to 2.75 times the 1983. The forecast suggests that such increased production will be attained by an improvement in the production rate of calves, the lowering of slaughter age, an enhanted slaughter rate and improvements in beef cattle production technology, thus raising the number of cattle slaughtered to 2.75 times. It also says that the beef production can be boosted by the improvement of the beef production system to meet the anticipated 2.9 times growth in domestic demand and the doubling of exports.

Although it is understandable that such an optimistic forecast cannot be made in an official supply and demand projection by the Government, it is a common experience in every beef-cattle producing country that the long-term production cycle of beef cattle - due to the physiological characteristics of cattle - and the fluctuating supply and demand conditions render beef production operations unstable and giving rise to a beef cycle.

In the development of the PGC Area, careful attention should be paid so that such marked changes in supply and demand situation as may threaten the continuity of operations, may be avoided as far as possible, especially the early stages.

In this respect, it will be necessary to clarify the share of the PGC Area in the production of beef and also to make clear a brood idea of future prospects to the producers, after studying carefully the supply and demand outlook of meat and beef.

8-5-3 The Category of Operations which will Take the Major Role in Beef Production

Products and categories of operations will vary depending on whether development is to be socially oriented or purely economic; whether it includes measures for the settlement of shifting farmers and for increasing employment, or whether the development is to be carried out with a major emphasis on the creation of highly productive agricultural operations in a newly developed producing area, or whether the development is to be a combination of the above.

The present beef cattle raising structure is polarized with a large number of small-scale cattle raisers at one extreme and a small number of large-scale cattle raisers at the other.

The small-scale raisers' type of beef cattle operation is mainly breeding combined with other kinds of production. The land distribution from the viewpoint of a social policy is unbalanced. This necessitates the combined type of operations and forces small beef cattle operations to be confined to breeding since it is difficult to extend the scale of operations to fattening because of the limited area of land holding.

In terms of efficiency of beef cattle production, there are several problems in the small-scale breeding operations. It is presumed that there are considerable difficulties in funding and in introducing new technology for such productivity - improving measures as quality improvement of breeding cattle, enhancement of calf production rate and lowering the rate of animal losses.

In the PGC Area, a substantial increase in the number of cattle raised is required to create adequate scale in beef cattle production and to allow a slaughter house with modern facilities to carry on its operations economically. For these purposes, it is also necessary that breeding, pasture land rearing and fattening operations are arranged appropriately within the Area in such a way that each of them can operate stably.

Large-scale fattening operations require a large amount of fixed capital and operating funds as well as management technology. Therefore, it will also be necessary to induce large-scale producers into the Area. The entry of large-scale producers from the advanced beef-cattle producing areas is already taking place, mainly in the southern part of Para. The remarkably high percentage of cultivated pasture lands in the sub-region of Maraba is attributable not only to the natural conditions but also to the entry of well equipped producers into this area.

In order to realize high economic efficiency in beef cattle production, it will be necessary to study how such producers should be fitted into the development program.

8-5-4 The improvement of Cattle and Land Productivity

In this report, the low efficiency of beef cattle production in Brazil has often been referred to. The improvement in beef productivity has been hindered by the low level of land productivity, which, in turn, causes a further decline of cattles growing capacity and lowers the quality of the cattle.

There are fundamental problems such as the low production rate of calves, the high death rate among calves and low rate of weight increase in cattle owing to the poor nutrition affected by such factors as the seasonal variation in grass production, the low level of grass production in the natural pasture lands and the deterioration of pasture lands due to the low quality of natural grasses and haphazard management.

Such low productivity in beef cattle production seems to be attributable mainly to the inadequate management of pasture which deprives the soil of fertility.

According to a research report by EMBRAPA, of the total pasture land area of three million hectares in the Amazon region, one third or one million hectares is maintaining productivity while 1.5 million hectares show a decline in productivity and half a million hectares are at

extremely low levels. In view of the fact that such conditions can be seen even in improved pasture lands, the state of the natural pasture lands must be ruinous, and their grazing capacity is probably remarkably low.

As described already, research on the re-activation of pasture lands have shown that such activation measures as (1) fertilization, (2) reinforcement of pasture lands with species adoptable to low soil fertility and (3) the introduction of legume, are economically much superior to the conventional land rotation method.

A study should be carried out to find ways to increase the rate of extension of the technology evolved by research institutions and to provide the funds necessary for pasture land improvement.

The fact that the pasture lands, which are already developed produce smaller amount of grass year by year culminating in devastation, is a great problem not only for the maintenance and expansion of beef cattle operations but also for the effort to reduce beef production costs and improve profitability. Also, of course there is the problem of ecological damage and the need to ensure the effective utilization of land resources.

From the viewpoints of ecology maintenance and pasture land management, there are several areas of concern to do with pasture land development methods in newly developed pastures. In some places, the tops and steep slopes of mountains have been deforested to create pasture lands, giving rise to land erosion in the early stages of development, in addition to the poor growth or rapid loss of grass due to grazing, and other problems in soil maintenance and pasture land management.

The forest law regulations requiring the reservation of forests equivalent to fifty percent of the area developed seem to be lacking a sufficient consideration of the function of forests in soil maintenance and water-source preservation for the details regarding which forests are to be left to the judgment of owners. Therefore, in this regard too, greater care and guidance in the development of new pastures are desirable.

As already indicated, improvements in beef cattle productivity will be possible through enhanced grass production and better nutrition from improved roughage. Another factor in the poor growth of cattle which could be overcome by improved management methods is parasite damage. Since the measures to be taken for the prevention of diseases are prescribed in the beef production system, counter-measures against parasites could be treated together with the infectious diseases prevention program since such hygienic measures require the enhancement of producers' knowledge about the diseases and blights.

Something that cannot be changed even by the improvement of herd management is the genetic capacity of cattle. Since the cattle raised under tropical conditions require good resistance to heat and disease, the breeds to be raised should be based on the Zebu-type. But, because

the Zebu-group breeds are inferior to the European breeds in meat productivity and other points, a new European-zebu hybrid has been created in Brazil, and is becoming established in the advanced beef-cattle producing regions.

The Federal Government has endeavored to promote the breeding of livestock and has succeeded in creating a new breed, Canchim. Although the Government authorities are trying to improve cattle quality by recommending the introduction of high-quality bulls to the less advanced northern region, such measures are usually left to the discretion of producers. While artificial insemination, which can utilize international bulls of excellent breed, is an effective way of accelerating the quality improvement of cattle, the rate of usage of artificial insemination is said to have been at only 6% until recently, with the main objective being to produce dairy cattle.

While the number of bulls (including candidate bulls) kept in Brazil is estimated at 2,280,000 head, it is impossible to improve the average quality and capacity of a large number of bulls to a high level in a short period of time.

The reasons why artificial insemination has not spread in Brazil despite its introduction in the 1960s, are that a limited number of producers desire to adopt the method and also that the liquid nitrogen required for preservation of frozen semen is not sufficiently available. More specifically, the producers engaged in small-scale breeding on a combined operation basis are not so earnest to improve the quality of their cattle. While, the large-scale producers engaged in integrated operations, - "breeding, rearing and fattening", with the economic capacity to buy seed bulls of good quality, believe that it is possible to improve the cattle quality by the current method of natural hybridization. More significantly perhaps there are physical limitations in the distribution of semen, even if a sub-station for semen is set up, because of unfavorable transportation conditions.

However, artificial insemination is now widely used in Paraguay, which could be a source of useful information on the use of artificial insemination in improving the cattle quality in small-scale breeding operations.

8-5-5 The Improvement of the Production Environment

Although it may have been because our field observations were made in a developing area, we were greatly impressed by the profound relationship between the construction of roads and the development of farm lands. In the area we visited, cattle farms were extending along the road side belt. The large-scale cattle farm which we visited, engaged in breeding and fattening operations (with the major emphasis on the fattening), was located at the end of a pasture road 50 km from a main road. The pasture road was built exclusively for the farm because there were very few branch lines from the main road.

Although a financially capable producer can develop a pasture by constructing such a pasture road depending on the price of land acquired, a medium- or small-scale producer without sufficient funds will find it difficult to bear the burden of road construction expenditures.

Therefore, consideration should be given to the construction of branch roads in adequate numbers of the trunk roads to facilitate the formation of prolific cattle production areas and the reduction of cattle transportation and marketing costs. In this case, it goes without saying that careful attention should be paid to natural ecology conservation.

In terms of slaughter house management, the PGC Area has a handicap in the high transportation cost of dressed carcasses (blocks) compared with the already developed beef producing regions. If the Area's slaughter houses are to match the domestic market competition, -- to say nothing of the necessity of improving the productivity on the part of beef cattle producers, -- careful attention must be paid to profitability in comparison with developed regions. Since a large-scale slaughter house with rationalized facilities would have to be established as a base for beef production in the Area in view of the above-mentioned requirements, unplanned development of dispersed areas of beef cattle production would force the cattle producers to bear excessive burden of transportation costs.

The location and scale of such a slaughter house will also have to be studied.

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11. Introducao e Avaliacao de Forrageiras no Municipio de MARABA-PA, Boletim de Pesquisa Nov. 1982

12. Analise Economica de Algumas Alternativas de Manejo de Pastagens Cultivados - Paragominas-PA, Boletim de Pesquisa Sept. 1982

13. Anais do 2º Simposio Nacional Sobre Sementas de Forrageinas

14. EMBRAPA, Canchim

Appendix Table 8-1 Number of Cattle Raised, by Purpose and by Region (1980)

(Unit: 1,000 head, %)

Region	Beef Cattle	Dairy Cattle	Cattle for Milk and Beef	Work Cattle	Total
North	3,555	307	123	4	3,989
	(89.1)	(7.7)	(3.1)	(0.1)	(100)
Para	2,500	160	66	3	2,729
	(91.6)	(5.9)	(2.4)	(0.1)	(100)
Northeast	15,572	4,283	1,502	148	21,505
	(72.4)	(19.9)	(7.0)	(0.7)	(100)
Maranhao	2,451	235	104	14	2,804
	(87.4)	(8.4)	(3.7)	(0.5)	(100)
Southeast	20,199	11,633	2,949	54	34,835
	(58.0)	(33.4)	(8.5)	(0.2)	(100)
Sao Paulo	8,039	3,047	598	1	11,685
	(68.8)	(26.1)	(5.1)	(0.0)	(100)
South	18,721	4,710	909	155	24,495
	(76.4)	(19.2)	(3.7)	(0.6)	(100)
Central-west	29,258	2,822	1,178	3	33,261
	(88.0)	(8.5)	(3.5)	(0.0)	(100)
Goias	12,799	2,278	1,010	3	16,090
	(79.5)	(14.2)	(6.3)	(0.0)	(100)
Brazil Total	87,306	23,754	6,661	365	118,086
	(74.0)	(20.1)	(5.6)	(0.3)	(100)

Source: IBGE, *Censo Agropecuario 1980*

Appendix Table 8-2 Number of Cattle Raised, by Region, PGC Area-Related States and Sub-region and by Raising Purpose (1980)

	Total Number		Beef Cattle		Dairy Cattle		Cattle for Combined Purpose		Work Cattle & Unknown Purpose	
	No. of Reporters	No. of Cattle	No. of Reporters	No. of Cattle	No. of Reporters	No. of Cattle	No. of Reporters	No. of Cattle	No. of Reporters	No. of Cattle
Brazil	2,477,652	118,085,872	1,237,168 (49.9)	87,305,677 (73.9)	947,074 (39.3)	23,754,484 (20.1)	161,922 (6.5)	6,660,984 (5.6)	129,488 (5.2)	364,727 (0.3)
North	54,840	3,989,113	40,231 (72.7)	3,555,300 (89.1)	9,381 (16.4)	306,721 (7.7)	2,009 (3.6)	122,858 (3.1)	3,219 (5.5)	4,234 (0.1)
Para	29,362	2,729,796	22,362 (75.9)	2,500,076 (91.6)	2,389 (6.9)	160,490 (5.9)	893 (3.4)	65,831 (2.4)	2,718 (10.3)	3,399 (0.1)
Maraba	2,918	391,125	2,387 (81.8)	354,286 (90.5)	424 (14.4)	28,653 (7.4)	98 (3.4)	8,168 (2.0)	9 (0.3)	18 (0.0)
Northeast	913,260	21,506,108	583,193 (63.9)	15,572,293 (72.4)	222,941 (24.4)	4,283,493 (19.9)	48,274 (5.3)	1,502,490 (7.0)	58,852 (6.5)	147,832 (0.7)
Maranhao	94,772	2,804,070	75,522 (79.6)	2,450,943 (87.3)	9,266 (9.8)	235,307 (8.4)	2,336 (2.4)	103,819 (3.7)	7,648 (8.0)	14,001 (0.5)
Imperatriz	6,057	402,850	4,682 (77.2)	346,786 (86.0)	1,052 (17.3)	40,418 (9.9)	308 (5.1)	15,615 (4.0)	15 (0.3)	31 (0.0)
Southeast	528,855	34,834,792	245,038 (46.3)	20,199,123 (58.0)	233,058 (44.0)	11,632,748 (33.4)	39,617 (7.6)	2,948,711 (8.5)	11,142 (2.1)	54,210 (0.2)
Sao Paulo	132,275	11,685,216	64,750 (49.0)	8,038,905 (68.8)	59,685 (45.1)	3,046,762 (26.1)	7,601 (5.7)	598,305 (5.1)	239 (0.2)	1,242 (0.0)
South	809,061	24,494,853	250,009 (30.9)	18,720,739 (76.4)	443,967 (54,9)	4,709,705 (19.2)	59,487 (7.3)	909,168 (3.7)	55.598 (6.9)	155,241 (0.6)
Central-West	171,636	33,261,006	118,697 (69.2)	29,258,222 (88.0)	39,727 (23.1)	2,821,817 (8.5)	12,535 (7.3)	1,197,757 (3.5)	677 (0.4)	3,210 (0.0)
Goias	118,409	16,089,510	78,681 (66.5)	12,799,361 (79.6)	28,963 (24.5)	2,277,916 (14.2)	10,281 (8.7)	1,009,698 (6.3)	484 (0.4)	2,535 (0.0)
Araguaina	9,744	989,573	8,008 (82.2)	909,119 (91.9)	1,209 (12.4)	53,563 (5.4)	506 (5.2)	26,798 (2.7)	23 (0.2)	89 (0.0)

Note: The figures in parentheses indicate percentages as against the total number in the extreme left column.

Source: IBGE, Censo Agropecuario 1980

Appendix Table 8-3 Changes in Beef Production

Year	Output (1,000 tons)
1970	1,845
1975	2,157
1977	2,445
1980	2,050
1981	2,250
1982	2,400
1983	2,360

Source: IBGE, MA, Apinco, Cacex, USDA

Appendix Table 8-4 Trends of Meat Supply and Demand

(Unit: tons, %)

	Beef	Horse Meat	Pork	Sheep Meat	Goat Meat	Poultry Meat	Others	Total
1980								
Production (1)	2,083,768	33,149	699,426	11,433	4,932	914,452	--	3,746,620
Imports (2)	64,505	--	--	--	--	--	5,581	70,086
Exports (3)	5,725	24,503	29	567	--	168,713	6,863	206,400
Supply (1)+(2)+(3)	2,142,548 (59.3)	8,646 (0.2)	699,397 (19.4)	10,866 (0.3)	4,392 (0.1)	745,739 (20.6)	-1,282 --	3,610,306 (100)
1981								
Production (1)	2,115,064	30,077	709,135	10,695	4,186	1,048,821	--	3,917,978
Imports (2)	60,355	--	--	--	--	--	5,692	66,047
Exports (3)	46,384	23,418	1,198	1,187	--	293,933	5,749	371,869
Supply (1)+(2)+(3)	2,129,035 (58.9)	6,659 (0.2)	707,937 (19.6)	9,508 (0.3)	4,186 (0.1)	754,888 (20.9)	-57	3,612,156 (100)
1982								
Production (1)	2,396,642	24,609	625,967	11,493	4,146	1,192,046	--	4,254,903
Imports (2)	20,635	--	--	--	--	--	1,611	22,246
Exports (3)	94,442	16,409	2,621	2,511	--	301,793	4,430	422,206
Supply (1)+(2)-(3)	2,322,835 (60.3)	8,200 (0.0)	623,346 (16.2)	8,982 (0.2)	4,146 (0.1)	890,253 (23.1)	-2,819	3,854,943 (100)

Note: Although other items of meat than "Beef" are all included in "Others" with regard to imports and "Goat meat" is included in "Others" with regard to exports, the respective amounts of supply for such specific items have been computed without taking this into account.

Source: IBGE, Anuario Estatistico do Brasil 1983, p. 435, 442, 444.

Appendix Table 8-5 Changes in Meat Consumption per Capita

(Unit: kg)

	Beef	Pork	Poultry Meat	Total
1970	17.8 (64.3)	7.6 (27.4)	2.3 (8.3)	27.7 (100)
1975	19.4 (61.6)	7.2 (22.9)	4.9 (15.6)	31.5 (100)
1977	20.1 (60.0)	7.4 (22.1)	6.0 (17.9)	33.5 (100)
1980	15.6 (46.0)	8.2 (24.2)	10.1 (29.8)	33.9 (100)
1981	15.9 (47.2)	8.0 (23.7)	9.8 (29.1)	33.7 (100)
1982	16.0 (46.6)	7.8 (22.7)	10.5 (30.6)	34.3 (100)
1983	14.5 (45.2)	7.6 (23.7)	10.0 (31.2)	32.1 (100)

Note: Figures in parentheses stand for percentages as against the total.

Source: IBGE, MA, Apinco, Cacex, USDA

Appendix Table 8-6 Utilized Land Area, by Region, PGC Area Related State and Sub-Region, and by Utilization Purpose (1980)

(Unit: ha)

Geographical Area	Total Area (ha)	Arable Lands	Pasturelands			Forests	Not Utilized
			Total Area	Natural	Improved		
Brazil	364,854,421	57,723,959 (15.8)	174,501,641 (47.8)	113,899,357 ((65.3))	60,602,284 ((34.7))	88,167,703 (24.2)	24,796,570 (6.8)
North	41,559,420	2,890,280 (7.0)	7,722,487 (18.6)	3,951,743 ((51.2))	3,770,744 ((48.8))	26,243,117 (63.1)	2,900,418 (7.0)
Para	20,448,422	1,798,596 (8.8)	4,513,420 (22.1)	1,711,731 ((37.9))	2,801,689 ((62.1))	11,075,809 (54.2)	2,076,021 (10.2)
Maraba	2,430,553	100,664 (4.2)	589,177 (24.2)	24,058 ((4.1))	565,119 ((95.9))	1,641,615 (67.5)	62,622 (2.6)
Northeast	88,443,907	18,077,343 (20.4)	34,158,706 (38.6)	23,812,927 ((69.8))	10,345,779 ((30.3))	19,750,792 (22.3)	12,293,317 (13.9)
Maranhao	15,134,237	2,482,837 (16.4)	4,849,106 (32.0)	2,690,740 ((55.5))	2,158,366 ((44.5))	3,438,493 (22.7)	3,810,430 (25.2)
Imperatriz	1,894,850	211,514 (11.2)	653,478 (34.5)	141,621 ((21.7))	511,857 ((78.4))	623,857 (32.9)	381,274 (20.1)
Southeast	73,502,906	13,017,399 (17.7)	43,639,266 (59.4)	27,453,623 ((62.9))	16,185,643 ((37.1))	10,627,660 (14.5)	1,446,583 (2.0)
Sao Paulo	20,161,000	6,100,148 (30.0)	10,307,060 (51.1)	3,214,406 ((31.2))	7,092,654 ((68.8))	2,396,636 (11.9)	346,749 (1.7)
South	47,911,723	16,122,488 (33.6)	21,313,458 (44.5)	15,678,716 ((73.6))	5,634,742 ((26.4))	6,460,995 (13.5)	1,210,132 (2.5)
Central-West	113,436,463	7,616,443 (6.7)	67,665,720 (59.7)	43,000,346 ((63.5))	24,665,374 ((36.5))	25,085,133 (22.1)	6,332,720 (5.6)
Goias	47,853,028	3,922,756 (8.2)	31,422,129 (65.7)	20,578,467 ((65.5))	10,843,662 ((34.5))	6,967,255 (14.6)	2,960,905 (6.2)
Araguaina	4,194,598	318,286 (7.6)	1,974,098 (47.1)	875,981 ((44.4))	1,098,117 ((55.6))	2,739,769 (65.3)	407,983 (9.7)

Notes: 1. Upper figures indicate the number of hectares, and the lower figures in parentheses show the percentages as against the total area. (The figures in double parentheses for Pasturelands -- Natural and Improved -- show the percentages as against the total area of the Pasturelands).
2. The figures of "Total Area" do not coincide with the sum of figures of respective items because the "Total Area" includes the area of lands unsuitable for utilization.

Source: IBGE, Censo Agropecuario 1980

Appendix Table 8-7 Utilized Land Area by Industry, Classified by Region, PGC Area-Related States and Sub-region (1980)

(Unit: ha)

	Total Area	Crop	Livestock	Crop amd Livestock	Horti-culture	Forestry	Poultry Farms	Raising of Rabits, Bees & Silkworms	Plant Oil Extrac-tion
Brazil	364,854,421	111,967,225 (30.7)	211,442,007 (58.0)	13,479,968 (3.7)	392,389 (0.1)	7,387,598 (2.0)	2,141,836 (0.6)	83,071 (0.0)	17,960,325 (4.7)
North	41,559,420	13,158,622 (31.7)	15,734,583 (37.9)	663,643 (1.6)	29,604 (0.1)	1,961,941 (4.7)	339,563 (0.8)	2,175 (0.0)	9,669,286 (23.3)
Para	20,448,422	6,934,999 (33.9)	8,753,262 (42.8)	426,335 (2.1)	8,374 (0.0)	1,752,604 (8.6)	137,817 (0.7)	140 (0.0)	2,434,887 (11.9)
Maraba	2,430,553	644,585 (26.5)	1,276,695 (52.5)	67,547 (2.8)	1 (0.0)	-- --	21,175 (0.9)	-- --	420,548 (17.3)
Northeast	88,442,907	34,542,296 (39.1)	46,573,229 (52.7)	3,676,062 (4.2)	46,406 (0.1)	275,052 (0.3)	315,059 (0.4)	946 (0.0)	3,014,853 (3.4)
Maranhao	15,134,237	5,651,956 (37.3)	7,888,242 (52.1)	610,374 (4.0)	2,917 (0.0)	11,864 (0.1)	80,403 (0.5)	18 (0.0)	888,459 (5.9)
Imperatriz	1,894,850	595,181 (31.4)	1,104,841 (58.3)	63,218 (3.3)	149 (0.0)	709 (0.1)	14,520 (0.8)	-- --	116,230 (6.1)
Southeast	73,502,906	21,496,587 (29.2)	42,787,685 (58.2)	3,460,447 (4.7)	236,417 (0.3)	3,075,063 (4.2)	543,170 (0.7)	40,693 (0.1)	1,862,839 (2.5)
Sao Paulo	20,161,000	8,738,066 (43.3)	9,206,162 (45.7)	872,919 (4.3)	86,854 (0.4)	888,161 (4.4)	219,482 (1.1)	38,442 (0.2)	110,910 (0.6)
South	47,911,723	21,635,785 (45.2)	20,995,739 (43.8)	2,001,245 (4.2)	56,763 (0.1)	1,513,177 (3.2)	299,343 (0.6)	30,993 (0.1)	1,378,674 (2.9)
Central-West	113,436,463	21,133,933 (18.6)	85,350,769 (75.2)	3,678,569 (3.2)	23,197 (0.0)	562,362 (0.5)	644,697 (0.6)	8,262 (0.0)	2,034,671 (1.8)
Goias	47,853,028	9,091,600 (19.0)	35,856,755 (74.9)	2,276,281 (4.8)	11,790 (0.0)	55,999 (0.1)	184,661 (0.4)	371 (0.0)	375,568 (0.8)
Araguaina	4,194,598	868,815 (20.7)	3,087,058 (73.6)	138,851 (3.3)	71 (0.0)	35 (0.0)	52,593 (1.3)	-- --	31,145 (0.7)

Note: Figures in parentheses indicate percentages as against the Total Area in the extreme left column.

Source: IBGE, Censo Agropecuario 1980

Appendix Table 8-8 Number of Cattle by Raising Purpose (1980)

Raising Purpose	Brazil		Para		Maranhao		Goias	
	No. of Informants	No. of Cattle	No. of Informants	No. of Cattle	No. of Informants	No. of Cattle	No. of Informants	No. of Cattle
Beef Production								
Breeding	535,680 ((43.3))	20,524,263 ((23.5))	9,979 ((44.6))	480,213 ((19.2))	33,043 ((43.7))	542,803 ((22.2))	39,691 ((50.4))	3,792,736 ((27.6))
Rearing	264,942 ((29.5))	10,109,983 ((11.6))	3,365 ((15.1))	181,075 ((7.2))	14,502 ((19.2))	245,314 ((10.0))	11,068 ((14.1))	1,380,216 ((10.8))
Fattening	103,413 ((8.3))	11,513,298 ((13.2))	1,026 ((4.6))	130,950 ((5.2))	3,647 ((4.8))	131,749 ((5.4))	3,396 ((4.3))	1,853,483 ((14.5))
Breeding and Rearing	210,712 ((17.1))	21,018,056 ((24.1))	5,479 ((24.5))	825,713 ((33.0))	15,894 ((21.1))	884,037 ((36.1))	20,323 ((25.8))	3,107,761 ((24.3))
Breeding and Fattening	28,136 ((2.3))	3,314,786 ((3.8))	455 ((2.1))	114,027 ((4.6))	1,744 ((2.3))	70,925 ((2.9))	725 ((0.7))	347,504 ((2.7))
Rearing and Fattening	22,129 ((1.8))	4,183,924 ((4.8))	243 ((1.1))	102,856 ((4.1))	1,003 ((1.3))	73,114 ((3.0))	830 ((1.0))	654,330 ((5.1))
Breeding, Rearing and Fattening	72,156 ((5.8))	16,641,367 ((19.1))	1,815 ((8.1))	665,242 ((26.6))	5,689 ((7.5))	503,001 ((20.5))	2,648 ((3.3))	1,663,331 ((13.0))
Sub-total	1,237,168 ((100))(49.9)	87,305,677 ((100))(73.9)	22,362 ((100))(76.2)	2,500,076 ((100))(91.6)	75,522 ((100))(79.6))	2,450,943 ((100))(87.4)	78,681 ((100))(66.5)	12,799,361 ((100))(79.5)
For Milk Production	949,074 (38.3)	23,754,484 (20.1)	3,389 (11.5)	160,490 (5.9)	9,266 (9.8)	235,307 (8.4)	28,963 (24.5)	2,277,916 (14.2)
For Combined Milk-Beef Production	161,922 (6.5)	6,660,984 (5.6)	893 (3.0)	65,831 (2.4)	2,336 (2.4)	103,819 (3.7)	10,281 (8.7)	1,009,698 (6.3)
For Work and Unknown Purposes	129,488 (5.2)	364,727 (0.3)	2,718 (9.3)	3,399 (0.1)	7,648 (8.0)	14,001 (0.5)	484 (0.4)	2,535 (0.0)
TOTAL	2,477,652 (100)	118,085,872 (100)	29,362 (100)	2,729,796 (100)	94,772 (100)	2,804,070 (100)	118,409 (100)	16,089,510 (100)

Note: Figures in parentheses indicate percentages as against the total, and the figures in double parentheses show percentages as against the sub-total for beef production purpose.

Source: IBGE, Censo Agropecuario 1980

Appendix Table 8-9 Area of Pasturelands by Scale in Area (1980)

Scale in Area	Brazil			Para			Maranhao			Goias		
	Total	Natural	Improved	Total	Natural	Improved	Total	Natural	Improved	Total	Natural	Improved
Total Area	174,499,641	113,897,357	60,602,284	4,513,420	1,711,731	2,801,689	4,849,106	2,690,740	2,158,366	31,422,129	20,548,467	10,843,662
Less than 10 ha	1,416,662 (0.8)	921,864 (0.8)	494,798 (0.8)	10,291 (0.2)	8,008 (0.5)	2,283 (0.1)	16,597 (0.4)	3,719 (0.1)	12,878 (0.6)	22,205 (0.1)	12,821 (0.1)	9,384 (0.1)
10- 50 ha	11,690,517 (6.7)	7,738,602 (6.8)	3,951,915 (6.5)	146,059 (3.2)	66,248 (3.9)	79,811 (2.9)	193,469 (4.0)	67,401 (2.5)	126,068 (5.8)	647,125 (2.1)	301,732 (1.9)	255,393 (2.4)
50- 100 ha	11,291,650 (6.5)	7,438,488 (6.5)	3,853,162 (6.4)	247,197 (5.5)	95,254 (5.5)	151,943 (5.4)	285,566 (5.9)	108,123 (4.0)	177,443 (8.2)	1,161,735 (3.5)	720,552 (3.5)	441,183 (4.1)
100- 500 ha	43,439,286 (24.9)	27,939,094 (24.5)	15,500,192 (25.6)	743,279 (16.5)	203,912 (11.9)	539,367 (19.2)	1,313,365 (27.1)	679,271 (25.2)	634,094 (29.4)	7,739,667 (24.6)	5,009,778 (24.3)	2,729,889 (25.2)
500- 1,000 ha	22,653,772 (13.0)	14,214,407 (12.5)	8,439,365 (13.9)	345,278 (7.6)	116,843 (6.8)	228,435 (8.1)	716,105 (14.8)	429,884 (16.0)	286,221 (13.3)	4,740,706 (15.1)	3,029,110 (14.7)	1,711,596 (15.8)
1,000- 2,000 ha	21,714,738 (12.4)	13,409,744 (11.8)	8,304,994 (13.7)	373,548 (8.3)	128,765 (7.5)	244,783 (8.7)	677,795 (14.0)	441,654 (16.4)	236,141 (10.9)	4,905,964 (15.6)	3,067,600 (14.9)	1,838,364 (17.0)
2,000- 5,000 ha	24,403,677 (14.0)	15,153,041 (13.3)	9,250,636 (15.2)	672,912 (14.9)	246,590 (14.4)	426,322 (15.2)	791,221 (16.3)	498,643 (18.5)	292,578 (13.6)	5,465,599 (17.4)	3,403,322 (16.5)	2,262,277 (19.0)
5,000-10,000 ha	12,755,621 (7.3)	8,465,201 (7.4)	4,290,420 (7.1)	486,911 (10.8)	236,959 (13.8)	249,952 (8.9)	428,755 (8.8)	265,530 (9.9)	163,225 (7.6)	2,425,667 (7.7)	1,511,778 (7.3)	913,889 (8.4)
Over 10,000 ha	25,133,708 (14.6)	18,616,912 (16.3)	6,516,796 (10.8)	1,487,935 (33.0)	609,146 (35.6)	878,789 (31.4)	426,225 (8.8)	196,511 (7.3)	229,714 (10.7)	4,313,451 (13.7)	3,431,769 (16.7)	881,682 (8.1)

Note: Figures in parentheses show percentages as against the total area indicated in the uppermost line.

Source: IBGE, Censo Agropecuario 1980

Appendix Table 8-10 Pastureland Area by Herd Scales (1980)

Herd Scale	Brazil			Para			Maranhao			Goias		
	Total	Natural	Improved	Total	Natural	Improved	Total	Natural	Improved	Total	Natural	Improved
Total Area	174,499,641 (100)	113,897,357 (100)	60,602,284 (100)	4,513,420 (100)	1,711,731 (100)	2,801,689 (100)	4,849,106 (100)	2,690,740 (100)	2,158,366 (100)	31,422,129 (100)	20,578,467 (100)	10,843,662 (100)
Less than 10 head	6,824,462 (3.9)	5,256,110 (4.6)	1,568,352 (2.6)	124,693 (2.8)	51,107 (3.0)	73,586 (2.6)	273,790 (5.7)	182,125 (6.8)	91,665 (4.3)	633,011 (2.0)	513,007 (2.5)	120,004 (1.1)
10- 20 head	7,608,892 (4.4)	5,674,863 (5.0)	1,934,029 (3.2)	121,820 (2.7)	41,173 (2.4)	80,647 (2.9)	317,065 (6.5)	196,101 (7.3)	120,964 (5.6)	974,592 (3.1)	774,933 (3.8)	199,659 (1.8)
20- 50 head	16,907,093 (9.7)	12,438,247 (10.9)	4,468,846 (7.4)	286,264 (6.3)	114,878 (6.7)	171,386 (6.1)	668,230 (13.8)	410,078 (15.2)	258,152 (12.0)	2,842,735 (9.0)	2,197,771 (10.7)	644,964 (5.9)
50- 100 head	18,169,833 (10.4)	12,923,694 (11.3)	5,246,139 (8.7)	290,843 (6.4)	115,334 (6.7)	175,509 (6.3)	672,248 (13.9)	416,089 (15.5)	256,159 (11.9)	3,374,607 (10.7)	2,493,614 (12.1)	880,993 (8.1)
100- 200 head	21,486,308 (12.3)	14,630,562 (12.8)	6,855,746 (11.3)	434,097 (9.6)	127,063 (7.4)	307,034 (11.0)	648,126 (13.4)	368,881 (13.7)	279,245 (12.9)	4,419,651 (14.1)	3,106,436 (15.1)	1,313,215 (12.1)
200- 500 head	29,363,188 (16.8)	18,547,221 (16.3)	10,815,967 (17.8)	568,462 (12.6)	171,595 (10.0)	396,867 (14.2)	698,950 (14.4)	356,574 (13.3)	342,386 (15.8)	6,039,429 (19.2)	3,825,144 (18.6)	2,214,285 (20.4)
500-1,00 head	20,526,066 (11.8)	12,064,543 (10.6)	8,461,523 (14.0)	472,170 (10.5)	181,648 (10.6)	290,486 (10.3)	405,075 (8.4)	155,175 (5.8)	249,900 (11.6)	3,875,060 (12.3)	2,161,320 (10.5)	1,713,740 (15.8)
1,000-2,000 head	16,464,207 (9.4)	8,877,704 (7.8)	7,586,503 (12.5)	435,961 (9.7)	151,361 (8.8)	284,600 (10.2)	261,312 (5.4)	69,719 (2.6)	191,593 (8.9)	2,786,162 (8.9)	1,322,866 (6.4)	1,463,296 (13.5)
More than 2,000 head	25,999,523 (14.9)	15,049,730 (13.2)	10,949,793 (18.1)	1,233,686 (27.3)	525,322 (30.7)	708,364 (25.3)	273,338 (5.6)	58,914 (2.2)	214,424 (9.9)	3,824,007 (15.4)	2,831,900 (13.8)	1,992.107 (18.4)
Not Reported	11,150,061 (6.4)	8,434,679 (7.4)	2,715,382 (4.5)	545,451 (12.1)	232,244 (13.6)	313,207 (11.2)	630,951 (13.0)	477,078 (17.7)	153,873 (7.1)	1,652,866 (5.3)	1,351,473 (6.6)	301,393 (2.8)

Note: Figures in parentheses indicate percentages as against the total area shown in the uppermost line.

Source: IBGE, Censo Agropecuario 1980

9. FORESTRY DEVELOPMENT

9-1 Background of Forestry Development

9-1-1 Situation of Forest Resources

The Greater Carajas Program Area (comprising approximately 900,000 km^2) is part of the Amazon basin, which has the most abundant tropical forest resources in the world.

Based on the vegetation map of the PGC Area drawn up by the ministerial council of the Program, the amount of area by forest type and average forest growing stock were estimated as shown in Table 9-1 (see also Figure 9-1). In the original map, the land which was deforested and is being used for other land uses was classified to each forest type as an area of potential vegetation type. According to the table, the dense forest (indicated by "Fd") accounts for 50% of the total area with growing stock estimated at 5,100 million m^3. In this forest, the forest stands (indicated by "Fd_2"), having a growing stock of 120 to 150 m^3/ha, represent the largest area both in terms of area and growing stock, followed by Fd_1 and Fd_3.

The open forest (indicated by "Fa") has an area of 100,000 km^2 (14% of the total) and its estimated growing stock is approximately 845 million m^3. In terms of timber production, however, because its growing stock is only 80 m^3/ha and the appearance frequency of commercial tree species (to be discussed later) is insufficient, there is little likelihood that this open forest, in its present condition, can be used as a commercial forest. It is a characteristic of this region that most of the forest types classified in Fa_1 are located on the eastern side of the Xingu river, and that of Fa_2 are distributed mostly to the south of the Carajas Mountains (The reasons for this will be discussed later).

The total area of the other forest types amounts to 30%, or 295,000 km^2. Under the present circumstances, however, they are of little significance in terms of forestry production. Trees grown in the Savanna forest area (120,000 km^2) are useful as charcoal material and the tree species are likely to be improved by artificial reforestation, leading to increased production in the future. A unique phenomenon of this forest type area is the existence of a babassu forest. The area where this species is dominant accounts for 3% of the total, or 25,000 km^2. This species represents a part, but not a major part, of the natural forest around the dominant area, but if canopies are opened up by felling or burning of the natural forest, the dominant formation of babassu will expand further. Under the present circumstances, pioneer formation (indicated by "P": 6%, 47,000 km^2), as well as S/F (Transition cerrado-forest), C/S (Transition caatinga-cerrado) and Fde (Deciduos forest), are considered non-commercial.

Based on the distribution of each forest type shown in the vegetation map, and after considering such factors as soil and climate,

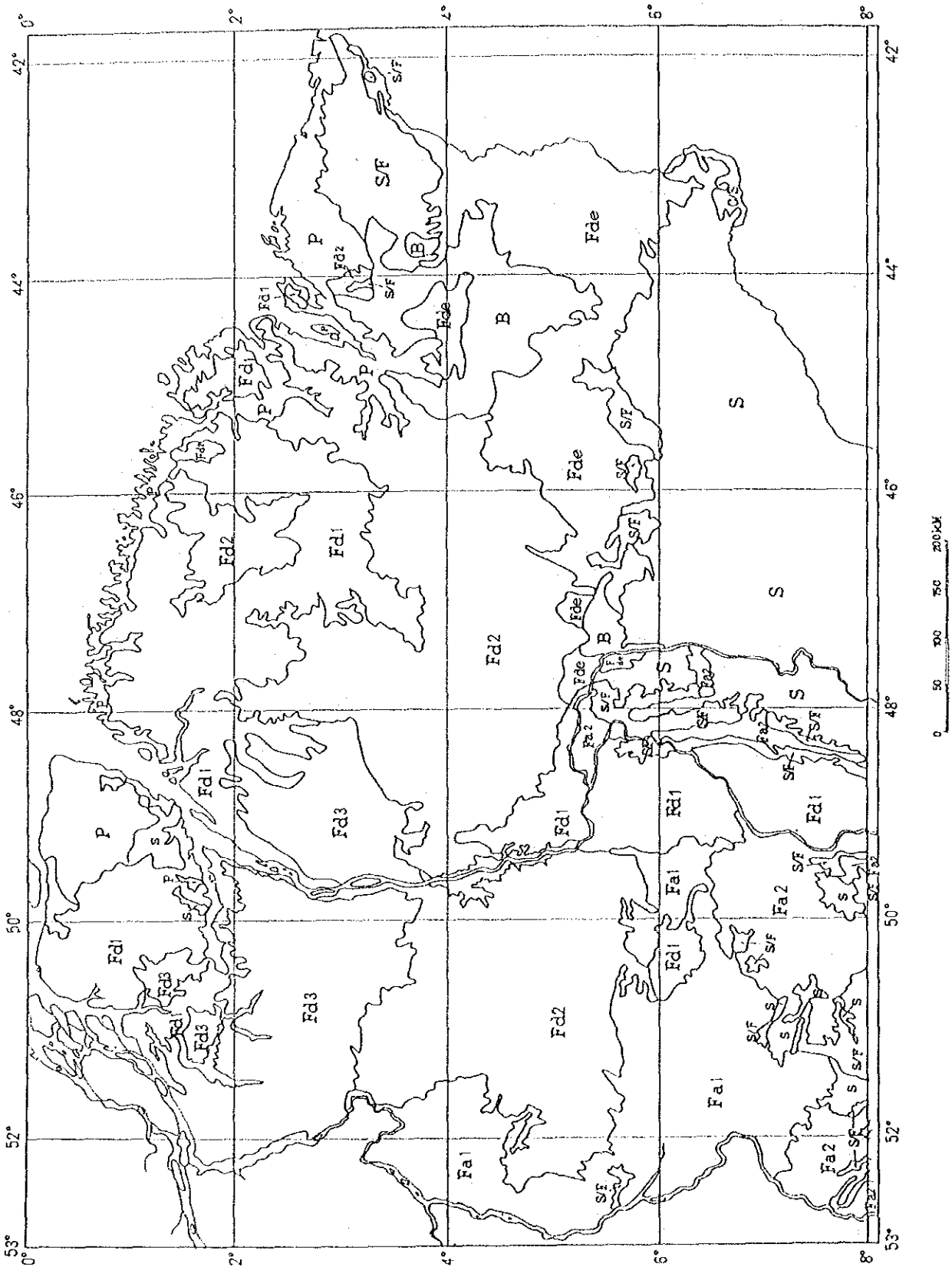

Figure 9-1 Vegetation

LEGEND for Figure 9-1

FLORESTA DENSA
CLOSED FOREST

Fd1 — menos de 120m³/ha
under 120m³/ha

Fd2 — 120-150m³/ha

Fd3 — mais de 150m³/ha
over 150m³/ha

FLORESTA ABERTA
WOODLAND FOREST

Fa1 — até 80m³/ha
up to 80m³/ha

Fa2 — mais de 80m³/ha
over 80m³/ha

FLORESTA DECIDUAL
DECIDUOUS FOREST

Fde

BABAÇUAL
BABASSU FOREST

B

CERRADO
CERRADO (SAVANNA)

S

CONTATO CAATINGA-CERRADO
TRANSITION CAATINGA-CERRADO

C/S

FORMAÇÕES PIONEIRAS
PIONEER FORMATIONS

P

CONTATO CERRADO-FLORESTA
TRANSITION CERRADO-FOREST

S/F

Table 9-1 Area and Growing Stock by Forest Type

Symbol of Forest Type	Contents	Proportion of Total Area (%)	Total area (km^2)	Estimated total growing stock ($1,000m^3$)
Fd_1	Dense forest with under 120 m^3 of growing stock per ha	17.2	137,400	1,374,000
Fd_2	Dense forest with 120-150 m^3 of growing stock per ha	22.6	180,600	2,438,100
Fd_3	Dense forest with over 150 m^3 of growing stock per ha	9.6	76,600	1,302,200
Fa_1	Open forest with under 80 m^3 of growing stock per ha	8.8	70,400	492,800
Fa_2	Open forest with over 80 m^3 of growing stock per ha	4.9	39,200	352,800
Fde	Deciduous forest	8.2	65,600	
S	Savanna	14.8	118,200	
B	Babassu forest	3.1	24,800	
S/F	Transitional cerrado-forest	4.9	39,200	
C/S	Transitional caatinga-cerrado	0.1	800	
P	Pioneer formations	5.9	47,200	
		100.0	800,000	5,959,200

Source: Study Team

the area was divided into the following four zones:

(1) Tropical humid forest zone
(2) Tropical sub-humid forest zone
(3) Semi-humid ∿ semi-arid forest zone
(4) Coastal/tidal forest zone (mangrove forest)

The boundary lines of these zones are quite arbitrary, because there is a transition zone inside each boundary with differences in local topography and sea-level creating subtle changes in the boundary.

The proportion and area of each forest type in each zone are shown in Table 9-2. According to the table, forest type Fd_1 spreads over wide areas. This type exists in the tropical humid forest zone, however, from the ecological point of view, it should not be considered in the climax stage of natural condition. This is because, in any forest seems to be virgin forest adjacent to the Amazon river and its tributaries, the influence of the life of the Indio people, which has continued over thousands of years, as well as the settlement policies carried out over hundreds of years, should be considered. It is likely that the present Fd_1 and part of Fd_2 are in the intermediate phase of plants succession and are likely to move into Fd_3 if there is no external interference.

The tropical sub-humid forest zone is a transition or intermediate zone altering from the tropical humid to semi-humid - semi-arid zone. This zone is characterized by F_1, lying on the eastern side of the Xingu river and by the distribution of Fa_2 to the south of the Carajas Mountains. Aerial observation of the forests revealed that, around Sao Felix do Xingu in particular, there are many vines and in some areas they are the dominant formation. Basically, vines can be part of a virgin forest or a closed natural forest, but the number and coverage do not usually become very large. In this zone, however, aerial observation revealed thick coverage.

These forestal phenomena evidently result from artificial opening of canopies, and are considered to be the result of shifting cultivation carried out by the Indio and colonial settlers. Therefore, the distribution of the Fa forest type adjacent to the Xingu river can be considered to be in the midst of transition, potentially belonging to Fd in terms of plant succession, soil and climatic conditions.

The semi-humid - semi-arid zone is characterized by the distribution of mixed deciduous trees (indicated by "Fde"). This forest type appears in areas that have abundant rain in wet season (the growing stage) and excessive dryness in dry season (the resting stage). In this zone, also babassu is a pioneer tree species, as mentioned above, in terms of forestry and ecology. Savanna and other forest types cannot be the object of active forestry development.

Pioneer formations (indicated by "P") were rather considered an edaphic climax stage comprising dominant mangrove formations and other coastal/tidal plants, and therefore were located in the coastal/tidal forest zone. In terms of its role in forestry, however, this coastal/tidal zone serves the function of protection as a coastal reserved forest, rather than as a source for timber production. Considering the present situation, only the tropical humid forest zone and part of the tropical sub-humid forest zone have much potential as forest resources. As for the Fa type, improvement of forest resources can be expected through adequate forest management, but there are many areas where such management is difficult because of the present lack of infrastructure. Of these different forest types, the most highly utilized tree species that comprise the tropical humid zone will now be discussed.

Table 9-2 Area By Forest Zone

Forest Zone	Symbol of Forest Type	Proportion of total area (%)	Total area (1,000 ha)
Tropical humid forest zone	Fd_1	13.1	1,048
	Fd_2	12.0	960
	Fd_3	8.2	656
	Fa_2	5.7	456
	S	1.0	80
	S/F	0.8	64
Subtotal		40.8	3,264
Tropical sub-humid forest zone (Transitional zone)	Fd_1	4.5	360
	Fd_2	10.7	856
	Fd_e	4.3	344
	Fa_1	6.0	480
	Fa_2	2.6	208
	B	3.4	272
	S	2.2	176
	S/F	3.6	288
Subtotal		37.3	2,984
Semi-humid - semi-arid forest zone	Fde	3.7	296
	S	11.0	880
	S/F	0.4	32
	C/S	0.4	32
Subtotal		15.6	1,248
Coastal/tidal forest zone	P	6.3	504
Total		100.0	80,000

Source: Study Team

The study conducted by Project RADAM 1973-74 determined that 363 species of trees make up the upper canopy of this area[1]. In that study report, the average growing stock of the forest is 115.32 m^3/ha and the number of trees is 57.7/ha. Among these tree species, those considered commercial or those used as a variety of saw-timber have been selected as shown in Table 9-3. The selection was based on oral inquiries conducted at saw and plywood mills, woodworking factories and logging sites; and species of which utilization are listed in documents and which included in the 363 species mentioned above had been selected.

Forty-seven species were selected in this manner. The Brazilian Institute of Forestry Development (IBDF) investigated the physical and

1) Ministry of Agriculture, Potencial Madeireiro do Grande Carajas, 1983.

Table 9-3 Commercial Tree Species: area per one tree

Number	Common Name	Area (ha)	Botanical Name
38	Andiroba	0.87	Carapa guianensis
174	Jatoba	1.97	Hymenaea couribaril
346	Ucuuba	2.31	Virola spp
262	Pau ferro	2.39	Zollernia paraensis
212	Marupa	2.55	Simaruba amara
75	Caju-acu	2.46	Anacardium giganteum
92	Cedrorana	2.82	Cedrelinga catenaeformis
95	Copaiba	3.59	Copaifera reticulata
87	Castanha do Para	3.15	Bertholletia excelsa
193	Ma aranduba	4.39	Manilkara huberi
255	Pau d'arco amareio	4.65	Tabebuia serratifolia
51	Aroeira	5.64	Astronium urundeuva
91	Cedro	6.08	Cedrela odorata
42	Angelim pedra	6.58	Hymenolobium excelsum
163	Itauba	6.58	Mezilaurus itauba
43	Angelim rajado	7.90	Pithecellobium racemosum
44	Angico	7.90	Piptadenia sp
98	Cumaru	7.90	Dipteryx odorata
225	Morototo	8.78	Didymopanax morototoni
232	Muiratinga	8.78	Maquira sclerophylla
305	Suqupira	8.78	Diplotropis purpurea
348	Ucuuba da mata	8.78	
311	Sumauma	9.87	Ceiba pentandra
49	Araracanga	13.18	Aspidosperma spp
229	Muiracatiara	13.18	Astronium lecointei
132	Faveira timbauba	15.80	Enterolobium sp
220	Mogno	15.80	Swietenia macrophylla
133	Freijo	19.76	Cordia goeldiana
268	Pau roxo	19.76	Peltogyne lecointei
347	Ucuuba branca	19.76	
351	Ucuuba vermelho	19.76	
252	Pau amarelo	26.31	
253	Pau d'arco	26.31	Tabebuia spp
273	Piquia	26.31	Caryo car villosum
165	Jacaranda	39.53	
187	Louro faia	39.53	Adenostephanus guianensis
308	Sucupira preta	39.53	Bowdicha nitida
56	Bacuri	78.74	
103	Cupiuba	78.74	Goupia glabra
143	Imbauba	78.74	Cecropia spp
194	Macacauba	78.74	Platymiscium trinitatis
254	Pau d'arco branco	78.74	
284	Quaruba	78.74	Vochysia spp
310	Sucuuba vermelha	78.74	
330	Tatajuba	78.74	Bagassa guianensis
349	Ucuuba da terra firme	78.74	
350	Ucuuba preta	78.74	Virola michellii

Notes: 1. Numbers are those registered in the Potencial Madeireiro do Grande Carajas.
2. Species are arranged in order of appearance frequency.

Source: Ministry of Agriculture, Potencial Madeireiro do Grande Carajas, 1983

mechanical characteristics of some and established their utilization, while the others are used only locally and are rarely recognized as international commodities.

According to Table 9-3, Andiroba (Carapa guianensis), which is the densest species, grows one per 1 hectare on average, Jatoba (Hymenaea couribaril), one per 2 hectares, and Mogno (Swietenia macrophylla) grows one per 16 hectares. This suggests the difficulty of collecting timber of the same or homogeneous species by selective cutting.

9-1-2 Current Situation of Forest Exploitation

The word "forest exploitation" has two meanings: (1) to use forests for forestry purposes; in other words, the utilization of forests in order to sustain timber production, and (2) to cut trees and use the land for non-forestry purposes such as agriculture; in other words, exploitation by converting the land use, which could be called "land exploitation".

When forest exploitation for forestry purposes is considered, the problem which first arises is the extraction of felled timber. No matter how abundant the forest resources are, if there are no means of transporting them to the point of processing, such forests serve only to preserve the natural environment. In this tropic, generally, the most useful forests for forestry purposes exist in humid and sub-humid zone. However, these zones in the PGC Area rely mostly on river waterways for timber transportation (73%) with truck transportation representing just one-third of that by water (27%)[1].

Geographically speaking, areas regarded as having advantageous economic site class are those within 50 to 100 km of the Amazon, Tocantin and Xingu rivers, and from such land routes as BR-230 (Trans-Amazon highway), BR-010 (Belem-Brasilia highway), BR-222 and PA-140. At present, however, there is a dam across the Tocantins river and only its lower stream functions as a waterway. As for the Xingu river, its most important forest zone has many waterfalls, rendering it useless as a waterway. Forest exploitation by the use of waterways is therefore limited to narrow areas.

Regarding land routes, BR-230, potentially the most expective land routes, is not yet in sufficiently adequate condition for the transportation of timber. At present BR-010 is the most important, and timber transportation on this route, as well as on PA-140, will have far-reaching effects on the forest exploitation in the surrounding regions. However, areas along BR-010 especially around Imperatriz, have already become pasture land devoid of trees, and stretch across 20-30 km along both sides; therefore without improvements in feeder roads the route cannot be expected to reduce transportation costs when its inland forest areas are used for forestry purposes.

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1) Ministery of Agriculture, Potencial Madeireiro do Grande Carajas, 1983.

The Amazon river flowing through the Greater Carajas Program Area is of value as a means of timber transportation from the forest region upstream not included in the PGC. However, the collection of timber produced in the Area is limited in the seasons and there is the problem that a large number of the valuable tree species in the forest along the river sides have already been cut.

Generally, the incomplete transportation network of waterways and roads inhibits timber production in the areas along rivers and roads; and the vast inland forest which can extract only high quality timber has few infrastructure elements. Aside from the large-scale factories, the saw mills in the Area, most of them small or medium-sized, are influenced by climatic variables such as dry and rainy seasons, and are not yet in full year-round operation. This situation is also caused by the logging system and the lack of a transportation network, leading to the waste and abuse of forest resources.

To summarize, the present situation of the forest exploitation is that production is limited to local areas, which rely on waterways, and is considered primitive stage. As mentioned above, the number of tree species grown in this area is 363, of which 47 are utilized as shown in Table 9-3. The physical and mechanical characteristics of only about thirty species among the 363 species have been confirmed, leaving the great majority yet to be investigated. When the timber quality of many species, from such viewpoints as suitability for wood processing and chemical characteristics, are studied and analyzed in the future, the contribution to forestry development will be great.

The other means of exploitation, land use conversion, especially conversion to farmland, was studied from the forestry point of view. It is obvious that establishing agriculture and a livestock industry in areas of vast unused land is an effective way of utilizing land. However, unsystematical felling of forests will not only reduce timber resources but also destroy the natural environment. The colonization method presently used involves creating farmland by clear cutting the forest and burning the non-commercial timber. This can be classified according to the following types of farming system.

(1) Establishment of settled agriculture land

This involves burning in order to develop farmland or pasture land (the type of which is found mainly in the southern states). As long as the place is for farmland, the burning is undertaken only once, however, the forest will not be regenerated.

(2) Periodical fallow system

In this system, burning, cultivation or livestock production, natural reforestation and burning are carried out periodically in certain area. In this cycle a forest develops periodically, but being in the second growth stage it only functions as forest fallow.

(3) Shifting cultivation system

This is primitive slash and burn cultivation, and is not limited by area or boundary. An unspecified area is burned and after a few years of cultivation the land is left untouched so that it returns to the condition of a forest. In this case, it is not predetermined whether or not the recovered forest is burned again.

The forest is converted and used as a farmland in these ways. Articles 2 and 3 of the Forest Code control the felling to prevent exploitation of forests for colonization purposes. According to Article 16 of the Code, when a privately-owned forest is exploited, clearing of a natural forest to make farmland is permitted up to a maximum of 50% of the total area. Furthermore, according to Clause (b) of Article 16 for the Northeastern region, such as the state of Maranhao felling and extraction of trees is permitted only when carried out in accordance with Article 15, which respects the development of the Amazon river, and when they are undertaken using technical methods designated by the relevant authorities (see Appendix).

However, aerial observation and the ground survey around Maraba, Imperatriz and the Carajas Mountains, where agricultural development and forest clearing is frequent, revealed that the regulations of the Forest Code are not always completely complied with. Although the requirements of Articles 15 and 16 are being met, in terms of farmland building little attention is being paid to Articles 2 and 3.

According to Article 1, the afore-mentioned destruction of the environment caused by felling, will be applied to the act contrary to this stipulation or illegitimate use of property in the case of developing and utilizing the forest resources.

In many countries the forests that ought to be conserved are determined according to their location, while in Brazil, except for certain areas, the location of the 50% of the forest to be conserved in the case of farmland development seems to be left to the decision of the developer.

A quantitative control like this, which does not specify the location, seems to be inadequate, it is desirable that, with the provisions of Articles 2 and 3 in mind, government specialists first draw up a location map showing the 50% area designated as forest that should be conserved in accordance with the Forest Code. The farmland development may be carried out after the designation of the reserved forest, thus the intent of the Forest Code will be achieved actually.

Construction of the settlement land has been carried out in the PGC Area by the government. According to this plan, all individual lots are of the same area. However, it is desirable that at the beginning of the land distribution process, the government establishes a plan for locating reserved forests which will contribute to land conservation, natural science and welfare.

From the aspect of forest utilization, it is significant that, prior to the farmland development, useful species in the planned area, such as Mogno (Swietenia macrophylla), Jatoba (Hymenaea couribaril), Muiracatiara (Astronium lecointei), and Aroeira (Astronium urundeuva) were felled and extracted as materials to become cash products for the settlers. Furthermore, it is expected that, by expansion of uses for the lesser known tree species, trees which are being burned will be able to be sold commercially.

Castanha do Para (Bertholletia excelsa), which comes under clause (f) of Article 3 and Article 7, under clause (b) of Article 14 of the Forest Code is prohibited from being cut (see Appendix). Although the stipulation itself is significant, another provision provides that, in the case of burning for farmland development, natural vegetation should be left within a radius of 10 m from Castanha do Para in order to preserve the environment and to prevent fire. Based on the intensity of the fire while burning, however, natural vegetation left for protection purposes might serve as a kindling and bring about a result which is the opposite of that purpose. It is worth considering the removing the natural vegetation so that an area within a radius of 10 m can be used as a fire break belt.

9-1-3 Current Situation of the Forest Industry

The forest industry in the PGC Area can be divided into three sectors: logging business, wood processing industry and wood material industry.

Logging business involves the felling, yarding and transportation of trees. Several types of logging can be found in this area. The first is the logging that at the time of the clear cutting of the forest and converting the cut over area into the farmland, only commercial timber is selected from fallen trees, then extracted and transported.

The extraction of commercial timber mainly by selective cutting while using the forest for forestry is another type. This can be further divided into three types: logging business as a part of section of a saw mill; the felling and yarding by local people called extractors, collection by a non-specialized group, then purchase by saw mills; and logging by specialized companies. These specialized logging companies are few in number, and modern systematic operations are seen only in a part of section of saw mills, with the result that logging operations in the PGC Area remain undeveloped on the whole.

Timber transportation is undertaken both on water and on land. Water transport is more advantageous because costs are low. In the case of factories located in Belem have a collecting area an average of 500 to 800 km upstream of the Amazon river to a maximum of 3,000 km. Water transport has its drawbacks, however, for instance, it is unsuitable for sinkers and depends on prevailing river conditions.

The collecting area for land transport is generally from 200 to

300 km, but its economic viability is related directly to road conditions. Data concerning the log procurements of a saw mill and a plywood mill in Belem and several saw mills in Acailandia and Sao Luis are shown in Table 9-4.

The wood processing industries which are mainly saw mills and a few plywood factories are located in Belem, Imperatriz, Acailandia and Sao Luis. The major log producing areas for these centers are the state of Para, the northwestern region of the state of Maranhao and the Amazon basin (in the case of Belem), which is not included in the Greater Carajas Program.

Table 9-4 Situation of Log Procurement by Wood Processing Mills

Mills	Means of procuring and transporting logs	Collecting Area
Plywood mill in Belem	Bought at a logging site; 95% are transported by raft, with the rest transported to the mill by road.	by water: 500-800 km, maximum: 3,000 km by land: 300 km
Saw mill in Belem	Bought at a logging site; transported to the mill by the company's vessel.	100 km - 500 km (36 hours two ways) - (180 hours two ways)
Saw mill in Acailandia	Felled by the company; transported to the mill by road.	200 km
Saw mill in Sao Luis	Bought at a logging site; transported to the mill by road.	maximum: 450 km

The advantages and disadvantages of the wood processing industry in this Area are:

Advantages:

(1) In the hinterland for the wood processing industry, enormous forest resources exist in Amazonia, both inside and outside the project area, and in Pre-Amazonia.
(2) Tropical hardwood logs of high quality are available.
(3) Stumpage and log prices are low relative to international prices.

Disadvantages:

(1) Trees of the same species of the mass-demanded tropical light hardwood (floater) are not grown in large quantities.
(2) Processing facilities, technology, grading and marketing activities require upgrading.
(3) Transport conditions for processed wood to the market are uneconomical both for the domestic and international markets.

The above points will now be described in detail. Enormous amounts of forest resources, which are basis of the wood processing industry in this Area, are the largest of any tropical region in the world. These resources are not only the source of the wood processing in the Area, but wood processors in Belem can expect the deep inland areas of Amazonia to be a material producing area.

This situation can be compared with that in the Sabah State of Malaysia. While annual log production from about 3 million ha of Sabah's commercial forests (natural forest) is about 12 million m^3 (the 1976-80 average), Amazonia is reportedly producing about 22 million m^3 of logs annually from 47 million ha[1] of natural forests. In other words, while Sabah's annual log production is 4 m^3/ha of forest, that of Amazonia is 0.47 m^3. It can, therefore, be said that maximum utilization of forest resources in Amazonia has not yet been achieved.

Concerning the availability of good-quality tropical hardwood which is the second advantage, the names of tree species are listed below:

Common Name	Botanical name
Acapu	Vouacapova americana
Andiroba	Carpa guianensis
Angelim	Dinizia excelsa
Angelim perda	Hymenolobium excelsum
Castanha do Para	Bertholletia excelsa
Cedro	Cedrea odorata
Copaiba	Copaifera reticulata
Cumaru	Dipteryx odorata
Cupiuba	Goupia glabra
Freijo	Cordia goeldiana
Jatoba	Hymenaea couribaril

1) Ministry of Agriculture, Programa Grande Carajas Agricola (Preliminary version), Vol. 3.

Macaranduba	Manilkara huberi
Mogno	Swietenia macrophylla
Muiracatiara	Astronium lecointei
Sucupira	Diplotropis purpurea
Tatajuba	Bagassa guianen

These species are excellent in their physical characteristics, timber color, timber grain and processing characteristics; they can be processed into such products which has high value added as furniture, joinery, interior materials and as overlay for fancy plywood. The number of good-quality natural hardwoods is decreasing sharply in the world's tropical and temperature zones, and therefore these goods are likely to reflect a sellers' market internationally in the future.

Regarding the third advantage, some examples of the low prices of stumpage and logs show that the average stumpage price is US$15/m^3 and the log price at saw mill in Sao Luis is US$25-30 and the log price of Jatoba at a logging site is US$12.5-15 and at a saw mill in Belem, about US$30. In comparison, the price of Dipterocarpaceae grown in East Kalimantan State, Indonesia is US$20-25 for stumpage (including royalty, taxes and premiums) and US$60-80 for logs at saw mill. It is evident therefore that the wood processing industry in the PGC Area has an advantage in terms of the material cost of logs.

On the other hand, the first disadvantage -- the tropical light hardwood cannot be collected in large quantities -- is the result of the forests in Amazonia consisting of many species and genera. Generally, in the course of modernization and expansion of a forest industry, logs which are light and able to be collected in large quantities are needed, thereby facilitating mass production and mass consumption, especially in the early stage of development. In Southeast Asia, for example, the existence of dominant trees of light wood in the same family (Dipterocarpaceae), such as Shorea spp., Hopea spp., Dryobalanops spp. and Parasherea spp. was the prime reason for the development of forestry in the region.

The second disadvantage -- the low standard of processing facilities, techniques, grading and marketing activities -- can be attributed to the short history of wood processing in the area. To increase exports of processed wood in the future, the following problems should be resolved.

- Insufficient quality control, such as the crooked sawing and surface defects in the processed wood.
- Lack of size uniformity (thickness, width, etc.)
- Low recovery rate (30 to 50%) in processing.
- Incomplete grading of processed wood.
- Insufficient marketing activities covering log exports and lack of goods reliability in the international market.

With respect to these problems, the activities of the "timber supply stations for export" (Entrepostos Madeireiros para Exportacao) which was recently established in Santarem by the IBDF are much welcomed.

The third disadvantage is that the processed wood is mainly in demand overseas, and in the central and southern states, while local demand is poor. According to a study undertaken by Araguaia-Tocantins Basin Integrated Development Plan (PRODIAT)[1], 33% of the processed wood is consumed locally, and the rest is used in other areas in Brazil or exported. Goods must therefore be transported long distances by maritime way or by land, raising costs and complicating the sales management (The operating conditions of the processing industry are shown in Table 9-5).

Table 9-5 Operation of Wood Processing Mills

Mills	Tree Species	Monthly consumption (m^3)	Products	Market
Plywood mill in Belem	Virola. For overlay: Frejo and Cerejeira. For lumber core: Sucuruba and Muiratinga	6,000	Plywood Lumber core	About 50% is exported
Saw mill in Belem	Ipe, Jatoba, Sucupira, Macaranduba, Angelim, Pau-amarelo, Pau-fo, Tatajuba.	2,000	Sawntimber Flooring board Wallboard	About 10% is exported; For mahogany, 100% is exported
Saw mill in Acailandia	Ipe, Jatoba, Muiracatiara, Cumaru, Tatajuba, Angelim, Cedro, Macaranduba, Sucupira	10,000 -12,500	Sawntimber Sleeper Sleeper	Mostly domestic
Saw mill in Sao Luis	Ipe, Jatoba, Angelim, Macaranduba, Tatajuba, Cupiuba, Muiracatiara	500	Sawntimber Furniture	Domestic only

1) PRODIAT, Analysis of the Primary Sector Related to Forestry Development.

Finally, the current situation of the wood material industries such as pulp, wood alcohol and charcoal manufacturing will be discussed.

At present there is a pulp industry in Jary near the boundary of the PGC Area. Though a study of it could not be carried out this time, the crucial factor in establishing a pulp industry in a tropical zone is usually to secure enough amount of material wood with uniform quality. This requires the securing of material by artificial reforestation. To achieve this, silvicultural studies and investigations must be carried out before establishing of a pulp industry.

The industry of manufacturing alcohol from wood in this area is still not established. Basically, this industry requires species that are grown by artificial reforestation and which are more uniform than those used in the pulp industry. Development of artificial reforestation is therefore eagerly awaited.

The charcoal industry in the PGC Area is still in the early stages of growth, with small-scale demand for home consumption. When demand for charcoal for steel making and other industries develops in the future, the charcoal-making industry is certain to expand.

For reference, the following is the example of a wood alcohol factory in Brasilia.

- Production scale

Alcohol	30,000 l/day
Furfural	1,420 kg/day
Protein	9,350 kg/day
Lignin (including 31% of water)	199 tons/day

- Materials

Eucalyptus spp. logs (without bark)	600 est/day
Fuel wood (logging residues of Eucalyptus)	295 est/day
Sulfuric acid (98%)	13,400 kg/day
CaO (85%)	13,100 kg/day
Ammonium sulfate	5,200 kg/day
P_2O_5	1,950 kg/day

- Production process and costs

Wood (cellulose) – Hydrolysis (H_2SO_4 (0.5%, 180°C) Catalyzer) > Sugar – Fermentation > Alcohol

Production costs in this factory are 20% higher than those of alcohol made from sugarcane.

- Material wood

Eucalyptus grandis and E. saligna are main species. Besides, E. urophylla, E citiriodora and E. alba are also used. The harvesting age of these species is 4 to 6 years and M.A.I. (mean annual