

**THE STUDY RELATED TO THE
REGIONAL DEVELOPMENT PLAN OF
THE GREATER CARAJAS PROGRAM OF
THE FEDERATIVE REPUBLIC
OF BRAZIL**

[PHASE II]

SUMMARY REPORT

JULY 1985

JAPAN INTERNATIONAL COOPERATION AGENCY
AND
EXECUTIVE SECRETARIAT OF THE INTERMINISTERIAL COUNCIL
OF THE GREATER CARAJAS PROGRAM

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国際協力事業団	
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PREFACE

In response to the request of the Government of the Federative Republic of Brazil, the Japanese Government decided to conduct a study on the Development Plan of the Greater Carajas Program and entrusted the study to the Japan International Cooperation Agency (JICA).

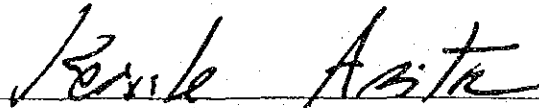
A Phase I Study Team consisting of thirty experts and headed by Dr. Saburo Okita was assigned by JICA to conduct a study on the supply and demand trends in the world market up to the year 2000 of twenty-eight agriculture, livestock and forestry products, and thirteen mining and manufacturing products which were considered having high productive potential in the Greater Carajas Program Area. In November 1983, this study team submitted the First Progress Report (Phase I) in four volumes.

Thereafter the JICA sent a Phase II study team of twenty-seven experts headed by Mr. Saburo Kawai to Brazil in July - September 1984. The team conducted further field surveys to ascertain development potentials of agriculture, livestock, forestry, mining and metallurgy in the priority sub-regions of the Greater Carajas Program Area and held discussions with the Brazilian officials concerned. After its return to Japan, the team conducted further studies and has prepared the present final report.

I hope that this report will serve for the development of the Greater Carajas Program and contribute to friendly relations between our two countries.

I wish to express my deep appreciation to the officials of the Government of the Federative Republic of Brazil for their close cooperation extended to our team.

July 20, 1985



Keisuke Arita
President

Japan International Cooperation Agency

LETTER OF TRANSMITTAL

July 20, 1985

His Excellency Mr. Keisuke Arita
President
Japan International Cooperation Agency
Shinjuku Mitsui Bldg., 2-1 Nishi-shinjuku
Shinjuku-ku, Tokyo
Japan

Dear Mr. President:

I am pleased to submit to you the final report entitled "The Study Related to the Regional Development Plan of the Greater Carajas Program of the Federative Republic of Brazil (Phase II)", in accordance with the contract signed on June 20, 1984 by the Japan International Cooperation Agency and the International Development Center of Japan. It is my great pleasure that the study led to this report has been undertaken under close cooperation of the Governments of Japan and the Federative Republic of Brazil.

Following the First Progress Report (four volumes), this Final Report presents the results of the Phase II Study related to the regional development plan of the Greater Carajas Program Area. The present report consists of five parts: Introduction (Part One); Study of Regional Development Potentials (Part Two); Study of Agriculture, Livestock and Forestry Development (Part Three); Study of Mining Resources Development (Part Four); and Study of Metallurgical Industry Development (Part Five).

I would inform you that the present study could not achieve rich and suggestive results without continual and effective cooperation of the Executive Secretariat of the Interministerial Council of the Greater Carajas Program and other concerned institutions of the Federative Republic of Brazil. I also wish to express my sincere acknowledgements for the tremendous efforts and heartening cooperation given to us from the Japan International Cooperation Agency and other concerned institutions of the Government of Japan.

I hope that the results of this study will give an impetus to the future development of the Greater Carajas Program Area and, thus, contribute to the achievement of the objectives of Japan's international cooperation.

Yours faithfully,



Saburo Kawai
President

International Development Center of Japan

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Theo Amorim	CONSIDER
Antonio Amaral Junior	CONSIDER

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Vera Lucia Fava - Professor, University of Sao Paulo

LIST OF VISITS FOR INFORMATION COLLECTION OF THE PHASE II STUDY

I. Study of Regional Development Potentials

July 4, 1984 SE/PGC (Brasilia; if there is no specification, office of Brasilia is adopted hereinafter)

- 5 CONSIDER
- 6 TELEBRAS
- 9 SE/PGC (Belem), ALBRAS/ALUNORTE
- 10 SE/PGC (Belem), SUDAM
- 11 Serra dos Carajas, Salobo 3-A (copper)
- 12 Logos Promon, Azul (manganese), Carajas town site
- 13 GETAT (Maraba), Industrial District (Planned)
- 14 Tucurui Dam
- 16 SE/PGC (Sao Luis), CODOMAR, Port of Itaqui
- 17 ALUMAR, CDI-MA, CONCRETEx, Secretary of Industry, Commerce and Tourism (Maranhao)
- 18 SE/PGC (Sao Luis), CVRD (Sao Paulo)
Railway Terminal (under construction), Port of Ponta da Madeira
- 20 SE/PGC, CVRD (Rio de Janeiro), Kawatetsu-Brasil
- 23 SUDENE (Recife)
- 24 SUDENE (Recife)
- 25 SE/PGC, MINTER, CVRD (Rio de Janeiro)
- 26 SE/PGC, PRODIAT
- 27 SE/PGC, GETAT, CONSIDER, ELETRONORTE
- 30 SE/PGC, Secretary of Planning (Para), PORTOBRAS, CODEBAR
- 31 SE/PGC, CDI-PA

- Aug. 1 SE/PGC, PRODIAT, CDP, ENASA, SUDAM
- 2 SE/PGC, Secretary of Industry, Commerce and Tourism (Maranhao)
- 3 SE/PGC, BDM, CEAG-MA
- 6 INCRA, MINTER, SEPLAN-MA
- 7 SE/PGC, IPEA
- 8 SE/PGC, IPEA, ELETRONORTE
- 9 SE/PGC, MINTER
- 10 ISHIBRAS, MMAJ (Rio de Janeiro)
- 13 SE/PGC
- 14 SE/PGC (Progress Report for Mining and Metallurgy Presentation)
- 15 SE/PGC
- 16 SE/PGC
- 18 Paracatu
- 20 SE/PGC
- 21 SE/PGC, PRODIAT
- 22 SE/PGC
- 23 SE/PGC
- 24 SE/PGC
- 25 DALBAN, OLEAMA
- 27 SE/PGC (Sao Luis), POLONORDESTE, COLONE
- 28 Santa Ines, Secretary of Fazenda (Maranhao)

Aug. 29, 1984 Colonization of Alto-Turi, CVRD (Sao Luis), SEPLAN-MA
 30 SEPLAN-MA, SE/PGC (Sao Luis)
 31 SE/PGC (Belem)

Sept. 2 Braganca
 3 SE/PGC, Secretary of Fazenda (Para)
 4 SUDAM, IDESP
 5 CODEBAR
 6 SE/PGC, CODEBAR
 7 Barcarena
 10 GETAT (Imperatriz)
 11 GETAT (Farm of Pimenta do Reino)
 12 GETAT (Araguaina), EMATER
 14 GETAT (Maraba)
 15 Fazenda Primavera (Livestock)
 16 Small and medium size farms at Itupiranga
 17 Carajas II and III (GETAT)
 19 SE/PGC
 20 SE/PGC
 21 SE/PGC

II. Study of Agriculture, Livestock and Forestry Development

Aug. 14, 1984	MA (Presentation of PGC)	Brasilia
15	INCRA (Activities, policy)	"
16	MA (Soil mapping, marketing system)	"
17	MA (Soil conservation service)	"
	EMBRAPA (Crops)	
	IBDF (Forestry development, forest exploitation)	
19	CENIBRA (Site visit, Discussion)	Belo Horizonte
20	EMBRAPA (Soil mapping, crop selection)	Rio de Janeiro
	BACEN (Financing policy)	
21	IBGE (Statistics)	"
	CIBRAZEM (Storage system)	Brasilia
	BNCC (Credit)	"
	PRODIAT (Contents and background data)	"
22	CFP (Price policy)	"
	Instituto Florestal (Forestry development)	Sao Paulo
23	PROFIR/PROVARZEA (Irrigation)	Brasilia
	COBAL (Food supply and marketing)	"
25	OLEAMA (Babassu processing)	Sao Luis
	DALBAN (Wood processing)	"
27	SE/PGC (Agriculture of Maranhao)	Sao Luis
	SEPLAN (Projeto NORDESTE)	"
28	EMATER (Discussion with small farmers)	Bacabal
29	EMATER (Discussion with small farmers)	Alto Alegre
	DVRD (Site visit of forestry experimentation center)	"
Sept. 2	Braganca (Field observation)	Braganca
	Coop. Tome-Acu (Cropping, Farm organization)	Tome-Acu
3	Coop. Paraense (")	Castanhal
	Coop. Amazonica (")	Santa Isabel
4	DENPASA (Oil palm plantation and processing)	Belem
	EIDAI do Brazil (Wood processing)	"
	SUDAM (Incentive policy)	"
	Coop. da Ind. Pecuaria (Slaughter house)	"
5	CPATU (Discussion, site visit)	Belem
8	Fazenda Santa Maria (Beef production)	Imperatriz
10	GETAT (Land settlement)	"
	EMATER (Soil, crop, pasture, farm organization)	"
11	EMBRAPA (Soil, crop, beef production)	"
	Pimenta do reino Fazenda (Site visit)	Acailandia
12	GETAT (Land settlement)	Araguaina
	EMATER (Extension service, cropping)	"
	EMGOPA (Research projects)	"
13	Fazenda Paraíso (Beef production)	"
14	GETAT (Land settlement)	Maraba
	EMATER (Cropping)	"
15	Fazenda Primavera (Beef production)	"
17	Projeto Carajas III (Site visit, discussion)	"

Sept. 19	MA (Cattle disease)	Brasilia
20	CPAC/EMBRAPA (Pasture)	"
	CAMPO (Financial situation)	"
21	MA (Cattle quality improvement)	"
22	IBDF (Material collection)	"
24	CFP (Price supporting policy)	"
25	SE/PGC, MA (Progress Report correction)	"
26	SE/PGC (Progress Report presentation)	"
27	Meat processing plant visit	Sao paulo
28	ABIOV (Oil plant & feed factory visit)	"
	JETRO (Information collection)	"

III. Study of Mineral Resources Development

July	3, 1984	R. de Janeiro	DOCEGEO	
	9	Belem	CPRM, DOCEGEO	
	11	Carajas	DOCEGEO	- Salobo 3A site visit
	12	"	CVRD	- CVRD museum visit
				- N4-E Iron mine visit
				- Azul manganese site visit
	13	Maraba		- Proposed industrial site visit
	14	Tucurui	ELETRONORTE	- Power plant dam site visit
	19	S. Paulo	USP	
	20	"	INPE	
	25	Belem	IDSP, SUDAM	
	28	Cumaru		
	29	"		
	30	Carajas	DOCEGEO	- Salobo 3A, Pojuca visit
	31	"	CVRD	- CVRD museum visit
				- N4-E Iron mine visit
				- Azul manganese site
Aug.	1	Belem	CPRM	
	6	"	SUDAM	
		S. Paulo	USP	

* Visits of DNPM are excluded in this list.

IV. Study of Metallurgical Industry Development

July	5, 1984	Brasilia	CONSIDER	
	6	"	TELEBRAS	
	9	Barcarena	ALBRAS/ALUNORTE	- Site visit
		Belem	ALBRAS office	
	11	Carajas	DOCEGEO	- Salobo 3A site visit
	12	"	CVRD	- CVRD museum visit
				- N4 ferro site visit
				- Azul manganese site visit
	13	Maraba		- Proposed industrial site visit
	14	Tucurui	ELETRONORTE	- Power plant dam site visit
	16	Sao Luis	CODOMAR	- Itaquí port site visit
	17	Sao Luis	ALUMAR	- Site visit
			CONCRETEX	
			CDI	
			SIC	
	18	"	CVRD	- Railway terminal site visit
				- Ponta da Madeira Port site visit
	20	R. Janeiro	CVRD Head Office	
			KAWATETSU Office	
			MITSUBISHI CORP.	
	23	"	MITSUBISHI CORP.	
	24	"	IHI-BRAZIL	
			DOCEGEO	
	25	"	CVRD	
			SUNOR	
	27	Brasilia	CONSIDER	
			ELETRONORTE	
	30	Belem	Secretaria de Estado (PARA)	
			PORTOBRAS	
			CODEBAR	
			ALBRAS Office	
	31	"	CDI	
Aug.	1	"	CDP	- Belem port site visit
			ENASA	
			SUDAM	
	2	Sao Luis	SIC	
	3	"	BDM	
			CEAG-MA	
	6	"	SEPLAN-MA	
	8	Brasilia	ELETRONORTE	

SUMMARY REPORT

CONTENTS

	<u>Page</u>
 [I] INTRODUCTION AND STUDY OF REGIONAL DEVELOPMENT POTENTIALS	
1. Introduction	3
2. Study of Regional Development Potentials	4
2-1 Current Status of Regional Development Programs	4
2-1-1 Background and Present Status of the Greater Carajas Program	4
2-1-2 SUDAM and the Greater Carajas Program	6
2-1-3 SUDENE and the Greater Carajas Program	7
2-1-4 GETAT, INCRA and the Greater Carajas Program	8
2-1-5 PRODIAT and the Greater Carajas Program	9
2-2 Current Economic and Social Conditions of the Greater Carajas Program Area	10
2-2-1 Population Changes	10
2-2-2 Changes in Employment Structure	11
2-3 Analysis of Physical Infrastructure	12
2-3-1 Introduction	12
2-3-2 Present Status of Infrastructure in the PGC Area ..	12
2-3-3 Major Infrastructure Programs in the Greater Carajas Program Area	14
2-4 Comments on the Potentials of the Greater Carajas Program Area	15
 [II] STUDY OF AGRICULTURE, LIVESTOCK AND FORESTRY DEVELOPMENT	
1. Introduction	21
2. Outline of the Study	22
2-1 The Special Features of the PGC Area's Agriculture, Livestock and Forestry Sectors	22
2-2 The Surrounding Conditions of the PGC Area's Agriculture, Livestock and Forestry Sectors	23
2-3 Comments on Preliminary Screening of Priority Products and Necessary Conditions for Development	25
3. Natural Conditions	29
3-1 Climate of Sub-regions	29
3-2 Topography of the Sub-regions	29
3-3 Soils of the Sub-regions	31
3-4 Some Comments on Soil Conservation and Improvement	32

	<u>Page</u>
4. Preliminary Crop Selection on the Basis of Natural and Technical Conditions	34
4-1 Summary of Natural Conditions by Sub-region and Crop Cultivation	34
4-1-1 Castanhal Sub-region	34
4-1-2 Bacabal Sub-region	35
4-1-3 Imperatriz Sub-region	35
4-1-4 Maraba Sub-region	35
4-1-5 Araguaina Sub-region	36
4-1-6 Balsas Sub-region	36
4-1-7 Xingu Sub-region	36
4-2 Technical Problems in Crop Production	37
4-3 Crop Selection by Sub-region	38
5. Farm Structure Analysis	40
5-1 Farm Structure in the PGC Area: An Outline	40
5-2 Farm Structure by Sub-region	41
5-3 Study Results	41
6. Institutional Systems Related to Agriculture	42
6-1 Outline of Institutions	42
6-2 Agricultural Institutions in Relation to Agricultural Development in the PGC Area	45
6-3 Research and Extension	47
7. Agro-Industry	48
7-1 Current Situation of Processing and Marketing of Agricultural Products	48
7-1-1 General Situation	48
7-1-2 Characteristics of Products in Terms of Processing and Marketing	48
7-1-3 Current Situation of Processing and Marketing by Major Product	49
7-2 Processing and Marketing of Agricultural Products and Crop Selection	50
8. An Approach to Crop Selection on the Basis of Social and Economic Conditions	51
8-1 Cropping Patterns and Farm Models	51
8-2 Analysis Results	52
8-3 Preliminary Crop Selection on the Basis of Social and Economic Conditions and Necessary Conditions for Agricultural Development	53

	<u>Page</u>
9. Livestock (Beef Production) Development	54
9-1 Beef Production and the Position of the PGC Area in Brazil	54
9-2 Current Situation of the PGC Area	55
9-3 Perspectives of Beef Cattle Production in the PGC Area	57
10. Forestry Development	58
10-1 Background of Forestry Development	58
10-1-1 Situation of Forest Resources	58
10-1-2 Forest Exploitation	59
10-1-3 Current Situation of Forest Industries	59
10-1-4 Current Reforestation	60
10-2 Comments on Forestry Development	60
10-2-1 Site Classification in Forestry Development	60
10-2-2 Forest Exploitation	61
10-2-3 Forestry Industries	62
10-2-4 Reforestation	62
10-2-5 Introduction of Agroforestry	63
10-2-6 Introduction of Agro-industry	64
 [III] STUDY OF MINERAL RESOURCES DEVELOPMENT	
1. Introduction	67
2. Major Findings	67
2-1 Inaja Area	67
2-2 Bacaja Area	68
2-3 Serra dos Gradaus Area	68
3. Future Exploration Project in the Greater Carajas Program Area	69
3-1 Recommended Project	69
3-2 Exploration Method for Each Area	72
4. Required Survey Items in Salobo and Pojuca Copper Deposits	73
 [IV] STUDY OF METALLURGICAL INDUSTRY DEVELOPMENT	
1. Introduction	77
2. The Major Premise	77
2-1 Hypothetical Model Plants	77
2-2 Infrastructure Gap Adjustments	78
2-3 Compilation of Input Data	79

	<u>Page</u>
3. Results and Considerations	81
3-1 Three Factors and Case Classification	81
3-2 Comparative Advantages of the Four Industrial Districts	82
3-3 Conclusion	84
Appendix: Utilization Measures for Sulfuric Acid	85

(I) STUDY OF REGIONAL DEVELOPMENT POTENTIALS

07/11/2019

1. INTRODUCTION

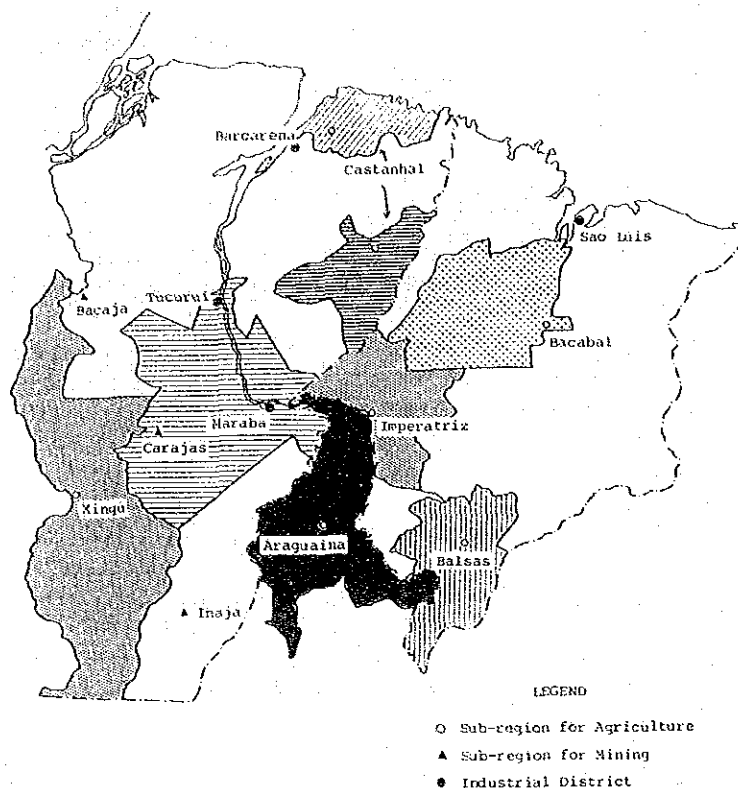
The major objective of the Phase II Study is to conduct studies in four subjects: 1) Regional Development Potential, 2) Agriculture, Livestock and Forestry Sectors, 3) Mineral Resources Development and 4) Metallurgical Industry Development, in the sub-regions and industrial districts of the Greater Carajas Program Area (the PGC Area). Although each of these study subjects has different characteristics in terms of objectives, methods and contents, the common purpose of these studies is nevertheless to contribute to the future development of the PGC Area by the Brazilian Government.

The study on agriculture, livestock and forestry has as its main purpose the preliminary assessment of crops adaptable to the regional conditions, through the analysis of the natural and socio-economic conditions of the selected sub-regions and at the same time to comment the requirements in future development of the agriculture, forestry and livestock sectors. The major objective of the study on mineral resources development is to prepare preliminary proposals regarding the future mineral resources exploration projects in the western part of the PGC Area consisting of the Inaja and Bacaja Areas centering on the Carajas Mountains, based on the data obtained on the mineral resources exploration work carried out in Brazil by government agencies and private organizations in the past. The study on metallurgical industry development places a major emphasis on the comparative study of locational advantages of the four industrial districts of Sao Luis, Barcarena, Maraba and Tucuruí in establishing the smelting and refining plants of copper, tin, ferro-manganese, nickel and ferro-nickel.

In the Phase II Study, therefore, no attempt has been made to utilize an approach for integrated regional development planning, in which a certain framework for development of the above-mentioned four study subjects is drawn up with clearcut development goals for each, and studies are made for the development of each subject for the final integration of these programs. For instance, with regard to copper, tin, manganese, nickel and other minerals which are included in the study on metallurgical industry development, no mine development projects have actually been commenced in the PGC Area. The development of these mineral resources still requires more detailed exploration work as pointed out in the Mineral Resources Report of the Phase II Study. In addition, there are many unknown factors such as the approximate size of smelters, as well as the smelting methods and infrastructure required in the industrial districts. Consequently, many pre-conditions had to be set for a comparative study on the locational advantages of the four industrial districts in establishing copper, tin, and other smelters which were indicated in the Terms of Reference (TOR) for the Phase II Study.

Figure I-1 indicates several selected sub-regions and industrial districts under the Phase II Study. Prior to a summary of the Phase II Study, next chapter will examine the various regional development programs presently being undertaken in the PGC Area while also presenting the results of the study on the infrastructures existing in the Area.

Figure I-1 Selected Sub-regions and Industrial Districts
for the Phase II Study



2. STUDY OF REGIONAL DEVELOPMENT POTENTIALS

2-1 Current Status of Regional Development Programs

2-1-1 Background and Present Status of the Greater Carajas Program

The Greater Carajas Program (PGC) was launched by the Brazilian Government under the Decree-law No. 1813 and Decree No. 85387, both of November 24, 1980. The area incorporating the PGC (hereinafter called "the PGC Area"), comprising the three states of Para, Maranhao and Goias, is located north of latitude 8° south, sandwiched by the Amazon, Xingu and Parnaiba rivers, with an area of approximately 900,000 km² (530,000 km² in Para, 310,000 km² in Maranhao and 60,000 km² in Goias), accounting for 10.6% of the national land area.

The origins of the PGC can be traced back to the discovery in 1967 of iron ore deposits, with estimated reserves amounting to 18 billion tons, in the Carajas Mountains (Serra dos Carajas) located in the PGC Area. Subsequent surveys of the natural resources in the Carajas Mountains revealed the existence of huge mineral reserves of manganese, copper, nickel, gold, etc., in addition to iron ore. Furthermore, favored by natural conditions the area possesses great potential for the development of tropical agricultural products such as oil palm and babassu, as well as rich forest resources and a promising livestock sector.

With the area having abundant natural resources and favorable natural conditions, the PGC has the following principal purposes: 1) the expansion of farming land by effective land utilization; 2) the promotion of immigration into the PGC Area through creation of industrial bases; 3) the decentralization of industries through establishment of new industrial nuclei; and 4) the promotion of private enterprises into the PGC Area by the provision of various incentives with the aim of reducing existing regional disparity.

In terms of mineral resources development, the Carajas Iron Mine, a crucial project of the PGC, has started operations in 1984; and the mining of manganese ore in Igarape Azul, located in the Carajas Mountains, is also expected to start its full operation in the near future. The economic infrastructure has been upgraded with the opening of the Carajas-Ponta da Madeira Railroad (EFPMC) with a total length of 890 km. It will play an important role in the transportation of not only iron ore but also agricultural and forest products and livestock produced in the areas adjacent to the railroad. Furthermore, construction and improvement of port facilities are in progress at a fast rate at the ports of Ponta da Madeira in Sao Luis and Vila do Conde in Barcarena, which are to become the physical distribution bases in the PGC Area.

As regards the industrial projects, the ALUMAR Aluminum Project in Sao Luis started trial operations in 1984, with the ALBRAS/ALUNORTE Aluminum Project expected to commence operations in 1985. To meet the increasing power demand from these projects and other industries in the area, the first phase construction of the Tucuruí Power Plant was completed in November 1984 with four million kilowatts of electricity generating capacity.

To promote industrial development in the PGC Area, six industrial districts have been designated under the PGC in Tucuruí, Marabá, Carajas, Barcarena, Imperatriz and Sao Luis. The Barcarena Development Company (CODEBAR) has been set up for the purpose of developing the Barcarena industrial district and for promoting the effective development and utilization of land for housing, commerce and farming.

One of the main thrusts of the PGC is the construction of the necessary infrastructure with government funds to encourage the entry of private enterprises into the PGC Area under the principle of market economy. The government created a special system of granting incentives under the Decree-law No. 1813 of November 24, 1980, as a means of such

encouragement. It involves the provision of tax benefits such as exemption both of corporate income tax, and of import duties on equipment, machines, vehicles, apparatuses, instruments, parts, spares, accessories, tools and utensils for private enterprises establishing projects and constructors engaged in construction work in the PGC Area.

Up to August 1984 twenty-six projects, ranging from large-scale projects such as the Carajas Iron Mine (Ferro-Carajas Project), ALBRAS/ALUNORTE and ALUMAR, to the Tucuma Colonization Project, livestock projects, palm-oil refining and charcoal production had received such benefits. Further, twenty-one construction companies have received tax exemptions in connection with the construction work of the aforementioned projects and various infrastructure elements.

The policies incorporated in the PGC, encompassing economic development, construction and improvement of the socio-economic infrastructure, are interwoven with those of various government agencies such as the Superintendency for the Development of Amazonia (SUDAM), Superintendency for the Development of Nordeste (SUDENE), National Institute of Colonization and Agrarian Reform (INCRA), Araguaia-Tocantins Lands Executive Group (GETAT) and Araguaia-Tocantins River Basin Development Project (PRODIAT).

2-1-2 SUDAM and the Greater Carajas Program

SUDAM, a government agency administered by the Ministry of Interior, was established in October 1966 to be responsible for the development of a defined area of the Amazonia, the so-called Legal Amazonia. In connection with the PGC Area, the state of Para and the area west of longitude 44° west in the state of Maranhao are also part of the SUDAM program. SUDAM has so far formulated the following development plans: 1) Initial Amazon Development Plan (1967-1971), 2) the First Amazon Development Plan (1972-1974), 3) the Second Amazon Development Plan (1975-1979), and 4) the Third Amazon Development Plan (1980-1985). Of these plans, POLAMAZONIA (Program for Agro-livestock and Agro-mineral Poles of Amazonia), a federal special program in operation since 1974 for the development of designated poles for agro-livestock, minerals and forestry resources, is closely related to the Greater Carajas Program. Under POLAMAZONIA, fifteen areas were selected as priority development areas to incorporate a comprehensive development of Amazonia, and a number of studies have already been conducted in addition to the construction of socio-economic infrastructure in the development poles. Of the fifteen development poles, "Polo Carajas", "Polo Altamira", "Polo Pre-Amazonia Maranhense" and "Polo Araguaia-Tocantins" are closely related to the PGC Area. In addition, another SUDAM federal special program related to the development of the PGC Area is PRONORPAR (Program for Socio-economic Redevelopment of Northeast Para) which has been carried out since 1976 for the purpose of socio-economic redevelopment of the 91,350 km² of northeastern area of Para.

These federal special programs are financed by PIN (National Integration Program), PROTERRA (North and Northeast Region Land Distribution

and Agroindustry Promotion Program) and FND (National Development Fund). Funds have been allocated to almost all the program areas: in the agricultural industry (for agro-livestock surveys, infrastructure for storage, distribution and supply of commodities, titling and distribution of agricultural lands and colonization projects); for the economic infrastructure (construction and improvement of roads, airports, ports and mine facilities), for urban development (construction of water supply and sewerage systems and power plants in Maraba, Tucuruí and other principal cities); and for the social infrastructure (education, public health and labor). Expenditure by SUDAM in the PGC Area under these federal special programs amounts to Cr\$6 billion for Polo Carajas, Cr\$3.5 billion for Polo Altamira and Cr\$7.1 billion for Polo Pre-Amazonia Maranhense during the period 1975-1984 under POLAMAZONIA (aggregate amounts of the expenditure for each year at current price), and Cr\$7.5 billion (in 1983 constant price) from 1979 to 1983 under PRONORPAR. However, reflecting the severe economic conditions in Brazil, the financial resources of SUDAM itself and for POLAMAZONIA and PRONORPAR have been decreasing substantially since 1980.

Let us look at the spatial overlappings between the sub-regions of PGC Area and the areas under POLAMAZONIA. In terms of agriculture, Polo Carajas and Polo Altamira coincide with the PGC's sub-regions of Maraba and Xingu and Polo Pre-Amazonia Maranhense coincides with the Bacabal sub-region in the PGC Area. The PRONORPAR area coincides with the Castanhal sub-region in the PGC Area. POLAMAZONIA will play an important role not only in the surveys of mineral resources now under way in Polo Carajas and Polo Altamira, but also in the development of the industrial districts of Maraba, Tucuruí and Barcarena and in the improvement of related infrastructure required for the development of the metallurgical industry as well as for urban development.

2-1-3 SUDENE and the Greater Carajas Program

SUDENE, an agency administered by the Ministry of Interior, was established in 1960 for the purpose of developing the northeastern region (Nordeste) of the nation. The PGC Area in the state of Maranhao is part of SUDENE program area. Cited as major programs of SUDENE are; Program for Integrated Area Development of Nordeste (POLONORDESTE), Special Support Program for the Development of the Semi-arid Region of Nordeste (Project SERTANEJO), Program for Hydro-resource Utilization of Nordeste (PROHIDRO), Irrigation Program of Nordeste, Special Support Program for Sugarcane Cultivated Area of Nordeste (PROCANOR) and Program for Agro-industry Development of Nordeste.

These special programs, financed jointly by the federal government and domestic and foreign financial institutions, are aimed at raising agricultural productivity and creating favorable conditions for the marketing of farm produce through production assistance and construction of the socio-economic infrastructure, thereby improving the living standards and insuring the long-term settlement of people in the northeastern region.

Of these special programs, the one bearing the greatest importance for the present Study is POLONORDESTE which was commenced in 1974 to achieve integrated rural development through technical and financial assistance to medium- and small-scale farmers in selected areas where it is possible to increase agricultural production by utilization of natural conditions and the existing infrastructure. There are three POLONORDESTE projects being undertaken in the state of Maranhao: The integrated rural development projects of Baixada Ocidental Maranhense and Medio Vale Mearim, and Colonization Alto Turi. The program area of these three projects is the central and northern parts of the state of Maranhao covering an area of 50,667 km² with a population of 1.2 million (as of 1980). The projects cover wide-ranging fields including titling and distribution of agricultural lands to small-scale farmers, economic infrastructure such as rural roads, rural electrification and utilization of substitute energy sources, social infrastructure such as education, public health and sanitation, as well as agricultural financing, technical guidance, agricultural research, provision of materials and supplies, agricultural mechanization, farmers' cooperatives, and assistance in sales and storage of products.

SUDENE outlayed Cr\$77.5 billion (1982 constant price) in POLONORDESTE between 1979 and 1982, of which Cr\$6.3 billion, or 8.1%, was allocated to the above-mentioned three projects in the state of Maranhao. However, with the substantial decrease in available funds since 1980, and in view of the fact that the above-mentioned program measures have been taken sporadically over such a vast area, a review of such programs will be necessary to limit the project areas and concentrate funds in specific limited sectors.

These projects are scheduled for completion in 1985, and SUDENE is now making preparations for the launching of a new PROJECT NORDESTE in 1985, by making an across-the-board reorganization of POLONORDESTE in coordination with the Maranhao state government. PROJECT NORDESTE is expected to be financed by the World Bank and the program area in the state of Maranhao will be expanded further, with the addition of four projects in the areas of Pindare, Cocaia, Grajau and Balsas.

Of these projects, Medio Vale Mearim, Pindare and Balsas overlap regionally with the sub-regions of Bacabal and Balsas included in "the Greater Carajas Agriculture Program,"¹⁾ and therefore careful discussion and coordination with the government agencies concerned will be required in the execution of agricultural development of these areas.

2-1-4 GETAT, INCRA and the Greater Carajas Program

GETAT began operations in April 1980 as an agency controlling titling and the distribution of lands and colonization projects in the basin area (452,000 km²) of the Araguaia and Tocantins rivers. Dividing the area into the seven program areas - Tucuruí, Conceicao do Araguaia,

1) Preliminary Version by the Ministry of Agriculture

Sao Geraldo, Araguaina, Acailandia, Imperatriz and Sunorte - GETAT has implemented measures to promote the migration and settlement of medium- and small-scale farmers in the area; so far 43,000 lots of agricultural land have been titled with each lot usually not more than 100 ha. GETAT expects to have distributed 1.16 million ha of land by titling 14,000 lots by the end of 1984. To help small-scale farmers settle in the area, the agency is also engaged in the construction of such socio-economic infrastructure elements as rural roads, schools, public health and sanitation facilities.

The major colonization projects of GETAT are Carajas II and Carajas III, undertaken since 1982 in the area south of the Carajas Mountains. In these projects, 520 families, mostly possessing 50-ha farms, settled during 1983 and an additional 1,343 families are expected to settle during 1984.

INCRA, like GETAT, is also responsible for titling and distribution of agricultural land and colonization projects, but its program area extends throughout the nation, as opposed to the limited areas of GETAT. In its relation with the PGC Area, INCRA has carried out colonization projects in the area along the Trans-Amazon Highway which was constructed in the 1960s and also has program areas centering around Altamira and Paragominas in the state of Para and Bacabal in the state of Maranhao.

Since the Greater Carajas Program also gives priority to colonization projects for small-scale farmers, the roles of INCRA and GETAT will become even more important in the future.

2-1-5 PRODIAT and the Greater Carajas Program

PRODIAT, a program for formulation of the integrated development plan of the 935,000-km² basin area of the Araguaia-Tocantins rivers extending across the states of Goias, Mato Grosso, Para and Maranhao, aims at the establishing of regional development poles to counterbalance the economic influence of the south and southeast regions. The formulation of the program was commenced in 1981 as a joint project of the Organization of American States and the Ministry of Interior of the Brazilian Government and its final report is expected to be released in April 1985.

The program area of PRODIAT is divided into twenty-three sub-regions based on the basic statistical unit of "micro-region." The program is composed of: a global plan to incorporate an overall development strategy for the whole program area; a regional approach to formulate individual development programs for the seven priority areas (Immediate Program Area: IPA) selected under the global plan; and sector plans to institute programs for the sectors to be developed.

Of the selected Immediate Program Areas, those located in the PGC Area are: IPA No. 1 Baixo Tocantins and IPA No. 3 Maraba in the state of Para; IPA No. 5 Imperatriz and IPA No. 7 Tocantinopolis in the state of Maranhao; and IPA No. 8 Araguaina in the state of Goias.

The individual programs for these IPAs, although they are still in the process of preparation, have as their major aim the promotion of agricultural development by adopting the most suitable patterns of farming operations in consideration of the regional natural conditions. Since PRODIAT is an integrated development program in which a part of the PGC Area is also included, the individual projects proposed in PRODIAT will influence the direction of development in the PGC Area, and in this respect they will have an important bearing on the future development of the PGC Area.

2-2 Current Economic and Social Conditions of the Greater Carajas Program Area

2-2-1 Population Changes

Of the three states of Para, Maranhao and Goias composing the PGC Area, Para and Goias showed a high rate of population increase during the 1970s, far in excess of the nationwide average, while the population growth in Maranhao was comparatively slow, being almost equal to the national average. The net population increases due to migration (the number of immigrants less the number of emigrants) in Para and Goias have risen since the 1960s, while in Maranhao the number of emigrants surpassed that of immigrants after 1970, resulting in a net decrease in the migrated population. As a total, the population of the three states rose 39% during the 1970s as against the 28% national increase. Consequently, the proportion of the three states' population in the national total rose from 8.4% in 1960 to 9.5% in 1980.

The population of the PGC Area increased from 4.89 million in 1970 to 7.12 million in 1980, a rise of 46%, and its ratio to the total population of the three states also went up from 60.4% in 1970 to 63.2% in 1980.

The population of the seven sub-regions in the PGC Area rose 52% from 1.47 million in 1970 to 2.24 million in 1980, reflecting a rapid concentration of population in these sub-regions. The population of the seven sub-regions accounted for 31.5 % of the PGC Area's total population as of 1980. The population in the PGC Area was made up of 79.7% of that of Para, 97.8% of that of Maranhao and 7.9% of that of Goias in 1980.

As regards the population growth for each sub-region, from 1970 to 1980 Maraba rose 258%, Xingu 225% and Imperatriz 114%, very large increases compared with the average of 52% for the seven sub-regions combined. On the other hand, Castanhal and Bacabal, which have relatively long histories of development, have large increases of populations despite their low growth rates, and will continue to hold an important position in the development of the PGC Area.

The rural population in the PGC Area was a very high 61.9% in 1980 as against the urban population of 38.1%, although the proportion of the latter has been rising (The national rural population was 63.8% in 1950).

2-2-2 Changes in Employment Structure

The proportion of the economically active population in the total population of each sub-region, which is an indicator of the employment situation, ranges from 32.3% in Bacabal to 20.1% in Xingu (in 1980), levels lower than the national average which improved remarkably from 31.7% in 1970 to 36.3% in 1980. Except for the slight upturn posted in Imperatriz, the proportion of the economically active population declined in the sub-regions from 1970 to 1980; one of the reasons being that although the improved social and economic infrastructure such as roads and the various projects like the iron ore mining project in the Carajas Mountains had brought about a concentration of population in these sub-regions during the 1960s and 1970s, the surge of population exceeded the employment opportunities. It is therefore important to secure more employment opportunities in the future in the PGC Area.

With regard to economically active population by industry, the proportion of workers in the primary industry in the seven sub-regions declined from 78.5% in 1970 to 63.1% in 1980. However, it still reflects the importance of the agriculture sector in the PGC Area compared with the nationwide average of 29.3% as of 1980. The number employed in the primary industry in these sub-regions increased by 71,000 persons during the period, and it was equivalent to 32% of the increase in the economically active population of all industries.

The economically active population also substantially increased particularly in the sub-regions of Maraba, Xingu, Imperatriz and Araguaina. In Maraba, Imperatriz and Araguaina, while the number of workers in primary industry increased much faster than that in the other sub-regions, the number of workers in the secondary and tertiary industries registered a higher growth than that of the primary industry during the 1970s. This suggests increased activity not only in agricultural production but also in investment activities centering around the agricultural products processing industry in the sub-regions; and also that the distribution and service sectors in the cities of these sub-regions were vastly improved to support the production activities of the surrounding areas.

According to data for 1981, government spending per capita (Federal, state and municipality expenditure) was an average of Cr\$37,700 across the nation, while in the states of Para and Maranhao the levels were Cr\$10,000 and Cr\$7,850 respectively, or only about one-fourth of the national average.

Although the basic infrastructure has been improved since the second half of the 1960s by the construction of the Belem-Brasilia Highway, Tucurui Dam and the Carajas Railroad, the infrastructure in the PGC Area, such as transportation, communications, electricity and energy supply systems is still inadequate on the whole, and in this respect the level of fiscal spending for the PGC Area should be raised further.

2-3 Analysis of Physical Infrastructure

2-3-1 Introduction

The Greater Carajas Program Area occupies 10.6% of the nation in area and 9.5% in population 1980 figures. Since statistical data for the PGC Area alone are difficult to obtain, the data on the three states of Para, Maranhao and Goias are used as substitute material for analysis of the physical infrastructure of the Area. Since the respective proportions of the population of the three states making up the PGC Area are 79.7% in Para, 97.8% in Maranhao and 7.9% in Goias, it is obvious that the features of the PGC Area are represented in the main by those of Para and Maranhao, and the features and data of Goias should only be considered as reference (The population ratios of the three states to the whole country are 2.86% in Para, 3.36% in Maranhao and 3.24% in Goias, while their ratios in terms of area are higher than those of population, with 14.66% in Para, 3.86% in Maranhao and 7.54% in Goias).

2-3-2 Present Status of Infrastructure in the PGC Area

The present infrastructure in the PGC Area is generally inadequate considering the proportion of the population and area relative to the whole nation. Table I-1 shows the proportions for each of the three states in terms of the national totals by road length, road and marine shipments, electricity output, and the number of telephones. For example, in comparison with the population proportions of Para and Maranhao to the whole country, their share of the national total in the volume of road shipments, electricity output and number of telephones is less than a half of the population proportion in Para and one-fifth to one-tenth in Maranhao.

In Para, for instance, an average length of the federal roads is 3.0 m/km² (7.6 m/km² nationwide), the state and regional roads 4.8 m/km² (16.1 m/km² nationwide), and the municipal roads 9.4 m/km² (139.0 m/km² nationwide). This indicates the low standard of the road system in Para, with the federal roads being one-half of the national average, the state and regional roads one-third, and the municipal roads less than one-tenth. The situation, however, is different in Maranhao where the federal, state, regional and municipal roads are all around the national standards, in contrast to the low levels of other kinds of infrastructure.

The low level of economic activity in the PGC Area is reflected in the ratio of the volume of road shipments to the population which is, compared to the national average of 1.85 tons per capita, only 0.27 ton in Para and 0.02 ton in Maranhao which has a road system comparable to national standards. Another exception in the Area is the high level of marine shipments centering at Belem Port in Para, with its proportion to the whole country standing at 3.15%. This suggests that Belem Port is the sole center of marine cargo transportation in the Area although there is also the port of Itaquí in Sao Luis.

Table I-1 Infrastructure in the Three States Relative to the Whole Country

State	Population (%) (1980)	Area (%) (1982)	Federal Roads		State and Regional Roads		Municipal Roads
			Length (%) (1982)	Length per km ² (m) (1982)	Length per km ² (m) (1982)	Length per km ² (m) (1982)	
Para	2.86	14.66	5.84	3.0	4.8	9.4	
Maranhao	3.36	3.86	5.20	10.0	12.8	134.4	
Goiás	3.24	7.54	6.77	6.8	27.1	126.0	
Whole Country	100.00	100.00	100.00	7.6	16.1	139.0	

State	Overland Transport Cargo Volume		Marine Cargo Volume	
	Proportion to Whole Country (%) (1981)	Volume per Capita (tons) (1981)	Proportion to Whole Country (%) (1982)	Volume per Capita (1,000 tons) (1982)
Para	0.43	0.27	Belem 3.15	2.09
Maranhao	0.04	0.02	Itaqui 0.18	0.01
Goiás	1.59	0.90	-	
Whole Country	100.00	1.85	100.00	1.97

State	Electricity Output		Number of Telephones	
	Proportion to Whole Country (%) (1982)	Output per Capita (MW) (1982)	Proportion to Whole Country (%) (1980)	Per 100 persons (1980)
Para	1.23	0.0013	1.11	2.4
Maranhao	0.27	0.0002	0.48	0.9
Goiás	1.33	0.0013	1.80	3.5
Whole Country	100.00	0.0003	100.00	6.2

Source: IBGE, Anuario Estatístico do Brasil, 1983

2-3-3 Major Infrastructure Programs in the Greater Carajas Program Area

(1) Electricity

The Tukurui Power Station of ELETRONORTE started operations in November 22, 1984, with a power generation capacity, in its first phase, of 4,000 MW, which will be sufficient for the power supply to the PGC Area. The capacity will be increased to 8,000 MW in the second stage, thereby having the potential to substitute the present supply of power from CHESF in the future. ALBRAS/ALUNORTE in the Barcarena Industrial District and ALUMAR in the Sao Luis Industrial District have already finished construction of transmission lines (construction of an auxiliary line is now under study) and substations, and are now awaiting the power supply to be connected from the Tukurui Power Station. In the industrial districts of Maraba and Tukurui the construction of substations and facilities for receiving the power supply is expected in the future as factory construction programs make progress.

(2) Water transportation

The major shipping ports in the PGC Area are Belem in the state of Para and Itaquí in the state of Maranhao. Belem Port is connected with Tukurui by the Tocantins river along which barges are used as the main means of transport. Its capacity is already fully extended, and it is too shallow to accommodate vessels over 10,000 tons. For this reason, the role now performed by Belem Port will be assumed in the future by the Vila do Conde Port in Barcarena, presently under construction, which can berth vessels of the 40,000-ton class; it is also close to the industrial districts.

In Sao Luis, in addition to the port of Itaquí with its relatively small cargo-handling capacity (448,000 tons handled in 1982 as against the 1,887,000 tons handled in Belem Port), the Ponta da Madeira Port is now being constructed by Companhia Vale do Rio Doce (CVRD). Having the capacity to berth 280,000-ton class vessels, it will have great influence on the whole PGC Area in the future when the port is used not only for the shipment of mineral products from the Carajas Mine but also for shipment of general cargo because of its access to the Carajas Railroad.

(3) Railroads

The CVRD Carajas Railroad runs over a distance of 890 km from the Carajas Mine to the port of Ponta da Madeira in Sao Luis. The whole line was opened in February 28, 1985, and because of its use not only for transport of mineral products but for the carriage of general commodities and agricultural products including forestry and livestock products as well, the railroad will have considerable impact on the area in view of the conceivable reduction of transportation costs (One estimate predicts a reduction of transportation costs to about one-tenth that of trucking costs).

(4) Road transportation

The main federal roads running through the PGC Area are the Belem-Brasilia (BR-010) and Trans-Amazon (BR-230) highways, to which the state roads are linked to connect the major cities. Although these roads are still adequate in terms of transportation capacity, one problem is that the roads have not yet been fully paved. The percentage of paved federal roads in the state of Para in particular is a very low 16.5% compared with the national average of 65.8% (1982 figures). The percentage of paved federal roads in Maranhao is 53.7%. The percentage of paved state roads are only 28.6% in Para and 18.5% in Maranhao as against the national average of 30.4%. Such a situation suggests that the paving of roads is a matter of urgency.

2-4 Comments on the Potentials of the Greater Carajas Program Area

Various development programs are currently being undertaken in the PGC Area by government agencies. SUDAM has formulated the third 5-year Amazon Development Program (1980-85) which involves, among other projects, preliminary studies for natural resources development and comprehensive development plans for major river basins in the Amazon region. POLAMAZONIA and POLONORDESTE have been implemented by SUDAM and SUDENE as federal special programs. INCRA and GETAT have carried out colonization projects and programs for titling and distribution of agricultural lands with the objective of promoting the settlement of medium- and small-scale farmers. An integrated regional development plan of the Araguaia-Tocantins river basin has also been worked out under PRODIAT.

POLAMAZONIA aims at utilizing the abundant natural resources and favorable natural conditions in the Amazon area. It incorporates a wide range of development projects, such as basic surveys on mineral resources; promotion of the agro-livestock industry; processing of agricultural products; establishment of industrial districts; construction of roads; power supply facilities and communications systems; promotion of public health and sanitation and education. On the other hand, POLONORDESTE aims at integrated rural development in the Nordeste region mainly through the titling and distribution of agricultural lands in order to promote the settlement of small-scale farmers in the area.

Although POLAMAZONIA and POLONORDESTE are the principal measures for regional development of the PGC Area, SUDAM and SUDENE have other means of promoting regional development, such as fiscal and financial incentives and investment funds (FINOR and FINAM) which may encourage private business in the PGC Area. If these programs and measures, in addition to the benefits given to private business by SE/PGC, are taken into account, the policy measures required for the regional development of the PGC Area appear to be virtually complete.

With regard to the population changes in the PGC Area, remarkable increases have occurred in the southwestern region of Para (Maraba and Tucurui) and in the western region of Maranhao (Imperatriz, Acailandia, Santa Luzia and Santa Ines) - the forefronts of agricultural development.

On the other hand, both the northeastern region of Para and the eastern region of Maranhao, which have relatively long histories of development and settlement, had slow rates of population growth, or even decreases in certain areas, during the 1970s.

In terms of the sectoral employment structure in the PGC Area, the proportion of the economically active population in the primary sector is extremely high compared with the other regions of the nation. Moreover, the number of workers in the primary sector of the PGC Area has increased as a result of agricultural development, while that of the nation has decreased, in recent years.

One of the main tasks in the further development of the PGC Area is the improvement of the infrastructure at regional and sub-regional levels. In this regard, it is crucial to improve the network of feeder roads in the areas along the Carajas railroad and the major trunkline roads such as the Belem-Brasilia highway (BR-010), the Trans-Amazon highway (BR-230) and state highway PA-332. The construction of feeder roads will be conducive to the smooth flow of physical distribution and services in the area, resulting in heightened development of the agriculture, forestry and livestock industries.

Another task in the transport infrastructure is the betterment of river navigation systems. It is necessary to secure stable navigation of the major rivers in the PGC Area, which will obviously contribute to the development of the Area. In more specific terms, the betterment of the navigation systems necessitates the construction of the lockages in Tukurui and Santa Izabel dams, and the dredging of Tocantins riverbed. This will facilitate large-scale river transportation between the major inland cities and the major coastal cities (Barcarena and Belem), extending to Aruana in the state of Goias, about 2,200 km from the coast. Together with the completion of both the Carajas railroad and the feeder road network connecting the major trunkline roads, the betterment of the river navigation systems may greatly advance the development of the inland areas.

During the 1970s a rapid inflow of population was seen mainly in the cities of Araguaina, Imperatriz and Maraba located along the Belem-Brasilia highway, but in the future the population is expected to move toward the inland areas as the access to the inland area west of the highway is improved, thus resulting in a movement of the agricultural development fronts further toward the western regions.

There are several matters to be resolved when considering the future development of the PGC Area. First, in regard to the direction of the Area's development, it is necessary to clarify, especially in respect of agricultural land utilization and development of the agriculture, livestock and forestry sectors, the Area's long-term prospects and its role in the national development perspective.

Secondly, the allocation of financial resources to those regional development agencies has declined in recent years, reflecting the severe economic conditions of the nation since 1980. The fundamental objective

of the Greater Carajas Program is the attraction of private industry into the PGC Area through the improvements of economic infrastructure. However, the recent substantial decreases in funding are a great stumbling block in the construction of the required economic infrastructure.

Thirdly, the areas covered by the federal special programs are vast, making it difficult to undertake public investment in an effective and concentrated manner.

As pointed out in the Study Report on agriculture, the newly-developing agricultural front areas face a large number of problems in the establishment of land titles; income raising for traditional self-sufficient farmers; and production increases for farms producing marketable crops. In order to solve those problems and enhance the agricultural development, it is necessary to formulate an integrated package of measures such as rural extension, improvement of the feeder road network and storage facilities, land price regulation and security of land titles, and rural credits as well as price controls.

The Study Report on the development of the mineral resources indicates that the geological and mineral explorations in the area are at the reconnaissance stage requiring better knowledge of the geology through mapping, geochemical and geophysical surveys.

The Study Report on the development of the metallurgical industry also points out the necessity of positive efforts for improvement of the transport infrastructure (mainly by utilization of the rivers), industrial water supply, and housing development in the industrial districts to be constructed in Maraba, Tucurui, and Barcarena.

If the aforementioned regional development programs and their execution schedules are viewed from the standpoint of the Phase II Study, the limited funding available will necessitate a concentration of the existing development measures into the selected sub-regions on a more coordinated basis than previously.

(II) STUDY OF AGRICULTURE, LIVESTOCK AND FORESTRY DEVELOPMENT

1. INTRODUCTION

In the Phase I Study undertaken in 1982-83, the JICA Study Team examined trends in the international markets of twenty-eight agriculture, livestock and forest products of the Greater Carajas Program Area. At the same time, a Brazilian counterpart conducted a study on the domestic production and domestic market trends of these products. The present study on the agriculture, livestock and forestry development in Phase II contains seven survey items (see Part I of the Final Report, Annex I-3). Based on the results of the study on the international markets in Phase I and those on the domestic production and markets conducted by Brazilian team, this study aims to examine the products that should be given priority for future development of the agriculture, livestock and forestry sectors, in consideration of the natural, social and economic conditions of the Area, and to provide comments on the various conditions necessary to realize the Area's development potentials.

Since this study covered a wide geographical area and a diversified range of study items, it was decided that the conduct of the study should be clearly defined in order to facilitate completion of the tasks within the limited time available. That is, regarding the method of study, in full coordination with the Brazilian authorities, we: (i) fully utilized the existing materials and data, (ii) draw on the interviews with the Brazilian people concerned, (iii) restricted the number of main crops for study (as described in the Inception Report), and (iv) visited the representative sites of the Area after discussing thoroughly with Brazilian officials. When compiling the report, focus was particularly placed on (i) the interrelationships of the study items, (ii) the distinctive features of the regions examined, and (iii) the preliminary screening of products suitable for production in the Area and an examination of the conditions necessary for development.

The full cooperation provided by Brazil meant the survey proceeded smoothly. However, the expanse of the PGC Area and the limited time for the survey meant that diversified aspects had to be handled, and therefore certain parts of the survey leave something to be desired. In fact, although we received generous cooperation from Brazil, the areas where the Study Team was able to visit were limited, and inevitably there were constraints on the collection of data. We attempted to compensate for this lack of information through discussions with Brazilian and Japanese specialists.

Areas covered by each sub-region are, as a principle, marked according to the classifications in Programa Grande Carajas Agricola (Preliminary Version).

2. OUTLINE OF THE STUDY

The study on agriculture, livestock and forestry development covers a wide range of study items. The studies by item are summarized in the following sections. The results of the whole study will be outlined in this section by focussing on the current situation of agriculture, livestock and forestry sectors, preliminary screening of priority products and conditions for their development in the PGC Area.

2-1 The Special Features of the PGC Area's Agriculture, Livestock and Forestry Sectors

The special features of the PGC Area's agriculture, livestock and forestry sectors which were clarified from comparisons of the Area with Brazil as a whole, and between the sub-regions of the Area can be summarized as follows:

- (1) The Area is endowed with abundant land resources, and in general many forests and much unused arable land exist.
- (2) However, rapid large-scale conversion of forests to arable land (mainly pasture) is under way together with a wide-spread practice of shifting cultivation, showing signs of deterioration of natural environment in some areas.
- (3) The structure of agricultural production is characterized by the coexistence of large number of small-size farms producing mainly subsistence food crops and large-scale cattle farms. The percentage of pastureland in the total area of arable land is remarkably high. The percentages of tenants and occupants in the total number of farm units are also high compared to other regions. The cultivation of commercial crops such as oil palm and soybean by using modern techniques has emerged in some sub-regions, but in general the technical level and land productivity are low.
- (4) The utilization of forest resource is still at a primitive stage. The artificial reforestation is very limited.
- (5) The seven sub-regions can be roughly divided into three groups according to natural conditions, history of settlement, and distances from main roads: (a) Bacabal, Balsas and Imperatriz with a relatively long history of development, large number of small- and medium-size farms, and high percentages of tenant farms; (b) Araguaina, Maraba and Xingu with land conversion for agriculture being under way, relatively high percentages of medium- and large-size farms, and large percentages of pasture area; and (c) Castanhal with a relatively long history of settlement, a large percentage of small- and medium-size farms, a high percentage of owner-farms, and farmer's willingness to be engaged in commercial crop production by using modern technology.

From the above observations, the following viewpoints seem essential for the future development of the PGC Area's agriculture, livestock and forestry sectors:

- (1) The need to enhance efficient use of land resource to actualize the Area's development potential;
- (2) Promotion of policy measures for improving the incomes of the overwhelmingly large number of small farms, and for immobilizing shifting farmers;
- (3) Strengthening the competitiveness of commercial crops suitable to the utilization of local conditions; and
- (4) Harmonizing development and environmental conservation.

2-2 The Surrounding Conditions of the PGC Area's Agriculture, Livestock and Forestry Sectors

The present conditions of the major natural and socio-economic factors surrounding the agriculture, livestock and forestry sectors of the PGC Area can be summarized as follows:

- (1) The Area is favored geographically by being covered with vast land, and the land price is relatively low.
- (2) The PGC Area belongs to the tropical zone, but there are differences among the sub-regions in soil and rainfall. Although there are differences among the sub-regions in the possibility of agricultural land expansion, in general the Area has high potential of land development for agricultural use.

The maximum rainfall is registered in the Castanhal Sub-region (annually 2,700 mm or more). In the PGC Area, generally the rainfall is high in the Northwest and gradually decreases southeastward, with the minimum being registered to the south-southeast of Bacabal (annually 1,100 mm or less). Sub-regions Xingu, Maraba, and Imperatriz, and part of sub-region Bacabal have soil of relatively high fertility. (The prevailing soil types are PV. LV at Maraba, LV. AQ at Imperatriz, LV. PV. AQ at Araguaina, LA at Castanhal, TR. PV at Xingu, PV. HL at Bacabal, and LV.AQ at Balsas.)¹⁾ Generally, considerations for the conservation and improvement of soil fertility are necessary. Xingu, Maraba, and Araguaina have relatively high potential for agricultural land expansion. Sub-region Maraba has large area of steep land.

The forests in the PGC Area are characterized by heterogeneous structures, although there exist high-quality species. Reflecting the pattern of rainfall distribution, the potential growing stock

1) See Chapter 2 (Final Report) for details of soil classification.

per unit area of the Area is high in the north and gradually declines southeastward.

- (3) In general, the so-called social capability — technical acceptance, production practice, etc. — in the Area is low, except in some areas in sub-region Castanhal and at relatively large-size farms.
- (4) All the sub-regions of the PGC Area are located in areas remote from such central markets as Sao Paulo and Rio de Janeiro. As Belem and Sao Luis are the largest cities within the Area, Castanhal and Bacabal are relatively favorable in terms of local market, compared with other sub-regions. The same thing can also be said with respect to international market. In sub-regions Maraba and Imperatriz, the size of local market which is small at present is expected to be enlarged along with rapid increase in population.
- (5) The access of most of the sub-regions to the central markets of Brazil and the world markets have been substantially improved by the construction of such main transport infrastructure as the Trans-Amazon and Belem-Brasilia highways, and the Carajas railroad. However, with the exception of Bragantina (in Castanhal sub-region) and some other municipalities, the Area is lacking a well-consolidated network of transport infrastructure. As a result, the development in the Area has been limited to the areas along the main roads, and the formation of producing areas has not been efficiently promoted.
- (6) The construction of processing and marketing facilities in the Area is also far behind that in the southern states of Brazil. This is, needless to say, closely related to the small size and instability of the production of the Area's agriculture, forestry and livestock sectors. It is observed that those areas close to Belem, Sao Luis and Imperatriz tend to be favorable in processing and marketing facilities, although the situation is dependent on the types of products. The Area is also backward in terms of agricultural cooperative activities, except in some limited zones. This seems to be due to the fact that the number of commercial-product-oriented and medium-size farms, which are the core of agricultural cooperative activities, is still small in the Area.
- (7) Some special features of the PGC Area are also observed in its institutional aspect. The Area has plenty of land of which the ownership is still not established. Moreover, the technical extension services are not sufficiently provided, due mainly to inadequate transport infrastructure and farmers' low technical acceptance capability.

With respect to credit and price policies, preferential treatment has been given for the whole North and Northeast regions including the PGC Area. However, the Area has relative disadvantages due to its timing of development and other specific conditions. For

examples, as the Area started to develop at a large scale when Brazil entered a period of credit squeeze, the Area is not favorable in the production of capital-intensive products, and some of the important products of the Area are not familiar to be covered by the present price support system.

2-3 Comments on Preliminary Screening of Priority Products and Necessary Conditions for Development

- (1) A preliminary screening of suitable products for the Area was made, based on the development perspective of the Area's agriculture, livestock and forestry sectors (2-1), their surrounding conditions (2-2), and the major characteristics of the products. Of the products which can be produced in the Area, those of high priority are stated in the following together with the major reasons for their selection.
 - (a) Rice, maize, feijao and cassava which are widely cultivated in all sub-regions, and suitable to the objectives of self-supply of food and increase in the incomes of small- and medium-size farms;
 - (b) Rubber, cacao, and other perennial crops for the purpose of farmer's immobilization and farm-management stabilization;
 - (c) Oil palm (Castanhal) and soybean (Imperatriz, Araguaína, Balsas, and the southern part of Bacabal) as newly-emerged commercial crops of relatively high profitability and being suitable to the utilization of local conditions;
 - (d) Babassu (Bacabal) and Brazil nut (Marabá) which are the Area's special products;
 - (e) High-quality tropical fruits and pepper suitable to the utilization of the Area's natural conditions (Castanhal);
 - (f) Fresh vegetables for local markets (Castanhal and Bacabal at present, and Imperatriz, Marabá and Xingu in the future);
 - (g) Rubber (Imperatriz, Xingu, etc.) and sugarcane as commercial crops, provided that market trend is favorable and production is promoted collectively to some reasonable scale at an area;
 - (h) Beef cattle utilizing abundant land resource of the Area;
 - (i) High-quality timber products benefited by the huge forest resources, and trees for wood industry material to be planted correspondingly to the Area's natural and economic conditions.

Needless to say, the above-mentioned products were preliminary selected on the basis of the various conditions which are presently given to the PGC Area. As already referred to, any changes

in these conditions will bring about changes in the priority of products. The fact that the emergence of a new soybean variety has made the production of this crop promising in the Area presents a good example of the impact of the influencing factors on the product selection.

Any favorable changes for the above selected products in their surrounding conditions are expected to facilitate the achievement of the product screening's objectives.

- (2) It is from the above point of view the Study Team elaborated the following comments on product screening and necessary conditions for the development of the PGC Area's agriculture, livestock and forestry sectors:

(a) Promotion of Basic Food-Crop Production

Rice, maize, feijao and cassava were recommended as high priority crops for their suitability to the natural conditions and their wide-spread cultivation as the basic food-crops for large number of small farmers. The objective of the promotion of the production of these four crops is to improve the level of these farmers' living standard. For this purpose, a package of supporting measures including improvement of extension services, activities related to cooperatives and other types of farmers' organizations, and processing and marketing facilities, as well as establishment of land-ownership seems desirable. This policy package is expected to work towards increasing the yield levels and the commercialization rates of these crops.

(b) Farmer's Immobilization

The shifting cultivation system which is presently practiced by large number of farmers in some sub-regions of the PGC Area is said to result in low farm incomes and deterioration of natural environment. Therefore, a transition of these farmers from the shifting cultivation system to a sedentary cultivation system is desirable for increasing their incomes and conserving the Area's natural environment. Some suitable measures for this purpose seem to be (i) reduction of the costs of soil fertility maintenance through research and technical services related to the sedentary cultivation system, and improvements in farmers' access to current inputs, (ii) establishment of land-ownership, and (iii) financial and technical supports for the introduction of perennial crops.

(c) Strengthening the Competitiveness of Commercial Products

The major commercial products which presently come to attention are (i) crops such as oil palm, soybean and pepper, (ii) local specialties such as babassu and Brazil nut, (iii) beef, and (iv) forest products such as high-quality timber products and other wood material for industries.

Regarding the commercial crops, oil palm is suitable mainly for Castanhal sub-region, and soybean mainly for Araguaina, Imperatriz and Balsas sub-regions. These sub-regions are expected to become producing areas of these two crops. Improvements in the access of cultivators to credits and in processing and marketing will be recommended in addition to suitable measures with respect to seed production, soil fertility maintenance, and cultivation.

For such special products as babassu (Bacabal) and Brazil nut (Marabá), development of new and comprehensive uses and promoting cultivation upon necessity are expected to strengthen the utilization of these precious resources.

The Area, specially in those sub-regions with high land-labor ratios, has high potentials for beef cattle raising. In order to enhance the competitiveness of this product it will be necessary to improve both the productivity of pastureland and the quality of beef cattle, to improve infrastructure for transportation both within the production area and from the production areas to markets, to plan the future location of slaughter houses, and to work out a beef cattle production plan for the Area in line with long-term demand and supply forecasts.

Forest resources may be used in two ways depending on the locational features of the areas: as a source for high-quality timber products, or as material for wood industries. In either case, the transport infrastructure needs to be improved, but the former urgently requires quality standardization to be acceptable to overseas markets; and the problems of the latter concern the possibility of establishing pulp mills, alcohol plants, and charcoal-consuming factories close to the forest site.

(d) Environmental Conservation and Integration of Development Policies

Following are some additional comments related to the development of the PGC Area's agriculture, livestock and forestry sectors.

The first is on harmonization of environmental conservation and development. As previously referred to, in the PGC Area generally land utilization is extensive and land productivity is low. On the other hand, there has been a high pace of conversion of forests into cropping or pasture land, and in some areas this conversion has given an impression of indiscriminate development. Though development is essential, the most pressing issue in the Area seems to be how to harmonize agricultural land development and environmental conservation. In solving this issue, it seems desirable that, on the one hand the productivity of the existing agricultural land be raised as much as possible, and on the other hand priority of new land development be assigned to areas favored by good natural conditions and well-established infrastructure. The so-called growth-pole development formula, seems effective in harmonizing development and environmental conser-

vation, as well as allowing for efficient use of financial resources.

Scenes in which forests were burned near the top of mountains and on steep land were also observed during the field observations. Careful considerations seem desirable in choosing the way of land clearance, as the Area belongs to a tropical zone where the rainfall strength is very intense.

The second comment is on the position of the PGC Area in the whole Brazil in terms of commodity production. The selection and production of agriculture, livestock and forest products depend not only on the natural conditions, the level of technology, and various factors such as the allocation of transport infrastructure and processing facilities, and land price, but also on institutional factors such as credit and support price and other policies. One example of the impacts of socio-economic factors including institutional systems on development is seen in the rapid conversion of forests to pastureland along the Belem-Brasilia highway, as induced by improvements in transport infrastructure, low land price, and policy incentives. Some of these areas could be converted to soybean production if soybean price, financing conditions, processing facilities and other surrounding conditions were favorable to this product. As mentioned in the above example, the products to be produced will change considerably according to the series of policies to be taken. In this sense, it will be very important to define, in relation to national policies, the position of the Area in Brazil as a whole as to what kinds and amounts of products are to be expected to the Area.

The third comment is on comprehensive implementation of policy instruments at the regional or sub-regional level. In implementing the policy measures, it is desirable that these measures are well adjusted to suit the specific conditions at the regional or sub-regional level. It is effective that these policy instruments, such as improvement of infrastructure including rural roads, processing and marketing facilities, establishment of land-ownership, enhancement of technical extension service system, and provision of necessary financial funds are consistently coordinated and implemented.

As the PGC Area has great potential for development, it is hoped that the Area will be developed through a carefully-devised program which is based on long-run perspective and ensures optimal utilization of the Area's development potential.

3. NATURAL CONDITIONS

The objectives of this part of the Study are to survey the geography, geology, climate, soil, vegetation and other natural conditions of the PGC Area. More specifically, this part aims to examine the relationships between current land use and agricultural production; to indicate the natural conditions which will influence crop selection, and subsequently, to consider the methods of land development and the measures to conserve and improve soil fertility along with development, and finally to assess the potentials for crop production.

3-1 Climate of Sub-regions

The annual average temperature is approximately over 25°C, and the maximum-minimum range is large in inland areas and small in coastal areas.

Rainfall shows the highest level around Belem (over 2,700 mm annually). In general, the rainfall in the Area is high in the northwest and gradually decreases southeastward. The minimum annual rainfall is registered at Barra do Corda 150 km to the south-southwest of Bacabal (less than 1,100 mm).

The annual sunshine duration is not inversely proportional to the rainfall. Sunshine is relatively little in inland areas, explaining the above observations on temperature range.

As the annual average temperature is high, the fundamental determinant factor of the growth of crops is duration of soil dry reflecting differences in annual rainfall between the areas.

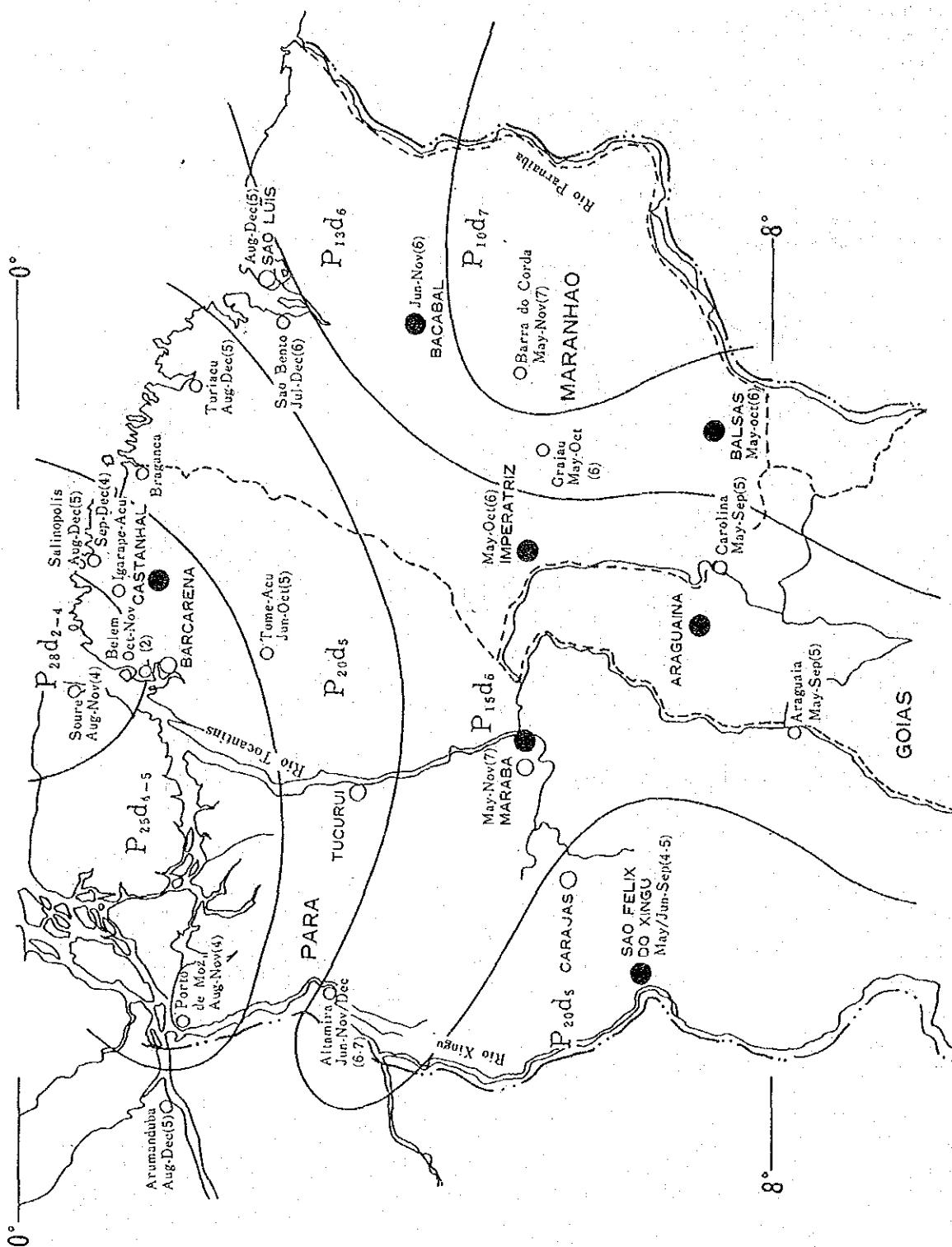
A "Climate Map of Soil Dry Period" (Figure II-1) was drawn, indicating the dry soil months and annual rainfall based on the Thomthwait moisture balance charts made from monthly rainfall and water loss due to evaporation for each area.

The climates are distributed as follows: the Belem district is P_{28d2-4}, most of the Castanhal sub-region is P_{25d4-5}, the remainder of the Castanhal sub-region and the Xingu sub-region are P_{20d5}, Maraba, Imperatriz, and Araguaina are P_{15d6}, Bacabal and Balsas are P_{13d6}, and the southeast part of Barra do Corda is P_{10d7} (See Figure II-1.).

3-2 Topography of the Sub-regions

Bacabal Sub-region: Mainly a rolling plain 100 m or less above sea-level, with swamps in low areas. Development is advancing gradually from the outskirts of the state roads to more remote areas. But as yet there are no paved roads leading to these areas, and the clay-rich podzolic soil area is difficult for traffic especially in the rainy season.

Figure II-1 Climate Map of Soil Dry Period



Note: P_i means an annual rainfall of $i \times 100$ mm.

d_j means a duration of j months of soil dry.

● Sub-region for Agriculture

Castanhal Sub-region: The whole area of Bragantina is a coastal plain 100 m or less above sea-level, and very gently rolling.

The coastal areas have many swamps with seawater.

Over one half of the total area of Paragominas is a plain 100 m or less above sea-level, and gently rolling. But the southern area around the national highway is a rolling plateau and hills about 200 to 300 m above sea-level.

Imperatriz Sub-region: The area around the national highway is a plateau 150 m high, but the areas north of Acailandia and in the eastern part of the sub-region are hills 200 - 400 m above the sea. Development is in progress in every part of the sub-region.

Araguaina Sub-region: The area around the national highway is a rolling plateau about 200 m above sea-level, and its western part consists of hills and mountains 300 - 400 m high.

Maraba Sub-region: The western part is dominated by the slopes of the Carajas Mountains of several hundred meters above sea level. The field observation of the Carajas Settlement Project III showed that the plateau and gently sloping areas were being developed. In Itupiranga District, the alluvial plain of the Tocantins river and the mountainous area behind it have been developed. Even the steep mountainsides have been converted into pasture. In the east part of Maraba which consists of alluvial areas and plateaus, the land in Sao Domingo and its neighborhood is currently under development.

3-3 Soils of the Sub-regions

On the northern side of the line linking Altamira, Tucurui, Acailandia, and Barra do Corda, yellow latosol LA is widely distributed. On the area south of this line and west of a line crossing south to north of Araguaina, and the areas around the line running from the southeast end of Castanhal sub-region (Bragantina) to Bacabal sub-region, red-yellow podzolic soil PV extends widely. The area extending from the Carajas Mountains to both sides of the Araguaia river and the proximity of Imperatriz contain much red-yellow latosol LV (See Figure 2-2 in Chapter 2 of Part III, Final Report).

Quartz sands soil AQ is widely distributed on the basins of the Tocantins river and the rivers which flow into the Tocantins, and ground water laterite HL is distributed on the northeast area on the edge of the PV area extending from the southeast end of the Castanhal (Bragantina) sub-region to Bacabal.

LA (26.5%) and PV (28.4%) account for 55% of the Area's soil, and the combination LV (12%), AQ (9.2%) and HL (7.4%) accounts for about 30%. The order of productivity of these main soils is $AQ < LA < LV \leq PV$.

The fertile soils formed from weathered basis rock which are scattered throughout the Area are dark-red latosol LE (1.4%), reddish brown lateritic soil eutrophic TR (1.3%), red-yellow podzolic soil eutrophic PE (0.6%), reddish brunizem BA (0.2%), and dusky red latosol LR (0.1%).

The main types of soil in the sub-regions are:

<u>Sub-regions</u>	<u>Main soils</u>
Bacabal	PV, HL, LA
Castanhal	LA
Imperatriz	LV, AQ
Araguaina	AQ, LV, PV
Balsas	LV, AQ
Maraba	PV, LV
Xingu	PV, TR

Results of the Soil Sample Analysis

The field of a well-managed truck farm at Bacabal was fertile through application of compost. The surface soil to a depth of 3 - 4 cm of grass land was moderately good even though it had not been cultivated. However, the lower layer was strongly acidic and deficient in phosphoric acid. The ashes from burnt mountain forests have a pH of 8 or more, and are rich in bases and available phosphoric acid, but the lower layer in which they were not mixed also consists of the same acid soil.

The grey humus soil of Braganca contains 11.3% humus, but it shows very strong acidity and is deficient in bases and available phosphoric acid.

Although soil of the uncultivated parts of the Cerrado is strongly acid even on the surface, the surface soil of vegetated areas in the PGC Area is not as strongly acidic. This seems to be due to differences in vegetation.

3-4 Some Comments on Soil Conservation and Improvement

(1) Land Use

Generally speaking, flat and gently-sloping areas are occupied by large cattle farms, while slopes and mountains are awaiting development. Many regions adopt a development system in which mountain forests are burnt to enhance fertility of the surface soil before commencing crop production. Despite the danger of severe water erosion on cleared mountainsides, there are cases where entire mountains, including the crest, have been cleared and burnt for cultivation. Such problems were observed in connection with land use in the PGC Area.

(2) Cultivating Methods (Clearing and Burning)

Development areas are normally cleared and burnt by man power — a huge task for developers. It is said that after burning, the soil fertility begins to decline in the 4th - 5th years in the case of primary forests, and in the 2nd - 3rd years in the case of secondary forests. For those developers who cannot obtain inputs, it is difficult to find an appropriate method to retain or enhance soil fertility. A recent follow-up study of the results of shifting cultivation practiced in northern Thailand showed that an increase in nitrogen as well as the necessary increase in basic substances in the surface soil can be brought about by partial burning rather than complete burning. This suggests that the burning methods in shifting cultivation deserve studies for searching ways to prevent fertility loss.

As a result of burning and cultivation many slopes are intensely eroded by rain. The use of organic mulch to prevent erosion seems worthy of consideration.

(3) Soil Fertility Conservation and Improvement

In Section 3-3, the productivity order of the main soils in the Area was given as $AQ < LA < LV < PV$. Globally, red-yellow podzolic soil is widely distributed in and around the state of Georgia, in the southeastern U.S.A. The property of this type of soil is similar to that of most soil in the PGC Area (low humus and strong acid).

In the U.S.A., up to present this soil had not been used, but recently soil improvements has been carried out on the soil of the coastal plateau with a view that the area can be developed to a highly productive area. This type of soil can be productive if treated with lime and phosphoric acid fertilizer.

The LV and LA surface soils in the PGC Area are sandy with little clay. PV is ranked above LV and LA in terms of fertility for its high clay content, but this type of soil has a disadvantage in that the high clay content makes the underlayer dense and less permeable to water.

In the Area, sloping lands are generally intensely eroded.

From the above observations the following measures with respect to the conservation and enhancement of soil fertility seem desirable:

- 1) Preventing erosion; and
- 2) Improving acid soil and increasing bases.

At present, generally after cropping the burnt field is converted to pasture before soil fertility declines. Fertility declining can be prevented by adding organic materials. A truck farm at Bacabal has obtained good results by applying this method. Mulch is very effective as a source of organic material and in helping to retain moisture in the soil.

The next improvement step is the application of lime and phosphoric acid, which is currently practiced in the Cerrado region. In this case, too, it is desirable that organic substances be applied at the same time.

An ideal improvement method is to intensively use low furnace slag (3 - 5 times the amount of lime). This slag consists mainly of calcium silicate but includes also magnesium, phosphoric acid, manganese, iron and boron, and therefore is a highly effective soil improvement agent if applied at the rate of 10 - 20 tons/ha.

4. PRELIMINARY CROP SELECTION ON THE BASIS OF NATURAL AND TECHNICAL CONDITIONS

The PGC Area covers an area of 840,000 km², and its diverse climate ranges from the tropical rain forest zone in the north to the cerrado-type tropical savanna zone in the south. Soil types vary widely from alluvial soil in the basins of small and large rivers, to red latosol, yellow latosol and red-yellow podzolic soil. Various crops are being cultivated: tropical perennial woody crops (for example, rubber and cacao); recreation crops characteristic of the Amazon (for example, guarana); and typical tropical crops such as rice and cassava. Further, useful plants such as the Brazil nut and pinhao grow naturally. This Area is a treasury of palms, with a number of useful palms such as oil palm and babassu being cultivated or growing naturally.

The selection for the preliminary crops by sub-region was made from the natural and technical points of view on the basis of field surveys on the natural conditions in different areas and present crop cultivation; through interviews with Brazilian government officials, researchers, farmers, staff members of agricultural cooperatives, and extension workers; and through analysis of the collected research materials.

4-1 Summary of Natural Conditions by Sub-region and Crop Cultivation

4-1-1 Castanhal Sub-region

The climate of the Castanhal sub-region is of the tropical rain forest type, with annual rainfall of more than 2,000 mm, and the tropical monsoon zone type, showing high proportion of perennial woody crops. The vegetation is characterized by the existence of many species of palms including coconut, tucum, pupunha, and assai.

Cassava, rice, maize and feijao are the ordinary crops mainly cultivated on small- and medium-scale farms. Larger number of crops such as cotton, tobacco, and castor bean are cultivated in this sub-region compared to the other sub-regions. This sub-region is also characterized by the cultivation of tropical fruits such as cupuacu and recreation crops such as guarana.

Pepper cultivation has been stagnant in recent years due to disease, but its cultivation is continuing in disease-free areas.

The crop which has recently drawn much attention and has been given priority as a local speciality is oil palm. The large-scale cultivation of oil palm is now mainly being undertaken by DENPASA and Japanese-descended farmers of some agricultural cooperatives, with further development being expected in the future.

4-1-2 Bacabal Sub-region

The Bacabal sub-region, situated in the tropical humid savanna climatic zone, is characterized by babassu forest, and has wide distributions of such useful palms as tucum, assai, buriti, carnauba and coconut palm. Many pastures formed by burning babassu forest can be seen in this sub-region, but in the southern areas the vegetation is shifting to the cerrado type.

As the basic crops for general farming, rice, cassava, maize and feijao are being cultivated mostly for self-consumption. In particular, the northern area of this sub-region, unlike the other sub-regions, is marked by extensive paddy fields. In addition, there is some cultivation of sugarcane, and various species of vegetables are cultivated and consumed locally. The Bacabal sub-region has large swamp area extending to the coast in the northern region, and paddy-rice production is expected to increase as the zone is developed.

4-1-3 Imperatriz Sub-region

The northern part of the Imperatriz sub-region is covered with Amazon-type tropical rain forest; in the southern part there is cerrado-type vegetation, and in the central part, extensive babassu forest.

The climate is of a tropical humid savanna-type with relatively low rainfall (around 1,230 mm) compared with the other sub-regions of the PGC Area. The existence of various species of palm is a special feature of the sub-region, with piacava palm being dominant, although macauba palm and babassu are also abundant. Other useful palms include buriti, coconut, and tucum.

Rice, cassava, maize and feijao are crops cultivated mainly for self-consumption. Castor bean and pepper, and in recent years soybean and Para rubber trees have been introduced. As a result of the development of the alcohol industry through the National Energy Plan, the production of sugarcane as a biomass resource can be anticipated.

4-1-4 Maraba Sub-region

Though lying in the tropical humid savanna zone, the Maraba sub-region has relatively high rainfall (around 1,800 mm). In the southern

part, the vegetation is of the cerrado type, while the northern and western parts are close to the tropical monsoon zone with distribution of forests.

The conversion of forests into farmland is under way, and full-scale mountain clearing by burning is being carried out in some parts of the sub-region. The sub-region is characterized by heavily concentrated Brazil nut forest, and the collection and utilization of the nuts are a major concern for agriculture in the sub-region.

Rice, maize, cassava and feijao are the major crops cultivated for self-consumption and sale, with castor bean, sugarcane, sorghum, and pineapple also being cultivated. Sweet potatoes are being planted in settlement sites after the mountains have been cleared. Because of the favorable climatic conditions, perennial crops such as cacao and coffee are also cultivated.

4-1-5 Araguaina Sub-region

The Araguaina sub-region lies in the tropical humid savanna zone where the cerrado-type vegetation is dominant. In the northern part of the sub-region, there are extensive babassu forests.

Rice, maize and feijao are the main crops cultivated for self-consumption and sale, and the cultivation of cassava is relatively rare. In addition, sugarcane, cotton, sorghum, and pineapple, and in recent years, soybean are also cultivated. The existence of babassu provides a major hindrance to the development of pastureland in this sub-region.

4-1-6 Balsas Sub-region¹⁾

The Balsas sub-region, which lies in the tropical humid savanna zone, has relatively low rainfall (about 1,260 mm) compared to the other sub-regions. The vegetation is mainly of the cerrado type, with babassu forest in the northern areas.

Rice, maize and cassava are the main crops cultivated for self-consumption and sale. This sub-region seems promising in soybean production.

4-1-7 Xingu Sub-region¹⁾

The Xingu sub-region, which lies in the tropical monsoon zone and has an annual rainfall of more than 2,000 mm, is heavily forested. A number of palm species are growing naturally in the forest. With regard to other crops, castor bean cultivation is observed, and rubber trees are ranging in low and damp areas.

1) In this sub-region, only an over-flight for general observation was conducted.

Although presently characterized by the existence of wide-spread forests, the sub-region has high potential of crop production because of excellent natural conditions.

4-2. Technical Problems in Crop Production

In the PGC Area there are crops like soybean and oil palm of which the breeding and introduction of excellent varieties rapidly improved their productivities. However, there are many crops like paddy rice in the Castanhal and Bacabal sub-regions, Para rubber in the Imperatriz sub-region, and tobacco in the Castanhal sub-region, of which the presently-diffused varieties are not necessarily suitable. In some cases like that of oil palm, the variety itself is good, but the high price and difficulties in the procurement of seedlings (imported) present an obstacle to cultivation. Thus, for oil palm which is adaptable to the environment and highly profitable, it will be necessary to improve the present varieties and develop seedlings by introducing the tissue culture method and other new techniques.

The acquisition of seeds and their distribution to farmers — the starting point of crop cultivation — often create problems in tropical zones because of the high temperatures and humidity. Although the cultivation of soybean, which was begun only recently in the Area, is highly promising, soybean seed is susceptible to high temperature and humidity compared with cereals, and therefore requires proper facilities and technology for storage. In the Bacabal and Imperatriz sub-regions, the loss of soybean seeds as a result of the shortage of such facilities has become one of the major problems.

In the tropics, especially the humid tropical zone, one of the biggest causes of losses in crop production is the presence of diseases and pests; this applies to the PGC Area as well. For example, the disease of pepper and the pest of papaya in the Castanhal sub-region, the disease of Para rubber in the Imperatriz sub-region, and the pest of cacao, vegetables and grass in the Maraba sub-region, all require countermeasures in the form of new varieties and cultivation control.

A comparison of the yield of major crop in Brazil with main producing countries and several tropical Asian countries reveals that Brazil is around or above the world average but considerably low compared with the main producing countries in the production of cassava, soybean and sugarcane. The unit yield of maize is particularly below the world average. Regarding the productivity levels in the Area as compared with the national average, the Castanhal and Balsas sub-regions rate lowly as the crops compared (rice, maize, cassava and feijao) are produced in many cases on small farms with a low level of technology, under relatively unfavorable soil conditions, and mainly for self-consumption. It may be said that the traditional varieties and cultivating methods cannot easily raise the productivity of those crops in these sub-regions. In all sub-regions, the maize yield was lower than the national average, indicating the need to improve its varieties and cultivating methods.

4-3 Crop Selection by Sub-region (See Figure II-2)

The following points were taken into consideration for crop selection in the PGC Area, based on the natural and technical conditions: (a) environmental adaptation, (b) crop characteristics and related problems, and (c) information and materials obtained during field observations.

In all sub-regions, four crops — rice, cassava, maize and feijão — play an important role in small- and medium-scale farming in terms of farmers' self-consumption and cash income.

In Castanhal sub-region, in addition to the above food crops such as perennial commercial crops as oil palm, guarana and Para rubber suitable for the tropical rain forest zone or tropical monsoon climate seem important. Pepper is also important as a commercial crop in those areas free of disease. Various kinds of tropical fruits such as papaya, cupuacu, and mangosteen are also important as local specialties. In addition, sugarcane, cotton, tobacco, and cacao are suitable, and in the suburbs of the northern cities, various kinds of vegetables are promising.

In the Bacabal sub-region, by utilizing marsh and irriguous land the production of rice is expected to be increased. Para rubber, cacao, cotton and sugarcane can be considered as complement commercial crops. In the southern areas where cerrado is dominant, soybean is adaptable, and in the suburbs of the northern cities, vegetables are important. As for babassu which is abundant in the sub-region, in addition to its current use, new applications such as intensive use as a crop in specified areas or integrated utilization are worthy of consideration.

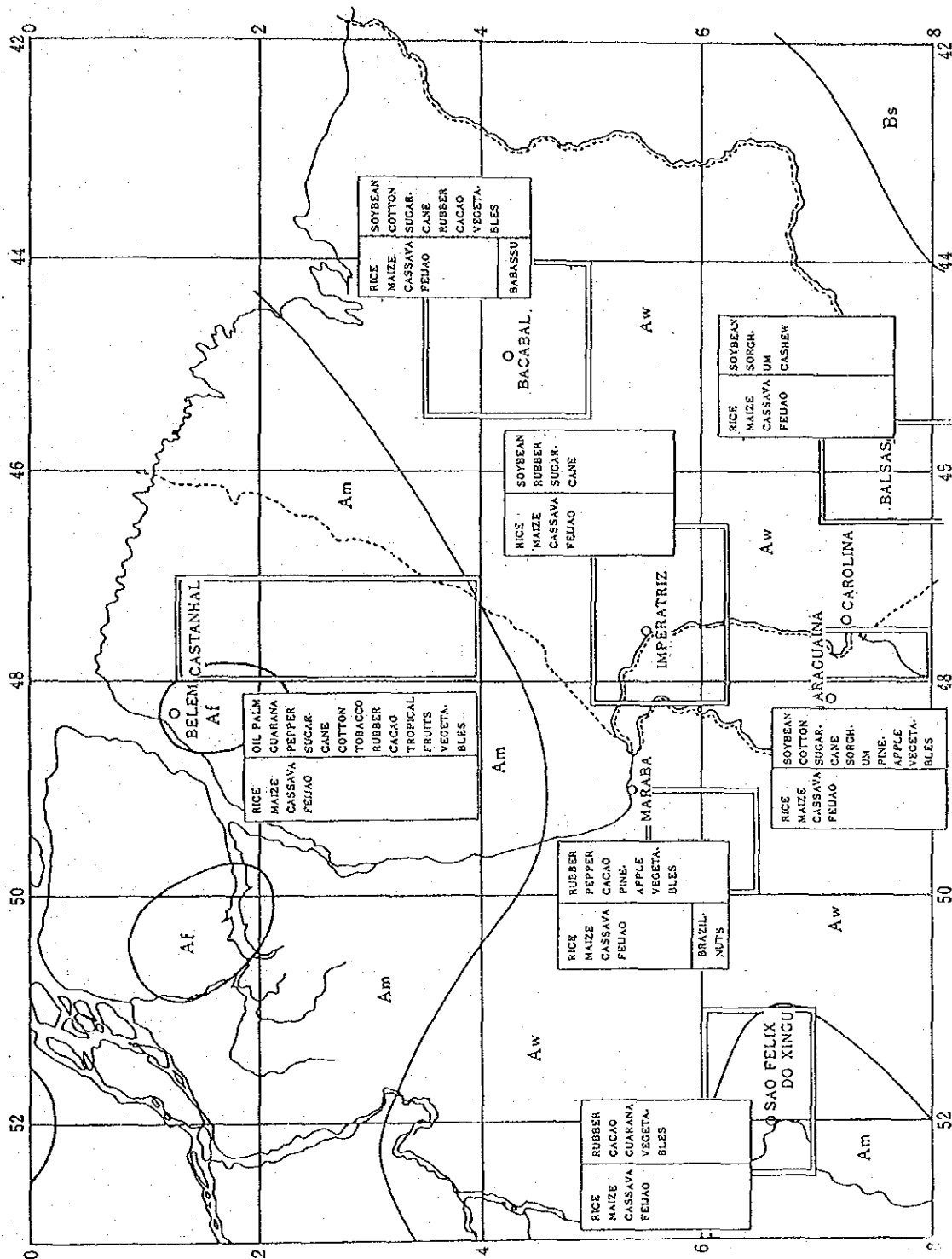
Regarding the Imperatriz sub-region, in the southern part which belongs to a cerrado region, soybean and sugarcane are suitable. In the northern part, low rainfall during the leafing time has a preventive effect on leaf blight disease so that Para rubber can be expected to be cultivated.

In the Maraba sub-region, due to plentiful rain, Para rubber, cacao and pepper are suitable in the northern and western parts, while in the southern cerrado part, pineapple and vegetables are suitable. With regard to Brazil nut trees which are concentrated in this sub-region, it seems necessary to enhance intensive use as a cultivated crop through introduction of new varieties of low trunk and high productivity, in addition to the current use.

In the Araguaina sub-region, which is in general of a cerrado-type environment, such relatively drought resistant crops as soybean, cotton, sorghum, and pineapple may be suitable.

In the Balsas sub-region, soybean seems to be the most promising crop.

Figure II-2 Suitable Crops by Sub-Region
(Based on Natural and Technical Conditions)



Finally, in the Xingu sub-region, which lies in the tropical monsoon zone with its abundant rainfall (similar to the Castanhal sub-region), Para rubber, cacao, guarana, and tropical vegetables are suitable. Since this sub-region is rich in fertile soil and has high potential of crop production, there is a possibility of large increase in the production of these crops in the future.

5. FARM STRUCTURE ANALYSIS

This chapter aims to clarify the features of the farm structure in the PGC Area and the cropping patterns of the sub-regions which are further dealt with in Chapter 7 of the Final Report. For this purpose, following a review of the existing studies included in the documents related to the Programa Grande Carajas Agricola and the PRODIAT Project concerning the Area, comparisons between the seven sub-regions and the whole country, and between the sub-regions themselves will be undertaken with a focus on: (1) the current use of land and labor, (2) trends in the production of main crops, (3) the distribution of farms by size, and (4) the form of land ownership. In this way, the position of the Area in the whole Brazil and the differences between the sub-regions will be clarified. The analysis in this chapter is based on the statistics of Brazilian Institute of Geography and Statistics (IBGE), Censo Agropecuario for the years 1970, 1975 and 1980.

5-1 Farm Structure in the PGC Area: An Outline

The purpose of this section is to summarize the farm structure in the Area by comparing its seven sub-regions with the nation as a whole. For this purpose, the farm structure has been divided into four elements as above mentioned. Regarding the current use of land and labor, comparison between the seven sub-regions and the whole country was made in terms of the area under cultivation (perennial and annual crops), the area of grassland (natural and improved pastures), the area of forests, unused arable land, and the ratio of land to labor. With regard to trends in the production of the main crops, in addition to the basic annual crops such as rice, maize and cassava, and the main perennial crops of cacao, coffee, oil palm and soybean, which have not yet been well developed, but which will play an important future role in the development of the Area, were studied in terms of the time serial changes in output and area to facilitate comparison between the seven sub-regions and the whole country.

Regarding the distribution of farms by size, farm sizes were divided into five categories (0 - 10 ha, 10 - 100 ha, 100 - 1,000 ha, 1,000 - 10,000 ha, and over 10,000 ha), and a distribution curve was constructed. Based on this curve, the features of the distribution patterns of the seven sub-regions were clarified. As for land ownership, the total number of farms was divided into four types: owners, tenants, occupants and administrators, and the percentages of each group were compared (The results are summarized in Section 5-3 below).

5-2 Farm Structure by Sub-region

This section clarifies the similarities and differences between the sub-regions in the Area. For this purpose the farm structure was divided into the four elements detailed above. In order to clarify the features of the sub-regions, comparison was made between the sub-regions (The results are summarized in Section 5-3 below).

5-3 Study Results

The results of the study analysis are as follows:

- (1) The PGC Area has undergone rapid agricultural development since 1970 based on expansion of pasture and cropping areas. In the comparison between the seven sub-regions and the country as a whole, in terms of trends in the production of main crops, the production of the main crops in each sub-region showed a strong increase, largely due to the expansion of the area under cultivation, rather than to an increase in the level of yield.

The recent increase in the area of pasture is remarkable, especially in the state of Para which registered the highest increase in Brazil in the decade 1970-80. One of the reasons was that there remained much unused arable land and many forest areas in the Area, resulting in relatively cheap land prices; and a lot of public investment was made in infrastructure during the 1970s with the focus on transportation.

- (2) Although the area for cultivation of crops and pasture has been rapidly expanded, a considerable part of the Area still has unused arable land and forests. Statistics prepared by IBGE based on the agricultural census shows that in 1980 the percentage of unused arable land and forests was about 35% of the total area on a national basis, and 60% on a sub-regional basis. Such a high percentage of unused arable land and forests indicates high potentials for the future development of the Area.
- (3) The PGC Area is becoming a production area for beef cattle with the ratio of pasture area to cropping area exceeding the national average, suggesting that beef cattle production is being carried out with modern technology in relatively new and large farms.
- (4) Rice, maize, feijao and cassava are cultivated by most small- and medium-scale farmers in each sub-region. Through the field survey, however, it was observed that the cultivation patterns of these four food crops vary from sub-region to sub-region, although, in general, they can be divided into three types: first, shifting cultivation in which farmers burn forests to cultivate the crops and shift to another place after harvesting; secondly, land rotation in which farmers burn forests to cultivate crops for a certain period of time (1 - 5 years), and fallow the land for 10 - 20 years in order to recover the fertility of the soil, after which