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AGRICULTURAL PLANS FOR BRAZIL'S GRANDE CARAJÁS PROGRAM: LOST OPPORTUNITY FOR SUSTAINABLE LOCAL DEVELOPMENT?

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Figure 1: Agricultural Development Poles of PGC-Agrícola

1. INTRODUCTION: THE PGC-AGRÍCOLA PLAN

Programa Grande Carajás Agrícola (PGC-Agrícola) is a US\$1.18 billion plan to radically transform the agriculture of the eastern portion of Brazil's Amazon region. The 840,000 km² Grande Carajás Program zone is larger than France and Britain combined, more than twice the area of the US state of California, or larger than all the states of Brazil's Southern Region plus the State of São Paulo. Seven agricultural development poles scattered throughout the project zone would serve as focal points for spread of the proposed technologies to the remainder of the area. Special tax and financial incentives already enacted apply to the entire program zone. According to the six-volume report that contains the plan (Brazil, Ministério da Agricultura, 1983, hereafter referred to as 'PGCA'), undertakings to be financed within the agricultural poles would include 238,000 hectares (ha)

of mechanized soybeans, 12,600 ha of sugar cane, 417,000 ha of cattle pasture, and what is described as enough rice to feed all of Northeast Brazil. Cattle export would be promoted through a special 'sanitary pocket' where hoof-and-mouth disease (aftosis) and undulant fever (brucellosis) would be eradicated, thus opening up currently-closed markets for unprocessed beef in the United States and Japan. Also included is a 3,600,000 ha charcoal production area in a 40 km-wide swath along the 890-km railway that has been built to carry ore from the Serra dos Carajás iron mines in Pará to the Ponta da Madeira port at Itaquí, near São Luis, Maranhão.

The scale of the plans for the Grande Carajás Program has major consequences for the future of the Amazon region. The plans carry heavy direct financial costs, as well as equally immediate and inescapable social costs, to say nothing of the environmental and opportunity costs associated with loss of the original forest cover in the areas affected. The financial and social costs may result in many of the proposed projects not being realized on the scale foreseen in official documents. Such a pattern is common in the region -- for example the greatly reduced colonization along the Transamazon Highway as contrasted with original plans, or the many roads shown crisscrossing Amazonia on maps published by the Brazilian government in the early 1970's that were never built, such as the Perimetral Norte, the Cachimbo-Manaus (BR-80), Vilhena-Manaus (BR-172), Lábrea-São Paulo de Olivênciã, Manaus-Tapuruquari (and its extension to the Colombian border), Boca do Acre-Benjamin Constant, and others. The budget for the agriculture sector of the Grande Carajás Program requires the Brazilian government to invest an amount of money it does not have: US\$ 1.18 billion over the 1985-1990 period.

The history of the Grande Carajás Program illustrates a general pattern in Amazonian development planning. The program has been presented to the public as an evolving series of trial balloons in the form of 'preliminary' reports and oral proposals. These have been met by a steady stream of criticism -- but officials can easily counter such criticism by claiming that the plan in question is no longer the current one, even though the basic form of Grande Carajás remains intact.

The Grande Carajás program began with a report drafted by a group of Japanese consultants invited by the Brazilian government's mining enterprise Companhia do Vale do Rio Doce (CVRD) to evaluate the export opportunities created by infrastructure to service the Carajás mining undertakings. The report (International Development Center of Japan, 1980) called for an 'export corridor' where agriculture, ranching and silviculture would be financed on properties of 10,000 ha each (Cota and Coelho, 1984). Later refinements of the proposal published by CVRD stipulate that there would be 300 such 10,000 ha properties installed in the 'ranching sector' of the plan, with a total investment of US\$1.73 billion, or US\$5.57 million per ranch (Brazil, CVRD, 1981a: 134; Brazil, Minist'rio das Minas e

Energia, nd [Circa 1981]: 34). Potential impact of the plan on agrarian structure has been sharply criticized (Coelho and Cota, 1984; Pinto, 1982; Sociedade Brasileira para o Progresso da Ciência, Núcleo de Rio de Janeiro, 1982: 46).

The scale of investments proposed for the agricultural sector decreased in subsequent revisions of the plan. The original plan called for US\$8.1 billion in agriculture, US\$1.7 billion in ranching, and US\$1.3 billion in silviculture (Brazil, CVRD, 1981a,b; Brazil, Minist'rio das Minas e Energia, nd [\Circa\ 1981]; Ferreira, 1982: 34). The present PGC-Agrícola plan (PGCA), calling for a total direct investment of US\$1.18 billion, is modest when compared to the initial proposal.

The 300 ranches of 10,000 ha each given prominence in the earlier proposal are not mentioned in the 1983 PGC-Agrícola document. These ranches, which would have occupied a total of 3 million hectares (presumably only half of which would have been planted in pasture under the plan, to conform to Brazilian law) would far exceed the 417,000 ha of pasture included in the 1983 PGC-Agrícola document. The 12,600 ha of sugar cane (PGCA: Vol. 3, p. VII.36) is a tiny fraction of the 2.4 million ha originally proposed for energy crops (sugar cane + manioc intended for alcohol) (Brazil, Minist'rio das Minas e Energia, nd [Circa 1981]: 32). Soybeans have been slightly reduced from 360,000 ha to 238,000 ha. The plans for the silvicultural plantations are unclear, but since the original 1981 budget of US\$1.36 billion for silviculture is greater than the entire PGC-Agrícola budget of the 1983 document, one might infer that the 3.6 million ha designated for 'charcoal' in the PGC-Agrícola plan will not be used to accommodate the 1.5 million ha *Eucalyptus* scheme described in the original proposal. The plans for silviculture and charcoal production, nevertheless, remain a major area of vagueness in the current plan.

The present plans for the agricultural sector of the Grande Carajás Program must be interpreted in the context in which they have been elaborated. Taking advantage of the opportunity afforded by the railway is a major justification for the agriculture project, since costs of producing and delivering export crops to market will be lower, and profit margins higher, thanks to this transportation windfall. The railway, built at a cost of US\$3.6 billion (Sociedade Brasileira para o Progresso da Ciência, 1984) with monies from the mining operation, comes at no cost to PGC-Agrícola. The PGC-Agrícola document states the program's objectives as follows (PGCA: Vol. 3, pp. IV.16-17):

1.) Contribute to increasing the agricultural productivity of the region;

2.) Stop the tendency to devastation of the forest and degradation of natural resources, and eliminate atmospheric pollution from burning forest;

3.) Make the agricultural sector economically viable, with a view to promoting a full employment economy;

4.) Reverse the tendency towards concentration of land ownership, and stimulate the formation and consolidation of a stratum of economically sound family farms.

Contradictions in these objectives make it unlikely that all stated goals will receive concerted effort, or that all will be achieved. The objective of maximizing earnings from export crops is not necessarily attained by means that promote full employment and support small farmers when conflicts for land and financial resources arise with large landholders. This has been the case in the Transamazon Highway colonization areas, where conflicting goals included alleviating population pressure in Northeast Brazil and producing an agricultural surplus for export (Fearnside, 1984a). In fact, the structure of the Programa Grande Carajás Agrícola plan assures that the bulk of resources are directed at boosting export production rather than attaining the social and environmental goals.

In addition to the stated objectives, others have been attributed to the program:

1.) Protect the mining operations of the state mining enterprise Companhia do Vale do Rio Doce (CVRD) against possible invasion by large numbers of squatters in nearby areas of land conflict.

2.) Stake out claims for establishing potentially highly-profitable enterprises in the most desirable locations for large agribusiness interests (located predominantly in Brazil's Central-South region). High profitability is expected due to the provision of infrastructure such as rail, road and barge transportation at government expense, the availability of special tax and other incentives, agricultural production, and greatly increased speculative value of the land benefited by the expected developments.

3.) Contain social discontent and violence potentially disruptive to projects contributing to the national economy.

The avowed purpose of the document presenting the plans for the Grande Carajás Program's agriculture project is to serve as a starting point for negotiating loans from the Interamerican Development Bank (PGCA: Vol. 1, p. i). Some parts of the plan described in the document might well not be approved and funded, or might be carried out on a merely token scale in practice. This is probably most likely for plans related to social services and other activities that do not produce immediate monetary returns.

A good example of the relationship between preliminary documents of this kind and the real events that follow is the 'Agricultural System for Rondônia' (Brazil, Governo de Rondônia, SEAG, 1980). This five-volume document was prepared under similar circumstances

to help convince the World Bank to finance the POLONOROESTE regional development project. As in the case of the PGC-Agrícola document, the developments proposed were peripheral to the major investment, which was paving the Marechal Rondon (Cuiabá-Porto Velho) Highway (BR-364). Many of the features of the Agricultural System plan designed to benefit small farmers have not been implanted in practice (Millikan, 1984). Most of the expenditures actually made have been for items profitable to construction contractors, such as the building of schools and health clinics, while less-profitable outlays such as providing these with teachers and doctors have been neglected.

2. PGC-AGRICOLA DEVELOPMENT POLES AND SUB-PROJECTS

The agricultural development poles (Figure 1) proposed by PGC-Agrícola were selected for a variety of reasons. As of September 1984, with PGC-Agrícola operating on a skeletal budget prior to the approval of any major funding, only two poles were active: Castanhal and Bacabal. One would not expect these two to receive priority based on the program's stated goals. Marabá, for example, is the closest to the Carajás mining operation and is experiencing the greatest increase in social and other tensions linked to the Carajás activities, yet it has so far received nothing, while Castanhal, near Belém and served by the already paved Belém-Brasília Highway (BR-010), is little affected by the advent of the Carajás mine and railway. It already has a greater concentration of high-input agriculture than other areas, reducing the demonstration effect where capital-intensive agricultural patterns of farmers financed under the program are copied by unfinanced neighbors who would otherwise continue practicing the region's traditional methods.

What is described as the 'basic proposal' of PGC-Agrícola is: 1) technical and administrative activities aimed at organizing production and transforming and marketing the agricultural goods produced, and 2) government actions to strengthen the infrastructure supporting production, by means of research, rural extension, credit, transport, storage facilities, supply of 'modern' inputs, 'prices' [NB: price supports are not included in the budget], land tenure policy, and agro-industries (PGCA: Vol. 3, p. IV.15).

An examination of the budget for PGC-Agrícola (Table 1) reveals that by far the largest item is agricultural and cattle ranching development (meaning credit for individual land owners), accounting for 42.8% of the total budget. When other forms of credit are added for marketing, seeds and seedlings, the portion devoted to credit rises to 56.1% (Column 8 in Table 1).

Outlays most closely related to the social benefits proclaimed in the PGC-Agrícola report -- such as expenditures for technical assistance, cooperatives, colonization and directed settlement -- total only 11.9% of the budget. Furthermore, other items related to the program's stated goals of developing

sustainable agriculture and forestry systems, such as the allocations for forestry development and agricultural research, total only 3.6% of the budget. The budget remains dominated by the agricultural development (credit), transport (highway construction) and agro-industrial development. These items total 69.2% (Columns 9 and 10 in Table 1).

The high budget total of US\$1.18 billion is one of the principal drawbacks to implementing the program as outlined in PGC-Agrícola. Once hidden subsidies are included, the real total would be substantially higher. The PGC-Agrícola document itself admits that 'due to inflation, the amortization of agricultural credit is negative in real terms,' and also confesses that 'it was judged convenient to include only the amortization of principal in the payment of debts, which implies a real interest rate equal to zero' (PGCA: Vol. 3, p. VII.7). The difference between the negative interest rate and zero represents a subsidy by the Brazilian government to the agriculture undertaken in the project. Since the credit for the different categories foreseen in the project totals US\$621.10 million (See Table 1), the real cost of the Grande Carajás Agricultural Program would be greater by an amount which, depending on loan payment terms and inflation during the project period, could easily surpass US\$100 million from this item alone.

In examining the budget in Table 1, it is important to keep in mind the ways in which it is likely to be cut if the project is undertaken. Items that do not translate quickly into profits, such as agricultural research, are most likely to be sacrificed. Irineu Bentes Lobato, head of the Programa Grande Carajás office in Bel'm, told this author that he would favor reducing the outlay for agricultural research since the Brazilian Enterprise for Agriculture and Cattle Ranching Research (EMBRAPA) had experiment stations in other parts of the Amazon that could produce results adequate for the agricultural development pole areas (I.B. Lobato, personal communication, September 1984). An argument might be made, however, that the 3.2% of the budget devoted to agricultural research should be maintained or increased, especially if the research is directed at the problems of sustainability that need to be solved if the general statements in the PGC-Agrícola document are to be realized. If the total PGC-Agrícola budget is to be cut significantly, it would most logically be in the area of agricultural credit. If the farming systems proposed are indeed as profitable as the PGC-Agrícola document claims, then investors should be willing to apply more of their own funds to them even without such heavy direct and indirect government subsidies.

3. PGC-AGRÍCOLA FARMING SYSTEMS

(a) *Crops and Yields of Proposed Farming Systems*

PGC-Agrícola proposes 19 farming systems to be promoted in the Agricultural Development Poles, with the hope that the farmers

outside of the poles will follow these patterns when the economic success of the systems becomes apparent. The systems are coded P1 to P10 for those intended for 'mini and small' producers (farmers 'capable of effectively exploiting' up to 15 ha), M1 to M7 for systems intended for 'medium and large' producers (60 to 80 ha), and G1 to G2 for systems for 'large' producers (80 to 500 ha) (PGCA: Vol. 3, p. IV.6.16.11). The producer types are officially defined in terms of area they are 'capable of effectively exploiting,' not the area of the land holding, which may be much larger, especially in the case of large producers. The areas of crops for each system are shown in Table 2, both for the beginning year ('year zero') and the 'target' year to be achieved by the end of the five-year PGC-Agrícola program and maintained indefinitely into the future. The numbers of properties and areas within the development poles for each system are also shown, along with the internal rates of return calculated in the PGC-Agrícola document. All of the systems are economically attractive, provided the assumptions regarding yields, credit terms, and the prices of agricultural products and inputs assumed in the calculation are correct.

The profitability of the agricultural systems depends heavily on achieving high yields. Yield increases over present levels ranging from 28 to 67% are assumed (Tables 3 and 4). These expected yields may be overly-optimistic for two reasons:

First, the assumed sharp increases in per-hectare yields may be unwarranted, since the past record of projects of this type suggests need for caution. In the case of the Transamazon Highway, similar high yields were foreseen at the outset of the project (Brazil, Ministério da Agricultura, INCRA, 1972), while real yields proved to be only a fraction of those predicted (Fearnside, 1978, nd-a; Smith, 1978, 1981; Wood and Schmink, 1979).

The second reason to question the high yields assumed for the proposed agricultural systems is the high starting yields to which the percentage increases are applied. In several cases, the present mean yields used as the basis of calculation are higher than available data would indicate. Bean yields are assumed to be 600 kg/ha, but the actual 1980 yields from the Programa Grande Carajás area averaged only 442 kg/ha. The lower yields are indicated by data from the Municipal Agricultural Production Census carried out by the Brazilian Institute for Geography and Statistics (F.IGBE), cited in another part of the PGC-Agrícola report (PGCA: Vol. 1, pp. II.4.101 and 103). Rice yields averaged only 1273 kg/ha in 1980, rather than the 1400 kg/ha assumed for present yields in deriving technical coefficients for the farming systems (Table 3). Multiplying these lower starting yields by the percentage increases assumed would result in lower production, and therefore less-profitable agricultural systems.

Obtaining high yields is not easy, even where average soil quality is relatively good as in the Altamira portion of the

Transamazon Highway. By Amazonian standards, the Carajás area includes a fairly high proportion of soils that are good: 20.7% are classified as eutrophic (calculated from Serviço Nacional de Levantamento e Conservação de Solos - Empresa Brasileira de Pesquisa Agropecuária (SNLCS-EMBRAPA) \Mapa dos Solos do Brasil\ by I.C. Falesi, personal communication, 1984). Not all soils are suitable. For example, the PGC land capability survey (Brazil, Ministério da Agricultura, Secretaria Geral, Coordenaria de Assuntos Econômicos, 1984) rated the soils at the locations chosen for PGC-Agrícola's sugar cane producing poles in Maranhão (PGCA: Vol. 3, p. IV.6.105) as only marginal to fair for that crop.

Failure in raising per-area yields in Amazonia stems, at least in part, from the historical tradition -- and the immediate advantage to farmers -- of increasing farm income and speculative property value by expanding area rather than investing in capital- and labor-intensive methods to raise per-area production (See Fearnside, 1979a, 1983a). In areas where perennial crops have been promoted, such as the Transamazon Highway and Rondônia, loan recipients have often found ways to illicitly apply the funds to cattle pasture (personal observation). The danger that the best-laid agricultural plans will end up as cattle pasture will continue so long as the system of rewards favoring this system remains unchanged.

From the point of view of mini and small producers, significant features have been ignored that dramatically reduce the desirability of these farming systems in practice. One is time and money spent by colonists in arranging for loans, collecting installments, and making payments. In the case of small loans, these costs can be so heavy as to cancel any advantage of planting financed crops (See Moran, 1981; Bunker, 1980: 587; Fearnside, 1980a).

A second vital factor from the point of view of the smaller farmers is the variability in crop yields. High variability from one year to the next and from one farmer to the next can make an agricultural system unattractive even if the high mean yields used in calculating the PGC-Agrícola internal rates of return prove to be correct. The vital role of crop variability has been demonstrated in the case of Transamazon Highway colonists through computer simulations using stochastic models of the agroecosystem there (Fearnside, 1978, 1979b, 1983b, nd-a). Agricultural systems that expose farmers to high risk are undesirable, regardless of how profitable they may appear based on average yields.

(b) *Chemical Inputs to Proposed Farming Systems*

The farming systems proposed by PGC-Agrícola rely heavily on applying fertilizers, pesticides and other 'modern' inputs to agriculture, with a simultaneous introduction of agricultural mechanization. The PGC-Agrícola document states that 'basically, this intensification translates into replacing fire by

fertilizers. The application of fertilizers requires plowing the soil, involving agricultural mechanization' (PGCA: Vol. 3, p. IV.17). The quantities of chemical inputs assumed for the crops included in the 19 farming systems are shown in Table 5.

In most parts of the world -- especially in the tropics -- where heavy pesticide use has been employed, the amounts required tend to increase steadily. The pattern of increase is a response to greater resistance among insect pests and to greater pest population densities once the species that parasitize and prey upon the pest species have been eliminated from the systems (e.g. Barducci, 1972 in Peru; Newsom, 1972 in Louisiana).

The plan calls for unprecedented increases in use of chemical input. Within the area, 13.6% of establishments used some sort of pesticide in 1975, as compared with the national average of 51.1% (PGCA: Vol. 1, p. II.4.1.3). Only 0.2% of the properties in the area used any kind of fertilizer, one-twentieth of the national average (PGCA: Vol. 1, p. 2). Most of those that use these inputs are in the area of Castanhal (PGCA: Vol. 1, p. II.4.1.33), an area occupied by many settlers of Japanese origin who have a longstanding tradition of intensive labor and capital inputs. This specialized population is not present at the other agricultural development poles.

4. EXPECTED CHANGES IN AGRICULTURE

(a) *Indigenous Agriculture*

A significant part of the Grande Carajás area is occupied by indigenous groups. These practice shifting cultivation, exploit a wide variety of forest plants and obtain animal protein through gathering, hunting and fishing (for Kayapó subsistence, see Posey, 1983, 1984, Werner, 1984). In response to opportunities to enter the national cash economy, some tribes have specialized in Brazilnut harvesting, while others have intensified subsistence production (Gross *et al.*, 1979, Werner *et al.*, 1979).

The foundation of indigenous agricultural systems is usually shifting cultivation. This system involves a short cropped period followed by a lengthy period in woody second growth as fallow. The long fallow is necessary, within limits, to restore nutrient stocks for release to the soil through burning (Ahn, 1979). The system is sustainable in Amazonia only if an extended fallow period is employed (See Nye and Greenland, 1960; S'nchez, 1973, 1976). Shifting cultivation is frequently criticized by agronomists because it provokes soil erosion, requires large areas, and makes little contribution to the cash economy (Alvim, 1978). The PGC-Agrícola document points out the loss of valuable wood:

Each hectare of forest incorporated into the productive process signifies the destruction of US\$10,000.00 in commercial timber in order to produce approximately US\$300.00 or US\$400.00 worth

of food in the first two years. Afterwards, the area is abandoned to idleness for a decade, so that it can return to produce at the most US\$200.00 in grain per cycle. (PGCA: Vol. 3, p. IV.13)

Shifting cultivation also appears to be the principal target of PGC-Agrícola's goal of reduced air pollution: 'The effects of shifting cultivation produce ... atmospheric pollution during the dry season by saturating the air with a dense layer of smoke, putting airplanes at risk over vast areas and causing problems for public health' (PGCA: Vol. 3, p. IV.10). Advantages of shifting cultivation (not mentioned in the report) include its independence of outside inputs and its potential sustainability at low population densities.

While printed words are abundant professing the 'respect' that PGC will have for indigenous cultures (e.g. Brazil, Presidência da República, SEPLAN, nd. [Circa 1982]), the practical effect of installing the massive agriculture and other schemes planned or in progress is the removal of progressively more land from indigenous control, and the violation of Amerindian areas and reservations by highways built to transport agricultural production to markets. Highway construction almost invariably leads to invasion of accessible areas by squatters. Maps of proposed highways and other developments indicate no fewer than fourteen cuts of roads through reserves, plus one cut by the railway, to say nothing of cutting at least one reserve by the electric transmission lines from Tucuru' and flooding parts of three reserves by the Tucuru' reservoir (Fearnside, in review; see also Ferraz, 1982).

(b) *Caboclo Agriculture*

Caboclos are poor rural inhabitants of in the Amazon who speak either Portuguese or Lingua Geral, rather than indigenous languages, as their mother tongue. Born and raised in Amazonia, they are distinct from 'pioneers' (squatters and colonists) who have come, or whose immediate ancestors have come, to the region from other parts of Brazil. *Caboclos* practice an agriculture similar in many ways to that practiced by indigenous groups, but differ in using fewer forest resources; practicing a more intensive agriculture, for example by employing a shorter fallow between successive plantings; and planting a higher ratio of cash to subsistence crops. Wagley's (1976 [1953]) book *Amazon Town* presents background information on the still poorly-documented traditional subsistence system of *caboclos* in the area. Under PGC-Agrícola, *caboclo* agriculture is likely to decrease as lands are incorporated into properties practicing the agricultural patterns promoted by the program.

(c) *Squatter and Colonist Agriculture*

Posseiros (squatters) are small immigrant farmers without documents for the land they occupy, while *colonos* (colonists) are

small farmers placed on lots in government settlement schemes. These groups usually begin by planting annual subsistence crops such as rice, maize, beans, and tuber crops. Rice and beans are subsistence staples, in contrast to the manioc flour and fish of *caboclo* and indigenous diets. Colonists almost invariably plant pasture after the initial use of land for annual crops, as do squatters if they manage to maintain their land claim past the first few years. Colonists often have access to bank financing, at least during the initial phases of their settlement before many of them become disqualified from further financing by defaulting on previous loans. In older colonization areas settled by the National Institute for Colonization and Ararian Reform (INCRA), colonists have planted some areas of perennial crops such as cacao and rubber. This has not yet occurred in the newer areas settled by the Special Group for the Lands of the Araguaia and Tocantins (GETAT), due partly to the lack of agricultural extension agencies such as the Enterprise for Technical Assistance and Rural Extension (EMATER) and the Executive Commission for the Cacao Plantation Plan (CEPLAC). The colonization programs will be discussed in a later section.

(d) *Mechanized Farming*

Mechanized cultivation, especially of soybeans, is steadily encroaching into Amazonia from the region's southern edge in Mato Grosso. This is occurring in these edge areas (outside of the PGC zone) even in the absence of the special incentive programs foreseen in the Grande Carajás area. The number of tractors in the PGC area grew from 1,063 in 1970 to 1,767 in 1975 to 10,674 in 1980 (PGCA: Vol. 1, p. II.4.1.28 citing F.IBGE Agricultural Census data). With the improved transportation system and the programs included in Grande Carajás specifically designed to boost mechanized grain production, this form of agriculture can be expected to increase dramatically in the area. The PGC-Agrícola document states:

soybeans represent the crop with the best economic prospects for the region. . . . After the introductory stages for the crop, it is estimated that annual production will be 476 thousand metric tons, worth US\$72 million or almost 50% of the gross value of [the total PGC] grain production. The area to be incorporated directly through the project will be about 238,000 ha. (PGCA: Vol. 3, p. VII. 34-35)

Mechanized agriculture carries with it a mixture of benefits and drawbacks. Productivity per hectare and per worker-day of labor is high relative to most other land uses. Drawbacks include the pattern of large landholdings often associated with this use; the increased dependence on imports from other regions of fuel, fertilizers and pesticides; the exposure to possible price variations for these inputs; and the eventual finite limits to available stocks of fossil fuels and mineable deposits of certain nutrients. The cycle of increasing pest resistance to agricultural chemicals is also intimately associated

with this agriculture form (Janzen, 1973). The soil in Amazonia does not always respond as favorably to plowing as is the case in the temperate regions where these techniques and equipment were developed: soils in the temperate zone are usually less acid and more fertile as one descends in the soil column, while turning over an Amazonian soil through plowing usually brings to the surface a horizon which is more sterile than the original undisturbed soil surface. Soil compaction also results, inhibiting plant growth and increasing erosion (Fauck, 1977).

The authors of the PGC-Agrícola document have complete faith in the beneficial effects of technification. They state flatly: 'It is proven that the productivity of the land is directly related to the technological level and the rate of capitalization applied' (PGCA: Vol. 3, p. VII.48). In addition to the reservations already mentioned, one might add that the 'productivity of the land' obtained from such technification does not usually translate into production of more agricultural jobs or increasing the number of people supported in the region where the transformation takes place.

(e) *Ranching*

Cattle ranching, which will receive new impetus for rapid expansion under the PGC-Agrícola plan, is the land use already occupying the most area in the Grande Carajás zone. Ranching has been expanding rapidly due in part to its profitability independent of the production of beef cattle for sale, a situation arising from the tax and financing incentives given to approved projects, and, even more importantly, from the role of pasture in securing land tenure for speculative purposes (Fearnside, 1979a, 1983a, 1984b; Mahar, 1979).

The planners of PGC-Agrícola believe that cattle pasture is well suited to the region. The Secretariat of Planning's announcement of the program states: 'Ranching activities, especially cattle raising, are highly favored by the ecological conditions of the program region' (Brazil, Presidência da República, SEPLAN, nd. [Circa 1982]: 28). The PGC-Agrícola document takes the rapid spread of ranching in the region as proof of its suitability:

The ecological conditions of the area of the project are favorable to the development of ranching, especially beef cattle raising which, over the past decades, intensified principally in the great ranching poles in the Araguaia-Tocantins valley, the Marabá region, Paragominas and Imperatriz. (PGCA: Vol. 1, p. II.4.1.2)

It is difficult to accept this conclusion given the description following it in the PGC-document itself outlining the usual pattern of declining pasture productivity with soil depletion and invasion of second growth, resulting in ranches becoming uneconomic after 5-8 years under normal conditions and

after 12-14 years with 'adequate management' (PGCA: Vol. 1, pp. II.4.1.2-3). Cattle pasture is, in fact, not sustainable under the low-input system in general use among ranchers in the area, principally due to declining soil phosphorus combined with soil compaction and weed invasion (Fearnside, 1979c, 1980b; Hecht, 1981, 1983). Far from being evidence of the ecological suitability of pasture to the region, the cattle ranching poles in places such as Paragominas stand as evidence to the contrary. By 1981, over 50% of the pastures in the Paragominas area were degraded (Hecht, 1983: 194).

Social, as well as agronomic, considerations make pasture the least desirable land use option from the viewpoint of the well-being of the region's population (Fearnside, 1983c; Goodland, 1980). As will be shown in a later section, pasture is inextricably linked to the increasing land tenure concentration and violent land conflicts in the region. PGC-Agrícola foresees the agricultural development poles having 417,000 ha of good quality pasture, producing 27,000 metric tons of beef and 5,900 metric tons of other meats annually, yielding a total animal production worth US\$41 million per year (PGCA: Vol. 3, p. VII.37).

One of the most far-reaching features of the cattle ranching plan is the proposal for a 'sanitary pocket' in Southern Pará and Northern Mato Grosso, located in 225,000 km² between the Araguaia and Xing' rivers. The proposal calls for two stages. The first stage (1984-1988) would eliminate clinical cases of hoof-and-mouth disease (aftosis) and reduce the incidence of undulant fever (brucellosis). This would allow access to export markets with limited sanitary restrictions, including Venezuela and the European Common Market. The second phase (1989-1993) would establish an area free of hoof-and-mouth disease and would certify properties as free of undulant fever, thus opening up the major markets in the United States and Japan (PGCA: Vol. 6, p. 4).

The 'sanitary pocket' plan would be profitable in monetary terms. The authors of the PGC-Agrícola document calculate an internal rate of return after 10 years of 16.35% (PGCA: Vol. 6, p. 77). The document fails to point out items on the negative side of the balance.

One consequence would be a reduction below the already low levels of employment generated by cattle raising. The ability to export meat in frozen form would eliminate the jobs in the Brazilian meat processing industry. The present necessity of processing the meat costs the industry an additional US\$335.00 per metric ton of treated product (PGCA: Vol. 6, p. 74).

A bigger drawback of the 'sanitary pocket' is its link to a continued pattern of large landholdings. A key part of the justification of the plan is the 'ideal conditions for this type of program due to the isolation provided by forest between the large properties' and the fact that there are 'properties of great extent, in the majority of which a complete cycle is developed of

rearing, reproduction and fattening, taking advantage of a large animal population...allowing the herd to be considered, for practical purposes, a closed population' (PGCA: Vol. 6, pp. 5-6).

Another disadvantage of the sanitary pocket plan is its impact on deforestation by opening up Brazil to the infamous 'hamburger connection' -- the overwhelming economic force currently exerted on the remnants of rainforest in Central America by Northamerican fast food chains such as MacDonal'd's (see Myers, 1981; Nations and Komer, 1983). This virtually insatiable market can be expected to induce ranchers in the Grande Carajás area to clear the remaining forests there at an even faster rate.

(f) *Silviculture and Forestry*

One of the major doubts concerning the future of the Grande Carajás area is the extent to which the program will pursue grandiose plans announced for charcoal production from native forests and from silvicultural plantations. In 1982, at the Brazilian Society for the Progress of Science (SBPC) meeting in Campinas, São Paulo, a plan was announced by Nestor Jost, then executive secretary of the Grande Carajás Interministerial Program (Fearnside and Rankin, 1982a). The plan called for installing 2.4 million ha of *Eucalyptus* plantations along the railway route. The plantations would be distributed in a series of 10,000 ha properties; it is unclear whether these refer to the same 10,000 ha properties that the earlier 1981 Grande Carajás proposal foresaw for cattle ranching (Brazil, Minist'rio das Minas e Energia, nd. [Circa 1981]: 34). In addition to the silvicultural area, charcoal would be obtained from native forest throughout the Grande Carajás Program zone. This would be purchased from local residents, including *caboclos* and even indigenous groups, at a network of charcoal collection points spread over the 840,000-km² region, according to the plan announced by Nestor Jost.

Since the announcement of the charcoal plan no more formal proposals have appeared, to this author's knowledge, that would indicate that the scheme is progressing. Plans for mounting two charcoal-fueled pig-iron plants along the railway line were under discussion by CVRD in 1985 (H.O.R. Schubart, personal communication, 1985). The pig-iron plans call for charcoal supply from cutting native forest, due to the greater expense of obtaining charcoal from silvicultural plantations.

Prior to the 1983 PGC-Agrícola document, one report of the Programa Grande Carajás charcoal plan (Brazil, Minist'rio das Minas e Energia, nd. [Circa 1981]: 30; see also Pinto, 1982: 61-62) stated that 180,000 ha of trees would be planted annually for 8 years, which would make to total plantation area 1,440,000 ha (rounded to 1.5 million ha in the report), or 15 times the area planted at the Jari project. Plantations on this scale would be subject to substantial risks of disease, insects and soil degradation, as is the case at Jari (Fearnside and Rankin, 1980; 1982b; 1985). These figures probably refer to the same plan

announced by Nestor Jost, since the report also states that the 1.5 million ha of silvicultural plantations will be supplemented with 'natural preservation areas' to bring the total under the rubric of the 'reforestation' project to 2.3 million ha. Soares (1982: 51) also reports the existence of a plan for 2.4 million ha of *Eucalyptus*.

CVRD's forest division, Florestas Rio Doce-SA, is producing charcoal using wood from a 10,000 ha forest tract at Buritucupu, Maranhão (de Jesus *et al.*, *nd* [1984]; Thibau, 1985).

When this author visited the scheme in January 1985, the management schemes under testing focussed on cutting all of the understorey and trees below a certain diameter (usually 10 cm at breast height) plus varying percentages of the larger trees. The project designers were most enthusiastic about clearfelling and near-clearfelling treatments that left only a few scattered trees standing in otherwise completely cut areas. Assessing the sustainability of such systems will be essential, since large areas both in the Grande Carajás area and at other locations such as Jari and Trombetas are being considered for similar management.

Removing the smaller trees can be expected to have a severe impact on the forest structure and tree populations, as will the modifications provoked by exposing the soil and compacting it with the machinery used to remove the harvested wood.

The PGC-Agrícola document calls for 'implanting a charcoal-making structure in a 40 km strip along the Serra dos Carajás--Ponta da Madeira railway, permitting an area of 3.6 million ha to be reached' (PGCA: Vol. 3, p. IV.6.99). It is not clear what part of this would be made up of silvicultural plantations and what part from 'forestry management.'

Forestry management applies to a much greater area than the 3.6 million ha mentioned in the charcoal scheme for the zone along the railway. The term 'forestry management' appears to be used by the PGC-Agrícola authors as a euphemism for using the biomass from forests as they are clearcut, rather than any sort of sustainable system that maintains forest cover intact. The document states: 'Forest management for energy production will be executed with usage of the woody material flowing from the removal of forest cover, over approximately 15 million ha' (PGCA: Vol. 3, p. IV.6.102).

The PGC-Agrícola plan leaves open the possibility that the areas mentioned for charcoal production may be greatly expanded at a future date. The document notes that 'concerning the private sector, there is great anticipation and interest in the field of brickette making from charcoal destined for foreign markets' and admits that 'in the future these [charcoal production] numbers could increase as a result of either installing industrial plants utilizing wood or charcoal ... or from expansion of the charcoal making industries' (PGCA: Vol. 3, p. IV.6.102).

General statements in the PGC-Agrícola document that

'timber exploitation should be conducted in line with sustained management of the forest' (PGCA: Vol. 3, p. IV.18) appear to have little corresponding specific planning or budgetary provisions included in the report. An especially difficult matter in designing sustainable forestry exploitation systems for tropical forests is the problem of discount rates used in economic calculations being higher than the biological rates at which forest tree species grow (See Fearnside, 1979a, 1983a). In the case of PGC-Agrícola, an opportunity cost of capital of 6% in real terms is used as a basis for assessing the internal rates of return computed for the program's farming systems (PGCA: Vol.3, p. VII.10). Natural forests cannot grow at 6%/year, meaning that the system of economic rewards must be modified if sustainable management systems are to become attractive to landowners

5. EXPECTED CHANGES IN LAND TENURE

Only a tiny fraction of the financial and other resources of PGC-Agrícola are earmarked for small farmers. Of major concern is the effect the plan might have on land tenure distribution and conflicts. Lúcio Flávio Pinto's (1982: 100-101) apt assessment of the earlier plan to introduce 300 new 10,000-ha ranches to the region still applies to PGC-Agrícola:

its installation would render even more explosive a situation often characterized as a powder keg, marked by the concentration of property, underutilization of land, expulsion of small farmers, and marginalization of squatters. In this aspect, the plan would be truly *grande* [great]: *grande* in the problems it would create.

The authors of the PGC-Agrícola document state clearly many of the basic problems of the region's land tenure situation. These include the fact that in 1980, large properties (over 1000 ha) accounted for only 0.7% of the landowners, but occupied 51% of the land in the PGC-Agrícola area (PGCA: Vol. 1, p. II.4.1.14). The document describes accurately the role that cattle pastures have played in further skewing the area's land distribution pattern (PGCA: Vol. 1, p. II.4.1.119). Census data indicate that the cattle herd in the area has rocketed from 2.7 million in 1970 to 3.4 million in 1975 to 5.6 million in 1980 (PGCA: Vol 1, p. II.4.1.122). The document describes how SUDAM incentives and speculative opportunities have speeded this trend, with its associated syndromes of violence and corruption (PGCA: Vol. 3, p. IV.11). The authors conclude correctly that 'these are areas of social tensions, with obvious pockets of poverty, where restructuring land tenure should precede the actions aimed at equilibrated development of the region' (PGCA: Vol. 1, p. II.4.15).

The document states:

the Grande Carajás Agrícola project will have a great positive effect on agrarian structure. As effects, the project foresees

selection of 10,580 mini and small production-units, which will receive technical and financial assistance. In contrast to this, only 5,580 medium and large properties will be incorporated into the project. (PGCA: Vol. 3, p. VII.61).

As was the case for the document's expressions of concern for agronomic sustainability and environmental impact of the land uses proposed, the plan's concrete proposals do not always match the high ideals mentioned in the more general statements of intent. The figures quoted above for numbers of small and large properties do not indicate a 'great positive effect on agrarian structure,' but rather precisely the opposite. The amounts of land and money allocated for large properties will greatly exceed the amounts allotted to small farmers.

Data on area and labor demand by land tenure class are presented in Table 6, showing that 82.9% of the land goes to medium and large properties. The worst, from the viewpoint of social problems, are the large properties: these occupy 47.2% of the area, even though small properties offer more than 16 times as much permanent employment per hectare occupied (Table 6). The amounts going to small farmers from within the region -- the only parts of the plan that can be expected to contribute significantly to alleviating social problems -- are even smaller than Table 6 implies, since much of the land and funds designated for small farmers can be expected to go to settlers in private colonization areas like Tucum~, which are dominated by farmers recruited from outside of the PGC-Agrícola zone.

Oziel Carneiro, first head of the interministerial Grande Carajás Program, is quoted as saying that 'measures are being developed by the federal organs responsible for land tenure matters such that the advent of the Grande Carajás Program should be a true vehicle of social peace and not of social tensions' (Pinto, 1982: 139). The federal organ referred to is undoubtedly GETAT, and the measures are probably that organ's 'settlement programs' and 'programs for settlement of colonists.' These programs, or others like them, are indeed necessary to contain the present explosive situation. The longterm effectiveness of these measures as 'vehicles of social peace,' however, is open to question.

It appears that a primary interest of GETAT is the rapid transfer to private ownership of as much as possible of the land presently classified as 'lands of the union' (federal lands). One result is that squatters entering the newly-titled lands become *invasores* (invaders) rather than *posseiros* (possessors), making it more difficult for them to establish legal status for land tenure claims based on occupancy. The private titling of the land also facilitates a peaceful transition to a landholding pattern dominated by large *latifundios* -- the same transition as is presently taking place in a violent manner. The next step is likely to be what is occurring now in the INCRA colonization areas

of the Transamazon Highway and Rondônia where one of the most frequent results of colonists receiving 'definitive' title to their lots is that they immediately take advantage of the land's increased speculative value by selling. The buyers are often wealthy newcomers, each of whom purchases as many as 20 lots for management as a medium or large property. Settlement and granting land titles are necessary, but other measures also need to be taken if PGC-Agrícola's vision of social peace and egalitarian development is to be achieved. Some of these measures will be discussed later in the context of Amazonian development.

6. EXPECTED ENVIRONMENTAL IMPACTS

Among the negative and far-reaching impacts of many of the large-scale operations described in the PGC-Agrícola plan is increased deforestation due both to the program's planned activities and as the unplanned results of (1) clearing beyond the unenforced 50% limit within individual properties, and (2) the arrival of many new migrants along the highway network to be financed under the plan. Massive deforestation, especially for cattle pastures, is linked to many undesirable potential environmental changes such as climatic changes, species losses, and nutrient losses that jeopardize sustainable use of the areas (see Brazil, Presidência da República, INPA, 1979; Fearnside, 1985a; Salati and Vose, 1984). The Grande Carajás zone is an important part of the region and is currently undergoing rapid deforestation with or without the PGC-Agrícola program. The climatic and other changes whose causes and impacts extend beyond the localities where the felling occurs will be aggravated by increased clearing under the program, the impacts of which are added to those from deforestation throughout the Amazon basin.

Soil erosion, especially under the mechanized agriculture to be promoted under PGC-Agrícola, poses another longterm threat to sustaining agriculture on the sites. Heavily eroded land in areas of the State of São Paulo that were productive earlier in the present century provides an example familiar to many Brazilians. Erosion also leads to siltation of reservoirs in downstream areas, as has occurred in many cases throughout the world (e.g. Allen, 1972 for the Anchicaya dam in Colombia). The Tucuru' dam -- completed in 1984 at a cost of US\$ 4.6 billion, not including interest on the debts incurred for its construction and the permanent loss of 2430 km² of forest -- is located at the lower end of the Tocantins-Araguaia drainage basin, the site of much of the PGC-Agrícola program. Also vulnerable to siltation are the dams planned for the Xing' River downstream from PGC-Agrícola's São Félix do Xing' development pole where erosion should be especially severe given the undulating nature of the soil type (*terra roxa*: Alfisol) that is the focus of the Tucum colonization project.

The use of agricultural chemicals promulgated in the PGC-Agrícola plan would have effects on the area's animals, including humans. While many agricultural undertakings would be

inviably without substantial chemical use, development of agricultural systems that minimize these requirements would be wise from the standpoints of both collateral effects and the sustainability of the farming systems themselves. The PGC-Agrícola plan places its faith entirely in chemicals.

Public perceptions of potential environmental impacts of the Grande Carajás Agrícola plan are obscured by the bureaucratic division of the overall Carajás plan between CVRD's 'Carajás Iron Project' and the administratively independent Grande Carajás Program (PGC). CVRD has established an apparently exemplary program of environmental protection that includes a committee of outside experts who periodically visit the area and meet to draft suggestions to the company (de Freitas and Smyrski-Shluger, nd [1983]; Goodland, 1985). CVRD also has an 'ecology' sector in its own staff, with offices at Serra dos Carajás (Serra Norte) and São Luis. There is no doubt that these entities are both professionally competent and truly dedicated to minimizing the environmental impacts of the iron project.

The danger always remains that CVRD's ambitious plans for environmental protection will be shelved when economic pressures intensify, as has happened in so many other parallel circumstances in Amazonia. It will be important to see the outcome when the time arrives for taking environmental protection measures more costly than those that have been undertaken so far. The probability is high of an eventual struggle occurring within CVRD between the ecology and accounting sectors, especially given the very unfavorable terms that Brazil has agreed to for sale of the iron ore (See economic analysis by Pinto, 1982). Environmental scientists must be prepared to supply information and other support to CVRD's ecology sector in order to assure a wise outcome of any such struggle.

The main reason for confusion over environmental and related issues linked to Carajás is the distinction between CVRD's 'Carajás Iron Project' and the wider 'Grande Carajás' interministerial program. The iron project is responsible only for the area around the mine (about 400,000 ha), plus a narrow strip along the 890 km railway to Itaqu', and the area of the docking facilities at Ponta da Madeira. In contrast to the environmental protection measures associated with the iron project, the Grande Carajás Program has virtually no concrete safeguards, numerous general statements about 'respecting the ecology' in the PGC-Agrícola report notwithstanding. The impact of changes stimulated by the availability of rail and barge transport, special fiscal incentives, etc. extends far beyond the narrow right-of-way controlled by CVRD. CVRD cannot be blamed for all of the region's current social and environmental problems or for much of the probable intensification of these. Nevertheless, the public is likely to misconstrue reports favorable to CVRD's environmental program as implying that the impacts of the wider developments associated with Grande Carajás are receiving similar treatment.

7. PGC-AGRÍCOLA IN THE CONTEXT OF AMAZONIAN DEVELOPMENT

The PGC-Agrícola plan, big though it is, represents only a small part of the panorama of agricultural and social transformations taking place in the Amazon region and in Brazil as a whole. The architects of the program have attempted to address problems whose solutions are beyond the capacity of this or any other regional program, and thereby have failed to address some of the important issues that could potentially be ameliorated by such a program. The program tries both to maximize export earnings from agriculture and to halt social conflicts in the region, with the result that the resources allocated for colonization and other programs benefitting small farmers, particularly those small farmers *already in the area*, are diluted to the point where they are no more than token. The program also claims to be designed to benefit the population of the program area, but much of the plan is most directly aimed at serving persons and groups recruited from outside of the area. The intense migration to the Grande Carajás area has its roots in population growth and, to an even greater extent, in continuing land tenure concentration in Brazil's Northeast and Central-South regions. No amount of colonization and agricultural development in Amazonia can solve these problems -- they must be faced in the regions where they are occurring. Such settlement acts as a temporary safety valve for pressures created by growing inequalities in other parts of the country, but the time now being bought for these other regions is purchased at a very high environmental price. Only a few years could be bought in this way even if the entire area were devoted to this purpose (See Fearnside, 1984b, nd-b).

The Carajás Project as a whole has been strongly criticized for its role in taking natural resources from the state of Pará in such a way that virtually all of the returns accrue to beneficiaries outside of the region, either in the Central-South or abroad. L'cio Fl'vio Pinto's (1982) book *\Carajás, o Ataque ao Cora,~o da Amaz^nia* and the frequent testimonials of Paraense geologist Manoel Gabriel Guerreiro (e.g. Brazil, Senado Federal / Camara de Deputados, 1981: 52-61) detail these criticisms. An agricultural program linked to the Carajás development represents one of the best opportunities to return to the area some of the wealth being removed from the mining operations. However, the way in which such an agricultural program is designed is crucial to the role such a program would play: it can either be used to develop truly sustainable agroecosystems for the longterm benefit of the region's inhabitants -- or it can be yet another continuation of Amazonia's traditional role as a mere colony of economic centers beyond its boundaries, such as Brazil's Central-South.

Violence has been the most salient characteristic of settlement on the agricultural frontier within the PGC area. The role of violence against *posseiros* (squatters) by *jagunços* or *pistoleiros* (gunslingers) hired by *grileiros* (land grabbers) and

fazendeiros (ranchers) in determining the land tenure and thereby the land use patterns of the area has been documented by Becker (1983), E. Martins (1979, 1982), J. de S. Martins (1980), Pinto (1980, 1982), Schmink (1982) and others. Violence was used primarily by large landholders in the period since massive immigration to the region began in the 1970's. However, increasing violence since 1983 on the part of *posseiros* (squatters) has made the balance in recent incidents quite equal. No breaking of the cycle of violence now in motion can be expected without fundamental changes. Until such changes occur, the violent atmosphere will impede any attempts to promote sustainable agroecosystems and contain environmentally-damaging trends such as the rapid conversion of rainforest to low-grade cattle pastures.

The balance of costs and benefits of the PGC-Agrícola plan depends very much on the question of to whom the costs and benefits accrue. The authors of the plan assert that the sum of the benefits minus the costs are greater than zero, and give the formula that would be used in such a calculation (PGCA: Vol. 3, pp. VII.63-64). The benefits in agriculture are given as the increase in agricultural production from US\$41.9 million in 1980 to US\$317.2 million expected in the 'target' year. The only thing said about the costs is that they cannot be calculated. Unfortunately, the greater difficulty of quantifying costs does not make them vanish! Just as important is the fact that many of the program's costs, particularly environmental costs, are spread over geographical areas and generations that do not enjoy the benefits. Most costs would be paid by future generations of residents of the program area. Since, in Brazil, most of the value of export crops usually goes to middlemen, one could expect most of the monetary benefits cited to accrue to this group, largely located outside of the program area. Supplying the tractors, insecticides and other inputs required by the farming systems to be promoted would also chiefly benefit manufacturers outside of the region.

A wiser plan than the one proposed for PGC-Agrícola would direct the bulk of its resources toward assuring the longterm wellbeing of the program area's present residents and their descendants. Such a plan would need to devote significant resources to developing sustainable agroecosystems for the region.

In a separate article, the merits of 14 classes of land use have been compared on the basis of agronomic sustainability, social sustainability, unsubsidized economic competitiveness, self-sufficiency, fulfillment of social goals, consistency with maintenance of areas in other uses, retention of development options, effects on other resources, and macro-ecological effects (Fearnside, 1983c). In general, uses which more closely resemble the natural forest are preferable from the perspective of sustainability and environmental criteria. Cattle pasture, which dominates land use in the region, is the least desirable choice on virtually all counts.

Changes designed to promote longterm wellbeing in the region must include institutional arrangements that would eliminate the forces now leading to conversion of forest to cattle pasture. These include fiscal incentives (still a problem despite SUDAM policy changes; see Fearnside, 1984b), and the use of cattle pasture as a rapid and cheap means of securing claim to the land for speculative purposes.

Many decisions affecting development in the region -- especially those leading to rapid deforestation -- are being taken by default rather than by active choice (Fearnside, 1985b). While individual unwise choices can be identified, such as the promotion of large cattle ranches, a more fundamental change is needed to restructure the decision-making processes that result in a pattern of unwise choices. Input to decision-making from research, especially that on environmental and social factors, is usually restricted to lessening the negative impacts of decisions already taken. Decision-makers must follow procedures that insure that they consider input, including that from scientific research, at a stage where the basic question is still open as to whether or not a given project or policy will be implemented.

Development of sustainable agroecosystems will require a substantial financial outlay for research both on the technologies employed and on how the modified ecological systems function. Heavy investment in research is necessitated by the greater complexity of systems that resemble more closely the natural vegetation than do monocultures of pasture or soybeans. Developing sustainable systems will also require redirecting agricultural research away from its present single-minded pursuit of maximizing yields; revised priorities should give greater weight to increasing the security of yields from year to year (important for small farmers), minimizing nonrenewable inputs such as petroleum and phosphate, and minimizing the use techniques leading to unwanted environmental side-effects, such as agrottoxins and erosion-provoking mechanized arable farming. In designing specific production systems, solutions to such problems as choice of species and varieties and perfection of agricultural or silvicultural practices can be expected to come once the more fundamental decision is taken to make sustainability a major national priority.

Sustainability of systems requires more than removal of remaining agronomic impediments. Social sustainability implies that the system does not contain the seeds of its own destruction by the social forces it generates, for example through extreme inequalities. Population pressure and resource distribution are therefore closely linked to the longterm sustainability of the agricultural system. A sustainable system for the local population must include assurance that the population does not exceed the carrying capacity of the land, a limit to the total consumption of nonrenewable resources, and a limit to the concentration of resources (See Fearnside, 1983c).

8. CONCLUSIONS

The Programa Grande Carajás Agrícola plan, as it stands, would (1) worsen social tensions, (2) contribute little to local welfare, and (3) probably not be sustainable over the long term. Most of the money and land will go to large landholders for either mechanized agriculture, cattle ranching, and possibly silviculture. Most resources are allotted to credit for the large agricultural undertakings and to providing infrastructure to facilitate exporting to foreign markets the soybeans, beef and other products to be produced in the program area -- and importing from Brazil's Central-South the machinery and chemical inputs needed by the proposed farming systems. Statements in the program proposal expressing concern for social and environmental problems are not matched by concrete plans or budget allocations.

The Carajás mining bonanza provides ample justification for a regional development program, of which agriculture should be an important part. A completely revised approach to such a regional development program could represent a unique opportunity to make the investments needed to develop truly sustainable agricultural systems, and to begin moving towards institutional adjustments to sustain the welfare of the region's inhabitants. This opportunity should not be wasted in futile efforts to solve the problems of other regions or in promotion of agricultural systems that maximize short-term export earnings at the expense of longterm social wellbeing and environmental quality in the region..

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TABLE 6: AREA AND LABOR DEMANDS BY LAND TENURE CLASS IN
PGC-AGRÍCOLA FINANCING

Category	% of Labor Force*	ha/person in perman- ent jobs	Total Area (1000 ha)**	% of land area
Small	61.0	3.3	163.2	17.1
Medium	32.5	9.5	341.0	35.7
Large	6.5	54.0	450.0	47.2
Totals	100.0		954.2	100.0

* PGCA: Vol. 3, p. VII.37.

** PGCA: Vol. 3, p. VII.47.

FOOTNOTE:

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Summary.- Development for whom and for how long? These are the questions that must be asked and answered with respect to the agricultural plans for the vast area of the eastern Amazon where a proposed regional development program would radically transform agriculture and other sectors of the region's economy. The 840,888 km² area is the zone of influence of Carajás, site of the world's largest high-grade iron ore deposits and focus of a frenzied development surge accompanying the beginning of commercial production in February 1985. Under the Grande Carajás regional development plan, most land and financial resources would be channelled to large landholders, with lesser amounts going to small farmers brought to private colonization schemes from outside the region, and only token amounts allotted to the landless already in the area, thus exacerbating the area's intense conflicts between large cattle ranchers and an increasing flood of landless squatters who migrate to the region due to population growth and land concentration in other parts of Brazil.

The development proposal under consideration would give priority to mechanization of agriculture for export crops such as soybeans, as well as to financing large-scale production of beef cattle and of wood for charcoal. The technological and land tenure transformations to be promoted would exacerbate social tensions, contribute to a variety of environmental problems, and probably not be sustainable for long. The wealth exported from the Carajás mining operations provides justification for public expenditures on regional development in this area. Such a program represents an invaluable opportunity to guide agricultural development toward sustainable forms chosen on the basis of long-term support for the region's present population and their descendants. This opportunity must not be squandered merely to enrich a small minority and to allay, only temporarily, the economic and social problems of other regions.

Summary.- Brazil's Grande Carajás regional development plan would radically transform agriculture and other sectors of the economy of the 840,888 km² zone of influence of Carajás, site of the world's largest high-grade iron ore deposits. Most land and financial resources would be channelled to large landholders, with lesser amounts going to small farmers brought to private colonization schemes from outside the region. The merely token amounts to be allotted to the landless already in the area are

unlikely to counteract the program's probable role in exacerbating the already intense conflicts between large cattle ranchers and an increasing flood of landless squatters who migrate to the region due to population growth and land concentration in other parts of Brazil. The agricultural transformations to be promoted would also contribute to a variety of environmental problems and probably not be sustainable for long. The present plan squanders an invaluable opportunity to guide agricultural development toward sustainable forms chosen on the basis of long-term support for the region's present population and their descendants.

Fig. 1

