ENVIRONMENT AND CATTLE RAISING IN THE AMAZON[1]

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ABSTRACT - The purpose of this paper is twofold: first, we discuss approaches to the problem of discrete choice between preservation and irreversible losses first proposed by Krutilla and Fischer (1985), Ciariacy-Wantrup (1952) and Bishop (1978) to work out an analytic schema to be applied to the case of the Brazilian Amazon Rain Forest. We work on the premises that there is ample reason to demand the preservation of almost the entire forested area as it exists today. Secondly, however, we try to show that for the rational individual, decision maker, the destruction of the forest through substitution by extensive cattle ranching is the correct decision, considering the opportunity cost of preservation alternatives. We conclude with a brief exposition of the policy implications of the picture depicted.

Key words: Amazon region, environmental policies, cattle ranching.

INTRODUCTION

For obvious reasons, environmental variables must play a strategic role in the formulation of development policies for the Amazon region. No other region on the planet has claim to such great biodiversity. Paradoxically though, the vastness of the Amazonian tropical rainforest has been used as an argument for the non-conservation of large portions of it. This contrasts with arguments taking place in other regions of the country, where there seems to be no doubt about the benefits connected with preserving their remaining forested areas.

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Nonetheless, we work with the idea that there is good reason to preserve in quasi-totality what remains of the Amazonian rainforest for two fundamental reasons. First, the limited benefits of alternative agricultural production contrast with the heightened value of preserving the tropical rainforest. This increased value is in turn due to two factors: the dramatic reduction of world forest reserves, and science now better understands the value of the rain forest's environmental services (biodiversity, maintaining of carbon stocks and water cycle). Thus, preservation of the world's remaining tropical rainforests is completely justifiable.

Secondly, considering the specific case of Brazil's Amazon, we see that the devastation that has taken place has not been due to a pressing need for increased agricultural areas, but to characteristic speculation and has kept large, cultivable areas of the country out of production.

In short, we are confronted with the choice of either conservation or irreversible loss, justifying the application of *safe minimum standards (SMS)*, under which conservation is awarded the highest priority *except* when this would entail intolerably high costs. Here, "intolerably high costs" refer to the survival needs of local communities and the conditions that ensure them. Thus, the losses caused by deforesting would be justified if the survival needs of local communities made the deforestation unavoidable, but would at the same time be minimized through the implementation of land-saving agro-forest systems.

AGRICULTURE VS. TROPICAL RAINFOREST: A MATTER OF DISCRETE CHOICE[3]

The debate between environmentalists and those who push for development often takes on the character of an issue requiring an "all or nothing" solution. In other words, the debate appears to force a discrete choice, pointing either to the irreversible destruction of a given natural resource or its preservation in its entirety. There are in fact many situations

[3]This section of the paper was presented at the Eleventh Brazilian Congress of Economists , Salvador, Bahia, November 1995.

in which legitimate claims to either wholesale preservation or irreversible ecosystem modification can be made; the problem, however, lies in the definition of such situations. Economists, such as Pearce and Turner (1990), have not been able to resolve this problem (and certainly it is unreasonable to expect them to be able to do so unaided) but have proposed some methods useful for moving in this direction. The most well known approaches to the problem of discrete choice between preservation and irreversible modifications have been based on the works of Krutilla and Fischer (1985), Ciariacy-Wantrup (1952), and Bishop (1978).

Krutilla and Fischer developed an algorithm designed to guarantee that the benefits of the conservation option be adequately incorporated into the basic cost-benefit analysis when applied to environmental issues. Thus, the estimated value that the benefits of preserving a particular resource comes to be seen as part of the costs of any development project. This value, in turn, takes into account that the price of this natural resource tends to increase over time, given the tendency toward scarcity. Furthermore, they take into account the possible negative effect of technical progress on the economic viability of the development project under consideration, insofar as progress may render other investment options more attractive.[4] As Pearce and Turner note, the inclusion of price and technology factors distinguishes the Krutilla-Fisher algorithm from more conventional analyses by placing the "benefit of the doubt" on the side of preservation. This reduces the risks inherent in any monetary cost-benefit calculations where uncertainties regarding the benefits of conservation are great.[5] In circumstances where these uncertainties

[4] The present value of a development project **D** is deduced from the conservation benefits **B**.

$$PV = \int_{0}^{\infty} \mathbf{De}^{-(\pi + \kappa)t}\,dt - \int_{0}^{\infty} \mathbf{Be}^{-(\pi - \delta)t}\,dt$$

where,

π is the discount rate;

δ represents the resources prices rate;

and κ as the rate of technical progress decay.

[5] The greatest problem with conventional cost/benefit approaches comes from the assumption that, in the first place, individual economic agents are capable of correctly evaluating the costs and benefits that are at stake and, secondly, that it is possible to reveal and aggregate these individual preferences regarding environmental benefits through a sole monetary metrics, in such a way that makes it possible to calculate the value of the latter through the use of a discount rate. For more on this matter, see Bromley, D. (1995)

are even greater and the benefits of development are unclear, the Krutilla-Fischer approach criteria are not sufficient to avoid irreversible loss of resources whose preservation is revealed to be of great value *a posteriori.*

The "safe minimum standards " model (SMS), developed by Bishop (1978) on the basis of Ciriacy-Wantrup's earlier work (1952) provides an alternative approach toward eliminating irreversible losses and their catastrophic effects. Using this approach, conservation is always a priority, except in very extreme cases. These extreme cases are those in which the social costs of conservation would be *intolerably* high. Of course, what is defined as "intolerably high" varies according to the conditions established by time and place, which in itself leads us to discussion of the way in which decisions regarding the environment should be made. The two basic options at hand for defining "intolerably high" are either reliance on market mechanisms that involve the aggregation of individual preferences (as postulated by neoclassical economists)[6] or prioritization of collective action that brings organized, civil society and the State together to define evaluation criteria, norms, etc.

Given this analytical schema, we are interested in discussing the discreet choice between maintenance of tropical rainforest biodiversity and agriculture. Historically, the benefits of agricultural expansion into forested areas, the basis of the "civilizing process," is undeniable.[7] A hypothetical option for preservation that would condemn humanity to live, like the remaining indigenous populations, "off the bounty of the land" would certainly imply intolerable costs. The problem inverts itself, however, when the rainforest retreats to the point that it compromises society's very survival or the production of additional food is no longer essential for society's well-being. In these cases, the benefits provided by conservation would certainly outweigh many of the benefits of non-conservation.

[6] Randall and Farmer (1995) consider that cost-benefit analysis provides a clear measure of the satisfaction of individual preferences, although they admit that there are good reasons to impose minimum safety standards, unless the latter would imply intolerably high costs. The definition of intolerably high costs is made in terms of standard economic thought that looks primarily at the whether or not human consumption levels are maintained at an adequate level.

[7] We use the concept of "civilizing process" in the strictest sense, referring to society's expansion and the consequent appropriation and valorization of a determined geographic space.

Taking India as an example, we can ask what benefits Indian society would gain from sacrificing what is left of its natural forests; and we can answer, none whatsoever. The additional food produced on this deforested land would not make any difference in terms of the development of the Indian civilizing process. Non-conservation would be justified if this additional food production were absolutely necessary for the survival of a portion of the population. Yet, even in this case, there is a prior question to be answered: why permit population growth to get to the point that it threatens the survival of Indian civilization to begin with? If it is true that population growth has to be stabilized, why not do so before it becomes necessary to sacrifice all remaining natural forests?

Therefore, the cost of preserving the remaining forests is determined by the value of the agricultural production within a given space. These costs can be considered small in comparison with the environmental "goods and services" generated by the forests: biodiversity, climate regulation, and the protection of water sources (as well as aesthetic benefits leisure, etc.). Thus, it would be up to Indian society to articulate a set of public policies (in contraception, education, science, access to technology, etc.) to provide life alternatives for the population so that preservation of the remaining forest does not involve intolerable costs.

If we now turn to the general problem of the tropical rainforests, in the terms proposed by the Krutilla and Fisher algorithm, it becomes clear that the present value of any agricultural development project that involves the substitution of forest lands is severely compromised by the evolution of the equation's two basic variables: the future value of the resource to be preserved and the investment options created by technological and scientific progress. The rainforests' future value would tend to increase (see: Gutierrez, 1994) given the drastic reduction of rainforest reserves in recent decades. Advances in science and technology are revealing the enormous potential benefits of rainforest maintenance, especially with regard to the extremely rich biodiversity of this natural resource. However, that these potential conservation benefits do not enter into the economic calculations of those social actors who have the power to decide whether or not to opt for preservation.

As a long term preservation strategy, Fearnside (1997) proposes that the developed nations pay for their environmental services; although, he admits this would be "miraculous." But even should that happen and the problems of channeling and distributing this money were solved, the economic survival of the forest area's inhabitants must be insured over the short and medium terms. For that, he suggests a variety of support mechanisms, including the economic use of the forest's non-timber products.

In a study of the economic value of the Amazonian tropical rainforest, Seroa da Motta and May (1994) demonstrate that deforestation involves considerable economic loss, even when only the value of wood and non-timber products (latex, cashew nuts, babaçu, palm hearts and carnauba) is subtracted from agricultural production in the converted areas. These losses would be even more expressive if the calculated value of agriculture included (discounted) the costs of maintaining soil fertility and terrain patterns.

However, for reasons that we will explore below, from the rational, microeconomic point of view of, non-conservation would be the correct decision. This is a typical case of private, economic rationality radically diverging from public, economic rationality, which seeks to maximize society's general interests. Thus, we are justified in treating this case as a discreet choice, subject to the rules of safe minimum standards. The conservation of this resource is contingent upon collective action arising from a strategic vision of what society as a whole stands to gain.

The Case of the Amazon

We will now turn to the case of the Brazilian Amazon. Is the expansion of agriculture in detriment of the Amazonian rainforest ecosystem necessary for continued Brazilian economic development? If we consider the amount of agricultural land available in other regions, where the original forests no longer exist, the answer would certainly be negative. If there is "population excess" in the country, it is the not the result of the absolute scarcity of land, but its relative scarcity, caused by the generalized use of land as a reservoir of value. In other words,

conservation of the Amazonian rainforest does not involve intolerably high costs linked with insufficient agricultural production. On the contrary, it is the non-conservation of the rainforest to deal with "excess population" that involves intolerably high costs in terms of biodiversity and "environmental servicing" losses.

The Amazon Rainforest is being converted not to relieve population pressures, but to preserve a political and institutional *status quo* that allows vast agricultural areas in other parts of the country to remain unproductive. What is needed then, is collective action (agricultural and agrarian reform) aimed at changing the political-institutional status quo; a status quo has been driving internal migration in search of cultivable land toward the Amazon.[8]

Nonetheless, there is the *de facto* situation of the region's resident population. This population depends on the substitution of rainforest by farm land for its own survival. In this case, the necessary loss of forested area should be minimized through the development of intensive agricultural systems with high per hectare productivity. We are taking for granted that these agricultural systems are also ecologically balanced; in other words, that they respect the conditions for the conservation of water, soil, etc., that are specific to tropical regions. The existence of extensive, agricultural systems in the region obviously maximizes the loss of forested lands. Nevertheless, cattle ranching, an extensive, agricultural system, has been and will continue to be the predominant form of agricultural expansion in the region.

During the seventies, the Brazilian Government considered the enormous and largely unsettled Amazonian rainforest a threat to national sovereignty. This view came from a mixture of ignorance and prejudice against the rainforest ('the green inferno") and the military's interest in the maintenance of large, open spaces to facilitate control and surveillance (combating guerrilla warfare). To speed development in the Amazon region, the start-up costs of private, large, cattle ranching projects were reduced to zero, through tax incentives and other forms of State income

[8] Homma et al. (1995) also discuss this problem and try to demonstrate the importance of agrarian and agricultural policies that offer life alternatives for a mass of small scale producers that are forced to destroy forest land in order to survive.

transfers. At present, although the area is militarily unimportant and prejudice against the rainforest no longer exist, cattle ranching continue to expand in the region. The reasons for this continuing expansion are found in the history of Brazilian cattle ranching.

Historically, the profitability of Brazilian cattle ranching has not come solely from the investment in cattle (resulting from the liquidity rate of herd reproduction and beef prices) but also from rising land values. It is a well-known fact that, until recently, Brazil's land was used as a value reserve. Several studies have demonstrated the correlation between fluctuations in land prices and government policies, both macroeconomic and agricultural. In one of the most recent studies, Reydon (1992) argues that the Brazilian land market obeys the same logic as assets markets in general, since land has the same characteristics as any other asset. Land prices, like those of other assets, reflect the gains[9] and losses that can be expected from the following capitalized attributes: a) the productive revenues coming specifically from agricultural activities, as well as those gains originating in the fiscal transfers (subsidies, tax incentives, etc.) that landed property allows; b) the costs of maintaining land as an asset, which includes transaction costs, financing costs (when and where this is necessary for land purchase), property taxes costs, and the costs coming from labor and legal conflicts; c) liquidity premiums, or the ease with which the asset can be sold in the future and d) patrimonial gains.

Taking into account these land price attributes, we can see that cattle ranching is the ideal agricultural activity under circumstances in which the speculative component is the most important factor determining the purchase of rural property. As land speculators ideally hope that their property will spontaneously increase in value, land purchased for cattle ranching offers them many benefits. Ranch land has a very low asset maintenance costs and requires little supervision and little control over production process, which can be costly over large areas or areas simultaneously occupied by various activities. Furthermore, ranch land, labor conflict costs are at a minimum. Within the Brazilian context, ranch

[9] In addition to the speculative and expectancy component, land prices also reflect specific local components. See Reydon and Romeiro (1994).

pastures can be claimed to be productive land, thereby reducing that property's tax burden. Cattle ranching in the Amazon Basin increases liquidity premiums, since, along the Amazonian agricultural border, pasturage must be planted in order to permit compensatory patrimonial gains. As a general rule, extensive cattle ranching in Brazil has primarily been a means to use land for speculative rather than productive purposes.

Small-scale, family farming has expanded livestock production activities in the Amazon region. Even though it may become counterproductive in the medium and long runs, livestock have become an increasingly important in the family farmer's survival strategy. This is due to several factors: first, the commercialization of agricultural products tends to be very complicated due to the precariousness of distribution channels; but livestock can "transport themselves" to market. Second, crop prices suffer accentuated fluctuations, as in the case of pepper and cacao, and official agricultural policies do not compensate for this. Livestock prices fluctuate less; the market is highly liquid; and the monetary risks are minimal. Lastly, the planting of pasturage allows for a significant patrimonial gain, of extreme importance in situations where land sale becomes the only solution for troubled family farmers.

This has become a typical sequence of events for small producers who turn to ranching and livestock, activities that require large landed properties, to sustain their farms. As soon as the small producer starts to depend exclusively on ranching, he or she faces basically two options: either to expand through the purchase of more land, or, more frequently, to sell the land and move on along into the agricultural hinterlands and reinitiate the entire process. As a rule, those who end up buying more land are already the region's larger scale ranchers, people whose main activities are usually centered in urban areas (merchants, professionals, etc.) and who use the land primarily for speculative rather than productive purposes.

In short, it makes economic sense to treat any project for the agricultural development of the Amazon region as a problem of discreet choice in which rainforest preservation is a leading priority. Our basic premise is that the benefits of Amazon Tropical Rainforest conservation are potentially far superior to those of any alternative agricultural project, with the exception of some special cases. These special cases are

development projects destined to guarantee the survival of the region's family farmers. The "development project" of the last 25 years was based on the opposite premise: that the benefits of non-conservation are always greater than those of conservation, with parks and reserves as the only exceptions. This economic philosophy, abetted to a large extent by land speculation, has been the reason that extensive ranching activities have been the main form of incursion into the rainforest.

AGRICULTURAL EXPANSION INTO THE AMAZON

Until recently, agriculture in the Amazon was largely a by-product of the expansion of the frontier by pioneers exploiting the region's natural resources. Beginning in the 1960s, this scenario to rapidly change; a new highway system was built (starting with the Belem -Brasilia highway), large mining and hydroelectric projects were started (The Carajás Project and the Tucurui Dam), and official settlement projects were initiated (the "*Transamazonica*"). The region came to represent a veritable agricultural frontier for hundreds of thousands of small-scale producers and family farmers driven from other parts of the country by land speculators.

Some of the region's new immigrants came through official settlement programs, which provided them with important initial support (land titles, access to financing, basic services infrastructure, etc.). Another group of settlers used their own capital to purchase property. The majority of them came those from the southern part of the country, where land scarcity had increased the value of the property they sold. Lastly, there was a large mass of poor peasants who established themselves precariously (both in terms of land ownership[10] and basic infrastructure) and resorted to activities outside family farming to survive. They worked in mines, quarries, building trades, domestic services, or as hired help on farms (frequently those of relatives) and cattle ranches. A wide range living situations appeared, varying according to the settlers economic starting point, individual abilities, the type and season of employment, the

[10] In the case of the Marabá region, research conducted with 150 families showed that close to 82% initiated their accumulation strategies without possessing titles to the land they settled. Gonçalves and Topall (1992). "Agriculture Familiale de la Region de Marabá: trajectoires d'accumulation", cited by Lasat/CAT, 1995.

degree to which producers and workers were organized, and the institutional setting.

In general, the results of a study by Almeida's (1992) show that producer revenues reflect the way the producers are able to adjust to the pricing in effect in their primary sphere of activity, given their particular asset level, their use of family labor, etc. Their level of land accumulation depends heavily on the resources they brought with them to the frontier and the amount of time they have been on the land. In other words, settlers' revenues are principally determined by the local economic and institutional environment (infrastructure, forms of access to land, market operation, and relative prices), while accumulation levels are linked more to the influence of the settlers' origin (patrimony, technical knowledge, experience in dealing with public and private institutions—especially those linked to financing, etc.). The best route to accumulation, particularly for producers lacking in capital, was often the "frontier strategy," which aims at adding value to real estate for later sale. Furthermore, for many agricultural producers, the move to the frontier provided not only capital gain through land sale but the chance to find a more favorable socioeconomic and/or physical environment.

Relocation along the frontier is not simply the destiny of itinerant, agricultural producers forced out by "capitalist penetration" (cattle ranches and permanently established farms) as Sawyer (1969) suggested, but also the conscious (rational) accumulation strategy that family farmers pursue. On the other hand, Costa (1995) puts together evidence showing the relative stabilizing effect of family farming, in which families demonstrate a surprising ability to hold on to their claims, a process that can be generalized for the state of Pará and for the Amazonian region as a whole. Large segments of family farmers have been able to escape the "frontier strategy," despite the advance of extensive livestock ranching and the concentrated, land ownership patterns that accompany it.

The critical element for accumulation that escapes the coercive logic of cattle ranching lies in the establishment of permanent farming. Permanent crops allow for a monetary balance[11] that is impossible to

[11] As we will see below, this monetary balance is related to the opportunity costs created by the increased value of landed estates. Almeida (1994) shows that, at given land prices, Amazonian agricultural producers compare the economic potential of agricultural activity with the speculative value of their land to decide whether to sell, hold onto as a value reserve or invest in production.

achieve with temporary farming. However, in recent years, the unfavorable evolution of prices for crops such as cacao and pepper, given the absence of efficient compensatory policies and increasing infrastructure problems (especially in product distribution channels), has led the family farmers of many regions to make the dangerous switch to livestock raising.

Family Farming and "Frontier Strategy"

As soon as farmers have enough resources, they take over or purchase a piece of virgin land (at approximately US$7.00/hectare). These farmers must put up with wilderness conditions and a total absence of infrastructure. Lack of adequate transportation and an absence of flour mills presents the farmer with additional problems. Their initial farming strategy is to diversify their crops, hoping to best employ available family labor. After harvest, the local economy dictates that they receive an average of two and one-half times less for their produce than they would in the region's population centers.

Rice is the most important subsistence crop in the first year, with the manioc crop coming in a year later. Wilderness areas also play an important role in the production system's early years, providing some of the basics for family survival (game,[12] fruits and nuts, and firewood). Wood sales are also important, less for the money than for the roads cleared to transport the product.

Farmers begin to raise livestock only after planting pasturage and accumulating enough capital or credit to invest in animals and fencing.[13] In general, livestock provide higher and more stable labor productivity than the temporary crops (rice, corn, and beans.). These labor productivity variations result from differences in production per area and prices obtained. For example, for rice grown in the Marabá

[12] Available information indicates that regular hunting on one or two nights per week provides approximately 80 kilograms of meat per hunter, per year (1.5 kilos peer week.) This is applicable to areas where deforestation rates remain at less than 30% (See LASAT/CAT, 1995).

[13] Fencing represents the most important investment, as livestock can come from a "sharecattle" system. 1000 meters of fencing costs about US$120.00 for wire (3000 meters) and 60 days of labor. Considering daily labor costs, US$2/day, 1000 meters of fencing equals 120 days of work. LASAT/CAT 1995.

region, land productivity varies on a scale of one to three, and prices vary on a scale of one to two. This implies a scale of variation for labor productivity ranging from one to seven (US$1 to $7/workday). Manioc flour presents a similar range of magnitudes, from US$1.30 to $10.00/ workday.

On the other hand, livestock prices and labor productively are relatively stable, with productivity, ranging from one to two (US$4 -7.50/ workday).[14] Livestock offer the advantages of high liquidity, low maintenance, and ease of transport (or "self-transported"), The raising of livestock allows family labor to be better distributed through the agricultural year. A heard of 10 cows on 20 hectares of pasture require approximately 40 days of work per year, pasture maintenance requires 60-100 days per year, and 10 -20 days per year are needed for fence upkeep, totaling 110-160 days of work to produce an average of 1300 kilos live-weight per year (approximately US$650) (See: LASAT/CAT, 1995).

An establishment with eight to ten cattle can generate enough capital to expand the herd and invest in necessary infrastructure. At this point, subsistence crops take on a new role—to prepare the way for expanding pasture lands—and the forest, which still covers up to 50% of the property, becomes considerably less important. A land owner with a herd of ten adult cows find that his/her labor needs have increased, and during the peak seasons day laborers are usually contracted. Nonetheless, this stage of development comes only after years of work, when the family's children are practically adults. As the region's farms develop so does the infrastructure, so that by this stage of farm development the road system's improvement allows the movement of goods even during the rainy season, thereby improving average prices received. At this point, planted pasture land can fetch as much as US$100/ha.

Evidently, each family's success depends on a series of natural

[14] Average fertility is about 80%. The meat production varies according to the animal's age and pasture occupancy. Where pastures are occupied by about 300 kilos of live weight per ha., expected average gains are 120 kilos in the first year, and then approximately 80 kilos/yr until four years of age. This data expresses regional average levels. Fluctuations in meat production are linked to the critical dry season, during which period pastures can be rapidly depleted.See Topall, O. (1992)).

and socioeconomic factors. Since livestock raising is a fundamental aspect of accumulation, it makes sense to classify producers according to the number of livestock they own. LASAT/CAT researchers propose the following classification scheme: establishments with more than 45 animals are Type 5; between 10-45 are Type 4; less than ten are Type 3; with no livestock, but the producer is a landowner are Type 2; and with no livestock, and the producer is not a landowner are Type 1. Production systems tend to evolve towards types 4 and 5, in which livestock play a fundamental role. However, it can take 15 years to get to these stages, and the path is not risk free.

We will now consider the expansion of livestock raising. As long as there is no livestock involved, a system of subsistence agriculture fits into the ecology of forest or brush area five to seven times greater than the planted areas. The average family farm is 50 hectares, of which only three hectares normally planted. From these numbers, it is clear that the subsistence, family farm system is environmentally viable but unfortunately, often economically unsatisfactory. This environmental balance is broken once stock farming is introduced to improve the economic balance.

Little by little the family farmer puts in pastures to feed his growing herd. After a certain point, the coexistence of increasing numbers of livestock and yearly crops becomes more difficult, even though there is still no scarcity of virgin land. The seeds from pastures and forage have been carried by the wind or animals from the pastures to the remaining forested areas or brush lands, creating future cultivation problems. Insects from the forage begin to infest the crops.[15] Eventually, expansion of ranching eliminates subsistence agriculture and the rainforest, two elements which initially were indispensable to the family farm system. At this point, regular sale of animals eventually becomes necessary to sustain the farmer's family; but the quality and productivity of pasture and forage land often has declined. After five years of use, the physical and chemical fertility of the Amazonian soil drops and weeds flourish.

[15]Research has shown that in areas settled for 15 years surrounded by ranches, rice production drops up to 0.5t/ha. There is also an additional fire problem; fires are difficult to control in open areas. ASAT/CAT (1995).

Pasture land can be used for 8 to 15 years, depending upon how long it is left fallow and the size of the herds it supports.

It is worth noting that this pasture lands "crisis" takes place only when the accumulation process itself has been successful. There are those who dropped out along the way, some failing (for family-related reasons such as the ratio available manpower/mouths to feed; or reasons linked to the environment itself, such as isolation, malaria, etc.) and becoming non-propertied peasants (Type 1) and some, moving on with a small amount of capital from the sale of their land to start again (type 2). Yet there are others who started with little capital, have had limited accumulation, but remain in older, isolated communities. These establishments normally stabilize over the medium term at somewhere between Type 1 and 3. In the case of older communities whose inhabitants started operations with larger than average amounts of capital and holdings between 100 to 200 hectares, the pasture productivity crisis has not arrived and, due to abundant available land, probably won't during the first generation.

There are two major strategies employed when facing a land productivity crisis: the sale of land and departure to another region, or the purchase of another plot in the same region; the choice is largely contingent upon locale. In newly settled areas, the head of the establishment anticipates future crisis by buying land (usually contiguous) with the proceeds from livestock sales. In older settlements, the scarcity of adequate lands obliges the head of the establishment to buy land in a new locale and send his children to reinitiate the accumulation process via stock raising.

The sale of the family farm does not necessarily mean failure; it can be part of an accumulation strategy, either because the initial locale or the land itself is unsuitable or because the land sale provides useful capital. Controversy remains, however, as to whether this is a simple "rational choice" made in order to better the establishment's chances for success—a consciously-pursued strategy aimed at accelerating the pace of accumulation (LASAT/CAT, 1995) — or if it represents a moment of cultural rupture, a "leap into the dark" when capital from the sale is the last barrier to downward mobility (becoming sharecroppers or employees) (Costa, F., 1993).

The price per hectare of virgin land varies from US$ 5.00 and US$ 70.00. This price differential is determined by the area's transportation infrastructure, the maturity of its settlements, and the conditions of local land ownership. Land acquisition and legal ownership come from a variety of situations, ranging from property disputes, appropriations, registered and claimed lands, claims with land titles being processed, and completely regularized properties. However, the last two types continue to be rare, and in practice the principal determinant of land rights continues to be the amount of time that has transpired since initial settlement. It is important to note that the socioeconomic and institutional factors that determine price clearly prevail over the actual land's value: the presence of permanent crops does not affect land prices, since according to the region's farmers themselves, "whoever buys land intends to plant pastures." (LASAT/CAT, 1995)

The partial planting of pasturage (20 ha per standard 50 ha lot) increases land prices to the level that reigning socioeconomic and institutional conditions allow; more than the planting of temporary, cultivated crops can, over the average length of settlement. In other words, the high opportunity costs of establishing their family farms induces poor peasants to pursue this "frontier strategy." This strategy provides real benefits for those who have access to land and are able to run the whole course of accumulation and actually move up the social ladder (Almeida, 1992). Unfortunately, relatively few are able to follow this path, as it requires many years of work under generally adverse conditions. Normally, economic pressure forces land sales before the land's value and the farmer's holdings have grown enough to finance any move into another economic sector.

In reality, the main beneficiaries of this land, accumulation strategy are urban actors, for whom land investment is an important means of channeling their surplus finances, thus creating a dynamic of concentration like those characterizing any capitalist, asset market. The "big cities" of the region, such as Marabá, are rapidly changing from frontier settlements, where commerce is geared toward cattle ranching and mining, to urban centers, with a life of their own. They are home to large numbers of merchants, small business people, and liberal professionals, all of whom

invest in stock farming. This is especially true in the case of merchants, who, to a large extent, have assumed the State's role as the source of small, family farmer credit.

Thus, from the point of view of the stabilization of family farming, the frontier strategy is paradoxical. On one hand, it guarantees that, however mobile, there are always farmers on the land; at the same time it leads to medium and long term failure for most of these producers, unless they successfully make the shift from farming to ranching.

FINAL CONSIDERATIONS

The Amazon region's environmental specificity demands a singular development strategy that has **conservation** of the largest, virgin area possible as a general goal. As discussed above, **non-conservation** of the rainforest may be justifiable in special cases when and where conservation costs become intolerably high. A case in point would be the effort to insure the rural population a reasonable level of subsistence. Nonetheless, the inevitable loss of some rainforest biodiversity to guarantee the survival of the local, rural population should be minimized. In this sense, extensive cattle ranching represents the worst possible strategy for sustainable development, both from the socioeconomic and the ecologic points of view. Ranching generates **minimal** employment and **maximum** rainforest devastation. We need to invert the terms of that equation; we need to promote and implement three basic types of production systems: a) systems of forest management; b) agro-forest systems; c) agricultural systems.

Forest management refers to a system of techniques designed to increase the productive potential of the forest's natural products while maintaining the ecosystem's biodiversity. It involves extensive systems of extraction that, even when well managed, could not guarantee survival to the region's almost 5 million, current, rural inhabitants, much less to foreseeable future populations.[16] In order to protect the existing local populations and provide for future population growth, systems that generate

[16]Estimates regarding the carrying capacity of the tropical rainforest vary greatly. According to Fearnside's calculations, it could hold a maximum of 0.24 inhabitants per hectare, which is, in practice, not viable. See Fearnside, P.M. (1990)

more value per hectare need to be promoted.[17]

Agro-forest systems attempt to integrate agricultural production with some forest specie management. These are labor intensive systems, which have the potential to produce large amounts of biomass per hectare. They are ideal farm systems for family farms that have an available supply of inexpensive labor, a characteristic of most of the region's small-scale producers. These systems have been put into practice by most of the region's native population, using techniques inherited from their indigenous ancestors.[18]

Over the middle run, regional development policy could promote these agro-forest systems as the main alternative to forest management. Considering the limits to increased labor productivity (mechanization) in the rainforest and the increased labor necessities that agro-forest systems imply, less labor-intensive alternatives need to be promoted. State policy should support agricultural systems open to mechanization yet respectful of the basic rules of soil management in high rainfall, tropical regions.[19] The farming system that promotes the simultaneous combination of different crops, a characteristic of the earlier system, should be replaced by a system of rotating crops (the combination of crops over time), which would assist in mechanization and permit stock farming.

Attention needs to be addressed to recovering degraded forest areas. A large portion of the land to be put into production using both the agro-forest and the agricultural systems should be located in degraded forest areas, in accordance with the plan provided by *FLORAM*.[20] This

[17] In 1980 close to 1.5 million rainforest inhabitants (50% of the region's rural population) lived precariously off the extraction of raw materials. Since then, the population has experienced tremendous growth. For an analysis of raw material extraction as a development alternative for the Amazon region, see the works collected in Clusener-Godt and Sach's anthology (1994). From these works it becomes clear that there are no precise answers for questions regarding the relative importance of the extraction of raw materials for Amazonian development strategies or, more specifically, if the current (extraction reserves???) are a generalizable model.

[18] These populations have a knowledge that has been accumulated over generations and can and should be recovered and filtered through our present day scientific and technical knowledge. This is the type of work that is being carried out by researchers from the program "POEMA" (Poverty and the Environment) with promissing results. The interaction between researchers and the local native community gave birth to a model for agro-forest systems — *Agricultura em Andares* -that has been put into practice with success. See Mitschein, T. et. al. (1994).

[19] For a description of the general agronomic principles for agriculture in tropical regions, Primavesi's (1980) work is still a reference. Published 15 years ago amidst the skepticism, and even hostility, of *status quo* agronomy, this work gradually gained its due recognition and became a fundamental reference for the guiding principles (based on good scientific sense) for agricultural practices under climatic conditions that are quite the opposite of those to be found in termperate regions and that therefore require different treatment.

[20] *FLORAM*'s proposal for the restoration of devastated areas in the eastern Amazon region is based on a tripartite land use model: 45% to be replanted forest, 30% for reconstruction of biodiversity, and 25% for agricultural projects compatible with each locals' climatic and soil conditions. See Ab'Saber, A.N. (1995).

would avoid interfering with the virgin rainforest and hopefully put the "altered areas" to more productive use.

Possibly, a much larger population could be maintained and further environmental devastation could be minimized by combining these three basic types of production system. Although subject to controversy, respect for the "carrying capacity" of the Amazon region under conditions that conserve what remains of the rainforest must be incorporated into any regional development strategy. According to Lena and Oliveira's[21] calculations, use of the already deforested Amazonian areas, combined with the rational management of the approximately 800,000 square kilometers of existing Amazon rainforest, would adequately sustain the region's close to 80 million inhabitants and maintain 2/3's of the Amazonian territory as a biodiversity reserve and "genetic bank."

All these policies, however, are deemed to fail, as a deep divergence persists between private and public economic motivations. The favorable resolution of this conflict demands more than technical alternatives, such as those described above. What is needed, first of all, is the end of land-less peasant migration into the region through implementation of agricultural and agrarian policies. This would not only alleviate the pressure that sheer population numbers put on the forest, it would also cause a rise in the opportunity costs of labor and, as a result, lower the profitability of cattle ranches.

Secondly, present planning strategies for the region's global integration through large-scale means of access, principally highways, must be fundamentally changed. Improved transportation infrastructure should be viewed as an instrument of territorial organization rather than as a vector for disorganized, predatory occupation. A first, fundamental, step would be to decree a moratorium on the building of new axes of penetration and a temporary halt to the rehabilitation of disused transportation corridors until a new, cohesive, feasible, master plan is concisely expressed.

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[21] Lena, P. and Oliveira, E. (1991) *Amazonia- Fronteira agrícola 20 anos depois*, cited by Clusener-Godt and Sachs (1995).

Finally, extensive cattle ranching operations on large tracts of land should be forbidden. The enforcement difficulties bound together with this ban would lessen as migration and transportation policies took effect. This prohibition would demonstrate the Brazilian State's real willingness to stop the destruction of the world largest biodiversity reserve.[22]

Until now, the position of the Brazilian State toward the Amazon area has been ambivalent and contradictory: on one side, through the Ministry of the Environment, it supports an array of sustainable development policies; on the other side, through the Ministry of Agriculture, it makes plans to devote large forest areas to the production of soybeans for export, in spite of warnings that this plan has potential for devastating ecological impacts. The forest's attributed value is less than the exported grain's expected value. In short, if the environmental costs of deforestation and land degradation are not included in the cost/benefit calculation, the return rate of cattle ranching or soybean production makes them the more attractive investments in the Amazon region.

There will be no solution to the conserve or utilize, environmental dilemma in the Amazon Basin until the Brazilian State promotes agrarian reforms throughout the country and is willing and able to consistently enforce all laws. Agrarian reform programs must be implemented that increase the region's opportunity cost of labor, and new laws must be enacted to protect the Amazon rainforest as a valuable public resource.

[22] For an excellent analysis, containing strategy and specific policy suggestions, see R. Smeraldi, et. al. (1996).

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