

Nogueira, Jorge Madeira; Kyle, Steven C.

Working Paper

Sustainable Development and Economic Growth in the Amazon Rainforest

Staff Paper, No. SP 92-15

Provided in Cooperation with:

Charles H. Dyson School of Applied Economics and Management, Cornell University

Suggested Citation: Nogueira, Jorge Madeira; Kyle, Steven C. (1992) : Sustainable Development and Economic Growth in the Amazon Rainforest, Staff Paper, No. SP 92-15, Cornell University, Charles H. Dyson School of Applied Economics and Management, Ithaca, NY,
<https://doi.org/10.22004/ag.econ.121364>

This Version is available at:

<https://hdl.handle.net/10419/276871>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

CORNELL
AGRICULTURAL ECONOMICS
STAFF PAPER

**SUSTAINABLE DEVELOPMENT AND ECONOMIC
GROWTH IN THE AMAZON RAINFOREST**

by
Jorge Madeira Nogueira and Steven C. Kyle

October 1992

A.E. Staff 92-15

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853

It is the policy of Cornell University actively to support equality of educational and employment opportunity. No person shall be denied admission to any educational program or activity or be denied employment on the basis of any legally prohibited discrimination involving, but not limited to, such factors as race, color, creed, religion, national or ethnic origin, sex, age or handicap. The University is committed to the maintenance of affirmative action programs which will assure the continuation of such equality of opportunity.

**SUSTAINABLE DEVELOPMENT AND ECONOMIC GROWTH
IN THE AMAZON RAINFOREST**

Jorge Madeira Nogueira and Steven C. Kyle

October 1992

ABSTRACT

This paper analyzes the implications of the concept of sustainable development for economic growth. Most definitions of "sustainability" currently in use provide little guide for policy while some would in fact work against the process of development if they were to be operationalized. The difficulties in promoting "sustainable development" in the context of a growing economy where there is a large segment of the population living in absolute poverty are illustrated with the case of the Brazilian Amazon.

SUSTAINABLE DEVELOPMENT AND ECONOMIC GROWTH IN THE AMAZON RAINFOREST

Jorge Madeira Nogueira and Steven C. Kyle¹

Introduction

This paper analyzes the economic content of the concept of sustainable development (SD). Most of its several meanings are, we suggest, of little operational use for economists even though they may be useful for other purposes. Moreover, they do not allow a clear understanding of how to achieve the goals of socioeconomic development and environmental conservation and so are of little policy relevance. As a matter of fact, to use some of SD definitions as guidelines for policy design can actually condemn Third World countries to a permanent state of sustainable underdevelopment: a development pattern perhaps environmentally sound in the short run, but certainly unsustainable in the long run due to low levels of productivity, production, and income.

This is a very important shortcoming for students of economic and social development, since higher income is the near universal goal of inhabitants of the Amazon or indeed of any undeveloped area. To focus on sustainability without providing for an increase in income (however measured) will result in the analyst's being ignored by the intended beneficiaries. Without joining those who would promote economic growth without regard to other considerations, it is nevertheless true that without income growth increases in welfare are virtually unattainable.

To explore these issues the Brazilian Amazon rainforest is used as a case-study. It is a particularly relevant area for a discussion of SD. Equivalent to almost 30% of the world's tropical rainforest, the pace of its destruction over the last decade has become the object of worldwide attention and concern. The contribution of the burning of biomass to the so-called "greenhouse

effect" and the loss of its biodiversity have put Amazonia at the top of the international environmental agenda. Also, many researchers have claimed that there are technically feasible options for a sustainable management of Amazon forest resources.

Following this introduction, the paper is divided into three main sections. Section I discusses the antecedents of the concept of sustainable development within the contemporaneous environmental debate. With this background, the literature on SD is surveyed and analyzed in terms of its consistency with economic reasoning. Special attention is paid to relating theoretical principles of SD to those found in classical models of economic development.

A brief description of major production activities in the Brazilian Amazon is developed in Section II. Both predatory and sustainable activities are discussed. Their basic characteristics, particularly those related to ecological impacts, are analyzed. Special emphasis is given to two activities: agricultural production and vegetal extractivism. Section III presents a comparative evaluation of these two activities - agriculture and extractivism - from an environmental (that is, socio-economic and ecological) point of view.

The paper ends by arguing that only under specific conditions of resource availability, technological knowledge and institutional arrangements can existing "sustainable development" options be considered a viable alternative to improve the welfare of those directly or indirectly involved with the production process, subject to maintaining the services and quality of natural resources over time.

I. Sustainable Development and Environmentalism.

Sustainable development has risen as a generally accepted concept during the second half of the 1980s. It seems that it will

be subject of much discussion during the 1990s. Actually, SD rhetoric has become so widespread and popularly misused that according to Terence Corcoran:

"Never have two words been used so much with so much inconsistency ...It is fast becoming a landfill site for every environmental idea ... For the most part, nobody seems to care what the words mean, or whether they even have any real meaning. Have we reached a point where sustainable development has become a hazardous concept?"².

We could not agree more. To find out why there are so many conflicting definitions of SD one must have an understanding of how it fits into the objectives of the modern environmental movement or environmentalism. But this is not a simple task, especially because there is no clear-cut and easily circumscribed definition of environmentalism. Within the environmental movement there is a host of ideologies and cross-currents, and there are many classifications of them, which overlap and produce confusion³.

In general, the various views and approaches can be broadly divided into two opposing groups: DEEP ECOLOGY or ECOCENTRIC; and FRONTIER ECONOMICS or TECHNOCENTRIC/CORNUCOPIAN⁴. Each of these visions has a long intellectual history dating back at least to Malthus, who is perhaps the best known example of the importance of natural resource limitations to economic growth. The Club of Rome in the early 1970's falls into this tradition as well. Opposed to this point of view is the technocentric view exemplified by scientific positivism and the belief that technological progress can continue to overcome resource constraints, as the industrial and agricultural revolutions in England had overtaken Malthus' predictions.

These were the two lines of thought available in the beginning of the seventies, just before the First World Conference on Environment and Development at Stockholm in 1972. Their

perspectives were so opposite⁵ that the reaction of Third World countries before and during the conference was not surprising. Through their cultural filter, they believed "environmental issues", as they were defined at that time, were not to be taken seriously. They were regarded as a luxury which perhaps could be afforded by the rich nations of the world but which were beyond the means of poor countries to address. Underdeveloped countries had many others relevant problems to solve, particularly poverty⁶. In spite of all these reactions, nations agreed at the Stockholm Conference on resolutions and recommendations designed to safeguard and enhance the environment for present and future generations⁷. However, the new framework upon which environmental problems were discussed led to a subdivision of the environmental agenda into concerns of developed countries (air, water, and waste pollution, non-renewable fossil fuels), of developing countries (natural resource degradation in terms of deforestation, desertification, threat to irrigation systems) and of international commons degradation (acid rain, climatic changes, disposal of toxic wastes).

In terms of developing countries, the dominant view of international environmentalism did not change much compared to that of a decade earlier in terms of causes of the "environmental problems of poverty". The population explosion was still the main explanation. Nevertheless, there was a clear improvement in the understanding of the types and intensity of the problems faced by those countries⁸. International commons problems were not focus of much attention during the decade.

At the same time, changes were taking place inside the existing lines of thought discussed above. By the first half of the 1970s a growing number of socio-economic researchers began to study environmental problems. The recognition of the validity of diverse approaches to these problems led to the perception of the necessity to make compromises or tradeoffs. Environmental impact

assessments became institutionalized in industrial countries (and later on in many developing countries) as a means to assist in weighing costs and benefits of socio-economic activities before they began. This can be interpreted as a broadening of the "pure frontier economics" line of thought that we can call ENVIRONMENTAL PROTECTION⁹. (See Table 1) It sprang from the realization that environmental concerns have great potential to affect economic welfare. Though many environmentalists resist efforts to place a monetary value on environmental characteristics, it is recognition of these values that often paves the way for incorporation of these issues into economic policy and action both by the government and by individuals.

On the other extreme, some supporters of the "deep ecology" paradigm have tried to develop operational principles in support of their position, and by the mid-1970s a new line of thought had emerged: ECODEVELOPMENT, understood by supporters as a shorthand phrase for ecologically sound development strategy. Its real goal has been to restructure the economy according to ecological principles. Growth is acceptable, actually necessary, but it will be a green growth based more on "increasing the information intensiveness, community consciousness, and experimental quality of economic activity, rather than the material-energy intensiveness."¹⁰ This approach combined basic needs, at that time the buzzword of development economics, with self-reliance and environmental compatibility¹¹.

Even though the issue of environment and development was perceived quite differently at the end of the 1970's compared to the predominant view at the beginning, the 1980's started with a continued suspicion in developing countries that environmentalism was foreign to their true interests. This suspicion did not diminish during the eighties, but increased considerably as structural adjustment and related liberalization programs and policies would be the dominant economic medicine of the decade.

These policies, brought about by the major international development institutions in order to encourage maintenance of debt repayment schedules, were implemented at very high social cost in many developing countries. Concomitantly, world environmental stresses - greenhouse effect, ozone layer, oceanic resources, acid rain, biodiversity - would become the center of attention of environmentalism and would demand joint action to be solved.

However, these world environmental phenomena emerged as issues when current legal, economic, political, and institutional structures and concepts were seriously deficient. Furthermore, the debt crises and stabilization programs often led to increased rates of extraction and destruction of natural resources in developing countries. They also forced governments in these countries to reduce financial support for the implementation of defensive or remedial measures proposed by the environmental protection line of thought. Even environmental impact assessments became costly in a reality of slow or no economic growth.

Thus, transnational pollution and the degradation of international common property resources arose as the most direct environmental link between rich and poor countries in a sensitive moment. They have become a source of contention between North and South, affecting political relations and demanding new approaches to deal with environmental issues. In terms of social science, the second half of the 1980s would witness the proliferation of new lines of thought under the label RESOURCE MANAGEMENT.

Resource management is understood by many analysts as the emerging approach. Its main representative, but by no means the only one, is **sustainable development** strategies. Others would say, with some reason, that it is a middle-of-the-road approach, trying to accommodate in one framework philosophical and ethical concepts borrowed from ecology and corrective actions from economics. From rainforest fundamentalism to re-industrialization (or de-

industrialization) alternatives, resource management has itself become a landfill of proposals.

In actual fact, early reference to the sustainable use of land and biotic resources within ecology can be found in the literature in forestry and wildlife management¹². O'Riordan (1988) traces the modern emphasis on sustainable utilization of resources back to a series of African-based conferences in the 1960s. Dasmann (1985) points out that the concept of sustainability received the greatest boost from the publication of the World Conservation Strategy (WCS) (IUCN 1980). Redclift (1987), however, argues that the term sustainable development was already in use by UNESCO in the early 1970s when it launched the "Man and the Biosphere" program¹³.

Although there may be debate over the birth place of the concept, there is little doubt that SD has become the trademark of international organizations dedicated to achieving environmentally benign or beneficial development with the publication of "Our Common Future" (also known as Brundtland Report) in 1987¹⁴. Since then it has symbolized the debate over the relationship between economic change and the natural resource base on which this change is grounded. The term **sustainable development** suggests that the lessons of ecology can, and should, be applied to socio-economic processes.

However, "Our Common Future" offered a statement of intent of sustainable development rather than providing a workable definition: "Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs."¹⁵ This vague definition is discussed throughout the report. Accepting that interpretations of sustainability would vary among countries, the Brundtland Report pointed out, nonetheless, that any feasible definition should share certain features. The one most emphasized in the document was that physical sustainability could not be secured unless economic and

social development policies paid attention to considerations such as changes in access to resources and in the distribution of costs and benefits.¹⁶

Following this line of reasoning, the report suggests that equity within the present generation would require meeting its perceived consumption needs, that are socially and culturally determined. In this sense SD would mean the promotion of values that encourage consumption standards that were within the bounds of the ecologically possible and to which all could reasonably aspire. Therefore, it pointed out that SD would clearly require economic growth where such needs were not being met. "But growth itself is not enough. ... sustainable development requires that societies meet human needs both by increasing productive potential and by ensuring equitable opportunities for all."¹⁷

Unfortunately, inequality and, consequently, many problems of resource depletion and environmental stress, arise from disparities not only in economic but also in political power. Moreover, the ability of a government to control its national economy is reduced by growing international economic interactions. The gains from trade are typically not distributed equally, and patterns of trade affect not merely a local producing sector, but the economies and environments of the many developing countries that depend heavily on some products that they export. "Hence, our inability to promote the common interest in sustainable development is often a product of the relative neglect of economic and social justice within and amongst nations."¹⁸

In this context, the pursuit of sustainability would require major changes in international economic relations. As economic and environmental links between nations have grown rapidly, this has exacerbated the impact of the growing inequalities in the economic development and strength of nations. "The asymmetry in international economic relations compounds the imbalance, as

developing nations are generally influenced by - but unable to influence - international economic conditions."¹⁹

In summary, the Brundtland Report sweepingly affirms: "critical objectives for environment and development policies that follow from the concept of sustainable development include: reviving growth; changing the quality of growth; meeting essential needs for jobs, food, energy, water, and sanitation; ensuring a sustainable level of population; conserving and enhancing the resource base; reorienting technology and managing risk; and merging environment and economics in decision making."²⁰

It is clear that precision, coherence and detailed policy prescription were not the characteristics that have made the Brundtland Report the principal catalyst for sustainable development efforts in the last few years. Nor was its diagnosis particularly innovative. In fact, one could correctly argue that it did not bring anything new. All it discussed and proposed could be found in other studies and documents published earlier²¹. Nevertheless, it was an important step forward in terms of international understanding of environmental issues for several reasons.

First, the Brundtland Report reflected the growing anxiety and increasing concern with environmental problems that were taking place in the developing countries by the middle of the 1980s and with the failure to relate them to development issues²². The Report was successful in identifying key contemporaneous socio-economic, technical, political and ideological aspects of the environmental debate, largely because of its membership and also because it was based, in part, on public hearings held across the world²³.

A related reason for its success in drawing worldwide attention to SD was that it provided a more sound analysis of causes and consequences of environmental stresses than the dominant

doomsday bibles of the 1970s²⁴. It was a welcome return to academic honesty to realize that other factors besides "population explosion" could be identified as origins of environmental degradation and something other than "population control" and "no-growth" could be carried out to achieve a healthier environment.

Another relevant reason for the spread of the SD proposal was that, as Buttel et. al.²⁵ point out, for many persons concerned with improving the livelihoods and living standards of developing world people, "Our Common Future" and its related notions were the most promising alternative to the structural adjustment orthodoxy that was being implemented with a very high social cost, in the majority of those countries. Therefore, it provided an authoritative basis for legitimate criticism of the destructiveness and inadequacy of prevailing economic policies and also served as an effective means for keeping issues of social justice on the agenda.

Nearly five years "post Brundtland", the terms sustainability and sustainable development are still sufficiently vague so that terminological exercises continue to be endemic. As Brookfield (1991) argues, SD carries "all before it except, ..., either adequate definition of what it means, or - except at a very micro-level (and under special conditions) - any practical solutions to the problems it seeks to define."²⁶ Those who believed that it could be an alternative to "structural adjustment" policies have not advanced much in terms of concrete policies and/or programs aiming to achieve sustainability. At the same time, those who did not want this alternative or did not understand what SD was all about have made "significant contributions" to transform it into "sustainable underdevelopment" strategies.

What has changed since "Our Common Future" in relation to sustainable development concept? What are the central aspects of this concept which have been lost in many of its current

definitions? Why do we believe that some of these definitions have the potential to be extremely harmful for the majority of Third World countries and their population? Answers to these questions can be found on both theoretical and empirical grounds. The former is discussed below in this section. Empirical aspects are analyzed later in this paper.

Theoreticians and practitioners of sustainable development have often failed to realize that environmental problems, and solutions to them, fit into the broader societal structure where socio-economic-political imperatives dominate what are seen as ecological concerns even while being strongly influenced by the resource base upon which they rest. Therefore, it is common to see theoretical models that represent stereotypes of developing countries but which are often inadequate to represent the complexity of the issues involved²⁷. It is within this complex set of constraints that sustainable development alternatives must be drawn. These alternatives must take into account that the structure into which they will be implemented will inevitably have its own dynamics and will present people with choices which may seem better to them than "sustainable" alternatives.

One of these dynamics is economic growth. There are a remarkable number of papers dealing with sustainable development and affirming that "economic growth does not mean development". Hueting (1990) and Daly (1990) are representative examples of this²⁸. As a matter of fact, this all too obvious point is so well-known that it does not merit such emphasis. However, these scholars should also know that without economic growth there is no development. Economic growth is almost always an indispensable prerequisite to any improvement of mankind's lot and it seems to be one of very few agreements between economists from different schools of thought²⁹.

It is often appealing to romanticize the notion of living

close to nature with simple wants and simple needs. Such a view often generates a misplaced ideal of the "sustainable subsistence farmer". While sustainability (however defined) is a legitimate ideal, subsistence level income is not. Subsistence is defined as that level of income which is just enough to sustain life. This condition is nothing to be aspired to, and certainly is one which is avoided (or remedied) by all who can do so.

The key is that development will result from economic growth (due to increase in the productivity of labor) only when its benefits are distributed equitably among groups in the society. The more equitable the distribution, the more development is achieved. Economic growth by itself is not the problem, but unequitable distribution of its fruits often can be. This inequality can lead to environmentally damaging activities at both ends of the income spectrum. Putting it another way: there is an institutional connection between poverty and wealth. We agree entirely with Buttel et. al. "...there is a tendency to see the resource-destroying poor and the resource-destroying wealthy as not being part of the same local, regional, and national social structures".³⁰

The distributive aspect of SD is a central aspect in Pearce's definition. In Pearce et. al. (1990) it is proposed that sustainable development must be measured by progress along a vector made up of attributes that include improvement in income and its distribution, in health, education, freedoms, and access to resources. Or, as they discuss elsewhere, it requires that "real incomes rise, that educational standards increase, that the health of the nation improves, that the general quality of life is advanced"³¹. However, their "working definition" of SD is much closer to mainstream economics: "it involves maximizing the net benefits of economic development, subject to maintaining the services and quality of natural resources over time."³²

They go on to stress that **maintenance** involves utilization of "renewable resources at rates less than or equal to the natural rate at which they can regenerate" and to "optimize the efficiency with which non-renewable resources are used, subject to substitutability between resources and technological progress."³³ It is important to notice, as Brookfield (1991) emphasizes, that this definition is in contradistinction to pure sustainability which would allow only to redistribution within a no-growth steady-state economy. It seems a tortuous route to recognition that while there is indeed a set of natural limitations, there might also be a sustainable way out. This makes it possible to move forward toward a definition of what SD means and how it might be achieved³⁴.

Criticizing Pearce's definition, Redclift (1987) argues that the constant reference to "sustainability" as a desirable objective has served to obscure the contradictions that "development" implies for the environment. In his opinion, a definition of SD needs to take account of the wide variations in the industrial and productive structures of different countries. In particular, as far as developing countries are concerned attention should be given to the international structures within which such countries are located.

In whatever way, independently of the school of economic thought followed by the scholar, resource management and sustainable development have not overcome the traditional limitations of their predecessors. In the words of Buttel et. al: "International environmental issues ... are typically characterized by environmental motives, claims, and rhetoric being superimposed on longstanding political, economic, and social struggles and policy questions. Thus ... most concrete environmental issues will involve ... distributional implications and specific material interests being brought to bear."³⁵ These aspects are very clear in the reality of the Amazon Rainforest.

II. Amazon Rainforest: The Last Frontier?

By the last decade of the 20th Century the deforestation of Brazilian Amazon has generated increasing national and international debate. The rapid incorporation of new land into cultivation and the westward movement of the frontier of agricultural settlement - "a marcha para oeste", an inherent feature of Brazilian agriculture - have reached the last frontier: Amazonia. It seems that history has repeated itself and the fierce attack on virgin forest has started again, to cut a similar swath in search of new lands.

The Amazon Rainforest is one of the last few natural reserves in the world. South America has the highest percentage of forest among all continents (Table 2). Most of this, but not all, is due to the existence of the Amazon Rainforest in the region. If one takes a more disaggregated view of the world forests (see Table 3), it becomes clear that in either absolute or relative terms South American forests are quite important globally. Eight countries in the continent have portions of the Amazon Rainforest³⁶. However, 60% of Amazonia is inside Brazil and it represents almost 40% of the Brazilian territory.

For centuries this immense region³⁷ had been marginal in relation to the rest of Brazil but by the end of last century the Amazon Basin experienced a "rubber boom", being the primary world provider of natural latex, extracted from wild hevea brasiliensis trees. Actually, the history of the Brazilian Amazon region can be told through the analysis of data relating the regional population to the Brazilian population. Tables 4a and 4b³⁸ show this data for selected years from 1785 to 1985. It is clear that the ratio of the regional population to the Brazilian population has achieved peaks³⁹ in three different periods of almost 500 years of Brazilian history:

- 1770s/1780s, reflected in the data for 1785, then declining for more than one century;
- late 19th Century/beginning of the 20th Century, expressed by data for 1920, then declining again for more than half a century;
- 1970s and in particular the 1980s.

The last two periods are of particular importance for the discussion in this paper⁴⁰. Since the second decade of the 19th Century there was registration of export of Amazonian rubber. But only by the end of the century, with the discovery of new industrial uses for it, exports of rubber increased remarkably. Velho (1972) provides evidence of these exports (in metric tons):

1841-50	4.600
1851-60	19.000
1861-70	37.000
1871-80	60.000
1881-90	110.000
1891-1900	210.000
1901-10	350.000
1912	42.000

The extraction of natural latex was performed in a semi-feudal arrangement, using Silberling (1991)'s concept, whereby workers (rubber tappers) were "fronted" tools and food for their jobs, paying back the estate owner with latex⁴¹. However, workers were never allowed to accumulate a surplus, and remained perpetually in debt to the estate owner. Living and working conditions were severe, with rubber tappers living in simple shacks, with no education or means of breaking of out the cycle of exploitation⁴². The estate boss was himself often in debt to middlemen who transported goods for export houses in the Amazon⁴³.

The rubber trade was extremely profitable. Most remarkable was

the fact that in spite of the increase in exports from the Amazon region the price of rubber on the international market continued to increase until 1912. It was an incredible period of wealth for the region until Malaysian rubber flooded the world market, causing prices to crash⁴⁴, as can be seen in Figure 1⁴⁵. When this occurred, some estate owners abandoned their holdings, leaving newly "autonomous" rubber tappers behind; other bosses stayed on. Thus, after WWI an economic cycle ended. From 1920 until 1970 the regional economy stagnated again, with only a few short and unsustainable periods of "recovery"⁴⁶.

The third period of the Brazilian Amazon exploitation would start only during the 1970s. This phase has received the attention of international public opinion. Amazonia's total population has more than tripled in three decades, from 2.5 million people in 1960 to 8.6 million in 1991⁴⁷. This massive migration into the region was followed by what Barraclough (1992) called possibly the most extensive, destructive and chaotic private land enclosures in history. Speculators and large ranchers burned huge areas of rain forest. Small settler colonists, even when sponsored by the official colonization agency, often fared little better than poor migrant workers and sharecroppers. Forest has been converted to a variety of uses⁴⁸:

Cattle Ranching - cattle pasture dominates land use in deforested areas of Brazilian Amazonia. The yield of beef is very low because of a steady decrease in pasture grass productivity caused by decline in phosphorus in the soil, soil compaction, erosion, and invasion by inedible weeds⁴⁹;

Lumbering - Timber exploitation has been much less prominent in Amazonia than in the tropical forests of Africa and southeast Asia due to the lower density of commercially-valuable trees in South America. Amazonian trees have so far defied efforts to group the species into a relatively small number of categories for

processing and marketing purposes. Fearnside (1989), however, believes that lumbering will increase rapidly in importance as a factor in Amazonian deforestation⁵⁰. Moran (1990) indicates that four of the six states in the region depend on wood products for more than 25% of their industrial output.

Slash-and-Burn Agriculture - Pioneer agriculture has been an important activity in Brazilian Amazonia. Farmers coming to the region from other parts of the country fell and burn the forest in the same way as the first step in traditional shifting cultivation, but after the brief cropping period they either leave the field fallow for a short period (insufficient to regenerate the productive capacity of the sites) or, more frequently, plant the area in pasture. The conversion of forest for agriculture has occurred in tandem with spontaneous or planned colonization⁵¹.

Agribusiness - Agribusinesses account for a small portion of the cleared area relative to other activities. However, as far as silviculture is concerned large-scale plans exist for financing mechanized agriculture and associated industries in the Grande Carajas area⁵². Perennial crops⁵³ are limited by commercial and biological factors. Market limits restrict the areas to which many crops can expand that are favored by agribusiness. Because Amazonia is so large, any significant portion of the region planted to perennial crops would saturate world markets for these commodities⁵⁴. Plant diseases severely curtail the potential for conversion of large areas to perennials⁵⁵.

The poor economic and agronomic performance and high environmental costs of almost all components of the "development strategy" for Amazonia in the 1970s and 1980s have illustrated the need for sustainable development strategies. Native people and the rubber tappers have become darlings of environmentalism and their activities touted as sustainable alternatives for using the forest. Before discussing them, however, it is essential to have a correct

understanding of the forces that motivate forest destruction to guide effective actions to control the deforestation process and to find alternative development patterns.

The social, economic and political dynamics of rainforest destruction have already been comprehensively analyzed by researchers⁵⁶. As a matter of fact, the Amazon Rainforest is also becoming a favorite testing ground for many environmental ideas. Here, only a brief outline of this body of work will be given, drawing out the issues that often seem to be overlooked in discussions on the fate of the forest and in policy deliberations outside the region. We suggest that aspects discussed below must be included in any discussion of Amazonian development.

First of all and as pointed out before, the Amazon Rainforest was not the first forest to be occupied by Brazilian farmers. The "agricultural frontier movement" has been the basic characteristic of agricultural production in the country. Rio de Janeiro, Sao Paulo, Parana, Minas Gerais were covered with forest when agricultural production started there, in an earlier period of the Brazilian economic development process⁵⁷. Slash and burning the forest and planting afterwards have been practiced since the beginning of agricultural production in Brazil.

The frontier movement has been a "strategy" that combined plenty of land, availability of labor, and scarcity of capital. Besides it has had the role of allowing an extremely high concentration of the agrarian structure without the necessity of a agrarian reform (safety-valve function). Brazilian agrarian structure is an example of what Barraclough called a bi-modal agrarian system⁵⁸. This system has often been called exclusionary. It effectively excludes many rural people from access to adequate land for their livelihood and when labor-saving technologies become advantageous for large land holders, it rapidly expels many of the rural poor from agriculture⁵⁹.

The bi-modal structure of Brazilian agriculture was continuously reproduced in new areas on the agricultural frontier. This also happened in the Amazonian frontier. According to Barraclough (1992): "Nor surprisingly, in the mid-1980s Rondonia's land tenure was in many respects the mirror image of that in the rest of Brazil. Large properties of over 1,000 hectares each made up 1.9 per cent of all rural properties but included nearly two thirds of the land. The vast majority of rural residents were landless while the majority of landowners had small properties of less than 100 hectares each that included only 13% of the land. By 1990, one fifth of the state's forests had already been cleared."⁶⁰

Land tenure in Brazil also facilitates some well off people to transform land from a productive asset into a speculative one. The Brazilian high inflation is centrally important to understanding deforestation in Amazonia. Land is an excellent hedge against rising and fluctuating prices. High levels of inflation in the 1980s lie behind what at first seems extremely irrational behavior, on both economic and environmental grounds. Furthermore, if the number of casualties in land conflicts is examined - as good an index as any to the level of land speculation - the late 1980s may actually have seen the situation worsen⁶¹.

In a country where annual inflation rates come in with three or four digits, land has a material value conspicuously absent in the currency. Cleary (1991) argues that "as long as Brazilian inflation remains high, and as long as the economic outlook in the country is fundamentally unstable, a speculative land market will be the dominant feature of life in rural Amazonia, and one of the most direct causes of deforestation."⁶² As far as we know, the first scholar to call attention to the importance of speculation with land in frontier areas and its consequences for the environment was Mueller in the beginning of the 1980s⁶³.

Land tenure relationships and inflation help to explain why

and how the deforestation has occurred on a gigantic scale in Amazonia in the late twentieth century. They are not the whole picture by any means, but they go a long way towards defining the context within which the picture is developing, why the destruction is so needlessly wasteful and who benefits and who loses. Moreover, only when these factors are taken into consideration do other possible explanations have real policy significance. For instance, to say that what has happened in the Amazon is only due to wrong government policies⁶⁴ shows a clear lack of understanding why such policies are formulated in the first place.

Also, consideration of land tenure is essential to give real meaning to the neoclassical hypothesis of factor proportions. This hypothesis is used by Kyle and Cunha (1990) to explain the extensive use of land (abundant factor) and minimization of labor and capital (scarce factors) in the Amazon Rainforest. Without considering the limits imposed by the agrarian structure upon access to land, it is difficult, if not impossible, to explain how in an region with the size of Amazonia and with a very small population, 56% of the population live in urban areas, most of them underemployed and in shanty-towns.⁶⁵

Finally, inflation is a symptom of imbalances between productive sectors and social groups inside a country and/or between a country and the international economic order. In the Brazilian reality of the 1980s, one of these imbalances was a consequence of the country's foreign debt and the high (environmental and social) cost of adjustments required to keep current on interest payments. This is an extremely important aspect⁶⁶, also mentioned by Cleary (1991), but is beyond the scope of this paper. It is sufficient to point out that foreign debt has a (indirect) role in the deforestation process of the Amazon Rainforest and must be considered in any serious discussion on regional environmental issues and sustainable development alternatives⁶⁷.

III. Sustainable (Under)Development of Amazonia

The attempt to repeat the Brazilian history of agricultural production inside the Amazon Rainforest has not been as successful as in other regions. Actually, as Kyle and Cunha (1990) point out, the social and ecological losses resulting from Amazon occupation to date have been enormous. "Certainly, what is being done in the Amazon would not fit anybody's idea of sustainable development"⁶⁸. Even the safety-valve function of the "agricultural frontier" has not worked properly. Investments on social infrastructure and on agricultural inputs necessary from the beginning were not there. Consequently, all structural factors (agrarian structure/land tenure) of the Brazilian reality repeated themselves in the region, but without a straightforward answer in terms of increasing production.

This does not mean that "all farmers failed", "the low productivity of pasture will mean that cattle ranchers will leave", "areas of the Amazon Forest have been transformed into desert, like the Sahara" etc. etc. This image of Amazonia, with the help of some "specialists" and a lot of media coverage, has spread all over the world, and has been not only misleading but actively harmful⁶⁹. There have been a few success stories such as the private colonization projects in the Northern Mato Grosso⁷⁰ and the Japanese colonization scheme in Tome-Acu (Para)⁷¹. To say that low yields will force cattle ranchers to leave represents a lack of understanding the difference between productivity and profitability.

But how about extractivism and rubber tappers? Do they represent an sustainable alternative for using the forest? We suggest that "traditional models of production" have become the darling of international/national environmentalism for the wrong reason and a brief discussion of the rubber tappers' reality can clarify our arguments. Homma (1989) argues in his excellent thesis

that some characteristics of extractive plants put them in economic disadvantage relatively to domestic/cultivated plants. Among the main limitations of extractive plants, can be mentioned⁷²:

Low density - There is a small number of units of a given plant per unit of area and their geographical distribution is very heterogeneous; this is why the rubber tapper has to walk tens of kilometers every day to find rubber trees;

Low productivity - Any plant will have a larger productivity after being domesticated than when it was native; the example of the Malaysian plantations of rubber vis-a-vis the Amazonian native rubber in the beginning of this century, is quite illustrative of this aspect⁷³;

Limited stock - Areas where an extractive resource occurs' although very large in some cases, have a finite stock of this resource, which soon or later may represent a limitation in supply;

Extraction constraints - Low density and geographical heterogeneity, associated with the fact that native varieties are in the interior of the forest, limit the possibilities of mechanical techniques of extraction and/or transport of the production. In addition, the fragility of the forest ecosystem itself, a mature and relatively stable system, limits the quantity of biomass that can be extracted.

If extractivists are to adhere to strict sustainability, then simple nutrient balance requires that they restrict themselves to an off-take no greater than the rate of natural increase of biomass in the forest. To extract a greater quantity would eventually deplete the system and cause fertility decline and collapse, as has in fact happened on many lands cleared for agriculture in the region.

There is a way out, however, and that is to replace biomass removed from an area with purchased inputs. Indeed, agricultural development which provides rising incomes is virtually synonymous with increasing market reliance both on the input and output sides. While such development can be unsustainable or sustainable, it is almost invariably an attractive option to producers at low income levels such as Amazonian rubber tappers. Thus "low input sustainable agriculture" almost inevitably implies "low income sustainable agriculture" since to be sustainable, production must be limited to the rate of natural increase of biomass in the system.

Therefore, it is not a surprise to find that under present conditions, rubber tappers cannot compete with domesticated production and their income is only enough to keep a family in very poor conditions. As a matter of fact, this is also true for other extractive producers in the region. For instance, Nugent (1991) presents the case of acai, a palm product, and concludes that the economic long-term implications of extractivism for direct producers seem less optimistic than suggested by some supporters of the forest-management approach⁷⁴.

In this context, there is an urgent need for much more research to find economically sound methods of production for rubber tappers, nuts collector, and so on. However, a global inventory on forestry research⁷⁵ by Mergen et. al. (1988) shows that there is a low level of investment in this area in most of the developing countries. It also shows that the stage of development of forestry research institutions today is probably comparable to that existing in agriculture 3 or 4 decades ago. In this respect, South American and Brazilian realities do not differ much from those in other developing countries.

What must be clear to all those interested in environmental issues is that the Brazilian rubber tappers have made an essential

contribution to the solution of environmental problems in another area, if not in terms of a production model. But this contribution has not received too much attention from environmentalists. Rubber tappers have obtained concessions only after many conflicts. Silberling (1991) provides some interesting aspects of their struggle:

"Some rubber tappers such as Chico Mendes had been organizing in the early 1970's to break away from the rubber bosses, ... (l)atter, rubber tappers needed to break away from exploitative middleman relations. ... Indigenous peoples were also being expelled in large numbers from their land, and in 1982, rubber tappers, traditionally at odds with indians, began to form alliances with them. ... (In 1985) they also came up with their first concrete, alternative proposal for development in the region: the extractive reserves."⁷⁶

The process was as important as the outcome. Rubber tappers have shown that conditions of security under which resource managers operate are essential in searching for a sustainable development strategy. It cannot be overemphasized that substantive tenure system reform is a sine qua non for a slackening of the pace of deforestation in the Amazon, and this reform is as important in the rural areas where migrants originate outside Amazonia as within the region. But land tenure relations are very difficult to reform; it takes time and very often lives.

Only when this security is achieved, one can think about the second step. To make development sustainable it is necessary both that natural reproduction capabilities not be drawn down, and that investment in conserving or improving capabilities be undertaken and sustained. However, it is difficult to imagine economic agents looking into the long run, if the socio-economic-political situation in the short run is one of instability and uncertainty. Proposals for long-term policies, like those by Lutz and Young (1992) and Redclift (1992), seem to avoid the hard questions in the

present situation of many countries, including Brazil, that need to conserve their natural resource base.

Above all, it is important to keep in mind the words of Brookfield (1991, page 57): "Sustainable development research cannot begin from ideals derived from non-existent past. It is necessary to begin by accepting the innovation that has taken place, however harmful some of it has been ...". We would add that a new pattern of development for the Amazon Rainforest must also be based on a strategy which allows for the economic context within which the Amazon region exists as well as the inhabitants' desire for economic improvement and higher incomes.

NOTES

1. Professor of Economics, University of Brasilia, Brazil and Assistant Professor of Agricultural Economics, Cornell University, Ithaca, New York. This paper was written during the period the first author was a Visiting Scholar at the Department of Agricultural Economics, Cornell University, with the financial support of CAPES/Fulbright, which is gratefully acknowledged.

2. Terence Corcoran quoted in Miller (1990), pp.28.

3. We are using environmentalism in the sense of ideologies and practices which inform and flow from a concern with the environment. Therefore, it is broad enough to accommodate official and non-official, national and international organizations and groups, those who seek environmental reform without corresponding social and economic reform, and those who believe that the former is not attainable without the latter.

4. This classification is adapted from Colby (1989) who uses the names Frontier Economics and Deep Ecology; and from O'Riordan (1981) who uses Ecocentric and Technocentric/Cornucopian.

5. Deep ecology has been interpreted as the polar opposite of frontier economics. It should not be confused with the science of ecology and has given particular emphasis to ethical, social, and spiritual aspects that have been down played in the dominant economic world view. Limits, self-reliance, self-sufficiency, small-scale production, low-impact technology, recycling, zero population and economic growth - these are all key words in the standard deep ecology vocabulary and can be found in the environmentalism bibles mentioned before.

In terms of economic theory, an important variant of deep ecology was the steady-state school of environmental economists, which was created in its modern form by Georgescu-Roegen (1971). Among its followers, Daly (1973) has written extensively on the subject. More details are in Brookfield (1991) and Perrings (1987).

Frontier economics was the approach that prevailed in the Western countries until the late 1960's. While it sometimes recognized the existence of environmental problems and desire to solve them, it has a faith in the idea of progress as expressed in, and equivalent to, material advancement, in the superiority of 'high' over 'lower' technology, in the sustainability of economic growth, in the ability of advanced capitalism to maintain itself, and that conflicts between the demands of economic man and the environment would be, in most cases, reconcilable through management. When not, economic man would win the day. A good example of this approach is Simon (1981).

Details are in Colby (1989) and Pepper (1984).

6. It became apparent to the planners of the 1972 Stockholm Conference that the relationship between environment and development would be a sensitive issue in the international debate. At the initiative of the Conference Secretariat, a panel was convened in 1971 to grapple with this fundamental problem, and out of this came the "Founex Report", considered to be the first comprehensive document on the development-environment issue. Its primary contribution was to broaden the definition of environmental concerns to include a variety of development-related problems. Those interested in more details may consult Pearson and Pryor (1978). For a discussion of what happened during the Conference see Nogueira (1992a) and references cited therein.

7. In practical terms, Third World countries basically followed Principle 17 of the Conference's recommendations and created an "appropriate national institution" entrusted with the task of planning, managing or controlling environmental resources with the view of enhancing their quality. Actually, these institutions have been responsible for setting limits, and in some cases, cleaning up after limits were exceeded. They have not been responsible for planning development activities in ways that did not pollute or impair necessary ecological functions. Development decisions have been the responsibility of other governmental institutions, dominated by the frontier economics line of thought. Nogueira (1992a) discusses the Brazilian experience with "environmental planning" during the 1970s and 1980s.

8. Another book important to international environmentalism was published for the first time in 1976: E.P. Eckholm, Losing Ground: environmental stress and world food prospects. It called attention to the deterioration of the world's land, particularly in the Third World countries.

9. This classification is used by Colby (1989) who argues that the "...environmental protection approach is basically a modest variation on the 'frontier economics' paradigm of development, and even that was at least in part thrust on developing countries by industrial nations. Because of the types of information sought in economic analysis, this variation only shows up as added costs." (pp.15 and 16).

10. Colby (1989), p.22. The normative character of the ecodevelopment strategy made it controversial and its complexity made the derivation of practical guidelines difficult, some would say impossible. See, for example Pearson (Ed.) (1987). Among social development theorists that began to write in terms of ecodevelopment there were Sachs (1976) and Riddell (1981).

11. As indicated by Brookfield (1991).

12. This point is discussed in Dasmann (1985).

13. See Redclift (1987) for details.
14. The World Commission on Environment and Development - WCDE (1990).
15. WCED (1990), page 43.
16. "Even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation" Ibid, p.43.
17. Ibid, p. 44.
18. Ibid, p.49.
19. Ibid, p.67.
20. Ibid, p.49.
21. See for instance the excellent publication by Sunkel and Gligo (Eds.) (1981).
22. For a discussion of the Brazilian case see Nogueira (1992a).
23. Using the words of M. Redclift (1987):
"Increasing concern with environmental problems in developing countries ... led to the establishment of the United Nations Commission on Environment and Development in November 1983. This Commission ... consisted of twenty two people from both developed and developing countries. ... (Its) main objective was to undertake public hearings in various countries, at which members of the public and community leaders could give evidence about the relationship between development and environment ... The members of the Commission were not chosen for their expertise as environmental 'specialists', but as prominent people who were appraised of the facts and were prepared to ask relevant questions about the causes of environmental problems". (pp.12-13).
24. Erlich (1968) and Meadows et. al. (1972). For an interesting criticism of both books see Simon (1981).
25. Buttel et. al. (1991).
26. Brookfield (1991), page 45.
27. One evidence of this is a general "characteristic" of many Third World countries: overpopulation. Using the words of Julian Simon: "The common view of ... population growth in poor countries ... is that people breed "naturally". That is, poor people are assumed to have sexual intercourse without taking thought or doing anything about the possible consequences." Page 174 of Simon (1981). Another is an implicit assumption that everybody in a Third World countries

is equally poor. These and other oversimplifications of the reality of poor countries are widespread among the environmental literature, scientists, and activists.

28. Huetting (1990) has this "masterpiece" of economic reasoning: "... growth of GNP and safeguarding the environment and resources are two conflicting ends. Sustainable use of our planet's resources requires a shift in priority from increasing GNP to saving the environment. This certainly does not mean "Stop production growth", but rather a shift in production and consumer activities in an environmentally acceptable direction in order to arrive at sustainable economic development, and then to wait and see what the increase in production would be." (p.112).

Daly (1990), a notable economist of The World Bank, also has a contribution: "An economy can grow without developing, or develop without growing, or do both or neither. Since the human economy is a subsystem of a finite global ecosystem which does not grow, even though it does develop, it is clear that growth of the economy cannot be sustainable over long periods of time." (pp.1).

29. From a neoclassical like J.L. Simon to a marxist like Ernest Mandel, we can find:

- "What the poor need is economic growth." - Simon (1981), page 155.

- "In the last analysis, every step forward in the history of civilization has been brought about by an increase in the productivity of labor." - Mandel (1974).

30. Buttel et. al. (1991), page 15.

31. Pearce et. al. (1989), page 2.

32. Pearce and Turner (1990), page 24.

33. Ibid, page 24. This definition is quite similar to that proposed by Cunha and Sawyer (1991), page 2: "Our definition (of sustainability) comprises three intermingled dimensions: technical, economic, and social. 1) The technical dimension concerns preservation of the resource base. ... 2) Because of the possibility of substitution among factors, implicit in resource management, technology comes into play. ... 3) Social instability is also necessary for long-run sustainability."

34. In other words, this is a clear example of the middle-of-the-road characteristic of the sustainable development strategy, trying to accommodate in only one framework much of the corrective actions from Frontier Economics/Resource Management with more or less of philosophical and ethical concepts from Deep Ecology/Ecodevelopment.

35. Buttel et.al. (1991), page 11.

36. Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela.

37. The Brazilian Amazon Rainforest has an area of 3.3 million square kilometers. This area is equivalent to a country of the size of India.

38. "Administrative Unit" means the states of the Amazon Region in 1990.

39. Showing an increase in the regional population relative to the total Brazilian population. If the natural population growth rate is not significantly different between Amazonia and the rest of the country, which is a very reasonable assumption to make, the increase in the ratio (Amazon pop./ Brazilian pop.) indicates migration towards the region, due to an "economic boom".

40. As mentioned before, the Amazon region remained in a situation of marginalization in relation to the rest of Brazil for almost three hundred years (from 1500 to the end of the 18th Century). To the Portuguese colonizers, Amazonia was one of their hopes to find gold in their American colony. To try to find gold, the Portuguese crown did not stop at sending official missions to the region. Missions were also sent to avoid the presence of English and Dutch in Portuguese lands. Most of these missions resulted in the death of native people (Amerindians) and in finding "as drogas do sertao" (natural products with high commercial value in Europe: cinnamon, clove, nut, and cocoa).

In the second half of the 18th Century cotton became an important crop to be exported to Europe, in particular to England. This country was at war with its colony and main supplier (United States). This explains the relative increase in the regional population, mainly in the state of Para, near the seaside. When the relationship between cotton main producer (USA) and main consumer (UK) returned to normal, the Amazon region lost dynamism and its population declined relative to the Brazilian population.

Details in Velho (1972).

41. The rubber tappers and other extractivists are largely descendants of poor migrants from the drought-ridden northeastern region of Brazil, or are descendants of a mixture of these migrants and indigenous peoples. Silberling (1991) points out that many of the original rubber tappers were indigenous peoples, forced to work for estate owners in slavery and that there remain some indigenous peoples who include rubber tapping as a primary income generating activity.

42. "Tappers could not leave, as they would be found and beaten; they could not produce other goods, or food, as it would be confiscated, and they would be beaten". in Silberling (1991), page 20.

43.This reality of exploitation continued into the 1970s in many areas of the Amazon Rainforest, and continues today in others. We return to this point later on.

44.The rubber tree (seringueira) is native to Amazonia, which was the only producer of latex in the world until the first decade of this century. The traders of Brazilian rubber (English) soon realized that the international market for rubber was immense and that exploitation of the native rubber tree was time and labor consuming. They decided to try to develop another more efficient way to produce latex. English scientists took a sample of rubber trees from the Amazon and brought them to London. There, they reproduced the seringueira in green houses in the London Botanic Garden and started to plant them in countries like Malaysia, Indonesia, Thailand, and Ceylon (Sri Lanka) using a plantation system. Details in Velho (1972).

45.From page 126 of Homma (1989).

46.Some estate owners returned during the 1940s, when Brazil provided rubber for the Allies in the Second World War. After the war, partly through the efforts of these estate bosses, the price of Brazilian latex was kept high in comparison to the world price, via government imposition of a tariff on imported natural latex. In 1973, the Brazilian government found its dependence on foreign petroleum for synthetic rubber production to be problematic, and it began a series of programs to stimulate research on and production of natural latex. The price of rubber continued to be supported until recently through these programs. Details in Dean (1987).

47.Preliminary data from the 1991 Census, cited in Barraclough (1992), page 12. He also affirms that 56% of the Amazon population are urban today, against only 37% in 1960. In spite of this growth the population density in the region (2.6 hab./ sq.km) is still very low.

48.It is not our objective to give the reader an in-depth presentation of all types of production activities that have been implemented in the Brazilian Amazon Rainforest. We do not mention mining, dam construction, or industrialization. We will limit ourselves to relevant aspects of agricultural production and extractivism. There is much literature elsewhere for those interested in different aspects of Amazonia's occupation. See for instance Goodman and Hall (1990) and Goodman and Redclift (1991).

49.Fearnside (1989), page 291.

50.Decimation of the tropical forests of Africa is essentially complete from a commercial point of view, while those of Southeast Asia are rapidly nearing a similar end. Exports from Amazonia will therefore increase.

51. For a discussion of consequences of colonization projects in the region see Chapter 2 of Goodman and Hall (1990). An historical perspective on spontaneous colonization is presented in Velho (1972).

52. Details on the Grande Carajas project are given in Chapter 6 of Goodman and Hall (1990).

53. Cunha and Sawyer (1991) seems to have forgotten this when they argued that "Sustainability depends on the extent to which observed land use matches the most desirable pattern in terms of resource conservation. In the Amazon, permanent crops should be preferred to annual crops, and these to pasture." (page 7). With this kind of reasoning, the only explanation left for the predominance of pasture is "wrong government policies".

54. Fearnside (1988), page 293.

55. Details in Ibid., page 294, and in ECO/UNB (1982), Volume II.

56. See Goodman and Hall (1990) and Goodman and Redclift (1991) for a representative sample of these approaches.

57. This is discussed with details by Nogueira (1982).

58. "Following European conquest and the advent of profitable markets for commodity exports, plantations and other large landholdings worked by slave or quasi-slave workers and tenants soon came to dominate the bi-modal agrarian systems of Latin America, the Caribbean and what is now the south-eastern United States. ... In sugar and cotton producing areas especially, African slaves were imported for labor. Workers on large estates were usually semi self-provisioning using small parcels within the boundaries or on the estate's margins. The indigenous populations remaining in marginal regions constituted a reserve of cheap labor and often also were required to pay tribute to colonial authorities." Page 7 of Barraclough (1992).

59. For data on the Brazilian agrarian structure see Nogueira (1992b).

60. Barraclough (1992), page 17.

61. Very revealing is the fact that from 1985 to 1991, the period with the highest inflation rate in all Brazilian history, there were 561 deaths due to land conflicts in the region, of whom Chico Mendes was merely the best known. But as Cleary (1991) points out: "It has been far more difficult to mobilize western public opinion on behalf of murdered peasants and labor organizers than it is on behalf of trees." (page 129).

62. Cleary (1991), page 128.

63.C.C. Mueller, O Estado e a Expansao da Fronteira Agricola na Amazonia Brasileira.in ECO/UNB (1982), Vol. I.

64.As Binswanger (1989) does. We do not want to imply that there have not been "wrong" government policies in relation to Amazonia during its occupation. What we suggest is that economic policies can also be a consequence, instead of a cause, of the social movements that took place in the region during the 1970s and 1980s.

A recent book by Galbraith (1992) suggests that "wrong" government policies are not privilege of Third World countries.

65.Data from Barraclough (1992).

66.For an interesting discussion on origins and consequences of Latin America crisis during the 1980's see Singh (1992).

67.For an analysis on the relationship between debt and sustainable development in Latin America see O'Brien (1991).

68.Kyle and Cunha (1990), page 3.

69.This point is well discussed by Cleary (1991), page 122.

70.Reported by Kyle and Cunha (1990).

71.Reported by Velho (1972).

72.For details see Homma (1989), pages 68-69.

73.Homma (1989) presents in Table 4, page 114, data on productivity (kilos of dry rubber per hectare) of rubber production under three different systems: native (2 kg/ha); rational cultivation at present level of technology (500 kg/ha); and rational cultivation with new technologies (from 1,300 to 3,000 kg/ha).

74.It is important to pay attention to two observations made by Nugent (1991):

"... half of all income (of direct producers of acai) is collected by the absent landlord." (p. 150), and

"Regardless of the superiority of the forest-management approach in terms of environmental protection, without agrarian reform and recognition of the way Amazonians actually live as opposed to might, in the best of all possible managed worlds, live, the viability of rational forest-extraction is threatened." (p.153).

75.Including forestry research related to activities surrounding the growing and harvesting of trees and manufacture and marketing of products derived from trees.

76.Silberling (1991), Chapter II, underline added.

REFERENCES

- BARRACLOUGH, S., "The Struggle for Land in the Social Dynamics of Deforestation". Paper prepared for the Fundacao Memorial da America Latina. Uma Estrategia Latino-Americana para a Amazonia. Sao Paulo, Brazil, March 25-27, 1992, 60p.
- BINSWANGER, H.P. "Brazilian Policies that Encourage Deforestation in the Amazon." (Washington, DC: World Bank, Environment Department Working Paper No. 16, April, 1989).
- BROOKFIELD, H., "Environmental Sustainability with Development: What Prospects for a Research Agenda?" in O. Stokke (Ed.), Sustainable Development. (London: Frank Cass, 1991, 132p.), pp. 42-66.
- BUTTEL, F.H., W.D. SUNDERLIN, and J.M. BELSKY, "Balancing Biodiversity and Human Welfare". Paper prepared for the United Nations Research Institute for Social Development. Geneva, October, 1991, Mimeog., 38p.
- CARSON, R., Silent Spring. (Boston, USA: Houghton Mifflin, 1962).
- CLEARY, D., "The Greening of the Amazon". in Goodman and Redclift (Eds.) (1991). Op. Cit., pp. 116-140.
- COLBY, M.E., The Evolution of Paradigms of Environmental Management in Development. (Washington: The World Bank, Working Paper Series No. 313, November, 1989, 37p.).
- CUNHA, A.S. and D. SAWYER, "Agricultural Growth and Sustainability: Conditions for their Compatibility in the Humid and Sub-Humid Tropics of South America". Paper presented at the Seminar on Agricultural Sustainability, Growth and Poverty Alleviation: Issues and Policies, Feldafing, Germany, September 24-27, 1991, Mimeog., 26p.
- DALY, H.E. (Ed.), Toward a Steady-state Economy. (San Francisco, CA: W.H. Freeman, 1973).
- DALY, H.E., "Toward Operational Principles of Sustainable Development". Ecological Economics, Vol.2, 1990, pp.1-6.
- DASMANN, R.F., "Achieving the Sustainable Use of Species and Ecosystems". Landscape Planning, Vol.12, 1985, pp. 211-19.
- DEAN, W., Brazil and the Struggle for Rubber. (Cambridge: Cambridge University Press, 1987).
- ECKHOLM, E.P., Losing Ground: environmental stress and world food prospects. (New York: Norton, 1976).

- ECO/UNB, Expansao da Fronteira Agropecuaria e Meio Ambiente na America Latina. (Brasilia, Brazil: Universidade de Brasilia, Anais do Seminario, November 10-13, 1981, 2 Volumes).
- ERLICH, P.R., The Population Bomb. (New York: Ballantine, 1968).
- FEARNSIDE, P.M., "Deforestation and Agricultural Development in Brazilia Amazonia". Interciencia, Vol.14, No. 6, December, 1989, pp. 291-297.
- GALBRAITH, J.K., The Culture of Contentment. (New York: Houghton Mifflin Company, 1992, 195p.).
- GEORGESCU-ROEGEN, N., The Entropy Law and the Economic Process. (Cambridge, MA: Harvard University Press, 1971).
- GOODMAN, D. and A. HALL (Ed.), The Future of Amazonia. Destruction or Sustainable Development? (London, MacMillan, 1990, 405p.).
- GOODMAN, D. and M. REDCLIFT (Ed.), Environment and Development in Latin America. The Politics of Sustainability. (Manchester: Manchester University Press, 1991, 238p.).
- HARDIN, G., "The Tragedy of the Commons". Science, Vol. 162, 1968, pp. 1243-8).
- HOMMA, A.K.O., A Extracao de Recursos Naturais Renovaveis: O Caso do Extrativismo Vegetal na Amazonia. (Vicosa, Minas Gerais, Brazil: Tese de Doutorado, Universidade Federal de Vicosa, Julho, 1989).
- HUETING, R. "The Brutland Report: A Matter of Conflicting Goals". Ecological Economics, Vol.2, 1990, pp.109-117.
- IUCN, World Conservation Strategy. (Switzerland: Gland, International Union for the Conservation of Nature and Natural Resource, 1980).
- KYLE, S.C. and A.C. CUNHA, National Factor Markets and the Macroeconomic Context for Environmental Destruction in the Brazilian Amazon. (Cornell University, Department of Agricultural Economics, Working Paper No. 90-8, 1990, 41p.).
- LOWE, P. and J. GOYDER, Environmental Groups in Politics. (London: George Allen and Unwin, 1983).
- LUTZ, E. and M. YOUNG, "Integration of Environmental Concerns into Agricultural Policies of Industrial and Developing Countries". World Development, Vol. 20, No. 2, February, 1992, pp. 241-253.

- MALAYSIA, The Greening of the World. (Kuala Lumpur: The Ministry of Science, Technology and the Environment, Government of Malaysia, November, 1991, 108p.).
- MANDEL, E., An Introduction to Marxist Economic Theory. (New York: Pathfinder Press, 1974).
- MERGEN, F., R.E. EVENSON. M.A. JUDD, and J. PUTNAM, "Forestry Research: A Provisional Global Inventory". Economic Development and Cultural Change, Vol.37, No. 1, October, 1988, pp. 149- 171.
- MEADOWS, D.H. et. al., The Limits to Growth. (New York: Potomac Assoc., 1972).
- MILLER, M., "Can Development Be Sustainable?". Development, The Journal of the Society for International Development, 1990:3/4, pp. 28-37.
- MORAN, E., "Deforestation in the Brazilian Amazon". Paper presented at the annual meeting of the America Anthropological Association, November, 1990, New Orleans, EUA, mimeog., 12p.).
- NASH, R., Wilderness and the American Mind. (New Haven, Conn.: Yale University Press, 1974).
- NOGUEIRA, J.M., The Economics of Soil Erosion Control Measures and Factors Affecting their Adoption, with Special Reference to Southeast Brazil. (Ph.D. Thesis: University of London, Wye College, 1982, 518p.).
- NOGUEIRA, J.M., a) "Sustainable (Under)Development: Environmental Priorities for Planning. Lessons from Brazil." Paper presented at the "Seminar on International Planning", Department of City and Regional Planning, Cornell University, Ithaca, USA, February, 1992. Mimeog., 27p.).
- NOGUEIRA, J.M., b) "Development and Environment: A Perspective from Brazil". Cuslar Newsletter, Spring, 1992, Cornell University, pp. 5-18.
- NOGUEIRA, J.M. and W.W. GOLDSMITH, "Who Pays the Bill? Urbanization, Industrialization and Ozone Depletion". Paper presented at the workshop on The Interface Between Environment and Development. Perspective on Latin America's Own Agenda", held at Cornell University, Ithaca, USA, March 27-28, 1992, Mimeog., 45p.).
- NUGENT, S. "The Limitations of Environmental 'Management': Forest Utilization in the Lower Amazon". in Goodman and Redclift (Eds.) (1991). Op. Cit., pp. 142-154.

- O'BRIEN, P.J. "Debt and Sustainable Development in Latin America". in Goodman and Redclift (Eds.) (1991). Op. Cit., pp. 24-47.
- O'RIORDAN, T. "Environmentalism and Education". Journal of Geography in Higher Education, Vol. 5, No. 1, 1981, pp. 3-18.
- O' RIORDAN, T. "The Politics of Sustainability" in R.K. Turner (Ed.), Sustainable Environmental Management: Principle and Practice. (London: Bellhaven Press, 1988), pp. 29-50.
- PEARCE, D.W., A. MARKANDYA and E.B. BARBIER, Blueprint for a Green Economy, a Report for the UK Department of the Environment. (London: Earthscan Publications, 1989).
- PEARCE, D.W. and R.K. TURNER, Economics of Natural Resources and the Environment (Baltimore, USA: The Johns Hopkins University Press, 1990, 378p.).
- PEARCE, D.W., E.B. BARBIER, and A. MARKANDYA, Sustainable Development: Economics and Environment in the Third World. (Aldershot, UK: Edward Elgar, 1990).
- PEARSON, C.S. (Ed.), Multinational Corporations, Environment, and the Third World. Business Matters. (Durhan, USA: Duke University Press, 1987, 295p.).
- PEARSON, C.S. and A. PRYOR, Environment: North and South. An Economic Interpretation. (New York and Toronto: John Wiley & Sons, 1978, 355p.).
- PEPPER, D., The Roots of Modern Environmentalism. (London: Croom Helm, 1984, 246p.).
- PERRINGS, C., Economy and Environment: A Theoretical Essay on the Interdependence of Economic and Environmental Systems. (Cambridge, UK: Cambridge University Press, 1987).
- REDCLIFT, M., Sustainable Development. Exploring the Contradictions. (London: Methuen & Co. Ltd., 1987, 221p.).
- REDCLIFT, M. "A Framework for Improving Environmental Management: Beyond the Market Mechanism". World Development, Vol.20, No.2, 1992, pp.255-259).
- RIDDEL, R. Ecodevelopment: Economics, Ecology and Development. An Alternative to Growth Imperative Models. (Farnborough, UK: Gower, 1981.).
- SACHS, I. "Environment and Styles of Development" in W.H. Matthews (Ed.), Outer Limits and Human Needs. (Uppsala: Dag Hammarskjold Foundation, 1976), pp. 17-21.

- SCHUMACHER, F., Small is Beautiful: Economics as if People Really Mattered. (London: Abacus, 1973).
- SILBERLING, L., Social Movement Activity as a Factor in Successful Common Property Regimes: The Case of the Brazilian Rubber Tappers. (Cornell University, Master's Thesis, October, 1991, Mimeog., 50p.
- SIMON, J.L., The Ultimate Resource. (New Jersey; Princeton University Press, 1981, 415p.).
- SINGH, A., The Lost Decade: The Economic Crisis of the Third World in the 1980s: How the North Caused the South's Crisis. (University of Cambridge, UK., Mimeog., 1992, pp. 136-168).
- SUNKEL, O. and N. GLIGO (Eds.), Estilos de Desarrollo y Medio Ambiente en la America Latina. (Mexico: Fondo de Cultura Economica, 1980, 2 volumes).
- VELHO, O.G., Frentes de Expansao e Estrutura Agraria. Estudo do Processo de Penetracao numa Area da Transamazonica. (Rio de Janeiro: Zahar Editores, 1972, 178p.).
- WCDE, Our Common Future. (England: Oxford University Press, The World Comission on Environment and Development, 1990, Reprinted, 400p.).

Table 1

RELATIONSHIP BETWEEN ENVIRONMENT AND DEVELOPMENT
MAIN LINES OF THOUGHT

Line of Thought →	F	ENVIRONMENTAL PROTECTION	RESOURCE MANAGEMENT	ECO-DEVELOPMENT	
.....	R				
Dimension †	O				
	N				D
Dominant Imperative	T	Trade-offs between Environment and Economic Growth.	Sustainability as Constraint for Growth and Development.	Green Growth. Co-development Humans and Nature.	E
	I				E
	E				P
	R				
Human-Nature Relationship	E	Strong Anthropocentric	Modified Anthropocentric	Ecocentric	E
	C				C
	O	.Environment as Economic Externalities.	.Economize Ecology.	.Ecologize Economy.	O
	N				L
Main Themes	O	."Business as Usual" plus some prohibition, limits, treatment, and clean-up.	.Enhance carrying capacity.	.Enhance carrying capacity.	O
	M				G
	I	.Environmental Impact Assessments.	.Polluter pays for right.	.Pollution prevention pays.	Y
	C				
	S		.Appropriate Technology.	.Eco-technology.	
			.Global Interdependence.	.Global Change.	

Source: Adapted from Colby (1989).

TABLE 2
FOREST COVER IN CONTINENTS OF THE WORLD

CONTINENT	LAND AREA		FORESTED AREA	
	million sq km	million sq km	million sq km	percent
AFRICA	24.37	7.22		29.6%
AMERICA	38.93	13.74		35.3%
North	20.31	5.07		25.0%
Central & Caribe	1.08	0.41		38.0%
South	17.54	8.26		47.1%
ASIA	26.45	4.88		18.4%
EUROPA	26.86	8.8		32.8%
OCEANIA	8.43	0.92		10.9%

SOURCE: The Greening of the World, 1991.

TABLE 3

FOREST COVER IN COUNTRIES OF THE WORLD

CONTINENT/COUNTRY	LAND AREA	FORESTED AREA	
	million sq km	million sq km	percent
AFRICA	24.37	7.22	29.6%
Algeria	2.38	0.02	2.0%
Sudan	2.38	0.48	20.2%
Zaire	2.27	1.78	78.4%
Gabon	0.26	0.21	80.8%
AMERICA	38.93	13.74	35.3%
NORTH	20.31	5.07	25.0%
Canada	9.22	2.64	28.6%
Mexico	1.92	0.48	23.0%
United States	9.17	1.95	21.3%
CENTRAL & CARIBE	1.08	0.41	38.0%
Costa Rica	0.05	0.02	40.0%
Cuba	0.11	0.02	24.0%
Nicaragua	0.12	0.05	33.0%
Panama	0.08	0.04	50.0%
SOUTH	17.54	8.26	47.1%
Bolivia	1.08	0.56	52.0%
Brazil	8.46	5.15	60.9%
Colombia	1.04	0.52	50.0%
Ecuador	0.28	0.15	53.6%
French Guiana	0.09	0.07	82.0%
Guyana	0.20	0.16	83.0%
Peru	1.28	0.71	55.5%
Suriname	0.16	0.16	97.0%
Venezuela	0.88	0.34	36.0%

SOURCE: The Greening of the World, 1991.

OBSERVATIONS:

- A) Data for 1980 for most countries and continents.
- B) Data for 1984-86 for Algeria, Mexico, Nicaragua, Bolivia, French Guiana, Guyana, Suriname, and Venezuela.

TABLE 3 (Cont.)

FOREST COVER IN COUNTRIES OF THE WORLD

CONTINENT/COUNTRY	LAND AREA	FORESTED AREA	
	million sq km	million sq km	percent
ASIA	26.45	4.88	18.4%
China	9.33	1.28	13.7%
India	2.98	0.74	24.8%
Laos	0.23	0.19	82.6%
North Korea	0.12	0.09	75.0%
EUROPA	26.86	8.8	32.8%
USSR	22.27	7.92	35.6%
France	0.55	0.14	25.5%
Finland	0.31	0.24	76.0%
Sweden	0.41	0.26	64.0%
OCEANIA	8.43	0.92	10.9%
Australia	7.62	0.42	5.5%
New Zealand	0.27	0.07	25.9%
Solomon Islands	0.03	0.03	93.0%

SOURCE: The Greening of the World, 1991.

OBSERVATIONS:

- A) Data for 1980 for most countries and continents.
- B) Data for 1984-86 for Finland, Sweden, and Solomon Islands.
- C) Data for 1990 for India, Laos, Australia, and New Zealand.

TABLE 4a
POPULATION IN THE BRAZILIAN AMAZON REGION

ADMINISTRATIVE UNIT	1785	1854	1890	1920	1940
Acre	-	-	-	92 372	79 768
Amapa	-	-	-	-	-
Amazonas	12 058	42 600	147 915	363 166	438 008
Para	57 666	207 400	328 455	983 507	944 644
Rondonia	-	-	-	-	-
Roraima	-	-	-	-	-
TOTAL	69 724	250 000	476 370	1 439 045	1 462 420
BRAZIL .	1 561 689	7 677 800	17 318 556	30 635 605	41 236 315
T/B (%)	4.5	3.3	2.7	4.7	3.5

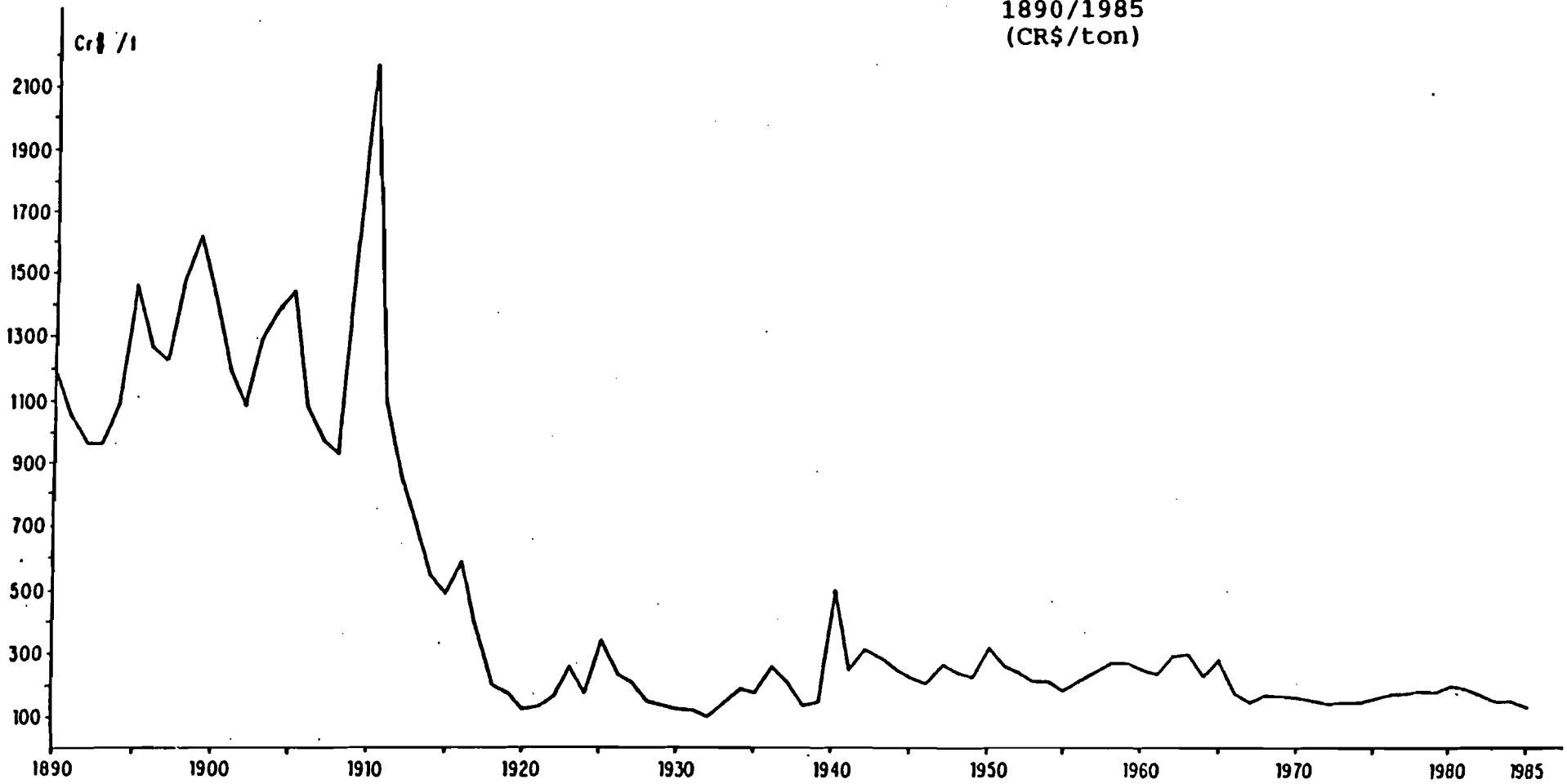
SOURCE: FIBGE, Estatísticas Históricas do Brasil, 1990.

TABLE 4b
POPULATION IN THE BRAZILIAN AMAZON REGION

ADMINISTRATIVE UNIT	1950	1960	1970	1980	1985
Acre	114 755	158 184	215 299	301 303	366 103
Amapa	37 474	67 750	114 359	175 257	217 027
Amazonas	514 099	708 459	955 235	1 430 089	1 739 540
Para	1 123 273	1 529 293	2 167 018	3 403 391	4 318 420
Rondonia	36 935	69 792	111 064	491 069	908 938
Roraima	18 116	28 304	40 885	79 159	102 491
TOTAL	1 844 652	2 561 782	3 603 060	5 880 268	7 652 519
BRAZIL	51 962 513	70 070 457	93 139 037	119 002 706	132 708 228
T/B (%)	3.5	3.7	3.9	4.9	5.8

SOURCE: FIBGE, Estatísticas Históricas do Brasil, 1990.
For 1985, FIBGE, Anuário Estatístico do Brasil, 1987.

FIGURE 1
REAL PRICE OF RUBBER RECEIVED BY RUBBER TAPPER
1890/1985
(CR\$/ton)



OTHER AGRICULTURAL ECONOMICS STAFF PAPERS

No. 92-05	Studies of Land and Agricultural Problems in Taiwan: An Annotated Bibliography	Tze-Wei Chen
No. 92-06	Environment, NAFTA, and New York Testimony, New York State Senate Hearing	Duane Chapman
No. 92-07	Organizational Structure: Does it Hinder or Promote Management Decisions	Robert A. Milligan Guy K. Hutt
No. 92-08	Knowing the Numbers is the Key	Eddy L. LaDue
No. 92-09	From Ecology to Economics: The Case Against CO2 Fertilization	Jon D. Erickson
No. 92-10	Rates and Patterns of Change in New York Dairy Farm Numbers and Productivity	Stuart F. Smith
No. 92-11	An Economic Analysis of the U.S. Honey Industry: Survey Sample and Mailing	Lois Schertz Willett
No. 92-12	An Economic Analysis of the U.S. Honey Industry: Data Documentation	Lois Schertz Willett
No. 92-13	An Economic Analysis of the U.S. Honey Industry: Data Summary	Lois Schertz Willett
No. 92-14	An Economic Analysis of the U.S. Honey Industry: Econometric Model	Lois Schertz Willett