Environmental Sustainability in Agriculture and Food Security in the Brazilian Amazon

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Abstract
The Brazilian Amazon is a gigantic territory covering 60% of Brazil and exceeding the size of half of Europe. 17% of the Brazilian Amazon, that is, 730,000 km2 or twice the size of Germany or Japan have been deforested until today. Nonetheless, the region contributes only 8% to national Gross Domestic Product. 13% of the Brazilian population, roughly 25 million people, live in the Amazon. Stopping deforestation and forest fires in the Amazon involves two major challenges. The first challenge is how to maintain its First Nature intact, that is, the remaining original vegetation. The second challenge relates to the transformation of the region's Second Nature, the deforested areas, into a Third Nature with profitable and environmentally sustainable agricultural activities. The Brazilian Amazon is not homogeneous. It is divided into 9 States and each State, almost like independent countries, depends on different economic and social activities that have their roots in particular historical and political processes. Moreover, environmental and social troubles in the Amazon are not isolated phenomena. In fact, many problems are consequences of poverty and under-development in some parts of Brazil and rapid growth in others. This has lead to migrant flows into the Amazon from the poor Northeast of Brazil, and agricultural expansion to supply global soybean, timber, and beef markets. Another phenomenon is the ongoing structural change in the Brazilian population that started in the 1970s. In the Brazilian Amazon, more than 75% of the population already live in cities. Since 1970, rural population has been decreasing nationwide every year with similar patterns in the Amazon since 1991. This comes with the need to increase both land and labor productivity to supply an increasing urban population. The viability of the extractive economy depends on the domestication process, discovery of the synthetic substitutes, the available stocks, the expansion of the agricultural frontier, the relative prices among extractive products and other economic alternatives, the population growth, among others. The biological sustainability cannot guarantee the economical sustainability and vice versa and the growth of the market tend to provoke the collapse of the extractive economy for the incapacity to attend the demand. It is false the conception of considering non-wood forest products as being sustainable by definition. Put shortly, development based on extractivism is seldom economically sustainable in the long-run. Constantly reducing deforestation rates over the last 7 years have shown that Brazilian forest conservation policies can be successfully implemented. But, to ensure long-term effectiveness of this regulatory policy approach, degraded and abandoned areas need to be put back into agricultural uses to reduce the risk of slowing down agricultural development. The large unused and degraded lands in the Amazon, thus, represent the backbone of a sustainable solution to natural resource degradation. It is popular to oppose cattle in the Amazon. But we can not forget that livestock is the major form of land use system in the Amazon. About 510,000km², representing 70% of the deforested area are in different stages of grassland degradation. As a consequence of low pasture productivity per ha heard productivity is extraordinarily low. Technologies exist that would allow to reducing pasture areas by half while maintaining herd size. The same applies to staple crops, such as cassava and rice, among others. Average cassava productivity in the Amazon is 15 tons/ha, whereas Southern Brazilian farmers harvest double or triple that amount. Harnessing the potential of deforested land in the Amazon through enhanced productivity will require a transformation from traditional (Neolithic type) slash-and-burn agriculture, practiced by the majority of the 600,000 smallholders towards increased use of fertilizer and agricultural mechanization. A still underutilized land use option for deforested and degraded areas is reforestation. Only 6% of the reforested area in Brazil, a little over 300,000 ha, are located in the Amazon. Expanding reforestation tenfold would be enough to replace predatory logging of native forests. Two major historically important native Amazonian species, cocoa and rubber trees today have their production centers in African and Asian countries. Currently, Brazil imports one third of cocoa and 75% of natural rubber consumption. Nonetheless, over 100,000 ha of cocoa and 300,000 ha of rubber trees must be planted to substitute imports and generate jobs and income for the Amazonian population. Ultimately, a solution to the Amazon will also depend on the political will for major investments into scientific and technological development. The challenges of an Amazonian technological revolution cannot be met without the recovery of deforested areas driven by a strengthened research and extension strategy.
Keywords: Amazon agricultural, Food security, environment

Introduction

Food availability in Brazil is more than sufficient to feed the country's entire population. Excluding exports and adding domestic food production to imports, availability of grains is over 340 kg/per capita/year, which represents almost one third more than the minimum nutritional needs. If one considers that 200 kg/per capita/year of grains is sufficient to meet energy needs of 2,000 kcal/day for an adult with 70kg and, considering that 25 million inhabitants live in Amazon, it would take an estimated 5,000,000 tons of grains to ensure self-sufficiency. Considering that there are some 600,000 smallholders that adopt slash-and-burn based migratory agriculture, who manage to produce a maximum of 1,500 kg of hulled rice per hectare, the maximum area needed to sustain the population of Amazon would be 2,800,000 hectares/year. As farmers using more advanced methods in Amazon easily manage to produce 5,000 kg of grains per hectare, the per capita area needed for farming is only 400 m², a mere cultivated 840,000 hectares, using technology to ensure high productivity, could feed the entire population of Amazon, an insignificant amount compared to the 74 million hectares already deforested by 2010. This provides a clear indication that zero deforestation could be attained in Amazon by using technology, concentrating on the already deforested frontier, instead of incorporating new areas, far from population centers.

Despite the great potential in 2011, it was estimated that existed 16.27 million people living in absolute poverty or 8.5% of the Brazilian population, living up to US$ 40.15 per month. In the North there is an estimated 2.65 million people living in absolute poverty, representing 16% of the regional population. Hunger in Brazil is not an endemic problem, it is political and economic in nature, that is, it is not due to lack of production capability or calamities or to a regime of scarcity. Studies unanimously point out that the problem of hunger in Brazil has been due to lack of income for people to properly feed themselves, a reflection of the inequality of income in Brazil. This is aggravated by high levels of unemployment, feeble rates of economic growth and poorly effective public policies regarding food security.

Household budget studies performed throughout the country demonstrated that poor households spent from 70% to 80% of their earnings on food purchases. Enhanced public policies on supporting family-based agriculture began to be implemented in 2003, in addition to social policies as well as others to increase basic food production, causing a drop in food prices and thus promoting a real increase in wages and income distribution. Except for the poorest segments of urban populations in Amazon, food security has only been a serious issue in the rural areas during periods of natural catastrophes, such as major flooding (2009) and the major drought along the Amazon River in 2005. Government-supplied food is often provided in settlement projects and land squattages, due to lack of productive alternatives and job opportunities (Becker, 2004; 2010). By 2008, there were some 3,244 settlement projects throughout Amazon, occupying over 462,000 km², involving 670,000 families (Brandão Júnior; Souza Júnior, 2006; Homma, 2005; Torneau e Bursztyn, 2010.

Beginning in 2003, the Brazilian government set up the *Bolsa Família* (Family Grant) Program, which, in January 2012, provided assistance to a total of 14,281,965 families, out of which 2,553,244 families were living in Amazon, corresponding to 17,88% of the national total, providing a monthly stipend of a minimum amount of US$ 40,15 and a maximum amount of US$ 100,65, depending on the number of children aged 15 years, youths between 16 and 17 if attending school or under and the state of poverty. This policy has reduced the poorest segment of the country’s population by nearly 20%.

Nearly 51% of Brazilian poor are concentrated in non-metropolitan urban areas, while 23% live in metropolitan areas and 26% in rural areas. Regionally speaking, 17% of the country’s poor are concentrated in the Southeast, 4% in the South, 3% in the Midwest, 16% in the North and 60% is concentrated in the Northeast.

A number of government assistance and welfare programs have been implemented over the last 50 years in Brazil to address nutritional deficiencies of the poorest segments of the population. Among the longest running, we highlight the School Lunch Program, established in 1940, and which currently serves some 46 million children in public schools, almost 1/4 of the country’s population. Generally speaking, the focus of these programs has been investment in human resources and welfare, along with poverty alleviation programs, especially welfare programs to provide assistance to rural smallholders, land reform and rural development.

Studies on family agriculture in Amazon and Northeastern Brazil have shown that produce sold represents 34% of total income earned by agriculture per se, household consumption valued at market prices represents 19%, selling their labor corresponds to 23% and retirement and community-based public service benefits (lunch providers, teachers, health agents etc.) represents 17%, while community joint efforts and aid from children and relatives who live outside the communities accounts for 7%. These results indicate that greater public investments must be made in hinterland communities, opening more schools, health clinics and, perhaps, involving communities in recovery of side roads, environmental surveillance etc. Insofar as 17% of family agriculture income is from public transfers, the role of the government is important in generating new jobs and enhancing the well-being of communities (Menezes, 2002; Rebello e Homma, 2009). Institutionalized payment for environmental services might also be considered in specific cases.

Amazon: Physical, Human and Political Environment

The continental biome of Amazon covers nine countries and includes an area estimated at 6.4 million square kilometers in size, 63% or 4 million square kilometers of which is located in Brazil. The remaining 37% (2.4 million square kilometers) are distributed among Peru (10%), Colombia (7%), Bolivia (6%), Venezuela (6%), Guyana (3%), Suriname (2%), Ecuador (1.5%) and French Guyana (1.5%). The continental Amazon River Basin corresponds to 44% of the surface area of South America and 5% of the Earth's land mass. It is the largest tropical forest on the planet, equivalent to 1/3 of tropical rainforest reserves and the world's largest gene bank (Fenzl; Mathis, 2004; Lentini *et al*., 2005; Abramovay, 2010). Despite the fact that 63% of continental Amazon is located in Brazil, it is noteworthy that the headwaters of the Amazon River and its tributaries are located in neighboring countries, which means that there is a need for Amazonian countries to form a group to ensure its preservation (Kinoshita, 1999) (Figure 1).

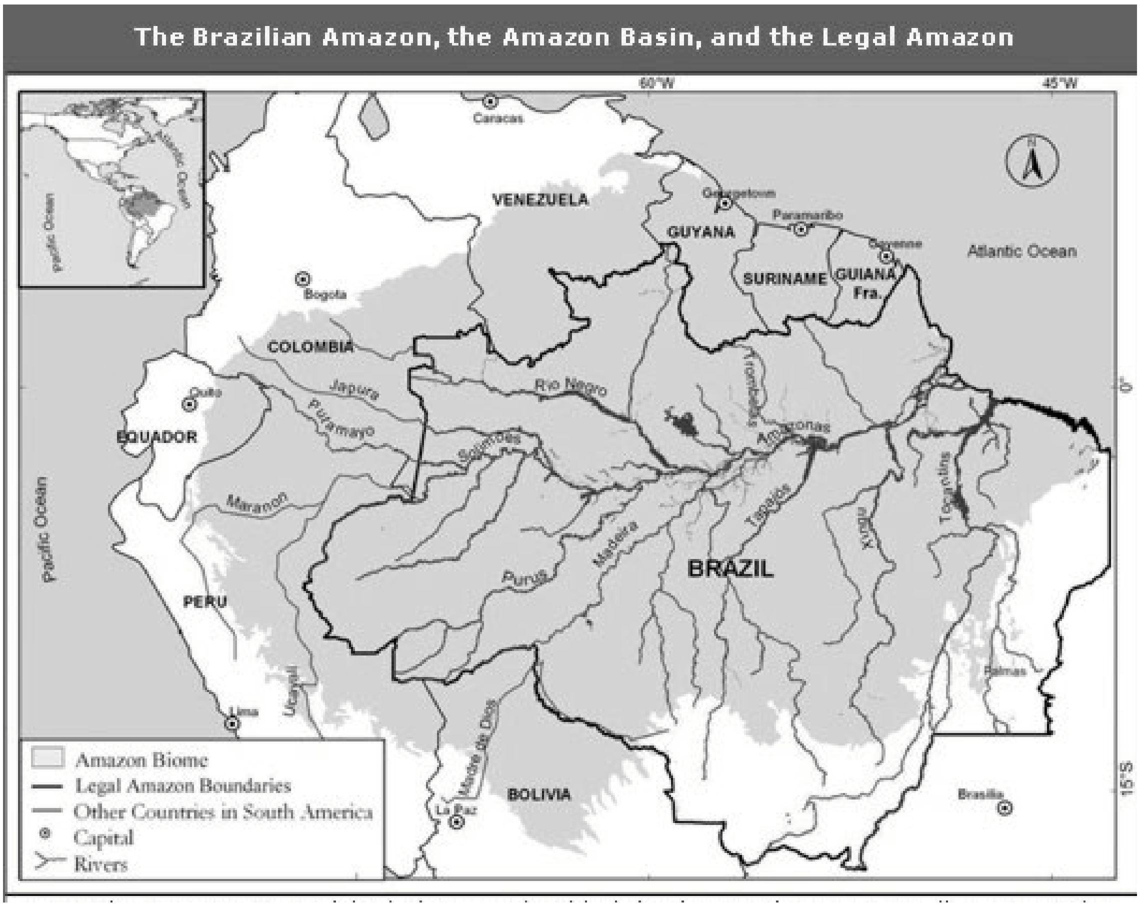

Figure 1 – Location of Brazilian Amazon
Source: Barreto *et al*. (2005).

For policy planning purposes, nine states, representing 60% of Brazilian territory, were defined in law in 1953 as Brazilian Legal Amazon: Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima and Tocantins and part of Maranhão. Despite the stereotyped image of "peoples of the forest", Amazon is practically urban. The urbanization of Brazilian society occurred in Amazon as in the rest of the country, where 71,74% of the population is now urban. This percentage reached 89,74% in Amapá, 81,71% in Mato Grosso, 76,46% in Roraima, 79,05% in Amazonas, 78,75% in Tocantins, 68,42% in Pará, 72,46% in Acre and 73,35% in Rondônia. The State of Roraima presents the lowest demographic density with 2.00 inhab./km² and the State of Maranhão the highest, at 19.79 inhab./km². Demographic density in Amazon (5.00 inhab.km²) contrasts sharply to that in Southeastern Brazil, where it is 86,66 inhab./km², followed by

Southern Brazil with 47.44 inhab./km² and the Northeast with 34.00 inhab./km². The high density of these regions is always a push factor for displacement of contingents of the population towards Amazon in search of public assets and new opportunities not found in their places of origin (Table 1). One can safely say that cities such as Manaus and Belém, with 2 million inhabitants, represent large population centers located along the planet's equator.

Table 1 – Area; total, rural and indigenous population (2010); demographic density in the states of Amazon and major regions (2010); HDI and families serviced by the *Bolsa Familia* program.

State	Area (km²)	Total Population	Rural Population	Indigenous Population	Demographic density Inhab/km²	IFDM 2009	Families serviced (Jan. 2012)
Pará	1,247,702.7	7,566,369	2,389,492	29,115	6,06	0.5966	767,940
Acre	152,522.0	730,903	201,280	13,326	4,79	0.6175	55,112
Amazonas	1,570,946.8	3,476,658	728,495	134,378	2,21	0.6064	305,939
Roraima	224,118.0	448,675	105,620	41,425	2,00	0.6538	45,230
Amapá	142,815.8	667,234	68,490	6,048	4,67	0.6008	50,677
Tocantins	277,297.8	1,380,208	293,339	10,952	4,98	0.6800	129,703
Rondônia	237,564.5	1,550,300	413,229	9,109	6,53	0.7024	110,956
Maranhão	331,983.3	6,568,693	2,427,640	28,361	19,79	0.6046	918,826
Mato Grosso	903,357.9	3,020,113	552,321	36,717	3,34	0.7131	168,861
Amazon	5,088,308.8	25,409,153	7,179,906	309,431	5,00	0.6416	2,553,244
North	3,852,967.6	15,864,454	4,199,945	244,353	4,11	0.6295	1,446,810
Northeast	1,561,177.8	53,081,950	14,260,704	102,541	34,00	0.6403	6,778,562
Southeast	927,286.2	80,364,410	5,668,232	18,697	86,66	0.7496	3,248,858
South	577,214.0	27,386,891	4,125,995	40,936	47.44	0.8010	1,009,567
Midwest	1,612,077.2	14,058,094	1,575,131	96,256	8,72	0.7392	1,798,168
Brazil	8,514,876.6	190,755,799	29,830,007	502,783	22,40	0.7603	14,281,965

Source: Basic data IBGE, www.ibge.gov.br, www.undp.org.br

This region is home to the tropical rainforest that Alexander von Humboldt (1769-1859) called '*Hylea*', being characterized by its singular biodiversity (Homma, 2003). It is estimated that every 250 hectare area of Amazon forest contains roughly 750 different tree species, 120 species of mammals, 400 types of birds, 100 varieties of reptiles, 60 amphibians, 43 types of ants and others. This number may be increased further to 950 bird species, 300 mammals, 100 amphibians, 2,500 fish species and 30 million invertebrates, depending on new discoveries.

History has witnessed a succession of cycles based on extraction of its natural resources. There was the cocoa cycle (*Theobroma cacao*) that began at the time City of Belém was founded (1616) and lasted until the period of Brazil's independence (1822). The opportunity presented by cocoa biodiversity was lost when, in 1746, it was taken to Bahia and from there to the African continent and to Asia, which became the new sites for large-scale production. This was the first case of biopiracy in Amazon of an active element of the economy.

After the biodiversity of cocoa came the rubber tree (*Hevea brasiliensis*), which lasted until the rational plantations in southeast Asia were operating, from seed taken by Henry Wickham (1846-1928) in 1876 (Homma, 2003). This was the second case of biopiracy and reminders of this period of opulence include the opera houses known as Theatro da Paz and Theatro do Amazonas, the building of railways, the floating port of Manaus, among others. The rubber tree was subsequently planted around the world, totaling more than 8.3 million hectares of plantations, resulting in the fact that, presently, Brazil imports 75% of its rubber consumption. The same thing occurred with neighboring countries in the case of tomatoes (*Lycopersicum esculentum*), potato (*Solanum tuberosum*) and tobacco (*Nicotiana tabacum),* which became products of worldwide consumption. Corn (*Zea mays*) is an example of a plant known to the Incas, Mayas and Aztecs, and cassava (*Manihot esculenta)* used by indigenous peoples, which were spread by the Portuguese to Africa and Asia.

Later came the biodiversity cycles of rosewood (*Aniba rosaeodora*) and Brazil nut (*Bertholletia excelsa*), which expanded and reached a peak, became vulnerable and listed as endangered species. Currently, timber logging and açaí (*Euterpe oleracea*) are the most biodiversity-based products, along with cupuaçu (*Theobroma grandiflorum)*, peach palm (*Bactris gasipaes*), guaraná (*Paullinia cupana*), ornamental and frozen fish, shrimp and others. Throughout this history, a number of exotic biodiversity elements have been introduced, as well, such as cattle, water buffalo, jute (*Corchorus capsularis*), black pepper (*Piper* *nigrum*), papaya (*Carica papaya*), jambo (*Syzygium malaccensis)*, mangosteen (*Garcinia mangostana*), durian (*Durio zibethinus*), rambutan (*Nephelium lappaceum*), melon (*Cucumis melo*), and others. In the case of jute and black pepper, introduced by Japanese immigrants, coming from former British colonies, represent the other side of biopiracy of species from Amazon, and had strong impact on regional economy, even though they have recently become relatively less important.

Chronic deforestation of the Amazon Rainforest (Figure 2) has become a national and international concern. Concrete measures must be taken to reach *zero deforestation* in order to avert repetition of what took place with the Atlantic Rainforest in Brazil, reduced to less than 7% of its original forest cover (www.obt.inpe.br). In 1975, when preliminary deforestation assessments for Amazon were released, based on the Landsat satellite launched on 07/23/1972, the deforested area of Amazon went from 15 million hectares to over 74 million hectares (2010), equivalent to the surface area of France, the Netherlands, Belgium and Israel or 17% of Amazon. This does not mean that 95% of Amazon will be completely deforested by 2020, as several scientific journals published in early 2001 (Laurance *et al*., 2001; Schneider et al., 2000). Data from the 2010 Demographic Census showed that 84.36% of the country's overall population and 71,740% of the population of Northern Brazil already live in urban centers. This means that, as a result of the urbanization process, there is insufficient labor available to effect such a sizeable deforestation. From 2006 the deforestation in the Amazon has been reducing, with variations for some states has increased. To maintain this reduction is necessary to incorporate a fraction of deforested areas and restore areas that should not have been cleared.

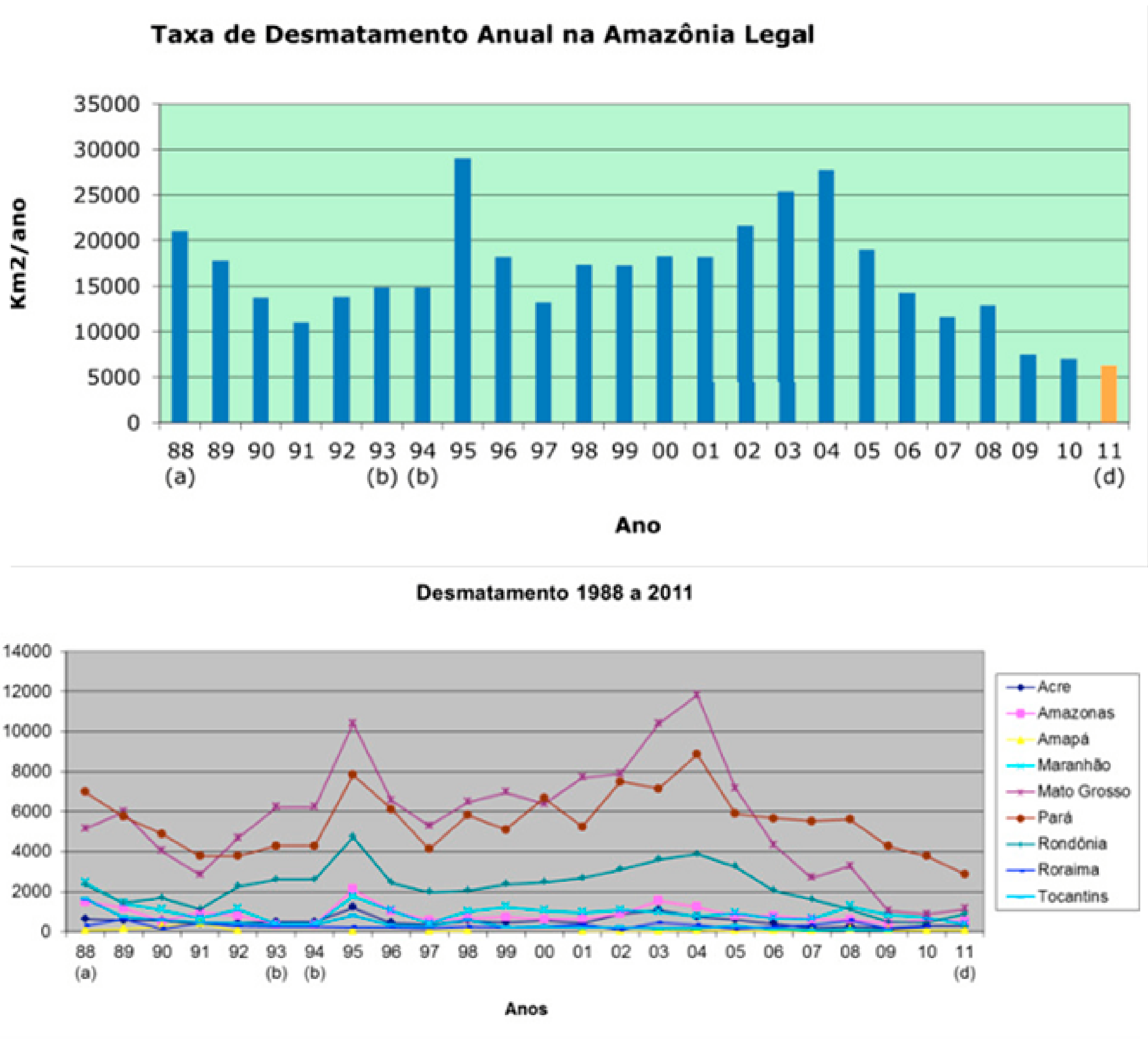

Figure 2 - Estimated deforested land in the Amazon region in Brazil (www.obt.inpe.br/deter)

In addition to the biophysical consequences caused by suppressing the forests, such as erosion, contamination of rivers, extinction of species and loss of environmental services that have impacts worldwide, deforestation has negative social impacts such as land conflicts, poverty, social inequality and innumerable problems in the field of public health.

Agriculture in Amazon – macroeconomic view

Grain production in Brazil increased from 57.9 million tons in 1991 to 137.6 million tons in 2009, while planted area increased from 37.9 million hectares to 47.6 million hectares. There was a large increase in agricultural productivity with land saving. Supply of three million tons of beef, pork and fowl multiplied eight times during the same period, totaling 23.4 million tons. The most expressive increase was in chicken, which rose sharply from 217,000 to 11,021 million tons, surpassing the production of beef. Amazon deforestation would have been greater had it not increase in chicken production. Increases were also seen in fresh produce, fruit, flowers, fibers and forest essences. In 2003, Brazil was already the world's major exporter of tobacco, orange juice (*Citrus sinensis*), sugar, alcohol, beef, tanned leather and garments, in addition to coffee (*Coffea* spp). In 2004, Brazil surpassed the United States as the world's largest chicken exporter. Agribusiness currently corresponds to 33% of the national GDP, contributes to 42% of export receipts and employs 37% of the economically active population.

The states that comprise the Amazon Region of Brazil are characterized, macro economically, by their low participation in the country's GPD (Gross Domestic Product). Considering that Amazon, in 2009 alone, was responsible for 8.0%, percentages that individual states such as Rio Grande do Sul (6.7%) and Paraná (5.9%) easily surpass, just to cite two examples (Table 2), the agricultural GDP share of the states from Amazon is quite small. With the exception of the States of Pará and Mato Grosso, the remaining states of Amazon contribute only negligible amounts. This leads to questioning the high environmental and social costs of agricultural activities in Amazon, when related to levels of deforestation and rural violence. The State of Paraná has a GDP that is triple those of states such as Pará and Mato Grosso or half of that of Santa Catarina (Produto, 2006; Eletronorte, 2006; IBGE, 2011).

Table 2 – Share in national GDP of states in Legal Amazon, total amount, per capita, state and national share in agriculture, rural population, and population engaged in agricultural activities

State/Region	GDP Share % 2009	GDP US$ 1,000,000 2009	Per Capita GDP US$	Agriculture Share in State GDP 2009 %	Agriculture Share in GDP Brazil 2008 %	Rural Population* % 2010	Active Agriculture Population* % 2000
Rondônia	0.6	11,605.87	7,717.11	23,6	2.4	26,65	33.14
Acre	0.2	4,236.06	6,129.53	17,2	0.7	27,54	25.63
Amazonas	1.5	28,454.92	8,385.49	5,1	1.3	20,95	24.98
Roraima	0.2	3,207,73	7,610.96	5,6	0.2	23,54	17.56
Pará	1.8	33,495.07	4,507.68	7,4	2.5	31,58	26.93
Amapá	0.2	4,246.39	6,777.13	3,2	0.2	10,26	8.86
Tocantins	0.4	8,356.85	6,468.05	20,6	0.2	21,25	27.27
Mato Grosso	1.8	32,859.60	8,836.29	28,6	8.9	18,29	20.87
Maranhão	1.2	22,857.88	3,589,95	16,6	5.0	36,99	43.15
Amazon	**8.0**	**149,321.52**	**3,555.43**		**21.4**	**28,26**	
North	5.0	93,604.04	6,094.17		7.3	30.30	26.45
Northeast	13.2	251,043.82	4,684.42		19.7	30.96	30.32
Southeast	55.3	1,027,786.76	12,702.00		26.4	9.48	9.11
South	16.5	307,216.10	11,083.18		27.1	19.07	19.10
Midwest	9.6	178,231.82	12,826.70		19.5	13.27	13.68
Brazil	100.0	1,857,882.54	9,702.72	5,6	100.0	15,64	15,12

Source: Basic data IBGE, www.ibge.gov.br, www.undp.org.br
Average exchange rate 1US$ = R$1,7436;
*Rural population and active population refers to year 2010.
Population active in agriculture as a percentage of persons 10 years of age or older occupied in the week of reference, by gender, groups of hours normally worked per week, in agriculture, ranching, forestry, hunting and fishing activities in 2000.

The transfer of regional wealth in the per capita GDP shows that the Northern Region only outranks the Northeast, which, despite having a GDP almost three times greater than that of the North, it is diluted by a larger population. The *per capita* GDP of the State of Amazonas, due to the industrial park at the Free Trade Zone of Manaus, ranks highly in national terms, below Brasília, Rio de Janeiro, São Paulo, Rio Grande do Sul and Santa Catarina (Table 2).

The performance of the states that comprise Amazon are specific and characterize agricultural and industrial predominance, as well as important third sector activities, particularly public services (Table 2). Agriculture is negligible in the makeup of state GDP of the State of Amazonas, where the transformation industry is responsible for over half of its GDP. One can say that the States of Mato Grosso and Pará are predominantly agricultural, with over ¼ of the wealth produced therein coming from primary activities. States with lower share in production of national wealth, third sector jobs, especially in the States of Roraima (53.4%), Amapá (87.5%) and Acre (70,1%), are important.

The present decline in population growth rate in Brazil, which should grow at an annual rate of 1% for the period from 2005-2014, added to rural migration to the city in the last few years, should reduce pressure on deforestation in Amazon. There is already a significant decline in deforestation in Amazon (Figure 3), even more than the decline in the international price of soybean, a commodity that has been attributed the responsibility for deforestation. The Northern and Northeastern regions are the ones that still present the highest percentages of rural population in Brazil. Of all of the states in Legal Amazon, Maranhão has the largest relative percentage of its population living in the rural areas and the State of Amapá has the highest rate of urbanization (Table 1). The decrease in percentages of the rural population and the share of agriculture in state GDP shows the low profitability of primary sector activities, except for in the States of Pará and Mato Grosso. The predominance of an extractivist economy and insufficient downstream integration are the main reasons for the low value attached to agricultural GDP.

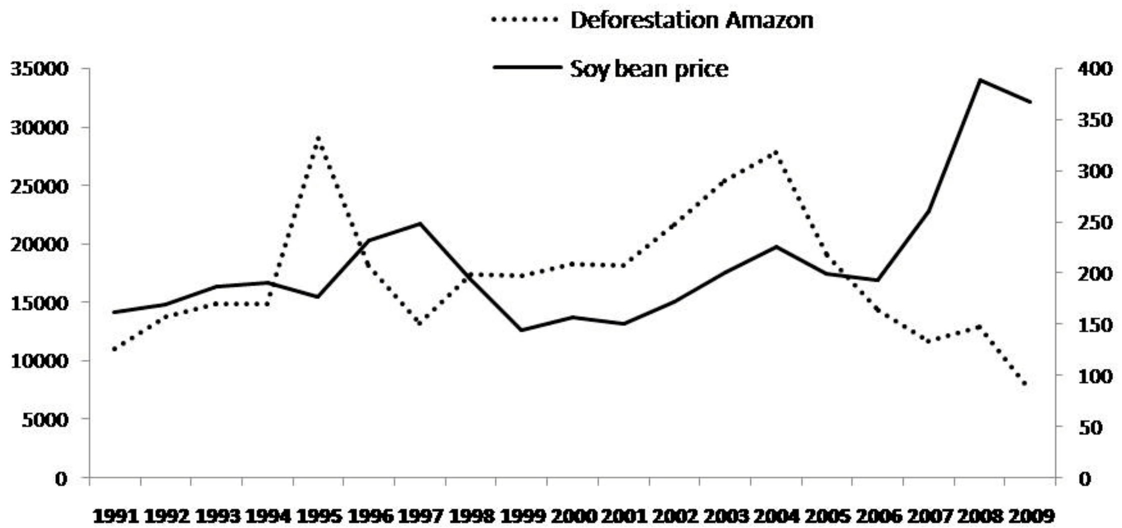

Figure 3 - Deforestation in Amazon versus international soybean prices since year 1991 (www.obt.inpe.br/deter**,** www.fao.org and www.ibge.gov.br)**.**

Productive macro systems in Amazon

When one divides worldwide arable land by the population that existed in 1900, one finds that there was a little over 2 hectares of land per capita for food production. In 1960, per capita arable land had dropped to 1.2 hectares and in 2000 had fallen to 0.5 hectare. Estimates are that this will drop to 0.3 hectare by 2025. One third of land in China is desert, another third is mountainous and only one third is available for agricultural activities (Dimárzio, 2004; Alves e Marra, 2009). The United States is reaching the limit of its farmable land, from 270 to 280 million hectares, and Europe is no different. In Brazil, without including Amazon, 380 million hectares could be used for agriculture, if one includes pasture lands (220 million), annual crops (59 million), perennial crops (8 million), planted forests (5 million) and 106 million in unused lands fit for agriculture. This shows the huge potential of Brazilian agriculture for the world food security in the future. In the case of Amazon, there are over 51 million hectares of planted and native pasturelands, showing the predominance of this type of activity, whereas annual crops occupy over 12 million hectares and permanent crops 648,000 hectares. As a long-term public policy for deforested areas, it would be interesting to expand areas with permanent crops and reduce the amount of pastureland (Table 3).

Table 3 – Area planted (1,000 hectares) and relative share of areas with annual, perennial crops and pastures, in selected countries and Brazilian Amazon, 2002

Country or region	Annual Crop		Permanent Crop		Pastures	
	Area	Relative share	Area	Relative share	Area	Relative share
Brazil	58,980	7.76	7,600	1	197,000	25.92
Amazon	8,722	13.46	648	1	51,149*	78.93*
Canada	45,744	338.84	135	1	29,000	214.81
China	142,621	12.58	11,335	1	400,001	35.29
Costa Rica	225	0.75	300	1	2,340	7.80
Indonesia	20,500	1.55	13,200	1	11,177	0.85
India	161,715	19.25	8,400	1	11,062	1.32
Malaysia	1,800	0.31	5,785	1	285	0.05
Australia	48,300	161.00	300	1	398,400	1.328.00
United States	176,018	85.86	2,050	1	233,795	114.05
Argentina	33,700	25.92	1,300	1	142,000	109.23
Japan	4,418	12.84	344	1	428	1.24
World	**1,404,052**	**10.78**	**130,257**	**1**	**3,485,339**	**26.76**

Source: Basic data FAO (www.fao.org), IBGE (www.ibge.gov.br)
* Related to the year of 1996 (planted and native pasture)

Using permanent crop areas as a reference indicator, one sees that certain countries specialize in annual crops, others in pastures and still others in perennial crops. Land availability in association with soil quality and favorable climatic conditions, and overcoming manpower constraints, is what made the United States, Canada and Australia specialize in grain production and livestock raising (Tables 3 and 4). Indonesia, Malaysia and Costa Rica, on the other hand, are characterized by development of permanent tropical crops, such as rubber and cocoa (which were originally from Amazon), oil palm (*Elaeis guineensis*), black pepper, coconut (*Cocos nucifera*), and others. Land availability in Brazil is characterized by relative expansion of ranching and grain production, despite the large absolute area for permanent crops such as coffee, orange, cocoa, reforestation, banana, oil palm, black pepper, cashew (*Anacardium occidentale*) etc.

Table 4 presents land use in states of Amazon and other selected states, according to destinations of use by annual and perennial crops and pastures for the years of 1985, 1995 and 2006, where one may observe the predominance of ranching and annual crops, except in the case of Mato Grosso but with decline in pasture areas (Rebello, 2004; IBGE, 2012).

Table 4 – Relative index of area planted with temporary and permanent crops and pastures in states within Amazon and other selected states, 1985, 1995 and 2006.

State	1985			1995			2006		
	Annual Crop	Permanent Crop	Pasture	Annual Crop	Permanent Crop	Pasture	Annual Crop	Permanent Crop	Pasture
Pará	2.44	1.00	13.57	2.08	1.00	22.20	3.32	1.00	35.32
Acre	3.03	1.00	15.11	3.60	1.00	33.43	1.58	1.00	13.91
Amapá	1.05	1.00	1.42	1.04	1.00	2.62	1.08	1.00	1.27
Amazonas	1.45	1.00	2.28	1.40	1.00	2.13	1.57	1.00	1.71
Rondônia	1.46	1.00	4.08	0.70	1.00	10.14	0.95	1.00	17.85
Roraima	4.98	1.00	31.57	1.07	1.00	4.60	1.26	1.00	6.27
Tocantins (1)	11.06	0.00	60.73	10.86	0.00	234.25	5.38	1.00	52.58
Maranhão	14.11	1.00	30.77	9.20	1.00	29.83	6.84	1.00	5.48
Mato Grosso	14.59	1.00	49.59	16.39	1.00	89.92	14.91	1.00	43.83
São Paulo	3.04	1.00	4.57	2.84	1.00	5.16	3.09	1.00	2.40
Paraná	8.65	1.00	7.29	15.38	1.00	17.02	5.63	1.00	3.48

Source: IBGE (2012).

Based on the Agriculture/Livestock Raising Census of 2006, pasture land in the State of Pará was 8.85 times larger than areas dedicated to perennial crops. Likewise, the area used for annual crops is 0.83 times greater than perennial crops, a reflection of the advance of ranching in the state. Other states that have large portions of their lands dedicated to pastures are the States of Acre (13.91), Maranhão (5.48), Mato Grosso (43.83) and Tocantins (52.58), in relation to their respective areas dedicated to perennial crops. Due to their characteristics, these areas may, in a certain manner, become future areas for the expansion of soybean (*Glycine max*) in these states. Heavy investments are needed to recover these pasture areas, due to the need to expand pastures for the vegetative growth of herds in these states.

Food security program for Amazon

Contrary to the image that only destruction reigns in Amazon, academic literature rarely mentions the region's productive park, not only agricultural and industrial, but of services, as well. With regards to the agricultural segment, Amazon represents an important center for agricultural production, not only locally but nationally and internationally. Table 5 lists the main crops, livestock, fish and important activities developed in the Amazon Region.

Table 5 – Primary sector production in Amazon and in Brazil (Average 2008-2010).

Crops/livestock	Brazil	Amazon	% in relation to Brazil
Animal food products			
Eggs (1,000 dozen)	3,169,021	220.278	9.95
Fowl (individual)	209,114,685	20,017,867	9.57
Milk (1,000 liters)	29,128,767	2,739,102	9.40
Pork (head)	37,940,409,67	4,857,459	12.80
Fish farming (ton)	390,508	62,655	16.04
Beef (head)	205,718,598	74,823,833	36.37
Buffalo (head)	1,155,464	828,055	71.66
Plant food products			
Orange (ton)*	18,086,081	258,403	1.42
Papaya (ton)	1,851,392	41,670	2.25
Sugarcane (ton)	684,789,477	20,442,313	2.99
Beans (ton)	3,368,954	295,069	8.76
Coffee (ton)	1,782,124	143,767	8,07
Corn (ton)	55,015,990	9,840,880	17.89
Passion fruit (ton)	772,683	50,730	6.56
Coconut (ton)	2,004,792	296,587	14.79
Banana (ton)	6,914,811	882,611	12.76
Pineapple (ton)	1,551,250	370.046	23.85
Cocoa bean (ton)	218,635	80,584	36.85
Soybean (ton)	61,978,277	20,949,453	33.80
Hulled rice (ton)	11,982,865	2,343,718	19.56
Urucum (ton)	12,870	5,315	41.29
Cassava root (ton)	25,210,446	9,227,733	36.60
Guaraná (ton)	3,800	1,311	34.51
Cotton (ton)	219	0	0
Oil Palm fruit (ton)	1,168,739	966,142	82.66
Black pepper (ton)	62,378	49,613	79.53
Planted timber			
Planted firewood (m^3)	44,168,977	579.827	1.31
Planted charcoal (ton)	3,600,698	194.063	5.38
Planted timber in logs (m^3)	107,971,613	3,637,158	3.36
Cellulose paper wood (ton)	64,435,379	1,601,191	2.48
Planted rubber (ton)	216,653	31,589	14,58

Source: Basic data IBGE (www.ibge.gov.br; Boletim Estatístico da Pesca e Aquicultura Brasil 2008-2009).

Agricultural activities not listed include leafy vegetables (native and exotic), small livestock (goats, sheep etc.), native fruit trees (cupuaçu, açaí, peach palm etc.) and exotic fruit trees [lemon (*Citrus* spp., tangerine (*Citrus nobilis*), mango (*Mangifera indica*), avocado (*Persea americana*), guava (*Psidium guayava*), watermelon (*Citrullus vulgaris*), melon, mangosteen, rambutan (*Nephelium lappaceum*), durian (*Durio zibethinus*), jambo etc.], and diverse plants such as noni (*Morinda citrifolia*), nim (*Azadirachta* *indica*). Native timber species such as mahogany (*Swietenia macrophylla*), parika (*Schizolobium amazonicum*), andiroba (*Carapa guianensis*), freijó (Cordia goeldiana), etc., and exotic tree species such as eucalyptus (*Eucalyptus* spp.), acacia (*Acacia mangium*), teak (*Tectona grandis*), gmelina (*Gmelina arborea*), and African mahogany (*Khaya ivorensis*), are being planted in monocultures or as components of agroforestry systems.

These activities undoubtedly contribute towards the 74 million hectares of deforestation (2010). Nevertheless, already existing knowledge and technologies show that production can be both maintained and increased, without the need to conduct further deforestation, by enhancing current technological standards.

As Amazon is home to 13,32% of Brazil's population, and many agricultural products are produced at levels below this percentage and are imported from other parts of the country, the major ones being corn, beans (*Phaseolus vulgaris*), coffee, pork, milk, eggs, sugar, fuel ethanol (*Saccharum officinarum*), oranges, potato, tomato, onion (*Allium cepa*), garlic (*Allium sativum*), and edible oil. Some products depend heavily on foreign imports, especially wheat (*Triticum aestivum*) and powdered milk, in the case of the Free Trade Zone of Manaus. Naturally, those foods that do not adapt ecologically to the region, such as wheat, potato, onion, garlic and apple (*Malus sp.*), will continue to be imported.

Amazon is also a major exporter of foods and raw materials, many of them typically regional, to other regions of Brazil and abroad, as occurs with soybean, beef, black pepper, urucum (*Bixa orellana*), cocoa, oil palm, Brazil nut, açaí, cupuaçu, banana, pineapple (*Ananas comusus)*, cassava, rice (*Oryza sativa*), cowpea (*Vigna unguiculata*), cotton (*Gossypium* spp.), guaraná, passion fruit (*Passiflora edulis*), palm heart, without mentioning the timber complex and others. For the oil palm Brazil imports ⅔ of what it consumes and the largest plantations in the country are located in Amazon. The region could expand production in already deforested areas with an immediate need of 320,000 hectares, thereby contributing towards the recovery of these areas to comply with current legislation stating that diesel fuel be mixed with 2% vegetable oil.

Contrary to perennial crops, except in the case of palm oil for biodiesel, where small fractions of the land are enough to saturate the local, regional, national and international markets, dimensions of land used for annual crops are much larger. Theoretically, in terms of land size, if we were to place tropical perennial crops of the major producing countries in Amazon, only 3% of the region would be enough to double world production of these crops. Since 17% of Amazon has already been deforested, one sees that Amazonian agriculture can increase its share of national and international production without the need to expand deforestation.

There is a brisk trade in food crops between the states of Legal Amazon. Dependency is high in certain states such as Amapá, Amazonas and Acre , which import large amounts of food from Pará, Roraima and other parts of the country. The low deforestation rates in the States of Amapá and Amazonas are the result of importing food from deforested areas in other states. As 25 million people live in Amazon, there must be sufficient food production to supply both rural and urban populations.

There is a number of products that are not listed in official statistics, which are "invisible products", important in survival and income generation and job strategies, especially of those in family-scale agriculture in Amazon. These include native fruits, fish, game, firewood etc. Even a part of the products tabulated in official statistics is withheld for domestic consumption, indicating that agricultural and livestock production in Amazon is underestimated in relation to more advanced locations due to improved data collection systems.

The most important products taken from the forest are timber, Brazil nut, rubber, açaí fruit, rosewood and babassu (*Orbygnia* spp.) (Table 6). Non-industrial fishing in Amazon should be mentioned, due to its great importance in feeding riverine populations and in the volume of fish caught at the national level. A large part of the fish and shrimp caught in Amazon is exported to other parts of Brazil and abroad.

Table 6 – Forest and fishing products from Amazon (average 2008-2010)

Products	Brazil	Amazon	% in relation to Brazil
Timber			
Extractivist firewood (m³)	40,588,108	12,605,250	31.06
Extractivist charcoal (ton)	1,788,255	630,607	35.26
Extractivist timber (m³)	14,011,252	11,806,513	84.26
Non-timber			
Brazil nuts (ton)	36,213	36,213	100.00
Açaí (ton)	124,260	124,260	100.00
Extractivist rubber (ton)	3,535	3,510	99.30
Babassu (ton)	108,663	100,126	92.14

Heart of Palm (ton)	5,290	4,911	92.84
Rosewood (ton)	29	29	100.00
Buriti (ton)	414	374	90.34
Jaborandi (ton)	281	266	94.66
Piaçava (ton)	71,392	2,239	3.13
Copaiba (ton)	544	544	100.00
Extractivist fishing			
Marine (ton)	557,722	135,105	24.22
Inland (ton)	250,388	171,535	68.51

Source: Basic data IBGE (www.ibge.gov.br)

Amazonian production is primarily extractivist: almost 80% of the timber is from native forests in Brazil, 64% of which is sold on the domestic market and 36% exported (Table 6). Timber exports from Brazilian Amazon represent from 2% to 3% of world timber product exports (Lentini et al., 2005). There is a large amount of charcoal production using native forests to supply 15 pig-iron plants, located in the States of Pará and Maranhão, which require timber from deforestation of roughly 120,000 hectares/year, mainly performed by small-scale farmers and using waste material from sawmills. It is interesting to note that firewood consumption in Amazon is low, despite being highly available, since even the poorest families prefer bottled gas and there is a comprehensive distribution of cooking gas even in remote locations.

There are dozens of non-timber forest products that are consumed as food and raw materials, the surplus of which is exported to other parts of the country and abroad, many never appearing in official statistics. Among these are native fruits such as açaí, cupuaçu, peach palm, bacuri (*Platonia insignis*), uxi (*Endopleura uchi)*, tucuman (*Astrocarium vulgare*), buriti (*Mauritia flexuosa)*, taperebá (*Spondias mombin*), muruci (*Byrsonima crassifolia)* and piquiá (*Caryocar glabrum*). Several leafy vegetables such as jambu (*Spilanthes oleracea)*, vinagreira (*Hibiscus sabdariffa*), cariru (*Amaranthus viridis*), maxixe (*Cucumis anguria*) and others, part of regional cuisine, are beginning to become known nationally and internationally. Medicinal plants including copaiba (*Copaifera* spp.), Andiroba (*Carapa guianensis*) and jaborandi (*Pilocarpus microphyllus*), and fibers such as piaçava (*Leopoldinia piassaba*) and others are exported.

Collection of non-timber forest products such as cocoa, rubber, Brazil nuts and rosewood was important in bringing civilization to Amazon, in settlement processes and providing economic support to the region and the country. Suffice it to say that extractivist rubber from Amazon was once the third ranking export product in Brazil, for a period of thirty years (1887-1917), surpassed only by coffee and sugar. Brazil currently imports ⅓ of the cocoa it consumes and ¾ of its natural rubber, indicating opportunities for family-based agriculture, through a policy to attain self-sufficiency in these products. The extensive waterway network of over 20,000 km of navigable rivers for deep keel vessels enabled access to natural resources and availability of fish and turtles, guaranteeing protein supply, which began to run into conflict with population and market growth, resulting in the exhaustion of many of these resources.

There are an estimated 200,000 extractivists who work collecting timber and non-timber forest products in Amazon, particularly babassu, timber, açai fruit, Brazil nuts, and others. Except for açai, income share from extractivist collection is less than 25% and all gatherers depend on other activities to ensure survival. Despite the symbolic aspect of rubber in 1991, the production of rubber planted in Brazil surpassed that of the wild rubber which represents only 1.60% of total rubber produced in the country.

These results indicate that, under current extractivist conditions, this activity by itself is unable to avert deforestation and burnings in Amazon. The extractivist movement gained momentum worldwide with the murder of union leader, Chico Mendes (1944-1988), but it must be stressed that extractivism of plant material is of limited supply capacity due to low density of plants in the forest. Market growth has led to the development of rational planting, as has taken place with several plants from Amazon such as cinchona (*Chinchona calisaya* and *C. ledgeriana*), cocoa, and rubber, and is currently occurring with cupuaçu, açaí, peach palm, Brazil nut, jaborandi, pepper (*Piper hispidinervum*), curauá (*Ananas erectifolius*), making economic sustainability of communities that depend on these activities difficult. Mankind has, over the last ten thousand years, managed to domesticate some 3 thousand plant species. Some of the other variables that affect extractivism is the discovery of synthetic replacements as happened with rosewood (synthetic linalool), timbó (*Derris nicou* and *D. urucu)* and their replacement by synthetic inseticides. Extractivist economy was important in the past, it is important in the present, but its future options must be seen in making use of the benefits of domestication, in order to buy time, until other technological alternatives appear or as complementary income.

Therefore fauna and flora management techniques, based on solid scientific research and flexibility to change strategies according to markets, is of great importance. Concrete results of açaí management performed by riverine populations at the mouth of the Amazon River and pirarucu (*Arapaima gigas*) management at the Mamirauá Sustainable Development Reserve (RDSM) demonstrate the possibilities for implementing programs that add value to and enhance living conditions of local populations, and of establishing strategic partnerships with governmental and nongovernmental organizations to develop proposals for sustainable use of natural resources. The concern lies in the fact that, with market growth, as is already taking place with açai, the management programs used may end up increasing ecological risk to flora and fauna, by homogenizing ecosystems.

New plants and animals

Several plants from the New World, including potatoes, corn, tobacco, tomato, avocado, rubber, cinchona and others, became universal and are planted and consumed worldwide. Even today, several Amazonian plants are becoming universal – this is happening with guaraná, cupuaçu, açai, peach palm, bacuri, jambu, curauá etc. Among aquatic species, we would mention pirarucu, peacock bass (*Cichla* spp.), tambaqui (*Colossoma macropomum*) and turtles (*Podocnemis expansa*, *Podocnemis unifilis*) etc. In the future, new plants, fish and animals from Amazon may be incorporated into the productive chain due to their nutritional and functional values, leaving behind extractivism for rational forms of production and management. The high price of many conventional fruits and vegetables, including bell pepper (*Capsicum annuum*), papaya, passion fruit and tomato, in the city of Manaus, a major research challenge will be to make these crops productive in the region, similar to what was done for soybean to grow in the Brazilian tropics.

In addition to the already mentioned plants and animals, new genetic resources from Amazon may be used as promising foods in the future. Some plants that have been quite important in the past, such as babassu, lost their relevance as an annual oleaginous crop, like cotton, peanut (*Arachis hypogaea*), soybean, corn and sunflower (*Helianthus annuus*), may become important in recovering areas that should not have been cleared, such as river banks, slopes etc. The patauá palm (*Oenocarpus bataua*), produces an oil similar to olive oil (*Olea europaea*). Expanded planting of the Brazil nut tree, replacing extractivist supplies, is already attracting the interest of farmers, as a tree for reforestation in recovering cleared areas and for Brazil nut production.

A major possibility for income and job creation reserved for Amazon is related to vegetable oil production from perennial plants such as oil palm, andiroba, copaiba, tucuman and others, to mix with diesel oil (biodiesel) or as a compound in the production process of diesel, resulting in less polluting and higher quality oils (H-bio), a field in which Brazil is pioneer. Such programs could act to recover degraded areas and provide socioeconomic inclusion for family farmers.

Within this context, agricultural research should receive incentives to expand on these possibilities, developing agriculture with plants native to the region and taking advantage of the enormous water resources the region has for fish farming. This agriculture and fish farming could provide new meaning to the underused areas already deforested and promote recovery of areas that should never have been cleared.

The Future of Food Security in Amazon

Amazonian society faces three major challenges: (1) to protect the largest amount of its area to ensure biodiversity, water resources, and global climate balance; (2) to ensure the survival of the population that lives in the region and enable its sustainable development over time, and (3) to maintain sovereignty over an area that represents 60% of the nation’s territory.

The current deforested area of Amazon (Figure 2) estimated at 74 million hectares (2010), would be more than enough to feed the population that lives in the region, now and in the future, using only part of this area and recovering areas that should not have been cleared according to environmental law and conservation and preservation principles. *Zero deforestation* will depend on technological improvements of agricultural practices adopted and resolving issues of poverty and formal education, which are problems that afflict Brazilian society. Reducing the costs of recovering degraded areas, which currently is quite high (US$ 700.00/hectare) and pushes farmers to use cheaper and unsustainable practices (US$ 300.00/hectare), could have positive effects on conservation and preservation in Amazon.

The Brazilian government has expanded the Conservation Units and Indigenous Lands in Amazonia (Table 7) as a means to preserve the Amazon Rainforest. There are 405 Indigenous Lands in Amazon, with 103,483,167 hectares and a population of roughly 309,431 indigenous people, representing 20.67% of land area in the Amazon or 98.61% of all Indigenous Land in the country in terms of size. The availability of 334 hectares per capita has raised voices in protest, some saying that there is “too much land for too few indigenous people" and others pointing to the hunger and malnutrition in many indigenous settlements when linked to the market economy. Amazon is home to 61,54% of the country's indigenous population, estimated at over 502,783 inhabitants.

Table 7 - Conservation Units and Indigenous Lands in Amazon (2010)

Type of use	Area (ha)	% Area Amazon	% Area Brazil
Conservation Units	**97,454,000**	**19.35**	**11.40**
Full Protection	**36,687,400**	**7.28**	**4.30**
Ecological Station	6,654,919	1.32	0.78
National Park	14,076,048	2,79	1.65
Biological Reserve	3,596,256	0.71	0.42
Sustainable Use	**60,766,600**	**12.28**	**7.12**
Environmental Protection Area	365,006	0.07	0.04
Area of Relevant Ecological Interest	19,012	0.00	0.00
National Forest	28,320,595	5.62	3.32
Extractive Reserve	7,910,428	1.57	0.93
Indigenous Lands	**103,483,167**	**20.67**	**12.11**
Total	**200,937,167**	**39.88**	**23.51**

Source: Basic data ICMBIO (www.icmbio.gov.b, www.mma.gov.br and www.funai.gov.br).

Conservation Units in Amazon are divided into full protection—which must remain untouched, and include Ecological Stations, National Parks and Biological Reserves, representing over 36 million hectares—and those that can allow economic activities, such as National Forests, Environmental Protection Areas, Areas of Relevant Ecological Interest, Sustainable Development Reserves and Extractive Reserves, which represent over 60 million hectares (Table 7). Thus, protected areas in Amazon (Indigenous Lands and Conservation Units) represent over 40% of Brazilian Amazon. The establishment of these areas continues, following a complex process under pressure from private interests, specific groups, and tracked by national and international institutions, as well as movements of local and foreign public opinion, which interact with national public policies at different levels (Miranda et al., 2006; Barreto et al., 2005).

Conservation Units can become efficient instruments for promoting and conserving biodiversity, and their current importance has expanded due to sustainable use conservation units. Chief among the models of Conservation Units is the category called Sustainable Development Reserves (RDS) (Queiroz, 2006).

The first RDS established in Brazil was the Mamirauá Sustainable Development Reserve (RDSM). The traditional population has participated in activities designed to conserve biodiversity, protect endangered species, use local natural resources in a sustainable manner and provide sustainable development to riverine communities. These activities are conducted through a participatory process, with involvement of the local population in different stages of land and resource management (IDSM, 2006). The major characteristics of this type of conservation unit are the following: maintenance of local population, which participates in natural resource management activities and surveillance of the reserve; the possibility of fauna and flora management based on solid scientific research; flexibility to change strategies according to market; maintenance of private property; implementation of programs to enhance living conditions of local population and establishment of strategic partnerships with governmental and nongovernmental organizations for developing proposals for sustainable use of natural resources. The results of ten years of investments in this area enable an assessment of the advantages of this category of conservation unit, and indicate that results are indeed significant, both from the standpoint of biodiversity conservation as well as in terms of improved quality of life for local inhabitants.

It should be mentioned that establishing Conservation Units and Indigenous Lands may be a precautionary instrument in areas where there is no pressure of occupation, but has proven to be ineffective in already occupied areas. Environmental destruction is also occurring endogenously within Conservation Units and Indigenous Lands, showing them to be as ineffective as the Maginot Line (1931-1936), which was built by the French to counter the advance of German troops during World War II (Miranda, 2006; Barreto *et al.*, 2005; Homma, 2010).

Despite this, it is possible to conduct agricultural activities in Amazon with a minimum of deforestation. Some states in Amazon, such as Amazonas and Amapá, *zero deforestation* could easily be reached, but they would continue importing products from deforested areas in Pará, Mato Grosso and Roraima. The buffering effect of the Free Trade Zones of Manaus, Macapá and Santana, have both promoted urbanization and greatly decreased deforestation. This indicates that the problem of deforestation and burnings in Amazon are not independent of, but rather linked to poverty in Northeastern Brazil, which leads to migration to the Amazon Region. Another factor is the importing of timber from Amazon by other parts of

Brazil and the world. This is why Amazon must be considered within the context of a national policy.

The general understanding is that ensuring conservation and preservation of Amazon will depend on seeking out new technological alternatives that focus on partial use of deforested areas and recover areas that should never have been cleared. Below is a list of five categories of alternatives considered as priorities to ensure food security and food preservation of Amazon in the future:

1 – Reduction of deforestation and burnings

Reduction of chronic deforestation and burnings can take place by partial use of the internal and already deforested frontier, which spans over 74 million hectares in 2010. Food and raw material production can be rendered compatible with preservation of Amazon, with income generation and job creation.

2- Increase sustainability of natural resource use

Several renewable natural resources in Amazon are being used faster than their regeneration capacity. Appropriate management techniques need to be developed for logging and use of other natural resources, where biological sustainability does not always ensure economic sustainability and vice-versa.

3- Increase sustainability of agricultural activities

There are two concurrent types of agriculture in Amazon, one using advanced farming techniques and, at the other extreme, traditional or swidden agriculture, based on slash-and-burn. Constraints must be overcome so that agriculture can remain in the same spatial area and avert constant incorporation of new areas. Considering that a typical family farmer in Amazon cuts down 2 hectares of dense forest and farms it for 2 years, then leaving it to fallow to cut down a new area, he would need 12 hectares and 12 years to return to the original site to again cut down the vegetation. If technological enhancements were to enable farming the area for 3 years, by increasing only one year, he would then need 10 hectares and 15 years to return to the original site, thus reducing deforestation by 17%.

4- Creation of new technological and economic alternatives

There is a need for ongoing discoveries and domestication, to make use of the wealth of Amazonian biodiversity, instead of the random and negligent manner it has been addressed heretofore. More intensive activities of land use and labor, such as ranching and reforestation, as well as those where mechanization is not possible at some phase of the productive process (harvesting of oil palm, cocoa, black pepper, açai, cupuaçu, tapping rubber trees, etc) are major opportunities for Amazon and family-based agriculture.

5- Expand knowledge of ecosystems and their interrelations

The efforts invested in many unsustainable agricultural activities in Amazon are the result of a lack of knowledge of the ecosystem, in addition to a lack of economic alternatives and appropriate technological practices especially exploring the large water resources existing in the region.

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