The Impacts of Soybean Cultivation on Brazilian Ecosystems

Three Case Studies

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1. Introduction

This document offers an overview of the expansion of soybean cultivation into forest and *cerrado* (bush savannah) biomes in Brazil. It presents the situation in three cases: the Uruçuí region in the state of Piauí, the state of Mato Grosso and the Humaitá region in the state of Amazonas. Information is based on field and desk research carried out in Brazil and Germany in 2003.

Soybeans

Soybeans are very suitable for capital-intensive, large-scale cultivation. As soybeans yield 18 percent oil and 79 percent meal after processing, the market for soybean products is mostly driven by the livestock feed industry. Brazil (42 million tons in 2002 or 23 percent of world production) is the second largest producer after the United States (74.3 million tons or 41 percent), ahead of Argentina (30 million tons or 17 percent) and China (16.9 million tons or nine percent). World production in 2002 totalled 180 million tons[1].

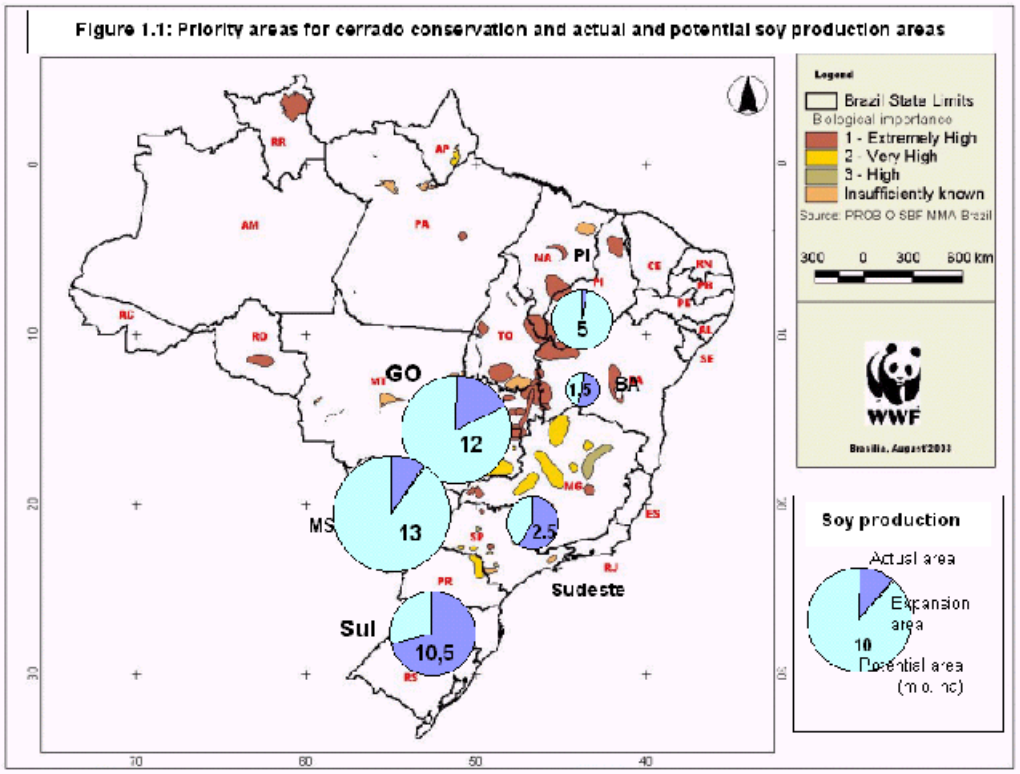
Rapid expansion of soy cultivation in Brazil started in the early 1970s. Starting with three million hectares in 1970, planted area expanded continuously, reaching a record harvest of 52 million tons on 18.5 million hectares in 2003, an increase of over two million hectares compared to 2002. Brazil's soybean producers, scientists, agricultural politicians and traders consider a total area of 100 million hectares suitable for planting soybeans[2]. Brazilian industry and research agencies are striving to challenge the role of the USA as the world's market leader. World demand for vegetable oil and highly valuable protein feed has grown steadily in both developing and industrialised countries, particularly since the BSE crisis. The price of soybean at the Chicago stock exchange rose to $12-13 per sack (60 kilograms) in the first half of 2003, making private and public investment in this grain legume attractive. Harvests in Brazil are pre-financed mainly by international corporations like Bunge, Cargill, Dreyfus and ADM, and by multinational fertiliser and pesticide companies which supply technology packages at the same time. Brazil's foreign exchange income from soybean exports was more than $6 billion in 2002, a sum urgently needed to service its foreign debts and stabilise its foreign trade balance; more than $8 billion of revenue from soybean exports are expected for 2003.

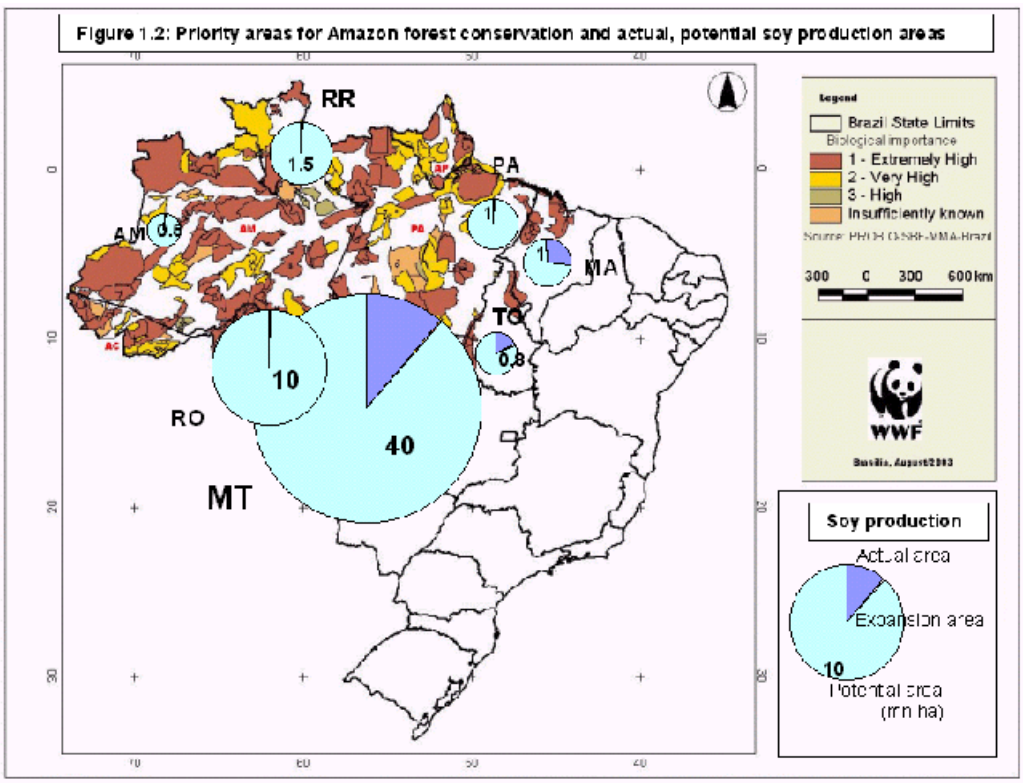
Due to the mechanised character of cultivation, soy is planted almost exclusively on plains offering easy access for farm machinery. Many state governments in Brazil are aiming to convert their sparsely populated subtropical and tropical plains to soy production areas to boost their economies. As there is little room for agricultural expansion in the south and southeast of Brazil, future soybean expansion will take place in central and northeastern Brazil and the southern Amazon region, where cheap land is abundant. This expansion has direct and indirect impact on natural habitats of high conservation value, the livelihoods of people and endangered species, depending on their habitats. Problems related to rapid soybean expansion include widespread deforestation of the cerrado and southern Amazon forest frontier, massive pesticide application, concentration of land into large enterprises that force out small farmers, neglect of staple food production for local consumption, and increasing cultivation of genetically modified soybeans bearing risks for the environment and human health.

Areas of expansion

The maps below (Figures 1.1 and 1.2) show the areas which were identified as priority areas for conservation during a series of workshops[3] held in 1996-99 by Brazil's ministry of environment and attended by a large number of scientists and NGOs. Pie charts on the maps show the present and potential extent of soy cultivation in each state[4]. As can be seen on the maps, expanding the cultivation of soybean threatens some of these priority areas. Three case

studies will illustrate some of the problems mentioned above, enabling us to draw general conclusions on the negative impact of soybean production and expanding cultivation on humans and nature. problems, before drawing general conclusions on the adverse impacts of soy production and expansion on people and nature.





Source: AIDEnvironment, Amsterdam, 2003, adapted from WWF 2003 and PROBIO-SBF-MMA Brazil 2003.

Soy planted area (Million ha)			
Region	**State**	**2002/03 planted area**	**potential soy planted area[5]**
South	Rio Grande do Sul (RS)	3.6	5
	Parana (PR)	3.6	5
	Santa Catarina (SC)	0.26	0.5
subtotal		**7.4**	**10.5**
South East	Minas Gerais (MG)	0.86	1.4
	São Paulo (SP)	0.60	1.1
subtotal		**1.47**	**2.5**
Central West	Mato Grosso (MT)	4.5	40
	Mato Grosso do Sul (MS)	1.4	13
	Goias (GO)	2.2	12.7
subtotal		**8.2**	**65.7**
North East	Maranhão (MA)	0.28	1
	Piaui (PI)	0.12	5
	Bahia (BA)	0.85	1.5
subtotal		**1.24**	**7.5**
North	Tocantins (TO)	0.15	0.8
	Pará (PA)	0.01	1
	Roraima (RR)	0.01	1.5
	Rôndonia (RO)	0.04	10
	Amazonas (AM)	0.003	0.5
subtotal		**0.21**	**13.8**
TOTAL		**18.5**	**100.0**

Table 1.1: current and potential soy planted area, Brazil.[6]

Fig. 1.3: Location of the case study areas
Source: WWF Switzerland

2. Uruçuí (Southern Piauí)

2.1 Soybean expansion in southern Piauí

Soybean plantations were first cultivated in Piauí in 1970. EMBRAPA, the public agricultural research centre, experimented in adapting soybeans to low latitudes. This work was publicly supported by the *Banco do Nordeste do Brasil* and the *Fundo de Desenvolvimento Cientifico e Tecnológico*. Soybean cultivation started on a commercial scale in 1988.

Since 1998, more than 100 formerly small farmers from the Santa Rosa cooperative Cotrirosa in Rio Grande do Sul have migrated to occupy 60,000 hectares of the Uruçuí cerrado (scrub savannah), and have built a new town, Nova Santa Rosa. The goal is to promote soy production in Piauí, an endeavour financed by subsidised credits from public banks (with a total volume of $11.7 million)[7].

Soybean cultivation and potential expansion concentrate on 23 southwestern *municípios* (districts**)** in the cerrados of Piauí.[8] The main district of Uruçuí possesses about 50 large producers of soybeans (80,000 hectares) and cereals (total 200,000 hectares), compared to 400 local smallholders. The following table shows the rapid territorial expansion and gains in productivity in Piauí within the last 15 years.

Year	Area (hectares)	Production (tons)	Productivity (tons/ hectare)
1990	1,550	906	0.59
1995-1996	12,784	20,199	1.58
1997-1998	18,780	40,520	2.16
1999-2000	40,004	100,963	2.52
2000-2001	62,729	128,315	2.07
2001-2002	89,935	91,014	1.05
2002-2003	116,645	290,625	2.49

Table 2.1: Area, production and yield of soy in Piauí
Source: Brazilian Statistics Institute (IBGE)

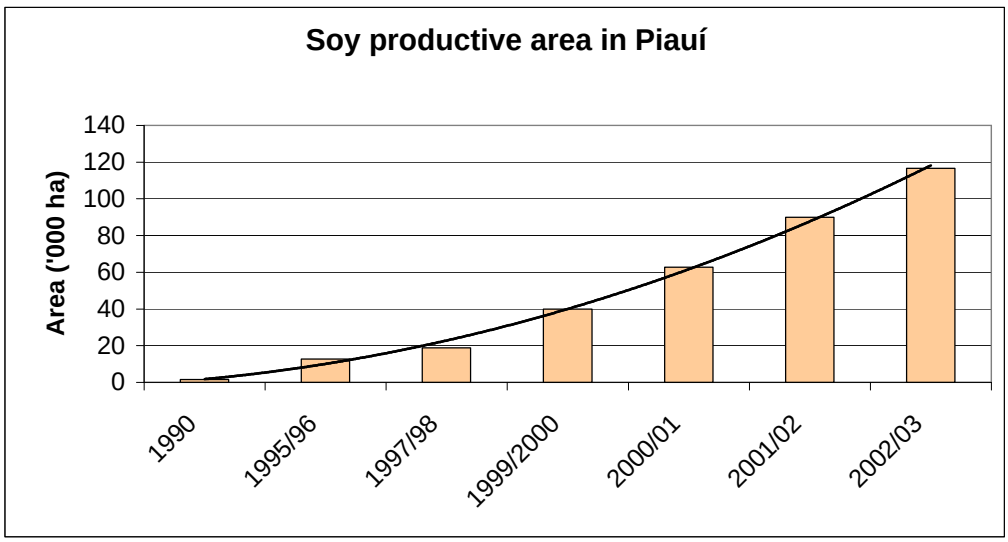


Figure 2.1: Soy planted area in Piauí and trend
Source: Brazilian Statistics Institute (IBGE)

Exports go through the "northern export corridor", the highway to Imperatriz (Maranhão) and Ferrovias Norte-Sul e Carajás railway connections, which take the soy from Imperatriz to the port of Itaquí in São Luís, Maranhão.
Soybean cultivation in the cerrados of Piauí could potentially expand to five million hectares, according to EMBRAPA and the agricultural commodity trader Bunge Limited[9]. The southwestern part of Piauí is one of the main soybean frontiers in Brazil, where cultivated area has expanded explosively within the last 15 years. From 2001 to 2002, soybean area increased 30 percent (Table 2.1). The public environmental agency IBAMA even considers eight million hectares of cerrado on the plateaus to be suitable for "agricultural development" and mechanised crops. In the northeastern region, neighbouring states are also seen as potential areas for expanding by one million hectares in southern Maranhão (presently 274,184 hectares) and 800,000 hectares in Tocantins (presently 145,206 hectares), totalling some seven million hectares for future soybean cultivation.

Factors favouring expansion are cheap land ($20-50 per hectare compared to prices of up to $7,000 per hectare in southern Brazil) and *chapadões* (flat upland areas) suited for large-scale mechanisation. Furthermore, public subsidies like cheap credit, tax exemptions on exports (the Kandir law) and on the new Bunge soy mill in Uruçuí (tax exempt for 15 years) are incentives that attract soy farmers and processing industries[10].

Factors limiting expansion are poor acid soils requiring imported mineral fertilisers and lime and a markedly dry climate bearing the risk of harvest losses. For example, the 2001-2002 harvest failed, yielding only 1.05 tons/hectare (Table 2.1). The rudimentary infrastructure (roads, energy, communications) is another severe limitation, but the government is addressing this as a priority. The state governor recently designated $1.7 million for the improvement of roads like the *TransCerrados* highway. Another $33 million are earmarked within the upcoming budget plan[11].

2.2 Link to European markets

A large soy mill (2,000 tons/day crushing capacity) owned by Bunge Limited has been operating in Uruçuí since August 2003. Annual production is envisaged at 110,000 tons of oil per year for national consumption and exports, and 456,000 tons of soymeal as animal feed for Europe and Asia and increasingly for domestic animal breeding in the northeast[12]. The new oil mill uses Siemens technology[13]. Bunge is financed by loans from private American and European banks[14]. There is no plan to exclude genetically modified soybeans from processing. The operating license granted to the Bunge oil mill is presently being revised because of the mill's severe impact on the environment (see section 2.4). The only other processor is the medium-sized Dureino oil mill in Teresina (200 tons/day crushing capacity), which since 1986 has extracted oil from soybeans from Maranhão, and in the last five years increasingly from southern Piauí. Formerly, the mill crushed native Babaçú palm fruit from local gatherers, but this has been increasingly replaced by soy[15].

Figure 2.2: The Bunge soy storage facility in Uruçuí
Source: www.terra.com.br/istoe 8.10.2003

2.3 Ecological and socio-cultural situation

The cerrados of Piauí occupy an area of 11 million hectares or 46 percent of the state's total area and six percent of the Brazilian cerrado biome, considered to be the savannah type with the highest biodiversity in the world[16]. The cerrados of southwestern Piauí in particular were classified a "priority area for biodiversity conservation" in a series of multi-stakeholder workshops that were part of Brazil's response to the UN Convention on Biological Diversity. The workshops identified areas for conservation and stressed the need for sustainable management options (see Figure 1.1)[17]. At present, over 2.5 million hectares have "conservation unit" status, but are not effectively protected[18]. The *Código Florestal* (forest law) requires that 20 percent of all landholdings in the Piaui cerrados should be protected and that permanent reserves should be established for precious woodlands and along watercourses. The additional obligation to preserve precious woodlands, difficult to meet in large-scale clearcutting, was converted into a blanket requirement to protect an additional 10 percent "for environmental compensation", which does not necessarily correspond to the most valuable areas of a farm in terms of biodiversity. Therefore, 30 percent of farms by law should be left under native cerrado vegetation; this is often not respected (see section 4 on deforestation).

Figure 2.3: Clearing of native cerrado vegetation with the *correntão* chain system
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2.4 Implications of expanding soybean cultivation in southern Piauí

Although farmers and other parties interested in modern agriculture argue that soybean cultivation would bring development, employment and income to the poor state of Piauí, these arguments often ignore the irreversible negative impact of cultivation.

Deforestation and loss of biodiversity

According to the IBAMA, demand for deforestation licenses is heavily increasing. Licenses to deforest 18,600 hectares were granted between January 2000 and May 2003 in the Uruçuí district alone; license applications for another 15,600 hectares are still waiting for approval[19]. However, according to soy farmers and the rural labour union of Uruçuí, the area of soy cultivation increased far more because of vast illegal clearcutting of native cerrado vegetation. As much as 6,000 to 7,000 hectares of a farm may be deforested illegally; IBAMA, lacking law enforcement resources, is unable to take effective action. Furthermore, the 135,000-hectare Uruçuí-Una ecology station in the Baixa Grande do Ribeiro district has been affected by burning and clearing and heavy deforestation for rice crops, and subsequently, soybean plantations[20]. EMBRAPA researchers lament that Piauí is suffering from the most widespread deforestation in its history[21].

The new Bunge oil mill needs to process 658,000 tons of soy annually in a first phase (until 2007) and 1,316,000 tons afterwards. More than 500,000 hectares would have to be cultivated with soybean to utilise this capacity[22]; it is highly likely that expansion would be at the expense of native cerrado.

IBAMA figures that the Bunge factory needs 400 stacked cubic meters of cerrado wood per day as fuelwood (equivalent to 20-25 hectares), or 7,300-9,125 hectares per year[23]. An additional 7,000 hectares would have to be cleared for eucalyptus plantations to satisfy an annual need for 228,000 cubic meters of fuelwood once the native cerrado vegetation is exhausted. Bunge has contracted smallholders in government-sponsored resettlement areas to develop eucalyptus plantations[24]. These fast-growing monocultures are a poor substitute for native biodiversity and create a severe hydrological deficit by drying out fragile cerrado soils[25]. The food security of peasants producing fuelwood would be jeopardised, since the long production cycle of eucalyptus reduces farmers' flexibility in planting food crops.

Figure 2.4: Delivery of fuelwood from recently cleared cerrado to the new Bunge oil mill in Uruçuí
© Ulrike Bickel

In the past, no environmental impact assessment was done regarding large-scale deforestation carried out for agricultural colonisation projects. Discussions regarding a "plan for sustainable development of the Piauí cerrados" were not initiated until 2000. However, no planning or agro-environmental zoning exists for those areas being considered for agricultural expansion, neither have conditions for such been defined, nor has it been indicated where it would be appropriate to install conservation units. Despite the workshop's recommendations on priority areas for conserving the cerrado, it is evident that the process of changing the Piauí cerrados is not under control.

Other factors that have environmental impact

Erosion impoverishes the soil, especially where no-tillage is not practised and soil is compacted by heavy machinery. However, while no-tillage is recommended as a more sustainable practice that prevents erosion, it goes together with the massive application of the Monsanto herbicide Roundup (glyphosate), which pollutes drinking water for humans and animals[26]. The use of Roundup and other pesticides endangers the water supply of the northeastern cerrado region, where the watersheds of the Parnaíba, Gurguia and Balsas Rivers are located.

Although the cultivation of genetically modified organisms (GMOs) was forbidden in Brazil until August 2003 and is still subject to strict environmental impact assessment and licensing processes, GM soybeans have been planted illegally on farms in southern Piauí. The seeds are smuggled from Balsas, Maranhão and Barreiras, Bahia, where irrigated GM soybean cultivation was initiated some years ago by Monsanto and the seeds were "branched off" when no license was granted[27]. Lacking any environmental impact assessment and protection measures, there is no way to guarantee there will be no uncontrolled spread of GMOs and contamination of the environment, with uncertain risks for nature and human health[28]. Additionally, uncontrolled proliferation of GMOs in northeast Brazil may threaten the GMO-

free status of this region, with implications for important export markets such as the European Union and Japan.[29]

Impact on social culture

Although the mechanisation of agriculture implies that new jobs will be created in associated service sectors (sale of pesticides and fertilisers, farm machines, repair and maintenance, banks), there is actually little employment benefit for the local population[30]. After temporary labour-intensive land clearing is finished, on average only one worker per 167-200 hectares of soybeans[31] is permanently employed. The new Bunge soy mill in Uruçuí claimed it would create 500 direct and 10,000 indirect jobs, but only 70 persons were employed in August 2003, mainly technicians and engineers brought in from southern Brazil[32]. The local population finds only temporary work as unskilled labour[33].

Labour conditions are poor when it comes to clearing land for soybean plantations and are generally below Brazilian and International Labour Organization standards. Labourers are exploited during the phases of deforestation, soil preparation for planting and the application of lime and pesticides, which require mostly manual labour since planting and harvesting are already mechanised[34]. For example, workers were paid $1.70 per day for removing roots after clearcutting[35]. The cost of opening new areas and deforestation is said to be ten times lower in Piauí than in Bahia or Mato Grosso ($10/hectare compared to $100/hectare in Bahia and Mato Grosso)[36]. Some extreme cases have even involved slavery. The ministry of labour recorded instances of slave labour being used for deforestation and land preparation for soy planting in Piauí [37]. Due to its poverty, Piauí is indeed the state that exploits the most agricultural slaves (15 percent of total). The Churches' Land Commission has said that the districts most affected in Piauí are Barras, São Raimundo Nonato and Uruçuí, the latter being the district where most soybean expansion is occurring. During the environmental impact assessment of the Bunge oil mill, rural people were found working for the Graúna enterprise under near-slavery conditions, clearing forests and removing roots without wearing protective gear. Graúna, located in the neighbouring Antônio Almeida district, sells fuelwood from cerrado clearing and also runs eucalyptus plantations for Bunge[38]. The wage for cutting one stacked cubic meter is $0.27. Two cubic meters may be cut in one day; pay is obviously below the minimum. The Piauí Minister for Agriculture, Supply and Irrigation said farmers repeatedly pledge to raise working standards[39].

Conflict over land is an issue. The search for new agricultural land has stimulated land grabbing and irregular land transfer practices by private estate agencies. Recent investigations by Interpi, the state land institute, and INCRA, the national institute for agrarian reform, revealed that ownership of more than 80 percent of land in Piauí is irregular. The ownership of some four million hectares, mainly in southeastern districts like Uruçuí, Ribeiro Gonçálves, Baixa Grande do Ribeiro and Bom Jesus[40], is now being investigated. The concentration of land into large farms, together with soybean expansion and the lack of federal support and perspectives for survival, have increasingly caused small farmers to give up and migrate to cities. There are at least 240,000 rural landless people in Piauí[41].

Figure 2.5: Labourer clearing cerrado for soy cultivation
Source: Isto é 2003[42]

Institutional aspects

The allocation of scarce government resources to an infrastructure facilitating large-scale mechanised agriculture results in less public money being available for social services like education and basic health care. EMATER, the public agricultural extension service, does not reach small farmers in Piauí, for example.

An environmental impact assessment (EIA) is obligatory for plantations greater than 1,000 hectares in size. Some producers virtually sub-divide their farms to avoid the expense of an EIA. According to the only consultancy accredited to carry out EIAs for agricultural enterprises in Uruçuí, the EIA is difficult to apply as it has "too many details hindering production". Thus, under *jeitinho brasileiro* (a flexible interpretation of regulations), statements are often formally issued saying vast plantations are harmless although there is uncertainty about their ecological impact. Public hearings on EIAs are held mostly in Teresina since "people like to do politics in the capital"[42], rendering the participation of affected populations in distant areas nearly impossible.

A recent analysis of the EIA of the Bunge oil mill in Uruçuí revealed severe deficiencies[43]. Nevertheless, three obligatory licenses (for preliminary work, installation and operation) were granted by the Piauí environment secretariat, which did not believe a public hearing was necessary. One major failing is that the assessment was confined to only 200 hectares of the Bunge plant's operating area, without taking into consideration the impact of production processes carried out to supply the mill that took place across a much wider area.

Another shortcoming was the survey of vegetation, which listed only 90 species; accessible data gathered for São Paulo University indicate that at least 412 plant species grow in the area. It is obvious that neither a hydrologist nor a biologist was on the EIA team, which by law must be multi-disciplinary. In view of these failings, Tranvanvan Feitosa, a federal procurator, has requested the public prosecutor's office to investigate the environmental license granted by IBAMA to build the Bunge soy mill in Uruçuí; this could lead to the operating licence[44] being revoked.

3. Mato Grosso

3.1 Soybean expansion in Mato Grosso

With over 90 million hectares, Mato Grosso is the third largest state in the Amazon region after Amazonas and Pará. Its original vegetation consists of Amazon forest (50 million hectares), and *chapadões* (flat cerrado highlands) and *campos* (fields) totalling 40 million hectares. The southern and central parts of Mato Grosso have a distinct dry season, which is more suitable for soy production, whereas the northern part has a humid rainforest climate.

Due to their poor soils, central-western cerrados were long considered unsuitable for agricultural use. Since the 1970s, soy varieties have been adapted for tropical conditions by EMBRAPA, the Brazilian agricultural research centre, permitting the agricultural exploitation of the cerrado savannah.

At the same time, large numbers of southern Brazilians started to migrate to the central west, driven by land being concentrated into larger farms and becoming scarce as the population in southern Brazil grew, and by government incentives such as colonisation programs for the midwest and central north regions. In the 1980s, these programmes were initially for small farmers from the south and were supposed to increase rice production for the domestic market; this was however gradually substituted by soybean production for exports. Hence, Mato Grosso has developed a highly mechanised, diversified agro-industry. Its history is marked by rapid territorial expansion and productivity gains. In the last eight years alone, soybean area has almost doubled to 4.5 million hectares, while average productivity increased from 2.4 to 3.1 tons/hectare (Table 3.1, Figure 3.2). Mato Grosso is today the largest soybean producing state in Brazil, containing one-fourth of Brazil's total of 18.5 million hectares planted with soy.

Year	Area (1000 hectares)	Production (1000 tons)	Productivity (t/ hectare)
1980	56	88.8	1.57
1985	823	1,611	1.96
1990	1,528	3,065	2.01
1994-1995	2,339	5,491	2.36
1996-1997	2,193	6,060	2.76
1999-2000	2,907	8,774	3.02
2001-2002	3,822	11,697	3.06
2002-2003	4,521	13,966	3.09

Table 3.1: Soy planted area, production and yield for Mato Grosso
Source: Brazilian Statistics Institute (IBGE)

Figure 3.1: Harvesting of soy; prior to harvesting the soy is sprayed with a drying agent
Source: www.lucasdorioverde.com.br/economia.asp

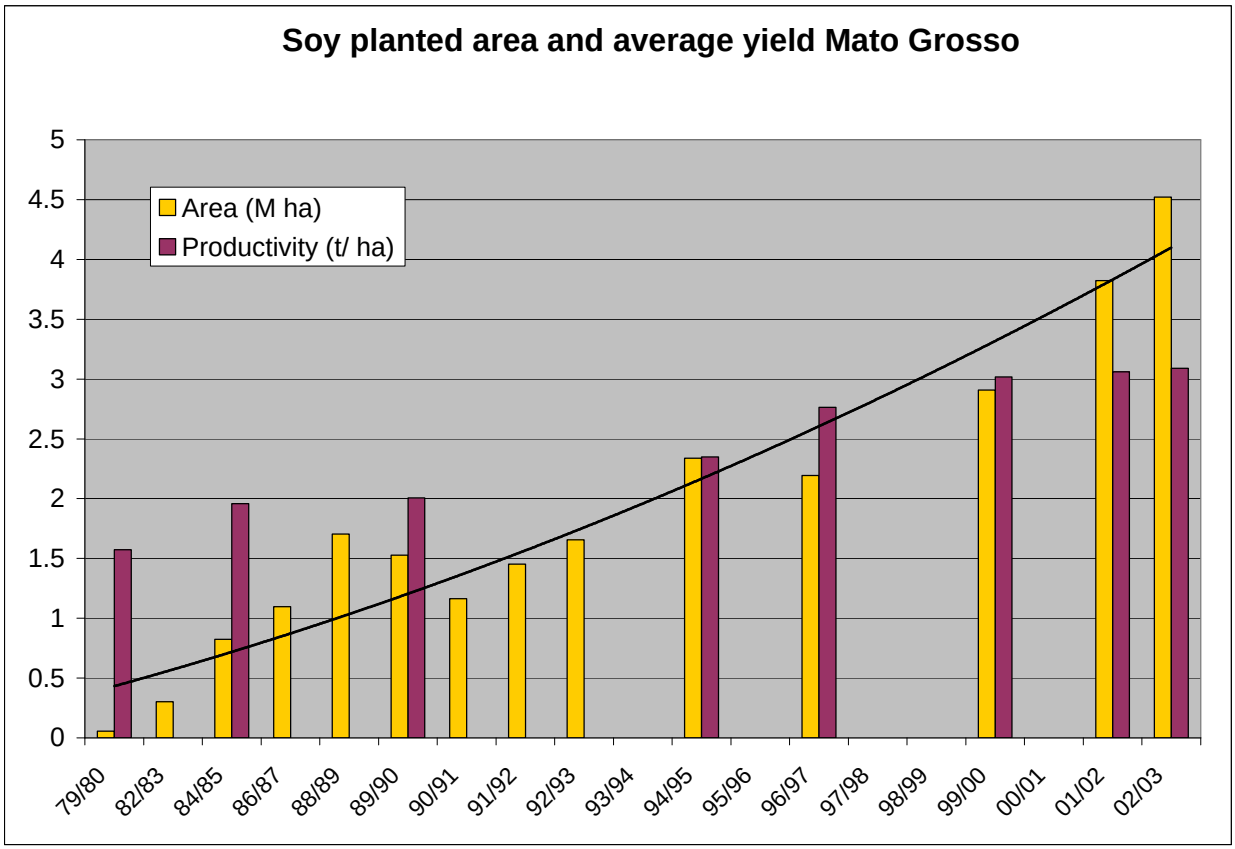

Figure 3.2: Soy planted area (and trend) and productivity in Mato Grosso
Source: Brazilian Statistics Institute (IBGE) and Blumenschein (2000)[45]

Soybean cultivation in Mato Grosso could potentially expand to 40 million hectares, particularly in the regions around Sinop, Sorriso, Chapada dos Parecis, Rondonópolis and the Serra do Roncador[46].

3.2 Link to European and American markets

According to company sources, 90 percent of the soy traded by the Maggi group is exported principally to the U.S. and Japan[47]. The Maggi group receives diverse loans from American and European banks (see section on institutional aspects). In Apri1 2003, Cargill opened a $20 million terminal in Santarem to export soy; it has the capacity to move 800,000 tons of soy a year, most of which the company expects will come from the centre west via the BR 163 highway. The port is three days closer than ports in the industrialised south to the main

soy markets in Europe and Asia. According to ministry of transport data, freight costs from central Mato Grosso to Rotterdam will fall by 20 percent[48].

3.3 Ecological and socio-cultural situation

Forty-six percent of Mato Grosso's territory belongs to the Amazon basin, one of the world's most biologically diverse regions, home to 55,000 recorded plant species, 428 mammal species, and 1,600 bird species. The cerrado (covering 49 percent of the state) is recognised as a biome with a high incidence of endemic species, but the area protected until now is absolutely insufficient for preserving its biodiversity[49]. Mato Grosso harbours many native species[50], some of which are threatened by soybean expansion (see section on deforestation).

According to the findings of the "priority areas for biodiversity conservation in the cerrado" initiative, sponsored by Brazil's ministry of environment in response to the UN Convention on Biological Diversity[51], some areas in Mato Grosso[52] where soybean cultivation is expanding are "biodiversity hotspots" and thus recommended as priority areas for conservation[53]. Only 1.8 million hectares of Mato Grosso were protected areas in 1997 (as conservation units for full protection and sustainable use, indigenous areas and areas of permanent preservation); however, the ministry of environment was calling for protecting four million hectares[54].

Figure 3.3: Cargill soy export terminal in Santarem
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3.4 Implications of expanding soybean cultivation in Mato Grosso and the Amazon

Deforestation and loss of biodiversity

Deforestation and environmental degradation are increasing; 14 percent of the forest area has been lost since the 1970s, compared with only two percent between 1498 and 1970[55]. In 2002, more than 2.5 million hectares were deforested, the largest area since 1995[56]. According to the ministry of environment, agricultural area in the Amazon region increased by 1.1 million hectares in the same period. Soybean expansion accounted for 70 percent or 770,000 hectares, followed by corn, rice and coffee plantations[57].

Of all Brazilian states, Mato Grosso is leading in deforestation with the loss of 795,000 hectares in 2002[58]. In the last 20 years, 30 million hectares of forest and cerrado have been replaced by plantations. This is almost half of the 75 million hectares of forests and cerrado which still covered Mato Grosso in the 1980s, or one-third of the state's total territory. Sixty percent of Brazil's forest fires in July 2003 occurred in Mato Grosso[59]. Burning is a common practice for converting native vegetation into agricultural land.

The *Código Florestal* (forest law) permits different "legal deforestation rates" in the Amazon region, depending on the type of vegetation. In the case of primary forests, 80 percent of the original vegetation cover has to be maintained in legal reserves, whereas in the case of cerrado and transitional vegetation zones between forest and cerrado, only 35 percent and 50 percent respectively have to be maintained. Soybean plantations are penetrating into primary forest regions, for example between Canarana and São José do Xingu[60]. Many producers do not comply with the forest law, deforesting large areas[61]. In June 2003, rural trade unionists had to take refuge in the Churches' Land Commission in Cuiabá after powerful farmers threatened to kill them; the unionists had publicly condemned the vast unauthorised deforestation occurring in Lucas do Rio Verde, the major soybean producing district of Brazil, and Nova Mutum[62]. The new Cargill soybean terminal in Santarém is another incentive for new farmers to produce soybeans along the BR 163 highway connecting the terminal to Mato Grosso. The Cargill port was constructed even though its environmental impact assessment was faulty, massively criticised by social and environmental organisations. The port dislocated small fisher families who lost their traditional source of subsistence and income[63].

One factor making it easy to clear land illegally is the acute shortage of staff in the *Fundaçao de Meio Ambiente de Mato Grosso (FEMA)*, the state environment agency; only 13 inspectors are in charge of protecting the state's conservation areas and monitoring deforestation and fires. As a consequence, only seven of Mato Grosso's 37 nature reserves are demarcated. The majority are located on privately owned land. In the past, the state has not allocated a budget for the expropriation and acquisition of nature reserves[64]. FEMA only recently began testing a new satellite-based system to permit and monitor the licensing of deforestation[65].

In some cases, soybean producers have penetrated into protected areas[66] or indigenous reserves like the Xingú National Park, with resulting deforestation and pesticide contamination[67]. Many indigenous areas are awaiting demarcation and do not yet have legal status. Although the present government has taken up the formal establishment of indigenous territories as a priority, this seems to concentrate on remote areas in the Amazon with little agricultural potential. The superintendent director of Hermasa, the Maggi group's transportation agency in Itacoatiara (Amazonas), made a curious statement when shown a map to discuss potential areas for soybean expansion. "Where do you have this map from? It's full of indigenous reserves!"[68]

With 95,000 hectares of soybean, 26,000 hectares of corn and 2,700 hectares of cotton newly planted in 2003, the Maggi corporate group is the driving force behind the expansion of the agricultural frontier into the Amazon[69]. It acts in 10 of the 27 Brazilian states, and has 35 storehouses with a total storage capacity of 1.9 million tons for cereals and derived products, two bulk freight terminals (Porto Velho, Rondônia and Itacoatiara, Amazônas) and two crushing factories with a processing capacity of 3,000 tons/day. The Maggi group is presently exporting two million tons of soy each year, which corresponds to export earnings of more than $350 million[70]. It recently announced its intention to double its own soybean area and called for tripling the area of soybean cultivation in Mato Grosso during the next decade[71]. Two regions are of particular interest to the Maggi group – an area of already deforested land of three million hectares near Sinop, close to the BR 163 highway, and the eastern Araguaia Valley, from where produce could be exported via the north-south railway.

Figure 3.4: Maggi Group soy storage and processing facilities
Source: www.grupomaggi.com.br/br/expimp/index.asp, www.grupomaggi.com.br/br/agro/estrutura.htm

Other ecological aspects

Besides the conversion of natural habitats, the heavy use of pesticides, an indispensable element of modern soybean production, poses another severe problem. Pesticides pollute drinking water and the environment. In particular, spraying pesticides by aircraft disseminates active ingredients over much larger areas than intended[72]. Small farmers' organic plantations in Lucas do Rio Verde have been accidentally sprayed. Pesticides are very toxic in the short and long term, accumulating in humans and the environment[73]. Insecticides affect not only harmful pests but also beneficial insects, resulting in the increasing instability of the ecosystem and requiring ever more pesticide application. The *Movimento pela preservação dos ríos Tocantins e Araguaia*, a movement to preserve the Araguaia and Tocantins rivers in one of the current soy expansion areas, estimates that around 220,000 people in Brazil die each year due to pesticides[74]. According to EMBRAPA, the public agricultural research centre, around 20 percent of total soy production costs ($330 per hectare) are for pesticides (roughly $66 per hectare). Depending on the level of technology used, five to ten litres of pesticide are applied per hectare of soybean. Each year, 4.3 million kilograms of empty pesticide packages are collected in Mato Grosso, which is the country's third largest producer of this type of waste[75]. Since the compulsory collecting and triple washing of empty packages is laborious, the total amount of empty pesticide packages is estimated to be much higher because of wild disposal in the field[76].

Figure 3.5: Pesticide filling on a large soybean and cotton farm
© Ulrike Bickel

Institutional aspects

Multiple public subsidies for soybean production and processing facilities encourage the substitution of native vegetation with vast monocultures. German environmental organisations[77] heavily criticised the Deutsche Investitions- und Entwicklungsgesellschaft and the Dutch Rabobank that provided a $12 million loan at low interest rates to the Maggi corporate group in 2001. Nevertheless, the International Finance Corporation (IFC) approved a $30 million loan for the Maggi group in autumn 2002[78]. The IFC's country manager justified the loan, stating that "the fact that problems exist within a sector does not mean that a single actor who behaves in a responsible way should not be supported"[79]. The World Bank itself, which participates in the G-7 Pilot Programme to Conserve the Brazilian Rain Forest (PPG7), is no longer financing soybean expansion into the Amazon[80]. In June 2003, the Maggi group announced receiving another $80 million loan from a bank syndicate headed by Germany's WestLB bank for financing soybean cultivation, $30 million of which had already been disbursed[81].

According to the PPG7's International Advisory Group, the new infrastructure projects foreseen within the next budget plan stimulate soybean production, consequently increasing deforestation in some regions like Itacoatiara (Amazonas), Santarém (Pará) and northern Mato Grosso, which the BR 163 highway passes through[82]. One example is the paving of BR 163, the highway connecting Mato Grosso with the port of Santarém (Pará). A joint study by the NGOs *Instituto Socio-Ambiental* and the *Instituto de Pesquisa Ambiental da Amazônia* has shown that paving the highway would deforest 2.2 to 4.9 million hectares along the road within the next 25 to 35 years[83]. Nevertheless, according to the new federal government's recently published budget plan, the road will be paved and costs will be divided among private actors, the government of Mato Grosso and the federal government[84]. State governments may obtain loans for infrastructure development directly from the World Bank

under its strategies aimed at economic growth and poverty alleviation, presented at the 2003 World Parks Congress in Durban[85]. Governor Maggi holds political and economic power but rejects accusations of conflicts of interest, since people voted for him knowing that he wanted to build roads and expand agricultural production[86].

Impact on social culture

Although the mechanisation of agriculture implies the creation of new jobs in associated service sectors (sale of pesticides and fertilisers, farm machines, repair and maintenance, banks), there is little employment benefit for the local population. After temporarily labour-intensive land clearing is finished, on average only one worker per 167-200 hectares of soybeans finds permanent employment[87]. Smallholder farming and other livelihoods are replaced by labour-extensive mechanised soy farming. Construction of the Cargill port displaced small fisher families who lost their traditional source of subsistence and income[88].

Mato Grosso and Pará are the states where slave labour is used the most in agriculture, according to reports by the International Labour Organization and the Churches' Land Commission[89]. In 2002, 723 cases of slavery were registered on farms in Mato Grosso; a shortage of staff in the ministry of labour's mobile detection team means that a much higher number of cases goes unreported. Fazenda Getúlio Vargas near Sorriso is an example. Two former slaves reported they had been forced to remove roots after deforestation, plant soybeans, corn and rice, and apply fertilisers and pesticides without wearing protective gear. Workers laboured from 3 a.m. until 8 p.m., in planting seasons until midnight, seven days a week. Nutrition was insufficient and labourers were charged excessively for daily necessities. Workers were "housed" under flimsy black plastic covers in a field, without sanitation and health care, drinking water came from a river. Promised salaries were not paid. The two workers managed to escape after more than one year of slavery, but the search for new slaves continues[90].

The cultivation of mechanised crops in Mato Grosso goes together with the concentration of land into large farms. The number of farms larger than 10,000 hectares in size rose from 643 in 1980 to 767 in 1996, extending their area from 17.8 million to 20.6 million hectares. Within the same period, the number of rural establishments smaller than 10 hectares decreased from 23,900 to 9,800[91]. Illegal land holding is also an issue. On behalf of the landless peasants' movement, the public prosecutor investigated the number and area of farms occupying public land. He found that 464 farms had settled illegally on 6.6 million hectares of public land in Mato Grosso in 1980, more than half of which have become legal. As a result, there are still 3.2 million hectares of public lands occupied illegally by large farms in 2003. The government is supposed to reclaim this land to enforce an agrarian reform as foreseen in the 1988 constitution[92], but political will seems to be lacking. While 10 percent of the farms occupy 82 percent of the productive land in Mato Grosso, the number of landless people and urban poor is steadily increasing[93]. In July 2003, there were 4,000 landless families in Mato Grosso (out of 80,000 for all Brazil) waiting in makeshift camps for their settlement[94]. Social pressure to enforce the agrarian reform has increased under President Lula's government[95].

4. Humaitá and the state of Amazonas

4.1 Soybean expansion in Humaitá, Amazonas

The state of Amazonas extends over 150 million hectares, of which 97 percent is still covered with original vegetation (mainly forest) and only 1.4 percent has been altered by human influence[96]. The government and producers consider only about 1.5 million hectares of *campos naturais* (savannahs) to be suitable for mechanised soy or cereal cultivation.

Soybean cultivation in the southern Amazonas Humaitá region began in 1994, financed by the Banco da Amazônia, a public development bank for the region, and facilitated by the state government. These public incentives attracted farmers with experience in cultivating cereals in Mato Grosso and in southern Brazil, in Rio Grande do Sul, Paraná for example, where land was becoming scarce and expensive. Initially, there had been experiments with cultivating rice as part of the state government's aim to increase the local supply of staple food. The *campos naturais* of Humaitá are considered suitable for soybean as their sparse original vegetation is easier to remove than primary forest. Soils in these fields are very wet due to high groundwater levels, thus drainage is required to enable agricultural production.

Between 1996 and 1998, there was a boom involving some 46 soybean farmers, and soy cultivated area rose to 15,000 hectares. The Maggi group in Mato Grosso planned to extend soy plantations up to Humaitá[97], and bought the farmers' harvests. However, soybean and rice production suddenly collapsed due to a lack of technical experience and varieties adapted to the poor and wet soil conditions, insufficient infrastructure (roads, silos, agricultural service providers), difficult access to credit, and heavy rainfalls (Figure. 4.1). Initial plans to construct a huge soybean shipping terminal on the Rio Madeira in Humaitá were dropped. The former agrarian cooperative is no longer functioning, and meanwhile all but two of the "pioneer" farmers have left the region, abandoning at least 9,500 of recently converted land. Last season (2002-2003), only 1,560 hectares of soybeans were cultivated on a total of 4,100 hectares of cereals including rice and corn.

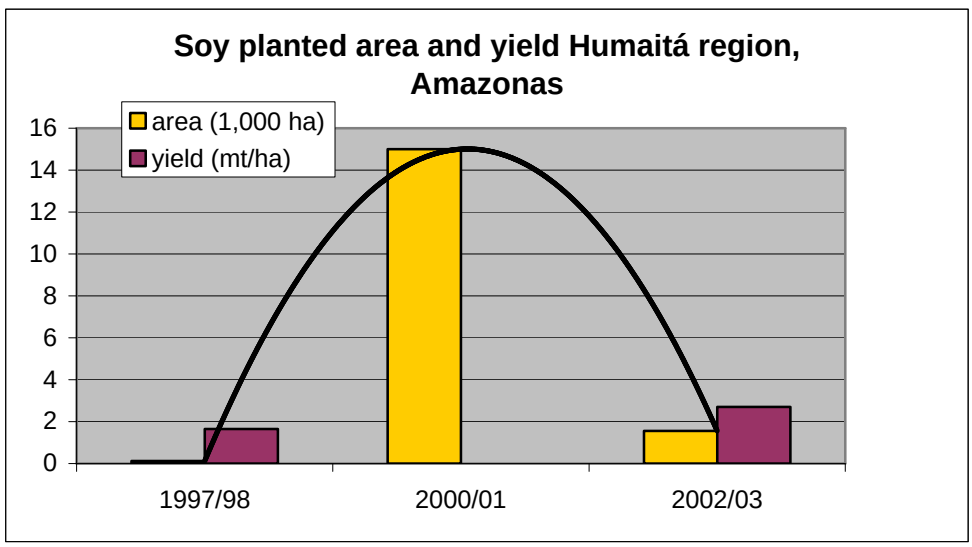

Figure 4.1: Productive area, yield and trend in soy acreage, Humaitá. Acreage was 120 hectares in 1997-1998; no yield data are available for 2000-2001.

Figure 4.2: Soy field in Humaitá
© Ulrike Bickel

The potential for soybean production in the state of Amazonas

According to estimates by EMBRAPA and the Maggi group, some 1-1.5 million hectares of *campos naturais* in the state of Amazonas are considered viable for soybean expansion, mainly in the district of Humaitá (800,000 – one million hectares), on a smaller scale, in the districts of Lábrea, Manicoré and Apuí, and on some 7,000 hectares of degraded pastures around Itacoatiara[98]. The first four districts are all located close to the Rio Madeira, the main link to the Amazon River and its ports. Itacoatiara is an attractive region due to the proximity of the Hermasa soybean terminal built by the transportation agency of the Maggi Group, the region's main exporter[99]. The main importing countries are the United States, Europe and Asia.

Fig. 4.3: Hermasa soy bean terminal, Itacoatiara, State of Amazonas
Photo: Roberto Jayme[101]

Fig. 4.4: Hermasa soybean terminal
Photo: Grupo André Maggi [102]

These regions are limited however for soybean cultivation. Main limitations are acid, wet soils and heavy tropical precipitation, which increase the risk of weeds, insects and fungi. Farmers reported on difficulties getting pre-harvest loans from public banks or soy traders on

time, complicating timely cultivation. Furthermore, the transportation infrastructure is underdeveloped, creating an expensive transport loop 400 kilometres long. Since there is no export terminal in Humaitá, soybeans must be trucked 200 kilometres southwards for loading in Porto Velho, only to pass northwards again on the Rio Madeira. Continuous dredging is required to allow transports in the dry season.

4.2 Link to European and American markets

According to company sources, ninety percent of the soy traded by the Maggi Group is exported principally to the U.S. and Japan[100]. The Maggi Group receives diverse loans from American and European banks (see section on institutional aspects).

4.3 Ecological situation

The wet savannahs of Humaitá are a rare and vulnerable ecosystem in the Amazon. Within the initiative to establish priority areas for biodiversity conservation in the cerrado, sponsored by the ministry of environment[101] in response to the United Nations Convention on Biodiversity, the *campos naturais* of Humaitá were identified as having extremely high biological importance, an area where a large conservation unit should be created. As yet no action has been taken to establish a conservation area or prevent further conversion of the natural vegetation.

4.4 Implications of expanding soybean cultivation in Humaitá and the state of Amazonas

Deforestation and loss of biodiversity

Despite initial difficulties encountered in cultivating soybean in Amazonas, pressure on native vegetation around Humaitá is increasing[102]. According to the Churches' Land Commission, soybean expansion in the state of Amazonas causes substantial damage to the environment (deforestation, biodiversity loss), threatening to rob small peasants and indigenous people of their traditional livelihoods and endanger other activities[103]. In the neighbouring state of Rondônia, farmers are already complaining that creeks are drying out, rains diminishing, and winds and resulting erosion increasing, which they claim is due to deforestation[104]. At the same time, scientists warn that almost all of Brazil's agriculture depends on the Amazon forest remaining intact since it regulates rainfall in the north of Brazil as well as in the central west and the southeast[105].

Due to the high cost of clearing primary forest, soybean farmers prefer to occupy savannahs and areas formerly deforested for cattle pastures. Another cost factor is that each private property in the region is legally obliged to leave 80 percent of the Amazon forest cover untouched as a reserve. This means that a farmer needs to acquire an area five times larger than the area to be cultivated. This stipulation drops to 35 percent for savannahs. However, when soybeans are cultivated on former pasture land, cattle farmers tend to advance into new forest areas, thus causing more deforestation (which is not always legal)[106]. According to the secretary for sustainable development in the ministry of environment, the growth of agricultural area in the Amazon region was about twice as high as for the rest of Brazil, and 70 percent of the 1.1 million hectares deforested in the year 2002 was cleared for soybean cultivation[107].

Hermasa (Maggi group) announced the purchase in 2001 of 15 million hectares for soybean cultivation on the northwestern agricultural frontier in Rondônia, Roraima and southern

Amazonas[108]. Hermasa consultant Morães estimated that the state of Amazonas alone could produce 500,000 tons of soybeans within 15 years[109]. This would require clearing enough forest to plant an area of 200,000 to 250,000 hectares. American investors are exploring the potential for investing in soybean cultivation in Amazonas and other Brazilian states; cultivation is much less expensive than in the USA, since land and labour are abundant and cheap[110]. Such plans by major actors in the soybean economy indicate that they seem quite confident the present ecological limitations to soybean cultivation in the Amazon region will be overcome by technological progress in the near future. A new boom might well follow the collapse of the soy economy in Humaitá in a few years. However, even if new soy varieties become available, the soil and climate will still require additional input or pose the greater risk of crop failure. This is illustrated by the reluctance of banks and traders to finance the Humaitá soy crop. Hence, conversion of additional land in the Amazon wet savannahs and *varzeas* will only be profitable under optimal market conditions and does not outweigh the loss in environmental functions and values.

Figure 4.5: Humaitá, state of Amazonas, on the bank of the Rio Madeira
Source: www.dmknet.com.br/54bis/humaita.htm

Public subsidies and adverse ecological effects – model studies indicate that soybean cultivation in the Amazon will concentrate around the transportation axes and may fragment the existing core area of the Amazon[111]. The process of often irregular land occupation and forest clearing is stimulated by public investments in transport infrastructure. No provisions are made to internalise negative social and environmental impacts, according to the International Advisory Group of the World Bank/G-7 Pilot Programme to Conserve the Brazilian Rain Forest[112]. For example, the port for bulk freight in Itacoatiara was constructed as a joint initiative of the Maggi group (53 percent) and the state government of Amazonas (47 percent), as were the construction works to make the Rio Madeira navigable from Porto Velho to Itacoatiara, which was crucial to allow the shipping of soybeans from Rondônia and northern Mato Grosso via the Amazon to European markets[113]. Here, public funds were spent without taking into account adverse environmental effects or establishing mitigation measures such as the establishment of conservation units as proposed by the Brazilian ministry of environment.

The expansion of the Rio Madeira waterway required investments of around $30 million, of which the Maggi group paid $16.6 million and the governments of Amazonas and Rondônia shared the rest[114]. Further extension of the Rio Madeira-Guaporé-Beni river systems is foreseen in the budget to open an export corridor to the Pacific. The *Grupo de Assessoria Internacional* has recently warned that while this would contribute towards increasing regional soy production up to 25 million tons/year, eight million hectares would have to be deforested[115]. Also, the Brazilian government is planning to extend the BR 364 highway through the state of Acre to the Peruvian port of Ilo to have direct access to growing Asian markets for soybeans[116]. The upcoming paving of the *Transamazônica* highway from Humaitá to Apuí[117], and from Humaitá to Lábrea[118], would improve conditions for commercialising regional cereal production while also increasing pressure on the rainforest and *campos.*

The economic motive behind improvements in infrastructure is clear. Shipping on the Madeira waterway reduces transportation costs for soybeans from northern Mato Grosso and Rondônia by 35 percent. Medium costs for exporting soy from Sapezal (Mato Grosso) via southern Paranaguá (Paraná) total $110/ton, compared to only $70/ton if soy is exported via northern Itacoatiara. Redirecting shipping has even reduced transportation costs from Rondônia from 70 percent to only 10 percent of farmers' returns[119].

Further public subsidies include the state program to supply lime (in unlimited quantities) at no cost to farmers to balance acid soils, and federal programs to finance the harvest and investments in agricultural machinery, and drying and storage facilities (subsidised loans from Banco do Desenvolvimento and Banco da Amazônia, Brazilian development banks)[120]. Thus, the federal and state governments are directly stimulating the expansion of soybean cultivation towards the Amazon region, despite the uproar caused by the recent publication of deforestation figures in 2002. Deforestation totalled 2.55 million hectares, the largest area since 1995[121].

Other ecological aspects

Spraying pesticides by aircraft[122] pollutes the environment, water and aquatic life, especially in the Humaitá region where the groundwater level is high. "Correcting" acid soils with high doses of lime irreversibly eradicates the original vegetation of the *campos naturais*[123]. Another negative effect mentioned by the state secretary for agriculture is that the heavy machinery used in soybean farming compacts the soil[124], a particular problem in the wet fields of Humaitá.

The development of intensive animal husbandry is also an issue. Regarding future soybean production in the state of Amazonas, the Maggi group announced in 2001 that it would invest more than $25 million in soy mills for producing animal forage and soy oil, with a crushing capacity of 2,000 tons a day[125]. Counting on support from the state government, this enterprise would supply feed for intensive animal production, mainly chickens and pigs, in the free trade area of Manaus. The Maggi Group plans to build an industrial complex by 2004 with the capacity to slaughter 80,000 chicken daily and store 140 tons of meat[126]. Neither the group nor the government has yet taken into consideration the negative effect of industrial animal fattening on animal welfare, food quality and the environment.

Impact on social culture

Inequity is increasing. The heavy diversion of scarce public resources to the agro-industry stands in contrast to the low public support of small farmers who constitute the majority of the rural population in the Amazon region. For example, the municipal government of Itacoatiara built a silo for storing cereals as an incentive for cereal production. Ironically, it is not used,

since major traders prefer to construct their own facilities with first-hand technology[127]. At the same time, the public rural extension service for smallholders offered by the *Instituto de Desenvolvimento do Estado do Amazonas*, a development institute, barely functions[128]. Soybean cultivation requires extremely high investments in soil improvement (lime and nutrients application), mechanisation, and storage and export infrastructure, which means it, is viable only for relatively wealthy farmers with substantial agricultural experience who benefit from government support. This is not the case for most small Amazon peasants, who live from extractive agriculture, cassava crops and fishing. Some peasants and their organisations report extreme difficulty in obtaining government support, such as adapted rural extension or processing and commercialisation aid, for bureaucratic and political reasons[129]. In addition, small farmers find it difficult to obtain credit from the Fundo Constitucional do Norte, where credit can be linked to inappropriate technology packages.

The Humaitá region is served by EMBRAPA, the public agricultural research centre in Porto Velho, capital of the neighbouring state of Rondônia, which is close by and has been carrying out tests on adapting soybeans to humid tropical conditions since the 1980s. At the local level, the Humaitá agriculture secretariat uses a paternalistic approach. Agricultural technicians with tractors are sent to mechanically prepare two hectares of each small peasant's land and distribute some seeds for free, instead of working out an adequate extension service together with farmers that is adapted to their reality.

5. Conclusions

As shown in these case studies, soy production entails a series of economic, ecological and social impacts, the benefits and burden of which are unevenly distributed to society. On the one hand, soymeal and oil are basic commodities that generate income to farmers, processing industries, and support services, providing some employment and valuable foreign exchange earnings. On the other hand, soy production often carries high external costs due to associated forest clearing, atmospheric, terrestrial and water pollution and disregard for workers', local community and indigenous rights. Soy production is usually capital-intensive and large-scale; soy is not a smallholder subsistence crop.

Brazilian industry and government actors foresee a growth of the soybean production area to 100 million hectares. Aside from the questionable capacity of the market to absorb the produced 250 to 300 million tons of soybeans, with resulting downward pressure on prices, this would require vast areas of native tropical vegetation to be cleared. Conversion of high conservation value forests and other critical habitats for soy cultivation is unacceptable as these habitats and associated biological diversity would be lost forever. Without significant changes in policies and practices, nature and people would suffer major damage.

Presently, sustainability criteria for soybean cultivation are being discussed by civil society in Brazil, and resulting considerations will have to be taken into account. The foregoing examples of massive deforestation, pesticide overuse and slavery are not confined to soybeans only, but at this point in time it is the predominate crop. These practices occur throughout the intensive agro-industrial production sector in the spirit of the "green revolution" aimed at maximising productivity and profit, instead of using human and natural resources sustainably. This study illustrates that solutions have to extend to generally reversing unsustainable production patterns. For the present, soy production has to be made more beneficial, socially and environmentally, by the private actors in the soy market chain (producers, traders, processors and retailers of soy products). Further action is needed by public entities (national and international) to develop and enforce sustainable development.

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[24] O Portal do Piauí na Internet, 22.4.2003, www.portalaz.com.br/arimateia/anteriores/2003/abril/22.htm.
[25] "The costs for high-productive monoculture plantations of eucalyptus are high: they require an enormous input of chemical fertilizers, herbicides and pesticides. This is also responsible for the low biodiversity in the plantations: the number of animals in the eucalyptus plantations tends towards zero, according to informations of local residents. As a result, possibilities for hunting and fishing of local populations are decreasing substantially. Another severe ecological problem is the water scarcity: eucalyptus in extended monocultures dries out the soils, decreases the water level in rivers and reduces ground water reserves." See www.urgewald.de/kampagnen/papier_und_wald/index.htm; Ricardo Carrere, World Rainforest Movement: The dangers of monoculture tree plantations. www.wrm.org.uy.
[26] There is substantial evidence of human poisoning from the use of **glyphosate** (1999 Pesticide Action Network Asia & the Pacific, www.poptel.org.uk/panap/pest/pe-gly.htm):
Short-term toxicity: ...Effects of exposure to glyphosate formulations include skin and eye irritation, respiratory problems, effects on the heart, altered blood pressure, gastro-intestinal problems... diarrhoea, increased blood glucose, red nasal discharge, pancreatic lesions, salivary gland lesions, growth retardation, and changes in the relative weights of organs. ... Its use as a pre-harvest desiccant and growth regulator is particularly problematic with respect to residues as there is insufficient time after use for the chemical to degrade before harvest. It can persist in food products for up to two years.
Long-term toxicity: Lifetime studies on animals have shown excess growth and death of liver cells, cataracts and eye lens degeneration. Although glyphosate is not considered carcinogenic to humans, only a small number of studies have been carried out. These have shown a range of tumours in the thyroid, pancreas, and liver. Studies have shown various negative reproductive effects in males and females...
Environmental effects: Glyphosate is of concern in particular for its effects on the aquatic environment. It is moderately toxic to fish. The surfactant used in Roundup(tm) is considerably more toxic. It also affects beneficial insects and earthworms, algae and non-target aquatic plants. The use of glyphosate may result in significant population losses of terrestrial species through habitat and food supply destruction and thus cause a threat to endangered species and **biodiversity**. Nitrogen-fixation may be reduced, lowering soil fertility. It can increase the susceptibility of some non-target plants to fungal diseases, and interferes with other metabolic processes such as ion and lignin production. Glyphosate can be persistent for more than three years in soils, depending on soil type and climate, and has been found in surface and ground waters. Recent research shows that glyphosate may be more mobile in the environment than previously thought, indicating a greater risk of groundwater contamination. Glyphosate found it the soil can be absorbed by plants long after its use.
[27] Information provided by: Dircéu Klepker/ EMBRAPA, Balsas, 22.4.2003, Joernilson Alves de Macedo/ Syngenta, Balsas, 21.5.2003, and Landino José Duktievicz/ Consultancy Plasteca, Barreiras, 17.7.2003.
[28] For the environmental effects of genetic engineering, see: Greenpeace Brasil: “Impactos Ambientais da Engenharia Genética”, “Resistência Antibiótica em Organismos Modificados Geneticamente”, e „Os mitos da biotecnologia agrícola: algumas questões éticas“. São Paulo, 1999.
[29] Dros, J.M. and M. Kriesch: GMO-free soy for Europe, AIDEnvironment, Amsterdam, 2003.
[30] Dr. Socorro Lira Monteiro: „The arrangements created by the federal government aiming at modernizing agriculture do not eliminate the problems of the native population. The development favors the big landowners who come in general from other States.“ In: Dissertation (summary): Ocupação do Cerrado Piauiense: estratégia empresarial e especulação fundiária. Teresina, june 2002.
www.eco.unicamp.br/teses/dout_desenvolvimento_economico_espaco_ambiente.html
[31] R. Carvalho: A Amazônia rumo ao “Ciclo da soja”. In: Amazônia Papers No. 2, Amigos da Terra, São Paulo, setembro 1999.
[32] Information provided by Osvaldo Julio Silva Filho, Bunge personnel officer in Uruçuí, interviewed 11.7.2003.
[33] A technical school for agricultural formation was constructed in Uruçuí some 16 years ago but never entered into function and is now decaying by lack of political commitment. Information given at the occasion of a public participatory planning workshop on the next budget plan, Uruçuí, 8./9.7.2003.
[34] Delegacia Regional do Trabalho in Teresina/ Piauí, interview with Paula Maria do Nascimento Mazullo, 5.6.2003.
[35] Superintendent of the National Institute for Agrarian Reform (INCRA), padre Ladislau, reporting about a field visit in the districts Uruçuí, Baixa Grande do Ribeiro and Ribeiro Gonçálvez. In: Journal Meio-Norte, 4.6.2003.
[36] Efrém Ribeiro: Região tem o segundo maior lençol freático do mundo, in: Journal Meio Norte, 13.11.1999, p. 8, www.estado.dogurgueia.nom.br/pesquisa/cerr.mnorte.htm.

[37] www.ilo.org/public/portugue/region/ampro/brasilia/trabalho_forcado/brasil/documentos/jornada_debates_trabesc.pdf. Exploitative working conditions include: exaggerated working hours, low to no salaries, work without social insurance and health care, precarious food and lodging, lack of clean drinking water and sanitary facilities, pesticide application without protection equipment, indebtedness through excessive charge of food and working equipment, sometimes child slaves, torture, supervision by armed security patrols and loss of individual freedom to leave. See: Collection of newspaper articles on slavery by the Churches' Land Commission (CPT), Teresina, 2002.

[38] Prof. Dr. Álvaro Fernando de Almeida, Responsible lecturer for the Sector of Nature Conservation and Environmental Impacts of the Forest Sciences Department, São Paulo University (ESALQ-USP), Piracicaba, 9.9.2003.

[39] Interview with Sérgio Luiz Oliveira Vilela, Piauí State Minister for Agriculture, Supply and Irrigation, Teresina, 3.6.2003.

[40] Journal „Diário do Povo", 7.9.2003: Grileiros oferecem terra a procuradores. http://www.diariodopovo-pi.com.br/politica.html; Luciano Coelho/ Agência Nordeste, 8.9.2003: Piauí tem 4 milhões de hectares de terras irregulares. In: http://www.agne.com.br/private/250803/2508031522.html.

[41] Jornal Agora, 6.7.1998, p. 7.

[42] Salviano de Souza Filho/ Agricultural Consultancy Serena, interviewed in Uruçuí, 11.7.2003.

[43] Prof. Dr. Álvaro Fernando de Almeida, Responsible lecturer for the Sector of Nature Conservation and Environmental Impacts of the Forest Sciences Department, São Paulo University (ESALQ-USP), Piracicaba, 9.9.2003.

[44] O Portal do Piauí na Internet, 24.6.2003, http://www.portalaz.com.br/arimateia/anteriores/2003/junho/24.htm; Tranvanvan da Silva Feitosa, Procurador da República, e Maria Carmen C. de Almeida, Promotora de Justiça de Meio Ambiente, 22.9.2003: Queixa contra Bunge Alimentos S/A Unidade de Uruçuí-PI, Grauna Mineração Ltda., Estado do Piauí e IBAMA. Ao Exmo. Sr. Dr. Juiz Federal da Vara da Seção judiciária do Estado do Piauí.

3. Mato Grosso

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[46] H. Escobar: „Soja não é ameaça para a floresta amazônica", em: O Estado de São Paulo, 31.3.2002, p. A-13.

[47] www.udop.com.br/diversas/materias/div_01_09_02.htm.

[48] Reese Ewing, Reuters news service 23 september 2003 see: http://www.planetark.org/ dailynewsstory.cfm/ newsid/22323/story.htm

[49] Ministério do Meio Ambiente: Biodiversidade Brasileira. Avaliação e Identificação de Áreas e Ações Prioritárias para Conservação, Utilização Sustentável e Repartição de Benefícios da Biodiversidade Brasileira. Brasília, 2002, p. 192-193.

[50] Among others Xingú, Karajá, Aripuanã, Bakairi, Paraburure, Areões, Pimentel Barbosa, Zoró, Japuíra, Kayabi, Nambikwara, Utiariti, Irantxé, Tirecatinga, Umutina, Paresi, Sarare and Rikbaktsa.

[51] See www.bdt.fat.org.br/workshop/Cerrado/br/; www.mma.gov.br/img/sbf/chm/areace.jpg.

[52] Such as the Eastern Serra do Roncador and Vale do Araguia River, the northern Serra do Cachimbo, the central western Chapada dos Parecis, as well as the central plains of Diamantino, Lucas do Rio Verde, Sorriso, Sinop and Sítio de Santa Filina.

[53] Governor maggi was quoted to say at a meeting with environmental NGOs: „If you want to play with Conservation Units, well, let's see, but don't talk about stopping the soybeans!" Information provided by Donald Sawyer, Instituto Sociedade, População e Natureza (ISPN), Brasília, 27.6.2003.

[54] Ministério do Meio Ambiente: Causas e dinâmica do desmatamento na Amazônia. Brasília, 2001, p. 142.

[55] E. Johnson: The Taming of the Amazon. In: Estudos Avançados, Vol. 16, No. 45, May/August 2002, Vol. 16, No. 46, August/December 2002, São Paulo.

[56] Axnews, online publication of international informations from Alternex, http://axnews.alternex.com.br/archives/00002927.htm: "Desmatamento na Amazônia atinge 25,500 km² em 2002", 26.6.2003.

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[58] A Gazeta, Cuiabá, 22.6.2003, p. 2-4.

[59] Ibid.

[60] www.netlignews.com/pgdetalhes.asp?ID_Categoria=2555 , Portal Amazônia, 7.7.2003.

[61] IBAMA Mato Grosso: Relatório de fiscalização, Cuiabá, 24.5.2003.

[62] Churches' Land Commission (CPT), Cuiabá, 23.6.2003.

[63] A Gazeta, Santarém, 3.-9.5.1998: GDA denúncia ampliação dos Cais do Porto. Diverse denunciations made by Grupo de Defesa da Amazônia (GDA), Diocese de Santarém, Pastorais Sociais, Comissão Pastoral da Terra, Projeto Várzea, Colônia de Pesquadores Z-20, Associação de Docentes da Universidade Federal do Pará and others.
[64] A Gazeta, Cuiabá, 22.6.2003, p. 2-4.
[65] I. Scholz u.a., Deutsches Institut für Entwicklungspolitik: Handlungsspielräume zivilgesellschaftlicher Gruppen und Chancen für kooperative Umweltpolitik in Amazonien. Darstellung anhand des Staudamms von Belo Monte und der Bundesstraße BR-163. Bonn, 2003.
[66] A Fundação Estadual do Meio Ambiente (FEMA) aplicou uma multa exemplar de aproximadamente R$18 milhões ao proprietário da Fazenda Santa Bárbara, Humberto Simioni Junior, pelo desmate ilegal de 3.196 hectares da Área de Preservação Ambiental (APA) Cabeceiras do Rio Cuiabá, na cidade de Nobres. ... No local haviam dois barracos de lona e vários maquinários como tratores, grades e pá carregadeiras e até uma enorme corrente, usada para desmatamento predatório em áreas de Cerrado e floresta. www.viagemaventura.com.br/news.php?action=newsview&recid=5016; www.icv.org.br/icvnoticias/one_news.asp?IDNews=1771.
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[68] Interview with Ozair Fabris, Superintendent Director of the Hermasa Navigation Amazonia S/A, Itacoatiara, 4.4.2003.
[69] O. Guimarães: Retomada de expansão no Cerrado. Grupo Maggi volta a ampliar lavouras na Chapada dos Parecis e prepara avanço no leste do Mato Grosso. In: Globo Rural, 1/2003, p.44-45.
[70] www.grupomaggi.com.br/br/eximp/numeros.htm. And: Grupo André Maggi: Business Profile. Rondonôpolis, without year (~ 2000).
[71] L. Rother: Relentless Foe of the Amazon Jungle: Soybeans. In: New York Times, 17.9. 2003.
[72] M. Fátima Coelho, Federal University of Mato Grosso, quoted in: Transgênicos rondam Mato Grosso, 24.2.2003: www.estacaovida.org.br/one_news.asp?IDNews=85.
[73] There is substantial evidence of human poisonings from the use of glyphosate (1999 Pesticide Action Network Asia & the Pacific, www.poptel.org.uk/panap/pest/pe-gly.htm).
[74] Movimento pela preservação dos ríos Tocantins e Araguaia, regional do Bico do Papagaio: Jornal do Tocantins. Projeto Sampaio. Tocantins, may 2002. The World Health Organization (WHO) estimates that for every notified case of intoxication, there are further 50 non-reported cases. According to the National System for Toxico-Pharmaceutical Informations (SINITOX), 72.786 cases of intoxications by pesticides were registered in 2000, which would correspond to a figure of even 3.639.300 cases in this year. In: National Health Foundation (FUNASA), www.funasa.gov.br/pub/GVE/GVE0515A.htm, www.fiocruz.br/cict/informacao/intoxicacoeshumanas/indexintoxicacoeshumanas.html.
[75] Environmental Agency (IBAMA) and National Institute for Processing Empty Packages (INPEV): Distribuição porcentual de embalagens por estado, 2001. Brasília, 2002.
[76] Bickel, U.: personal observation, 2003.
[77] Urgewald, Rettet den Regenwald, Greenpeace Germany.
[78] Washington, DC, October 29, 2002 — The International Finance Corporation (IFC), the private sector development arm of the World Bank Group, provided a 30 million US-$ loan for Amaggi Exportaçao e Importaçao Limitada, a soybean merchandiser, crusher and exporter in Brazil. The IFC loan will help Amaggi finance its growing permanent working capital needs which consist of advances to farmers and inventories of soybeans and their by-products... http://ifcln1.ifc.org/IFCExt/Pressroom/IFCPressRoom.nsf/0/03FFDA56CF3E002685256C6100577457?OpenDocument.
[79] Telephone interview with IFC Brazil Country Manager Wolfgang Bertelsmeier, São Paulo, 23.7.2003.
[80] The following quotations illustrathe the Bank's strategy in the past. Stephen Kennedy, Virginia Polytechnic and State University: „The World Bank also directed Brazil, in an effort to increase positive income flow, to increase exports. Hence vast stretches of fragile rain forest are cleared in order to increase production of agricultural exports; predominately soybeans. Rural indigenous peoples are pushed from their land either into urban areas where problems continue to worsen, or further into the forest where the need for subsistence living further degrades virgin areas. The tragedy in this soybean farming example is that the vast majority of soybeans are produced for cattle feed that reaches and aids developed countries. This lack of national subsistence continually backfires hurting the masses of impoverished urban dwellers and the pristine Amazon Rain Forest." In: www.majbill.vt.edu/students/geog3104/group4/Brazil.htm.
In March 1994, still, the World Bank approved a loan for road improvement, paving and rehabilitation in the North Brazilian savannahs, which will probably contribute massively to the expansion of soybean production,

causing land conflicts with traditional slash-and-burn farmers, polluting drinking water and destroying up to one million hectares of savannahs. nativenet.uthscsa.edu/archive/nl/9408/0122.html.
In the 1980s, the World Bank had sponsored several devastating road and agricultural projects like the Polonoroeste project which opened up the virgin rainforests of Rondônia to more than a million landless peasants.
www.mongabay.com/20brazil.htm.

[81] Grupo Andre Maggi: Grupo André Maggi acaba de ingressar US$ 30 milhoes referente a uma operação sindicalizada no exterior, liderada pelo banco alemão WestLB. www.grupomaggi.com.br/br/news.asp?idnews=9.

[82] Programa Piloto para a Proteção das Florestas Tropicais do Brasil (PPG7), Grupo de Assessoria Internacional (IAG): Relatório da XIX Reunião: „*O PPA 2004-2007 na Amazônia: novas tendências e investimentos em infraestrutura*“. Brasília, setember 2003. www.worldbank.org/rfpp/iag/iag19p.pdf.

[83] D. Nepstad, Instituto de Pesquisa Ambiental da Amazônia (IPAM); J. P. Capobianco, Instituto Socio-Ambiental (ISA) et al.: Roads in the Rainforest: Environmental Costs for the Amazon. Belém, 2002, p. 9.

[84] L. Rother: Relentless Foe of the Amazon Jungle: Soybeans. In: New York Times, 17.9. 2003.

[85] WORLD BANK ANNOUNCES SUPPORT FOR MORE SUSTAINABLE AMAZON, world bank web site; http://lnweb18.worldbank.org/external/lac/lac.nsf/0/1514180bc0676cc185256da2007a4070?OpenDocument; 15 September 2003.

[86] Ibid.

[87] R. Carvalho: A Amazônia rumo ao “Ciclo da soja”. In: Amazônia Papers No. 2, Amigos da Terra, São Paulo, setembro 1999.

[88] A Gazeta, Santarém, 3.-9.5.1998: GDA denúncia ampliação dos Cais do Porto. Diverse denunciations made by Grupo de Defesa da Amazônia (GDA), Diocese de Santarém, Pastorais Sociais, Comissão Pastoral da Terra, Projeto Várzea, Colônia de Pesquadores Z-20, Associação de Docentes da Universidade Federal do Pará and others.

[89] ILO-Report “I Jornada sobre trabalho escravo”. Brasília, nov. 2002, www.ilo.org/public/portugue/region/ampro/brasilia/trabalho_forcado/brasil/documentos/jornada_debates_trabesc.pdf, and CPT yearly report 2002, Goiânia, 2003.

[90] Interview with two rural workers from north-eastern Brazil, taking refuge in the Churches’ Land Commission (CPT) in Cuiabá/ Mato Grosso, 23.6.2003. For security reasons, their names must not be quoted.

[91] E. Almeida: Latifúndios dominam 82 % das terras em MT e êxodo rural continua. In: 24 Horas News, 14.9.2003. www.amazonia.org.br/noticias/print.cfm?id=82282. Figures from the agrarian census by the National Statistics Institute (IBGE).

[92] José Orlando Muraro-Silva, Defensor Público do Estado de Mato Grosso: Governo Lula: terras da União e reforma agrária. Cuiabá, março de 203.

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[94] Interview with MST Mato Grosso, Cuiabá, 23.6.2003.

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4. Humaitá/ Amazonas

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[97] A crítica, 11.3.1997, p. A-12:„Humaitá disputa mercado nacional“.

[98] N. J. de Castro, H. P. de Moura Filho: Um novo ciclo para a agricultura. Em: Gazeta Mercantil, 14.12.2001. www.nuca.ie.ufrj.br/infosucro/biblioteca/agricultura/artigo9.html.

[99] Soybean fields close to the port of Itacoatiara win 39 percent of transportation costs in relation to the farms in the Sapezal region (Mato Grosso). See: Gazeta Mercantil, 10.12.2001:"A soja brota no Amazonas", in: Transportes Agora, www.transportes.gov.br/ascom/transporteAgora/Detalhe.asp?Origem=8327.

[100] www.udop.com.br/diversas/materias/div_01_09_02.htm.

[101] See www.bdt.fat.org.br/workshop/Cerrado/br/; www.mma.gov.br/img/sbf/chm/areace.jpg.

[102] University of Brasília, august 2003:„A região de Humaitá - AM também está sobre intensa pressão de desmatamento para o plantio de soja“. www.unb.br/ib/zoo/grcolli/alunos/daniel/resultados.html.

[103] Adilson Vieira, coordinator of CPT Amazonas, Manaus, 20.2.2003; representatives of the Tenharim indigenous tribe, interviewed in Humaitá, 1.4.2003.

[104] Anselmo de Jesús Abreu, president of the federation of rural workers of Rondônia (Fetagro), quoted in: Correio Braziliense, 27.2.2001, http://www2.correioweb.com.br/cw/2001-02-27/mat_28859.htm.
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[106] F. G. Costa, J. V. Caixeta-Filho, E. Arima (2000): Influência do transporte no uso da terra: o caso da logística de movimentação de grãos e insumos na Amazônia Legal. http://sifreca.esalq.usp.br/artigos/ART6.4.17.pdf; F. G. Costa: Avaliação do potencial de expansão da soja na Amazônia Legal: Uma aplicação do modelo de von Thünen. Tese de Dissertação, São Paulo, 2000.
[107] Gilnei Viana, Secretary for Sustainable Development in the Federal Ministry for Environment, quoted in: Diario O Estado de São Paulo, 4.7.2003: Brasil: Novo perigo na Amazônia: Plantio de soja. www32.brinkster.com/grrlaplata/Julio2003/Peligro-soja.html.
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[117] Marcosa News, without date: „Transamazônica será recuperada à altura de Humaitá... Cerca de Rs. 300,000 estão liberados para a etapa inicial o dinheiro será repassado em caráter emergencial pelo Governo do Amazonas...“ In: www.intelligentsia.com.br/pages/topicos.asp?tipo=70.
[118] IAG-report 2003, see above.
[119] Correio Braziliense, 27.2.2001, www2.correioweb.com.br/cw/2001-02-27/mat_28859.htm; Gazeta Mercantil, 10.12.2001:"A soja brota no Amazonas", in: Transportes Agora, www.transportes.gov.br/ascom/transporteAgora/Detalhe.asp?Origem=8327.
[120] http://www.agricultura.gov.br/spa/spa_pap_2002_2003.htm.
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[122] Sebastião Roque, coordinator of the Institute for Agrarian Development of the Amazonas (IDAM) in Humaitá, quoted in: Gazeta Mercantil, 10.12.2001, p. B-14.
[123] Nilo d'Avila, Greenpeace Manaus, interviewed 28.3.2003; Dr. Dietrich Burger, GTZ, information provided in march 2003.
[124] Luis Castro Andrade Neto, State Secretary for Agricultural Production, Fishing and Integrated Rural Development, interviewed in Manaus, 26.3.2003.
[125] Gazeta Mercantil, 10.12.2001:"A soja brota no Amazonas", in: Transportes Agora, www.transportes.gov.br/ascom/transporteAgora/Detalhe.asp?Origem=8327.
[126] Gazeta Mercantil, 10.12.2001:"A soja brota no Amazonas", in: Transportes Agora, www.transportes.gov.br/ascom/transporteAgora/Detalhe.asp?Origem=8327.
[127] Interview with Lázaro Monteiro Reis, Secretário de Agricultura e Terras de Itacoatiara, and Technician of the Institute for Agrarian Development of the Amazonas (IDAM), Itacoatiara, 4.4.2003.
[128] Observations at the occasion of field visits and discussions with IDAM in Humaitá and Itacoatiara, april 2003.
[129] Interview with Antônio Peixoto, town counsellor of the Workers' Party (PT) in Itacoatiara, 3.4.2003.