Working Paper

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World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

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## Abstract

While biodiesel production in Brazil has relied heavily on soybeans, recent initiatives and policies for the Amazon have focused on palm oil, touting it as a promising new crop for increasing Brazil's energy independence, recovering degraded lands, avoiding GHG emissions and creating jobs. Based on literature review of agroenergy policy in the Amazon, interviews with policy officials and participation in two national conferences on biofuels, we examine the extent to which these initiatives are considered sustainable with regard to social and environmental impacts. Recent scientific studies are questioning the social and environmental sustainability of the oil palm production model currently being adopted in the Amazon. We conclude that biodiesel industry and the federal and state governments are taking into account these studies – but that palm oil developments will need improved policy and monitoring.

## CONTENTS

## The explosion of biodiesel in Brazil and in the Amazon

> "As one heads up to Mato Grosso, Acre or Alto Juruá, or to the far reaches of Maú, how wondrous the means of spreading life or of making it useful and perhaps shining." (Euclides da Cunha, 1904, in Brandão, 1996)
>
> "All of Brazil is casting its gaze towards the North with a patriotic desire to help bolster its development boom". (Getúlio Vargas, in the Rio Amazonas Speech, October 10th, 1940 in Belém)

Biodiesel is a fuel produced from vegetable oils or animal fat. Dozens of plant species present in Brazil have been researched and used for producing biodiesel, amongst which one might underscore soybeans (*Glycine max*), oil palm (*Elaeis guineensis*), sunflower (*Helianthus annuus*), babassu nut (*Attalea speciosa*), peanuts (*Arachis hipogaea*), castor beans (*Ricinus communis*), jatropha (*Jatropha curcas*), and brazil nuts (*Bertholletia excelsa*), in addition to bovine tallow and used cooking oil. The development of biodiesel in Brazil gained strides as of 2005, when a host of research and development plans and biodiesel production projects sprang up in several Brazilian states. Spearheaded by researchers, investors, new biodiesel plants and several government agencies, some of these initiatives were located within the "Legal Amazon" [1], as outlined below:

1. The Agropalma group inaugurated its palm oil-based biodiesel plant in the state of Pará and began seizing the opportunities provided by the "Social Fuel Stamp" [*Selo Combustível Social*];
2. The Amazonas State Science and Technology Secretariat (SECT) organized the first seminar on biodiesel and sustainability: "1st State Seminar on Renewable Energy: Biodiesel and Sustainability"[2] to discuss the Amazonas Biodiesel Plan, a strategic policy geared towards adopting alternative energy sources based on social inclusion and regional development;
3. Eletronorte and the Acre State Technology Foundation (FUNTAC) began negotiations to set up a biodiesel center of excellence at the Federal University of Acre based on the Acre State Biodiesel Plan;
4. In Amapá State, the Federal Government spent R$ 391,000 in research projects: R$ 80,000 for research fellowships, with a R$ 50,000 state counterpart funding to research oilseeds such as andiroba (*Carapa guianensis*), piquiá (*Caryocar villosum*) and pracaxi (*Pentaclethra macroloba*) to produce biodiesel for use in small communities, with the aim of taking electrical energy to 6,500 families living on rural settlements[3];
5. The Federal University of Mato Grosso (UFMT) held the Seminar Biodiesel BR 2005 to discuss the role of the state and of the soy-based biodiesel industry in implementing the National Biodiesel Production and Use Plan – PNPB, set up by the then Minister of Mines and Energy, Dilma Roussef;
6. The Rondônia State Federation of Agricultural Workers – FETAGRO, in partnership

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[1] The Legal Amazon is a federal planning region created in 1966 by the Brazilian government. It comprises the states of Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, Tocantins, and the portion of Maranhão state west of 44° W.
[2] http://www.sect.am.gov.br/noticia.php?xcod=1543
[3] http://www.sefaz.mt.gov.br/portal/index.php?action=noti&codg_Noticia=1243

with the Secretariat of Agrarian Reordering at the Ministry of Agrarian Development (SRA/MDA) held the Seminar on "Rural Credit and Biodiesel" aimed at discussing the Biodiesel Program and family farming production, technological conversion and marketing of farm products[4].

At first sight, this cornucopia of projects and plans aimed at developing biodiesel in the legal Amazon might seem like a cacophony of unrelated initiatives. A more in-depth analysis, however, shows that these actions actually followed in the wake of policies orchestrated by the Federal Government since 2003, when Luiz Inácio Lula da Silva began his first term as President of Brazil. At the very outset of his presidency, Mr. Lula set up an Interministerial Working Group (GTI) to lay out the top priorities for developing biodiesel (COPPEAD 2007).

Envisioning promising prospects for the future of biodiesel with regard to energy and environmental issues, agribusiness and social inclusion, the GTI reached out to different sectors in an effort to promote regional and local biodiesel development policies. The National Biodiesel Production and Use Program (PNPB), approved in 2004, "organized the chain of production, defined funding mechanisms, supported the technological base, and set up the regulatory framework for this new fuel" (Roussef 2004; Portal do Biodiesel 2006)[5].

The regulatory framework was presented in the first half of 2005, when President Lula sanctioned the Biodiesel Law [*Lei do Biodiesel*], which introduced biodiesel into the energy mix, created a specific permit for biodiesel producers and importers, and set up the biodiesel social certification process known as the Social Fuel Stamp [*Selo de Combustível Social*], amongst other policies such as providing fiscal incentives for biodiesel sales. At the launching ceremony, President Lula turned to the photographers and, advising them to keep those photos in a safe place, said, "You don't realize what biodiesel will mean to Brazil and to the world, as it is bound to largely replace petroleum".[6]

This vision of a promising future for biodiesel as a potential commodity along the lines of ethanol was part and parcel of the Brazilian agroenergy policies drafted from 2003 onwards. While biodiesel was being seen as a new fuel to be blended with diesel, in the Legal Amazon (which encompasses the Amazon biome and Cerrado areas), these agroenergy policies also gave rise to controversy, especially in light of the potential social-environmental impacts of producing oilseeds in the Amazon and Cerrado biomes.

Some studies pointed to the expansion of soybeans in the Cerrado and Amazon biomes as a cause of deforestation in this region (Bushbacher 2000; Greenpeace 2006a, 2006b). Meanwhile, the spread of palm oil monocultures in the region, which was likened to the Indonesian experience (Friends of the Earth 2005), began to raise eyebrows both in Brazil and abroad among social movements focusing on family farming, human rights groups, and environmentalists, who rallied against the spread of agrodiesel monocultures.

The controversy over soybeans was raised by international environmental groups (WWF 2006; Greenpeace 2006a, 2006b, 2009), who drew a link between deforestation and soybean cultivation in the Amazon, where production had increased substantially, as seen in Figure 1. This pressure had an impact on the soy industry as the ABIOVE (Brazilian Oilseed Processors Association) and ANEC (National Association of Grain Exporters), and their respective members, "committed to not selling soybeans produced in the Amazon Biome in areas deforested after July 24, 2006" (Soy Moratorium 2007). This commitment was signed as part of the Soy Moratorium and stood as a major achievement for environmental groups such as WWF and Greenpeace.

4 http://www.creditofundiario.org.br/comunicacao/one-entry?entry_id=70499
5 http://www.biodiesel.gov.br/
6 Agência CT on 05/19/2005

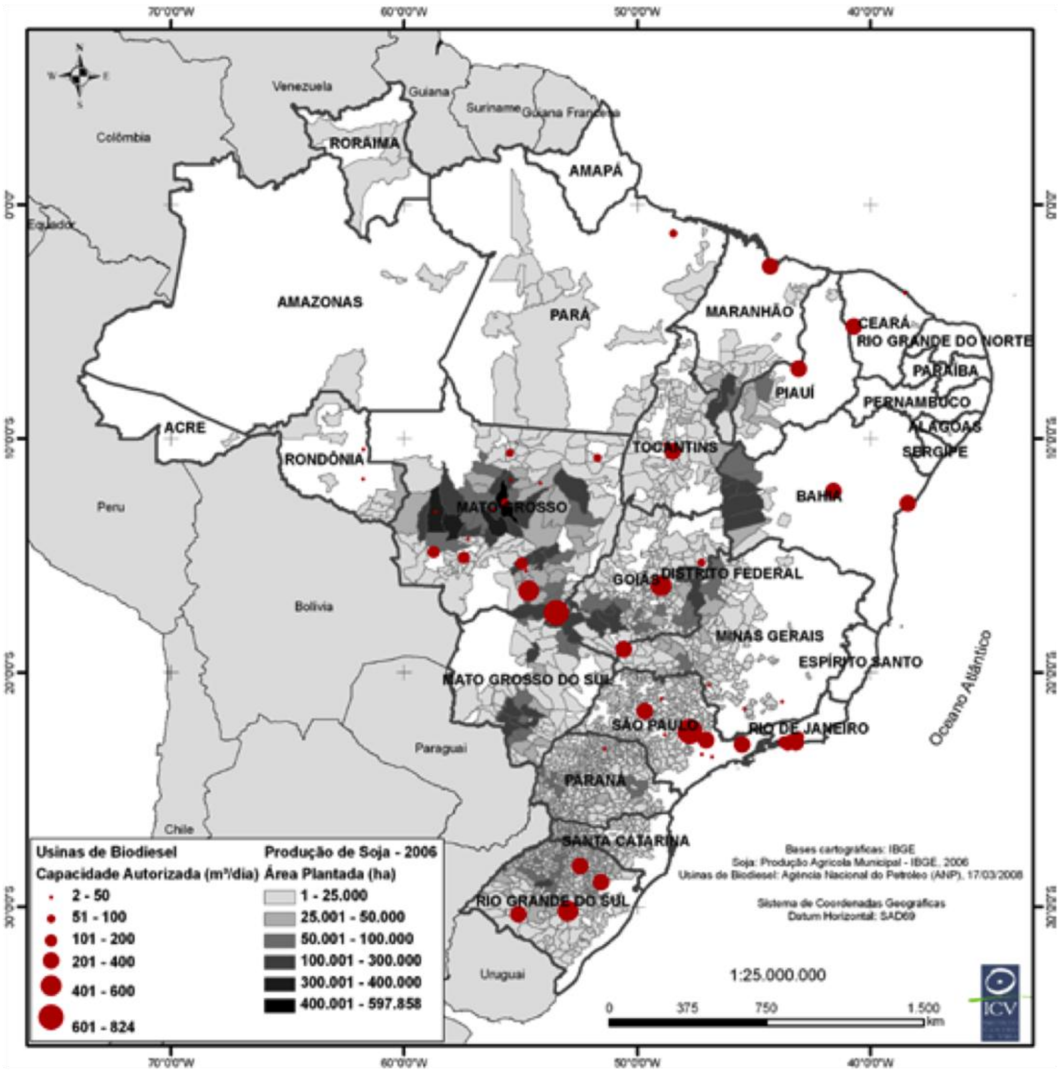


**Figure 1.** Soybean and biodiesel plants in Brazil 2006. Agricultural data: IBGE 2006, Biodiesel plants data: ANP 2006. (Source: Repórter Brasil 2008)

Despite the Moratorium, however, the controversy surrounding the production of biodiesel and other biofuels persisted in 2008. In November, two events held simultaneously in São Paulo underscored the varying perspectives about the sustainability of biofuels production (Andrade and Miccolis 2009). The "First International Conference on Biofuels" was a major event organized by the *Casa Civil* (a ministry analogous to the President's Chief of Staff) and by the Ministry of Development, Industry and Trade. The participants included the highest echelons of government (including President Lula and the Minister of the *Casa Civil*, Dilma Roussef), the national and international scientific community working on biofuels, as well as representatives of civil society and non-governmental organizations, who discussed the state of the art and sustainability of the biofuels industry in Brazil and throughout the world.

Meanwhile, at another event also held in São Paulo, a forum comprised of environmental NGOs and human rights groups was questioning the socio-environmental sustainability of expanding biofuels which, according to their claims, will undermine food production, transform landscapes and, consequentially, threaten the livelihoods of traditional populations and family farmers. The "International Seminar on biofuels as an obstacle to building food and energy sovereignty" drew together 33 social and environmental NGOs from 14 countries, who discussed the "myths about

the sustainability" of agrofuel production, especially ethanol and biodiesel.

One of the Seminar organizers, the NGO Repórter Brasil, coordinates the Agrofuels Monitoring Center (CMA), which has been watching the evolution of agrofuels in Brazil with regard to socio-environmental impacts and human rights issues. In 2008, it published a five-volume report entitled "*O Brasil dos agrocombustíveis*" [The Brazil of Agrofuels], described in detail in Part II of this paper. Other key institutions included Friends of the Earth; Instituto Ethos, and the Pastoral Land Commission (CPT). The forum of organizations drafted a Manifesto questioning the sustainability of agrofuels based on several issues, including: 1) increased deforestation in the Cerrado and Amazon; 2) its effects on food prices and supplies; 3) its tendency to increase land concentration, which entails less land for subsistence farming and less access to natural resources by smallholders; and 4) infringements of labor laws and human rights abuses.

In order to shed light on the debate surrounding biodiesel in the Amazon, this paper first maps out the policies aimed at developing biodiesel in Brazil as a whole and particularly in the Amazon region. The intention here is not to conduct an in-depth analysis of economic and environmental policies dealing with biofuels, but rather to lay out the main pathways and trends in strategic policies drafted at the federal and state level and by the private sector. We then present differing perspectives on the obstacles and advantages of implementing biofuels policies in the Brazilian Amazon region, thus widening our understanding of the current situation and future scenarios.

This chapter is divided up into two main parts: the first describes the key agro-fuel-oriented energy policies in Brazil. Focusing on biodiesel, we first lay out the underlying energy and agrarian arguments for setting up and implementing the PNPB in Brazil. We then go on to discuss the technical and technological features of biodiesel production chains and describe the key stakeholders in the development of biodiesel policies and their implementation in the Amazon. In Part II, we map out the current crop-based production of biodiesel in the Amazon biome, focusing on soybeans and oil palm, and discuss the advantages and obstacles of these two feedstocks by analyzing their production chains from socio-environmental and economic standpoints. In our conclusions, we put forth perspectives and recommendations that should be taken into account in designing public policies geared towards biodiesel in the Amazon.

## Part 1 – The social fuel: biodiesel

On July 3rd, 2009, the president of the Brazilian Union of the Biodiesel Industry - UBRABIO, Sérgio Beltrão, was celebrating the advent of B4, which entails blending 4% of biodiesel into diesel at filling stations. During a breakfast meeting at the Brazilian Chamber of Deputies, he delivered a presentation about the many advantages of progressively blending more biodiesel into diesel, including: "more partnerships and stronger ties between biodiesel producers and family farmers; spurring economic activity, fighting the effects of the crisis; job creation in rural areas, in industry and in related services; positive impacts on the Trade Balance due to reduced diesel imports and more favorable prices for Brazilian vegetable oil exports." (interview with Beltrão 2009). How can we shed light on this range of social and economic factors associated with the growth of the biodiesel industry in Brazil?

As a first step, we map out the key players in the biodiesel sector as well as the main arguments and policies supporting production in Brazil and in the Amazon — which are grounded on notions of energy independence and territorial security, technological development, social and agrarian sustainability, and a solid regulatory framework. The main component of the framework is the National Biodiesel Production Program (PNPB), which establishes policies and guidelines pertaining to biodiesel production. This program is part of strategic actions spearheaded by the Ministry of Agriculture, Ranching, and Food Supply and the National Agricultural Research Corporation (MAPA and EMBRAPA 2006), whose mission is to "promote the sustainable

development and competitiveness of agribusiness for the benefit of Brazilian society". As part of the National Agroenergy Plan 2006-2011, the PNPB must abide by the Guidelines for Agronergy Policies (MAPA, MCT, MME, MDIC 2006). This strategic document divides agronergy into four different main pillars: (a) ethanol; (b) biodiesel; (c) cultivated energy forests; and (d) agroforestry waste products. The key guidelines pertaining to biodiesel are summarized in Box 1.

The key regulatory bodies dealing with biodiesel in Brazil are outlined below:

- CNPE – the National Energy Policy Council (*Conselho Nacional de Política Energética*), a body that advises the President and drafts energy-related policies;
- MME – the Ministry of Mines and Energy (*Ministério de Minas e Energia*), in charge of carrying out energy policies;
- ANP – the National Petroleum, Natural Gas and Biofuels Agency (*Agência Nacional do Petróleo, Gás e Biocombustíveis*), which regulates the biodiesel market and is also in charge of regulating, awarding concessions and overseeing economic activities related to petroleum, natural gas and biofuels; the ANP establishes standards regarding biodiesel specifications and the diesel-biodiesel blend, promoting adaptation to regulations, and conducts auctions to spur increases in the biodiesel supply.
- MDA – the Ministry for Agrarian Development (*Ministério de Desenvolvimento Agrário*) issues the Social Fuel Stamp and helps to organize family farming production chains;
- MAPA – the Ministry of Agriculture, Livestock and Food Supply oversees the agricultural climactic zoning process.

**Box 1: Agroenergy Policy Guidelines**

- **Inclusion of biodiesel into the energy mix**.
- **Community-level energy autonomy**. Providing isolated communities, individual farmers (through cooperatives or associations), or agrarian reform settlements with the means to generate their own energy, especially in remote regions throughout the national territory.
- **Implementing the biodiesel production chain** nationally, focusing on efficiency and productivity and favoring less developed regions.
- **The expansion of biodiesel should not affect food production** for domestic consumption, especially staple foods. On the contrary, biodiesel co-products such as soy and sunflower seed meal, should supplement the supply of foodstuffs aimed at human and animal consumption.
- **Research and development of agricultural, livestock, and industrial technologies** should be tailored to biodiesel production chains, thus enabling greater competitiveness, adding value to products and reducing environmental impacts. These technologies should also contribute to social and economic inclusion and enable appropriate means for using biomass-based energy on a small scale.
- **Job creation and income generation**. The biodiesel policy should serve as a vector for promoting development and social inclusion in the country's hinterlands so as to reduce regional disparities and enable local populations to remain in the countryside, in particular by adding value to the production chain and integrating the various dimensions of agribusiness.
- **Leadership in the international biodiesel trade**, increasing exports while also generating tax revenues, thus solidifying this sector and promoting national development.
- **Biodiesel crop production systems must comply with sustainability standards** and discourage the unwarranted encroachment of the agricultural frontier onto sensitive or protected ecosystems, such as those found in the Amazon and Pantanal regions, among others. They should also contribute to recovering degraded lands and can be coupled with carbon sequestration.
- **Compliance with environmental policies**. Biodiesel programs must comply with Brazilian environmental policies and with the provisions laid out in the Clean Development Mechanism (CDM) under the Kyoto Protocol, thus increasing the use of renewable sources of energy, reducing greenhouse gas emissions and contributing towards mitigation through carbon sequestration.

While still fledgling, the political and ecological history of biodiesel in the Amazon is fraught with complexities. Biodiesel in the region emerges in a historical context where concepts surrounding sustainability intermingle with national and local notions of *sociobiodiversity* and socio-environmental responsibility. Here, one must underscore the role of the Amazon forest in the debate on climate change and the implementation of clean development mechanisms in light of energy and territorial security. As seen above, a myriad of players help to forge the political and ecological history of biodiesel in the Amazon: new science and technology networks comprised of researchers from various federal universities throughout Brazil; socio-environmental networks committed to defending human rights and environmental justice; rural workers' unions and cooperatives, technical assistance agencies working with family farmers involved in biodiesel production; the growing industry of large-scale producers and investors; national banks issuing rural credit, regulatory agencies such as ANP and various government institutions (ministries, secretariats, thematic chambers) dealing with biodiesel at a federal, state, and municipal level, as well as periodicals and publications such as the BiodieselBr portal.

To varying extents, these stakeholders contributed towards building four main thrusts of the PNPB policies aimed at introducing, expanding, and developing biodiesel in Brazil, especially in the Amazon, namely: energy and sustainability, agroenergy and social inclusion, the production chain and clean technological pathways, and the underlying mechanisms within the regulatory framework.

## 1.1. The sustainability of biodiesel for energy and isolated communities in the Amazon

The vast distances and logistical obstacles typical of the Amazon inevitably raise the price of mineral diesel, the main fuel used in river transportation and power generation in isolated communities. These factors in and of themselves generate a repressed demand for more sustainable alternative energy sources suited to the Amazon reality.

In order to promote energy sustainability, the PNPB set up a regulatory framework including a bidding system operated by the ANP, which promotes competitiveness, distribution and outflow of all biodiesel production in Brazil (Análise 2008). Meanwhile, the Biodiesel Law determines policies aimed at energy sustainability as well as the introduction of different percentages of biodiesel into petro-diesel from 2008 to 2013, with the ultimate goal of producing biodiesel in amounts equal to or greater than diesel imported by Brazil until 2013. The UBRABIO (Brazilian Biodiesel Union) forecasted a simple scenario of stepping up biodiesel production from B3 to B4, based on an annual consumption of diesel in the order of 45 billion liters/year:

> "Each 1% of biodiesel blended into diesel amounts to 450 million liters/year, thus the demand for B3 is equivalent to 1.35 billion liters/year, or 338 million liters/quarter; whereas the demand for B4 amounts to roughly 1.8 billion liters/year, or 450 million liters per quarter. Petrobrás is bound to increase, then, the amount it buys from industries by 112 million liters/quarter." (Beltrão 2009)

The historical trajectory of biodiesel as a potential substitute for petroleum-based diesel began during the 1970s oil crisis, when the Brazilian government set up two research programs: the PROÓLEO, which enabled blending *in natura* vegetable oils into diesel so as to increase their production at competitive prices; and "PRODIESEL and the Vegetable Oils Program – OVEG, both of which aimed to test different proportions of biodiesel in motor vehicles". (SANTOS 2008:131)

Thus, energy sustainability stands as one of the main arguments underpinning the PNPB. According to the ANP, "the production and use of biodiesel in Brazil will enable reducing diesel imports" (ANP 2009). The ANP's Annual Statistical Report shows that the use of biodiesel in

2008 replaced 1.1 billion liters of imported diesel, which meant annual savings of approximately US$ 976 million (ANP 2009). Furthermore, various studies have underscored the environmental advantages of using biodiesel, claiming it reduces greenhouse gas emissions by 78% and sulfur particles and compounds by 90% (Holanda 2004: 13; Coelho 2008; MAPA 2006). Indeed, several government documents have championed the introduction of biodiesel into the Brazilian energy mix since it reduces diesel imports and greenhouse gases, thus increasing Brazil's energy sustainability and independence (Holanda 2004; Nunes 2008; Análise Energia 2009; MAPA 2006).

In the case of the Legal Amazon, energy sustainability is intertwined with the issue of territorial vastness and isolation. The Legal Amazon encompasses more than 5.2 million $km^2$ (61% of Brazilian territory), of which 5.1 million $km^2$ are made up of land and 96 thousand $km^2$ of water. On the land, roughly 900 thousand $km^2$ are comprised of floodplains located mainly near large riverbanks. The watershed comprised of the Amazonas and Solimões rivers has about 13 thousand km of navigable waterways (with depths above 1 meter for 90% of the year). Indeed, as commonly stated in Brazil, the distances for transporting people and cargo are truly "Amazonian", which means traversing thousands of kilometers oftentimes solely by boat.

Manaus, for instance, the largest urban center in the region, may be considered an island since the only modes of cargo and passenger transport to the rest of Brazil are by boat or plane. The only land connection is the federal highway BR-174 to Roraima and Venezuela, which leads to Boa Vista (RR) and the Guyanas through highway BR-401. Thus, the main means of transportation is a fleet of nearly 100 vessels that navigate the vast waterways of the Amazon, which is comprised of two sub-systems: the Amazonas/Solimões and the Tocantins/Araguaia basins. River transport for passengers and cargo is provided by 61 large-sized diesel-powered vessels that service six main lines: Manaus - Belém; Manaus - Porto Velho; Manaus - Santarém; Belém - Macapá; Belém - Santarém; and Macapá – Santarém. (BNDES 1997)

River transport also enables distributing petroleum derivatives used by automobiles and aircrafts as well as generating electricity in the Amazon. Cargo is generally loaded in Belém, which receives petroleum derivatives via cabotage or at Renam, a Manaus refinery. One must also highlight the Manaus-Porto Velho route, which accounts for 80% of fuel transported throughout the region, since economic activities in the states of Acre and Rondonia are highly dependent on the fuel transported through this route. (BNDES 1997)

Due to these factors, the Amazon is home to the most isolated power generation systems on the planet, which rely heavily on diesel-powered generators or LNG thermoelectric plants. These Isolated Systems currently encompass roughly 1.4 million consumers throughout the states of Acre, Amazonas, Amapá, Rondônia, Roraima, and some municipalities in the states of Pará and Mato Grosso, in addition to three locations in the Northeast (Fernando de Noronha, Batavo and Camamu Island). The 273 isolated systems located in the Northern region, which is the main focus of this chapter, account for 96% of the overall nominal installed capacity within the non-interconnected areas. The extent of electrical exclusion is also very high in these areas (Santos 2008).

These power generation systems are predominantly thermal (81%) and rely heavily on petro-diesel and fuel oil. Figure 2 below shows the location of 1065 thermoelectric plants in the three biomes (Amazon, Cerrado and Caatinga) that exist in the Brazilian Northern region (Furtado 2008). These plants, which run on diesel and oil fuel and produce approximately 2822 MW of electricity, are located close to the banks of large rivers (Santos 2008:34). The use of renewable energy sources in the Amazon energy mix is still quite incipient, with the exception of the state of Pará, where the Tucuruí I e II hydroelectric plants produce 8,370 MW.

According to data from the state power utility (*Centrais Elétricas do Estado do Amazonas - CEAM*), in the state of Amazonas, for instance, in 2007 there were 115 diesel-powered electricity

generators, 13 of which supplied energy to the 1.5 million inhabitants of Manaus. That same year, the generators in Manaus consumed nearly 800 million liters of diesel and other petroleum derivatives to the tune of R$ 1.5 billion. In other locations throughout the state of Amazonas, the CEAM purchased roughly 250 million liters of diesel at a total cost of R$ 500 million. Due to the high degree of isolation and long distances, diesel shipments take up to 40 days to reach generators at certain locations. Hence, the various state governments in the Amazon region hope that decentralized production of biodiesel might bring about a strategic shift in this situation by enabling energy sustainability for many isolated municipalities (Salomon 2009).

Indeed, "The inclusion of Amazonas State in the PNPB means that we can strive for the dream of self-sustainable energy production in our state's 61 hinterland towns since, according to the state version of the Program, each town should produce enough power to supply its own needs." (announcement of 1st Seminar on Renewable Energy: Biodiesel 2005).

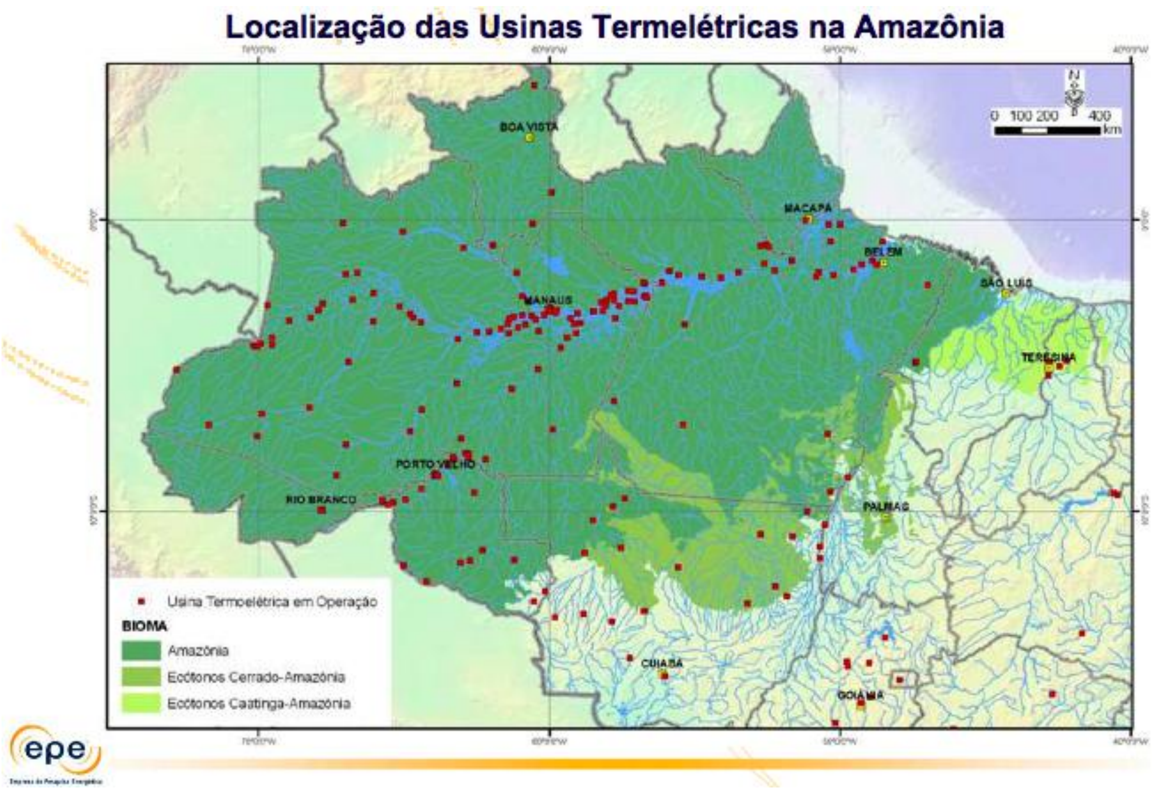


**Figure 2**. Location of thermoelectric plants in the Amazon region in 2008. (Source: EPE 2008)

As seen in Table 1, Amazonas is the third highest consumer of diesel in the Legal Amazon after the states of Mato Grosso and Pará.

**Table 1.** Sale of diesel by distributors per state in the Legal Amazon in 2007 (thousands of $m^3$). Source: ANP (2008)

| Amazônia Legal | |
|---|---|
| Rondônia | 631 |
| Acre | 124 |
| Amazonas | 703 |
| Roraima | 56 |
| Pará | 1481 |
| Amapá | 232 |
| Tocantins | 538 |
| Mato Grosso | 1663 |
| Total | **5429** |

In the states of Acre, Roraima and Pará, the number of communities isolated from the electrical grid is still high, even those close to the Tucuruí hydroelectric plant. This is why CELPA, the Pará state power utility, is also looking to decentralize biodiesel production to help meet the state's energy needs (Santos 2008).

## 1.2. Biodiesel as an instrument of social inclusion

The second main argument and set of policies aimed at producing biodiesel in Brazil, and more specifically in the Amazon, is the notion that the agroindustrial development of biodiesel is an avenue for the social inclusion of family farmers.

### 1.2.1. Biodiesel agribusiness policies and strengthening of family farming

The underlying strategies for government decision-making with regard to agriculture and agroenergy since the 1990s have been based on two central pillars: raising the competitiveness of corporate farming, on the one hand, and strengthening family farming, on the other. Policies aimed at developing the oilseed production market for biodiesel within the large-scale agribusiness sector, much along the lines of what was done with sugarcane-based ethanol, have been orchestrated by the Secretariat for Production and Agronergy within the Ministry of Agriculture, Livestock and Food Supply (MAPA), and by the Agency for Promoting Exports (APEX), which recommended the following measures:

- encouraging the territorial expansion of crops that provide raw materials for biodiesel plants through an agricultural-climactic and ecological-economic zoning of these oilseed plantations. The states of Acre and Roraima requested specific climactic zoning appraisals on planting several oilseed crops;
- attracting national and international companies and investors in agribusiness; and
- fostering the creation of centers of excellence and cutting-edge research on biodiesel production chains (see Section 1.3).

In 2006, the MAPA set up the Biodiesel Production Chain Sectoral Chamber, which takes part in the Agribusiness Council, where, among other measures, it puts forth "proposals aimed at improving agricultural and livestock activities, by expanding domestic and foreign markets, creating jobs, generating income and bringing about well-being".

Meanwhile, the Ministry of Agrarian Development (MDA) has implemented and organized biodiesel producers through the following actions: a) supporting family farming-based production centers; b) conducting the agricultural zoning in partnership with MAPA by 2010; c) producing seeds and seedlings; d) providing technical assistance in coordination with the Biodiesel Thematic Network, which drafts proposals for activities to be included within specific projects through agreements with Emater branches (rural extension and technical assistance agencies)/MDA; and e) tacking stock of oilseed crops in a partnership with the Federal University of Viçosa. The MDA has mapped out the demands for family farming and supported, both directly and indirectly, research aimed at developing solutions and new agroenergy-related prospects for family farming.

Thus, the Secretariat of Family Farming (SAF/MDA) set up the PRONAF-Biodiesel Program (*Programa Nacional de Agricultura Familiar no Biodiesel*, MDA 2006) as an instrument for including family farming within the biodiesel production chain. PRONAF's overarching strategy (MA 1996) is to build the capacity of family farming cooperatives and foster entrepreneurship among smallholders so as to create jobs and generate income in this sector. Ever since PRONAF-Biodiesel was implemented, family farmers already account for approximately 15% of all

feedstocks used for the Brazilian biodiesel industry.

The beneficiaries of PRONAF are producers and their organizations, provided they are classified as family farmers according to the following criteria: using family-based labor supplemented by temporary workers and a maximum of two full-time employees; possessing or farming a plot of land smaller than 4 "fiscal modules"[7]; residing on the rural property or in a nearby rural settlement or town; 80% of the income must stem from farm-based, fishing or extractive activities. Compliance with these requirements is verified by the unions, which classify family farmers who wish to take part in PRONAF.

In the Northeast, Southeast and South of Brazil, around 80 thousand family farmers are involved in cultivating oilseed crops, as compared to only 2.7 thousand in the North and Center-West region.

### 1.2.2 The Social Fuel Stamp

According to the SAF/MDA, the Social Fuel Stamp will be issued to biodiesel producers who purchase a minimum percentage of feedstock from family farmers, depending on the region: "30% in the Northeast, Southeast and South and 10% in the North and Central West up until the 2009/2010 harvest and 15% as of the 2010/2011 harvest" (SAF 2009). These biodiesel producers are obliged to sign contracts duly negotiated with the family farmers including: a pre-defined term, purchase prices and readjustment criteria, conditions for delivering feedstock, safeguards on both sides, identification of and agreement by a representative of the farmers in the negotiations and, lastly, clauses that ensure technical assistance and training for the family farmers.

Up until the beginning of 2009, the 30 companies that earned the Social Fuel Stamp accounted for over 90% of the volume purchased through the ANP bidding process. The public auctions for selling biodiesel set aside 80% of lots exclusively for producers who hold the Stamp, which is therefore deemed essential for ensuring sales. While these companies must in theory meet all of these requirements, as we shall see in Part 2 of this chapter, some studies show that they do not always do so.

The Stamp entitles producers throughout the country to lower rates on taxes such as PIS/PASEP and COFINS as well as more favorable financing conditions at the National Economic and Social Development Bank (BNDES) and its Accredited Financial Institutions, Banco da Amazônia S/A (BASA), Banco do Nordeste do Brasil (BNB), or Banco do Brasil S/A, among others.

### 1.2.3. Biodiesel Thematic Network

The MDA currently has 13 active networks: Agroecology, Agroindustry, Indigenous Technical Assistance and Rural Extension (ATER), Rural Women's ATER, Biodiesel, Marketing, Diversification of Family Farming Tobacco Cultivation, Financing and Protecting Production, Training ATER agents, Dairy, Differentiated Products and Markets, Participatory Methodologies and Tourism in Family Farming. Comprised of over 500 coordinators from the technical assistance and rural extension agencies throughout the country, these networks aim to achieve the goals set out by the SAF: overcoming rural poverty, promoting food security and sovereignty, rendering production systems more ecological, generating income and adding value.

According to the MDA, the goal of the Biodiesel Thematic Network[8] is to "coordinate and support the insertion of family farming into the biodiesel production chain and leverage Technical Assistance and Rural Extension (ATER) activities". The Biodiesel Thematic Network aims to widen access to public policies and support family farming-based oilseed crop production.

[7] A fiscal module is a unit for measuring land for tax purposes that varies in size depending on the municipality. In the Amazon, a fiscal module varies from 10 to 100 hectares but, on average, is equivalent to 76 hectares.

[8] http://www.territoriosdacidadania.gov.br/dotlrn/clubs/redestematicasdeater/biodiesel/one-community?page_num=0 (last accessed on 06/10/09)

According to the MDA, the network's main activities include: integrating actions carried out by ATER state agencies with biodiesel companies and family farmers in Biodiesel Hubs; support training, organization and activities undertaken by family farming cooperatives and associations involved in the biodiesel production chain, and exchange information and experiences between coordinators of state-level actions. Since the lack of land legalization and environmental sustainability are considered key bottlenecks for implementing agricultural production programs in the Amazon, a separate program aimed at land regularization will make it easier for family farmers to enroll in ATER and PRONAF programs.

## 1.3. The biodiesel production chain and technology base

The third argument and set of policies is based on research aimed at optimizing the biodiesel production chain economically through different technological pathways.

Several feedstocks hold a potential for producing biodiesel, including vegetable oils stemming from soybeans, oil palm, castor beans, sunflower seeds, jatropha, cottonseeds, other palm trees, Brazil nuts, waste oils (such as used cooking oil), and oils from animal fats, such as bovine fat. Table 2 outlines the main agricultural attributes of some of these raw materials. It is worth underscoring that oil palm has the highest yields in terms of kg/ha and l/ha, is a perennial crop and requires low technology in production processes. Together, these characteristics make it one of the most important crops in the biodiesel production chain in the Amazon, as we shall see in greater detail in Part 2 of this chapter.

**Table 2.** Characteristics of raw materials used in producing biodiesel in Brazil (Source: Souza 2009)

| Oilseed | Average oil content (%) | Yield (kg/ha) | Oil production (l/ha) | Cycle | Available technology |
|---|---|---|---|---|---|
| Soybean | 19 | 2.669 | 507 | 4 months | High |
| Cotton | 18 | 3.026 | 544 | 5 months | High |
| Castor bean | 45 | 740 | 333 | 6-8 months | Medium |
| Sunflower | 45 | 1.473 | 662 | 4 months | High |
| Peanut | 45 | 2.329 | 1.048 | 4 months | High |
| Oil palm | 20 | 13.328 | 2.665 | 20 years (perennial) | Low |

In order to map out the potential for producing each of these raw materials in different regions of Brazil, the MDA conducted studies on the logistics of the biodiesel production chain and agricultural zoning and climactic risk assessments for each species in certain states (MDA 2009). The next section summarizes studies on the biodiesel production chain and associated technological pathways.

### 1.3.1. The production chain and technological pathways

Some of the most thorough studies on the biodiesel production chain were conducted by COPPEAD/UFRJ in 2007. In the wake of the study on biodiesel organized by the Chamber of Deputies' Commission for High Studies (Holanda 2004), the COPPEAD drafted a landmark study for the PNPB/MAPA entitled "Strategic Planning for the National Biodiesel Production and Use Program (2007-2013)". This study presented scenarios for biodiesel production logistics in Brazil, per state and region, to meet the needs of biodiesel blended into diesel at the rate of 2% during this period. By collecting data on oilseeds (Table 3) such as cotton, oil palm, castor beans, peanuts, sunflower, and soybeans, as well as on bovine fat, the study drafted a series of strategic technical inputs and suggestions for the PNPB Strategic Plan - 2008 to 2013.

**Table 3**. Oilseeds and their uses

| Oilseeds | Key points in the chain | Oil use |
|---|---|---|
| Soybeans | grain, oil, meal sold to differentiated domestic and international markets | Input for producing pharmaceuticals, textiles, leather, rubber, food industry |
| Castor beans | oil has prices fixed by international market in Rotterdam. | Manufacturing lubricants, dyes, glue, varnish, nylon, prosthetics, plastics, and others |
| Sunflower | oil | Cooking and salad oil, margarine, vegetable oil for condiments, refined oil used for pharmaceuticals and cosmetics |
| Cotton | fiber (plume), secondary products, linter, meal, and oil | Fuel |
| Oil palm | oil | Cooking oil, soaps, detergents, foodstuffs, cosmetics, and pharmaceuticals |

Source: COPPEAD 2007. Extracted from the National Biodiesel Production and Use Program Strategic Planning – TECHNOLOGY BASE – ANNEX 3

In short, there are two main technological pathways in the biodiesel production process: transesterification (a chemical reaction between an ester and an alcohol) or thermal cracking (a process involving pyrolysis of vegetable oils). Transesterification is achieved through two different technological routes: the ethylic and methylic routes. The cost of processing biodiesel hinges primarily on the cost of the vegetable oil, of the alcohol, (ethyl or methyl) and of the catalyst (sodium hydroxide). The subproduct is distilled glycerin, which can be processed and sold.

The study assesses six production chains (Figure 3) with varying levels of value addition and verticalization of agricultural production, extraction processes, oil refining, and biodiesel production and distribution. The chains classified as C1, C2, C3 and C4 are crop-based, whereby C1 is a fully disaggregated chain and C4 is totally vertical. C5 and C6 represent biodiesel produced from bovine tallow.

For each region, the study ran different cost scenarios of blending 2% of biodiesel into petro-diesel using different feedstocks (cottonseed, oil palm, castor beans, peanuts, sunflower, soybeans, and beef tallow) and different technological routes for producing biodiesel (methylic vs ethylic transesterification) in each production chain (C1-C6). As seen in Figure 3, for each region certain oilseeds and classes of production chains perform better than others with regard to logistics and economics.

| INSUMO | Norte | Nordeste | Centro-Oeste | Sudeste | Sul |
|---|---|---|---|---|---|
| Algodão | | 0,424 a 1,159 C1 C2 C3 C4 | 0,461 a 1,116 C1 C2 C3 C4 | 0,887 a 1,342 C1 C2 C3 C4 | 0,439 a 1,107 C1 C2 C3 C4 |
| Palma | 0,937 a 2,375 C4 | | | | |
| Mamona | | 1,468 a 2,378 | | | |
| Amendoim | | | | 1,454 a 2,337 | |
| Girassol | | | 1,289 a 1,482 C4 C3 | | |
| Soja | 1,056 a 1,621 C4 | 0,914 a 1,451 C4 C3 | 0,888 a 1,420 C4 C3 | 0,859 a 1,395 C4 C3 | 0,852 a 1,390 C4 C3 |
| Sebo Bovino | 0,754 a 1,248 C5 C6 | 0,744 a 1,244 C5 C6 | | | |
| Óleo Diesel² | 1,350 a 1,361 | 1,296 a 1,321 | 1,392 a 1,396 | 1,363 a 1,368 | 1,320 a 1,387 |

Fonte: 1 – COPPEAD; 2 - ANP (2007)

**Figure 3.** Possible scenarios: inputs for the C1-C4 production chains and results of relative costs of oilseeds in all regions. From top to bottom: cottonseed, oil palm, castor beans, peanuts, sunflower, soy, beef tallow, diesel (Source: COPPEAD 2007)

This report suggests using soybeans in the C3 and C4 production chain (methylic route) for producing biodiesel throughout the country due to its lower production costs given the different blend scenarios. For the Northern Region, which encompasses the states of Pará, Tocantins, Amazonas, Acre, Amapá, Roraima and Rondônia, the study recommends using beef tallow (C5 and C6), soybeans and oil palm in verticalized production chains (C4, methylic route).

In 2009, two years after the COPPEAD projected these logistics scenarios, the ANP revealed that the distribution of feedstocks for producing biodiesel will rely heavily on soybeans throughout the country. In the North, soybeans account for over 95% of raw materials, whereas beef tallow, oil palm, and cotton make up a small portion.

According to an article published in the Folha de São Paulo on April 6th, 2009 (Salomon 2009), the MAPA plans to expand oil palm cultivation in the Amazon so as to increase its role in biodiesel production. Planned for 10 million hectares in the Amazon in areas considered degraded, an area equivalent to the size of Pernambuco State, this expansion faces two main obstacles: land tenure uncertainty for settlements and biodiesel production hubs; and the Brazilian forest code, which in principle prohibits cultivating exotic species in permanent preservation and legal reserve areas.

The National Congress is currently debating changes to the forest code that would allow cultivating oil palm in these environmental preservation areas and thus greatly strengthen its production chain, while also bringing about considerable socio-environmental impacts. A controversial bill of law drafted by Senator Flexa Ribeiro (PSDB-PA) in 2005 aims to enable this expansion by making sweeping changes in the forest code (Camargo 2009). In Part 2, we shall discuss the controversies and potential impacts of expanding oil palm in the Amazon which, as Senator Ribeiro put, is being touted as the "green gold"[9].

COPPE/UFRJ has shed light on the potential impacts of this expansion by supporting scientific research on this topic. Two MSc theses by Santos (2008) and Villela (2009), in particular, analyzed the advantages and disadvantages of expanding oil palm on degraded lands to produce electricity for isolated communities with regard to economic/energy sustainability and climate change (as part of the Clean Development Mechanism - CDM), respectively.

[9] http://www1.folha.uol.com.br/folha/ambiente/ult10007u546684.shtml

These studies point to promising prospects for producing energy through oil palm planted on degraded and previously deforested lands, in part because oil palm-based biodiesel planted under these conditions "bears a great potential for mitigating greenhouse gas emissions"[10]. Part 2 of this chapter analyzes the controversies surrounding the expansion of oil palm in the Amazon.

## 1.4. The regulatory framework and future expansion of the new fuel

The "Biodiesel Law" (num. 11.097), drafted by the National Energy Policy Council and published on January 13, 2005, introduced biodiesel into the Brazilian energy mix and widened the role of ANP, thenceforth called the National Petroleum, Natural Gas, and Biofuels Agency. Based on this law, ANP took on the role of regulating and overseeing activities related to biodiesel production, quality control, distribution, and sales, as well as the diesel-biodiesel blend (BX).

In January of 2008, the Biodiesel Law went into effect, thereby instituting the mandatory blend of 2% biodiesel into petrol-diesel sold in Brazilian filling stations. In July of the same year, this percentage rose to 3%. In a short period of time, then, this measure made Brazil one of the leading biodiesel producers in the world as its production jumped to 1.17 billion liters in 2008 (MAPA 2009). One indicator of the program's success, especially with regard to rising production, was the earlier than expected leap from 2% to 3% in 2008 and to the current 4% as of July 2009. The National Energy Policy Council (CNPE) took this measure based on the suggestions made by COPPEAD (2007) and on the current supply and demand within the national biodiesel production chain. Since 2008, 42 plants have been installed nationwide with a total production capacity of 3.6 billion liters per year (ANP 2009).

This rising demand for biodiesel led Souza (2009) to study the spread of oilseed plantations in Brazil. Table 4 presents the estimated impact of the Brazilian policy of blending 5% biodiesel into diesel on the territorial expansion of various oilseeds. This study's findings show that in terms of percentages, soybeans are bound to remain the dominant force in biodiesel production. Part 2 will examine how agricultural and supply policies regarding soybeans and oil palm are being planned for the Amazon.

**Table 4.** Estimated impacts of blending 5% biodiesel into the diesel consumed in Brazil with regard to the increase of cropland area for selected oilseeds (Souza 2009)

| Crop | Area (ha) | Increase (ha) | Percentage (%) |
|---|---|---|---|
| Soybeans | 18,534,300 | 3,408,885 | 18.39 |
| Sunflower | 43,200 | 3,097,981 | 7171.25 |
| Cotton | 739,200 | 4,437,500 | 600.31 |
| Castor Beans | 128,000 | 2,454,787 | 1917.8 |
| Oil palm | 45,000 | 307,667 | 683.7 |
| Sugar cane | 5.149,227 | 47,166 | 0.92 |

Source: CONAB, IBGE, Calculations from FAESP Economic Department, cited by Meireles (2003) and adapted by Souza (2009)

Besides its implications on agricultural supply policies, the expansion of biodiesel requires aligning policies across sectors, including tax/fiscal, agrarian/land tenure, rural credit, energy, science and technology, environmental, industrial, international trade, and foreign affairs policies. Recent shifts in policies pertaining to the biodiesel production chain have been achieved through specific laws and norms, as seen in Box 2.

[10] Villela 2009: 142

**Box 2: Main laws pertaining to the biodiesel production chain in Brazil**

**Law 11116 – 18 May 2005**
Pertains to Special Registration through the Federal Revenue Secretariat under the Ministry of Finance, for biodiesel producers or importers, and describes PIS/Pasep and Cofins taxes that must be paid on revenue stemming from the sale of this product; and amends Laws num. 10.451, of May 10$^{th}$, 2002, and 11.097, of January 13$^{th}$, 2005; among other measures.

**Law 11097 – 13 January 2005**
Pertains to the introduction of biodiesel into the Brazilian energy mix; and amends Laws num. 9.478, of August 6$^{th}$, 1997, 9.847, of October 26$^{th}$, 1999, and 10.636, of December 30$^{th}$, 2002; among other measures.

**Decree 6458 – 14 May 2008**
Widens the options of raw materials produced by family farmers in the North and Northeast and Semi-arid regions and changes PIS/CONFINS taxes for these regions.

**Decree 5457 – 06 June 2005**
Cuts rates for PIS/PASEP and COFINS taxes on biodiesel imports and sales.

**Decree 5448 – 20 May 2005**
Regulates paragraph 1, Art. 2 of Law num. 11.097, of January 13$^{th}$, 2005, which pertains to the introduction of biodiesel into the Brazilian energy mix, among other measures.

**Decree 5298 – 06 December 2004**
Changes the rate of the Tax on Industrialized Products in the case of biodiesel.

**Decree 5297 – 06 December 2004**
Pertains to coefficients for cutting PIS/PASEP and COFINS taxes on the production and sale of biodiesel, as well as to the terms and conditions for applying such lower tax rates, among other measures.

**Decree passed on 23 December 2003**
Institutes the Inter-ministerial Executive Commission in charge of implementing the actions aimed at the production and use of vegetable oils - biodiesel as alternative energy sources.

**Decree passed on 02 July 2003**
Institutes the Inter-ministerial Working Group in charge of presenting studies on the feasibility of using vegetable oils for biodiesel as alternative energy sources and, if needed, proposing actions required to use biodiesel.

**MME Ruling 483 – 03 October 2005**
Establishes guidelines for ANP to conduct public auctions for purchasing biodiesel.

**ANP Ruling 240 – 25 August 2003**
Establishes regulations for using solid, liquid, and gas fuels not specified in the country.

**ANP Resolution 07 - 18 March 2008**
Changes the specifications for selling biodiesel.

**CNPE Resolution 3 - 23 September 2005**
Reduces deadlines for meeting the minimum mandatory percentage of mixing biodiesel into diesel and determines the purchase of biodiesel produced by companies that hold the Social Fuel Stamp, through public auctions.

**ANP Resolution 42 – 24 November 2004**
Establishes specifications for marketing biodiesel that may be blended into diesel at 2% of volume.

**ANP Resolution 41 - 24 November 2004**
Institutes the regulation and mandatory authorization by ANP of biodiesel production activities.

**BNDES Resolution 1135 of 2004**
Subject: Program for Financial Support to Investments in Biodiesel within the Biodiesel Production and Use Program as an Alternative Energy Source.

**Normative Guideline of February 19th, 2009**
Establishes criteria and procedures regarding how the Social Fuel Stamp shall be issued, maintained and used.

# Part 2 – The Amazon and biodiesel: the rush for the "green petroleum"

> Two foreigners in Brazil last March got everyone talking about biofuels. U.S. president George Bush catalyzed the euphoria around Brazilian ethanol becoming a valuable product in times of global warming. Meanwhile, the executive director of the United Nations Environment Program (UNEP), Achim Steiner, expressed concerns that a boost in biofuels production might cause environmental degradation in the Amazon. Amid this enthusiasm and concern, advanced research in Brazil is working on processes to extract green energy from the largest tropical forest in the world.[11]

Part 2 of this chapter examines the controversies surrounding this "green petroleum" by addressing the implementation of biodiesel policies in the Amazon, especially in the soybean and palm production chains. First, we summarize the various initiatives and projects within the PNPB pertaining to the region and map out the existing biodiesel plants in the Amazon Biome. Then we discuss the potentials and bottlenecks for expanding the soybean and oil palm-based biodiesel production chains. In both cases, the lack of legal land tenure stands as a major obstacle and, in the case of soybeans, political and environmental initiatives such the Soybean Moratorium will tend to thwart the expansion of this oilseed in the Amazon biome. Our analysis goes on to show that oil palm gives rise to a series of potential socio-environmental and economic advantages and disadvantages. In our conclusions, we present lessons learned with regard to producing biodiesel from oil palm through case studies in Brazil and international guidelines.

## 2.1. The PNPB in the Amazon

In the Introduction, we show how the PNPB spurred the expansion of biodiesel by setting up a series of federal policy initiatives with clear implications on the Legal Amazon. Table 5 summarizes state-level players, types of oilseeds and main lines of action within the states of Acre, Amapá, Amazonas, Pará, Rondônia, and Roraima. Most notably, Embrapa (the Brazilian Agricultural Research Corporation under MAPA) has been spearheading cutting-edge research and implementing pilot projects with a special emphasis on oil palm, which comprises main lines of action in all states except for Amapá. One might classify these lines of action as: technological (biodiesel production processes), infrastructure (power generation for rural communities using biodiesel), markets (new biodiesel enterprises), agricultural (agricultural zoning, use of native species and plant breeding), and environmental (recovering degraded lands by planting native species and oil palm for agro-energy).

While the Soy Moratorium thwarts the expansion of this crop in intact areas of the Amazon, other oilseeds are drawing attention from policymakers, research institutes and the private sector. Among these plants, one might highlight species of palm trees such as oil palm (*Elaeis guineensis*), babassu (*Attalea speciosa*), macaúba (*Acrocomia aculeate*) and tucumã (*Astrocaryum aculeatum*), in addition to jatropha (*Jatropha curcas L*), which has also been in the spotlight lately despite fledgling production and genetic research initiatives. With the exception of oil palm, none of these palm trees are being cultivated on a wider scale, however, babassu and macaúba hold a vast potential for extraction from native forests (EMBRAPA 2007). Indeed, a flurry of state-level policy and research initiatives is currently studying these oilseeds, as seen in the table below.

[11] Faleiros, Gustavo. 2007. Amazônia Bioenergética. *O Eco* (16/03/07). Available at http://www.inpa.gov.br/noticias/noticia_sgno2.php?codigo=294

**Table 5.** Amazon biome state-level biodiesel programs and lines of action

| State Biodiesel Program | Line of Action | Key players | Oilseeds | Observations |
|---|---|---|---|---|
| **Acre** | • Agricultural Zoning<br>• R&D – Agro-energy Reference Center | UFAC<br>Banco da Amazônia<br>Eletronorte<br>Embrapa | Forest waste products, rubber, buriti, castor beans, palm oil | R$ 400 thousand - MCT |
| **Amapá** | • Electricity generation in rural communities<br>• R&D of native oilseeds | Embrapa<br>IEPA SECT, SEA, UFPA, Rurap, Senar | Andiroba, pracaxi, ucuuba, buriti, piquiá and inajá | |
| **Amazonas** | • R&D<br>• Biodiesel from oil palm<br>• Biodiesel from other oilseeds | SECT/AM<br>Embrapa<br>UFAM<br>IME | Oil palm, tucumã, urucuri, murumuru and babassu | • Ethylic biodiesel from oil palm<br>• Genetic improvement, efficiency of process, routes, and different catalysts |
| **Pará** | • Agricultural zoning<br>• Fostering enterprises<br>• R&D | Agropalma<br>UFPA<br>SAGRI<br>Embrapa | Oil palm | |
| **Rondônia** | • Adapting jatropha<br>• Transferring raw materials technology | Embrapa<br>UNIR<br>SEAPED<br>CNPq | Jatropha, peach palm, babassu, andiroba, buriti, inajá and tucumã, sunflower, soybeans and castor beans | R$380 thousand - MCT |
| **Roraima** | • Generating electricity in rural communities<br>• Refinery Technology | IME<br>Embrapa<br>ELETRONORTE | Inajá | • Recovering degraded lands<br>• Power generation plants |

Sources: (compiled by the authors from Santos 2008, Silva 2005, Cristina 2005, SECT/AM 2005, Tupinambá 2006, SECON/MT 2005, SRA 2005, França 2005, Azevedo et al. 2007)

## 2.2. Mapping biodiesel plants in the Amazon biome

Despite the many prospects for producing biodiesel within the vast expanses of land in the Amazon, which occupies 60% of Brazilian territory, there are still very few large-scale producers headquartered in the region. Most of these producers rely heavily on soybeans, although some use spent cooking oil, beef tallow, and palm oil, as seen in Table 6.

**Table 6.** Main characteristics of biodiesel plants in the Brazilian Biome

| State | Plant | City | Production capacity* | Overall production** | Raw material | Social Fuel Stamp | ANP- authorized | Plans for expansion | Status |
|---|---|---|---|---|---|---|---|---|---|
| Mato Grosso | Barralcool | Barra do Bugres | 58,80 | 33,10 | | Yes | Yes | No | Producing |
| | Agrosoja | Sorriso | 28.80 | 8.40 | | Yes | Yes | No | Producing |
| | Biopar Parecis | Nova Marilândia | 8.40 | 2.60 | Animal fat | Yes | Yes | | Producing |
| | Cooperfeliz | Feliz Natal | 2.40 | 0.70 | used cooking oil – crambe oil | No | Yes | Yes | Producing |
| | CLV Agrodiesel | Colider | 36.00 | 2.50 | Soy sunflower cotton and animal fat | Yes | Yes | | Producing |
| | Cooami | Sorriso | 3.60 | 0.25 | Animal fat | No | Yes | | Stopped |
| | Araguassu | Porto Alegre do Norte | 36.00 | 0.42 | | Yes | Yes | Yes | Producing |
| | Usibio | Sinop | 7.20 | 0.03 | | No | Yes | | Stopped |
| | Beira Rio Biodiesel | Terra Nova do Norte | 18.00 | 0.00 | Animal fat | No | No | Yes | In construction |
| | KGB | Sinop | 1.80 | 0.00 | | No | | | Stopped |
| Ron dônia | Amazonbio | Ji-Paraná | 16.20 | 0.08 | Jatropha animal fat | No | Yes | | Stopped |
| | Biodiesel da Amazonia | Porto Velho | 21.60 | 0.00 | Used cooking oil | No | No | Yes | In construction |
| | Ouro Verde | Rolim de Moura | 6.12 | 0.35 | Used cooking oil | No | Yes | No | Producing |
| Pará | Agropalma | Belém | 28.80 | 9.80 | Palm oil | Yes | Yes | No | Producing |
| | Nubras (ex-DVH) | Tailandia | 12.60 | 0.03 | Palm oil | No | Yes | Yes | Producing |

Source: adapted by the authors from data provided by BiodieselBr and ANP (2009), Análise de Energia (2009)

*amounts in millions of liters

** total produced by April of 2009

Based on data from the BiodieselBr Portal and ANP, Table 6 includes only registered biodiesel plants located in municipalities officially considered part of the Amazon biome, which excludes plants in the "Legal Amazon"[12]. Only 15 of the 110 plants installed or under construction in Brazil are located in the Amazon biome, including 10 in Mato Grosso, 3 in Rondônia, 2 in Pará and 1 in Acre. Our analysis of these plants points to significant trends and characteristics, as summarized below:

- *Volume produced vs. capacity*: the fact that the vast majority of plants in the biome are producing far below their total capacity suggests the incipient and highly idle nature of these plants;
- *Geographic distribution*: the majority of plants (10 out of 15, or 67%) are located in the north of Mato Grosso state, which has relatively well-developed production storage, and transport infrastructure;
- *Geographic distribution*: the lack of registered plants in the other states that comprise the Brazilian Amazon biome (Amazonas, Acre, Roraima, and Amapá[13]), confirms the fledgling status of biodiesel in these states;
- *Social Fuel Stamp*: among the 12 plants that are built, half already hold this certificate (see Stamp criteria in Section 1.2);
- *Production technology*: over half of plants (8) use their own production technology;
- *Technological pathways*: only one plant uses the ethylic route, whereas 6 used the methylic route and 5 plants use both;
- *Source of oil*: the oil extracted in half of all plants currently in production is not produced by the same company, which suggests the high rate of integration agreements with producers of raw materials;
- *Time in operation*: among the plants that reported when their operation began, the oldest experience is that of Agropalma, which began biodiesel production in April of 2005, followed by Barralcool, in January of 2006, and the remainder from 2007 to 2009.
- *Raw materials*: soybeans are the prevailing raw material; the only companies using palm oil as a raw material for producing biodiesel in the Amazon are located in Pará State; and five companies use animal fats.

This data confirms the prevalence of soy as a raw material in the biodiesel production chain within the Amazon region. Indeed, soybeans account for 95.35% of raw materials used in the Northern Region (ANP 2009), as compared to 70.8% nationwide, followed by beef tallow (24%). This prevalence of soy in biodiesel production is due largely to the availability of stratospheric volumes throughout the country, which surpassed 57 million tons in the 2008/2009 harvest (according to a survey by Conab in July of 2009). The "Soy Complex" also plays a pivotal role in the national economy, since it accounted for approximately 8% of exports in 2006 (Schlesinger 2008), thus generating important revenues and contributing to achieving a positive trade balance for the country.

In the following sections, we discuss the main obstacles and opportunities for producing biodiesel from soybean and palm oil, especially with regard to potential economic, environmental and social impacts.

## 2.3. Soy in the biodiesel production chain in the Amazon

The hegemony of soy in biodiesel production up until now can be attributed in large part to the highly developed links across the Soy Complex production chain (grain, meal, and oil), including

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12 Here, it is worth underscoring that the official ANP data and information provided by the Biodieselbr Portal map out biodiesel plants per geographic region (North, Northeast, Central-West, South, Southeast), and not by biomes, which means a certain overlap and confusion between data for the Legal Amazon and Biome.

13 The states of Maranhão and Tocantins also contain Amazon forests but to a smaller extent than these other states.

farming, storage, transport/distribution and processing infrastructure. This is evidently not the case for other potential raw materials in the Amazon such as oil palm, babassu and macaúba, palm trees for which agricultural and processing infrastructure still needs to be built throughout the region. As seen in Section 2.2, the geographic distribution of the 15 commercial plants in the Amazon is highly concentrated, since 10 are located in northern Mato Grosso state, where soy cultivation is quite developed as compared to other states in the region.

In the North and Central-West (where Mato Grosso is located), the soy production chain is comprised of vertical structures dominated by large agribusiness conglomerates such as ADM, Amaggi, Bunge and Cargill, who partner up with other large and medium-sized companies and farmers' cooperatives. While in Southern Brazil family farming has played a key role in soy farming, in the Amazon biome large companies hold a greater stake in the various links of the soy production chain. Here, one must underscore that infrastructure in the Amazon tends to be quite precarious, thus undermining the economic feasibility of soybeans as a source of biodiesel in the region. Moreover, the direct and indirect environmental impacts of building the necessary transport infrastructure are widely acknowledged, as roads are springboards for deforestation and disorderly land occupation in the Amazon.

In July of 2003, the Institute for Environmental Research in the Amazon – IPAM, published the findings of extensive research showing, among other conclusions, that:

> "The recent expansion of mechanized grain cultivation in the Amazon region is taking on a key role in deforestation dynamics...in Amazon forest areas, soy plantations have focused on pasturelands, which reduces the cost of implementing this monoculture. However, the use of pasturelands is displacing cattle to new areas of forest, which means an indirect stimulus for deforestation."

More recently, in 2006, Greenpeace published a report entitled "Eating up the Amazon" (Greenpeace 2006), which acknowledges the important measures taken by the Brazilian government to slow down deforestation in the Amazon, but also reveals the environmental and social risks associated with the expansion of soy cultivation in the region, including deforestation, land concentration, social conflicts and the contamination of soils and rivers.

### 2.3.1 The Soy Moratorium

Bowing to pressure from these and other studies, as well as to growing demands for a "greener" soy from consumer markets (especially in the E.U., U.S., and Japan), the soy industry and Brazilian government began stepping up efforts to quell these concerns. These efforts greatly influenced the current scenario and future prospects for producing soybeans in the Amazon context. First, the "Soy Moratorium", a voluntary agreement signed by the main business groups in the Soy Complex along with a set of national and international NGOs, prohibited companies from purchasing soybeans cultivated on lands deforested after July of 2006.

In order to make decisions regarding the implementation and monitoring of this initiative, the signatories to this pact set up the Soy Working Group, comprised of representatives from the business community: ABIOVE, ANEC, ADM, Amaggi, Bunge, Cargill, and from NGOs in the *Articulação Soja-Brasil*: Conservation International, Greenpeace, IPAM, The Nature Conservancy and WWF Brazil. Initially designed for a two-year period, the Moratorium was extended for an additional year to July of 2009 and, more recently, to July of 2010.

The Moratorium's most recent monitoring report[14], based mainly on aerial surveillance, analyzed 630 areas with over 100 hectares cleared after July of 2006 and in municipalities with at least 5 thousand hectares of soybean plantations, comprising a total of 46 municipalities and 157,898 ha. According to this survey, new deforestation was found on twelve polygons (ranging from 3.81 to

14 This monitoring was done by the agricultural monitoring company, which was commissioned by the Soy Working Group.

630.9 hectares per plot) within ten different properties, which added up to a total area of 1385 hectares of soybeans cultivated on recently deforested areas[15]. In relative terms, then, areas deforested recently for planting soybeans in the surveyed properties may be considered small (less than 1% of surveyed areas).

At a meeting to present the Moratorium's results in April of 2009, the main soy traders within the Brazilian Association of Vegetable Oil Industries (ABIOVE) and the National Association of Cereal Exporters (ANEC) vowed that "they would no longer purchase soy that caused deforestation in the Amazon. Moreover, farmers who do not comply with the Moratorium will not have access to credit."[16] At this same meeting, the Brazilian Minister of the Environment, Carlos Minc, announced federal support for implementing the Moratorium and pledged R$ 5 million from the PPG-7 (Pilot Program for the Protection of the Brazilian Rainforests) to conduct rural and environmental property registration, while also committing to conclude the Amazon's Ecological Economic process.

### 2.3.2 Access to rural credit depends on compliance with land tenure and environmental licensing requirements

A second important initiative pertaining to soy production in the Amazon was a Resolution passed by the Central Bank's National Monetary Council in early 2008[17], which prohibited public and private banks from issuing credit to landowners who were not in compliance with legal requirements regarding land tenure and environmental licensing. The Resolution made it mandatory for farmers to submit a Certificate of Rural Property Registration (CCIR) and other documents proving that the property complies with environmental regulations. This measure had wide-reaching implications for farmers throughout the Amazon who rely heavily on credit to finance their farming activities.

In short, these two initiatives greatly discouraged investments in new soybean plantations in regions covered by Amazon forests. Nonetheless, regardless of the controversy surrounding soybean plantations as a vector of deforestation in the region, this oilseed will undoubtedly continue to play a central role in biodiesel production (both in Brazil and in the Amazon), especially since it is the only feedstock currently capable of meeting the rising demand for biodiesel due to the mandatory blend of 4% biodiesel into diesel starting in the second half of 2009 (ANP 2009).

### 2.3.3 "Green Arc Legal Land Program" [*Arco Verde Terra Legal Amazônia*]

Throughout the last 50 years, the population in the Brazilian Amazon has grown twenty-fold thanks to intense waves of migration by settlers and squatters from various parts of the country. These migrants were attracted initially by ambitious government settlement policies during the 1970s aimed at boosting economic development in the region through farming, livestock, timber and mining activities. This wave of demographic growth brought with it rising land tenure irregularities and ensuing deforestation of the rainforest through uncontrolled land use practices (Arco Verde Terra Legal 2009), as seen in Figure 4 below, which shows the "arc of deforestation" in the Brazilian Amazon.

15 This report is available at: www.greenpeace.org.br/amazonia/pdf/boletimmoratoriaweb.pdf
16 Greenpeace 2009. Amazônia Viva. Greenpeace publication on the moratorium on selling soybeans cultivated on newly deforested lands in the Brazilian Amazon. Num. 5 May 2009.
17 Resolução do BACEN [Central Bank Resolution Num.] 3545, of February 29th, 2008. DOU 03.03.2008

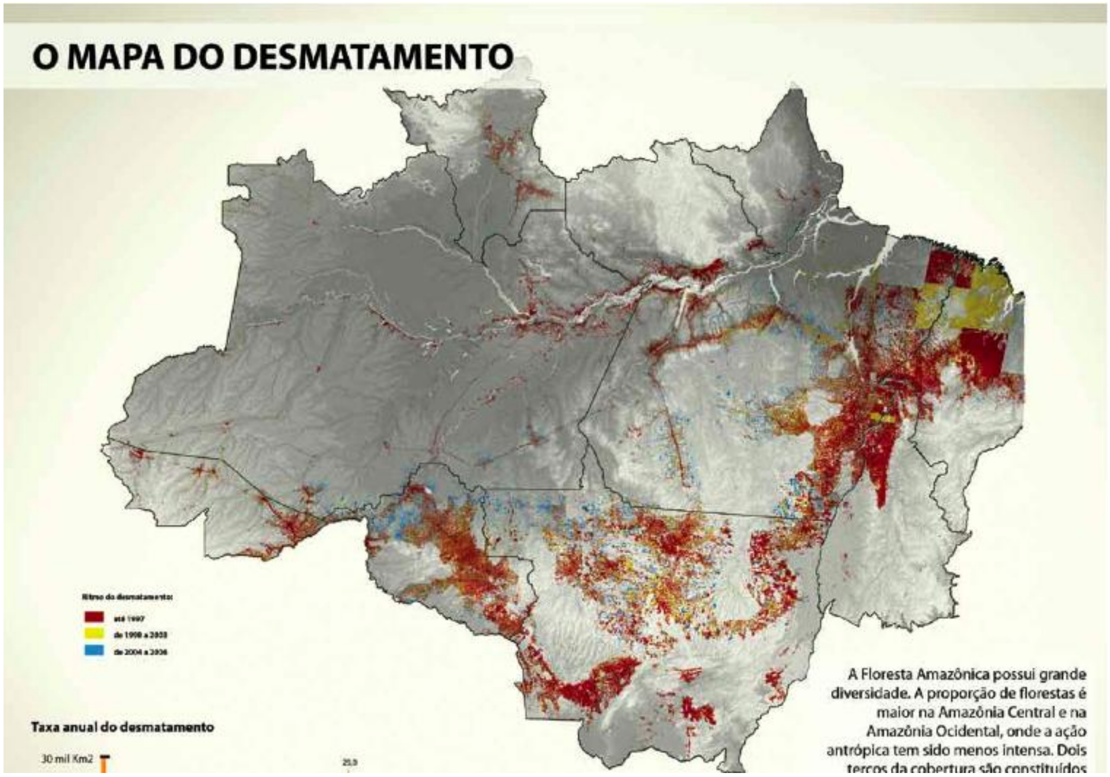


**Figure 4.** Map of Deforestation in the Legal Amazon (Arcoverde Terra Legal 2009)

In order to address this situation, the federal government created the Green Arc Legal Land Program (PTLA) in 2009 with the aim of issuing land titles to legitimate settlers in the Amazon region (Arco Verde Terra Legal 2009).[18] Since land tenure irregularity is deemed a huge obstacle for expanding various government-backed development programs in the region (including the PNPB), the PTLA's goal is to remove this barrier by promoting land legalization, especially in sub-regions with high deforestation rates, thus widening opportunities for establishing agro-energy in the region.

Coordinated by the Casa Civil (ministry equivalent to President's Chief of Staff) and by the Ministries of Agrarian Development (MDA) and of the Environment (MMA), the PTLA is implemented in partnership with the states and municipalities. While it is still too early to measure any impacts on land regularization and deforestation, the program has received 1,878 requests for legalizing non-devolved federal lands. Only plots measuring up to 15 "fiscal modules" are eligible for the program. While the size of a "fiscal module" varies per municipality, on average in the Amazon, one fiscal module is equivalent to approximately 76 hectares.

This program is a multi-sectoral effort involving the following ministries and associated agencies: Agriculture (Embrapa, Conab and Ceplac); Social Security (INSS), Cities; Culture, Defense; Education, Labor and Employment; Secretariat of Federal Assets, Special Secretariat for Aquiculture and Fishing, Special Secretariat for Human Rights, Banco do Brasil, Banco da Amazônia, BNDES, Sebrae, as well as municipal and state governments in Mato Grosso, Pará, Maranhão, Roraima, Rondônia and Amazonas states.

[18] Arco Verde Terra Legal Portal: portal.mda.gov.br/arcoverde/

For the purposes of biodiesel production, the program hopes to open up opportunities for planting oilseed crops in areas where farmers did not have access to public financing programs, fiscal incentives and technical assistance. Judging by Brazilian federal government policies within the PNPB – and those put forth by state governments such as Pará and Amazonas, as well as by private sector trends discussed above – the main crop that will receive fiscal incentives, research and investments aimed at expanding production in the Amazon will be oil palm. Thus, oil palm is clearly being touted as the main oilseed for supporting the expansion of biofuels in Northern Brazil (NAE 2005; CAE 2006; COPPEAD 2007). This expansion will result in substantial changes to both the landscape and peoples of the region. The following section draws together divergent perspectives raised in recent studies about the social and environmental impacts that might stem from the expansion of the prevailing oil palm production model in the region.

## 2.4. The expansion of oil palm in the Amazon: opportunities and obstacles

Although significant oil palm (*Elaeis guineensis*) production projects aimed at the food and cosmetics industries have been developed for over three decades in the Brazilian Amazon, especially in Pará State (which has 80% of national oil palm production), biodiesel made from palm oil accounts for only 0.06% of biodiesel production nationwide and, even in the North, only 1.58% (ANP 2009). One advantage of expanding this crop is the energy balance for producing palm oil (relationship between energy produced and energy consumed), which is considered more favorable than that of other oilseeds (NAE 2005). Moreover, while the height of production only begins after the sixth or seventh year in the field, it remains commercially feasible for 25 years[19]. In addition to being a species of palm that is well adapted to the humid tropics, oil palm holds a high capacity for sequestering carbon and for producing organic matter, which should contribute towards offsetting the effects of greenhouse gas emissions while also reducing soil erosion and leaching (NAE 2005; Santos 2008; Villela 2009).

Besides its positive energy balance, another argument for palm oil highlighted by the Center for Strategic Studies within the Presidency of the Republic (2004), is the availability of over 70 million hectares of lands in Brazil considered suitable for cultivation, of which 40% are considered highly suitable (based on climactic zoning of risk, which depends on rainfall, sunlight, soils, topography, etc.) (NAE 2004:12). These areas suitable for oil palm production in Brazil are far greater than the areas available in the main oil palm-producing countries – Indonesia and Malaysia – which have 617 thousand $km^2$ and 110 thousand $km^2$, respectively (Butler and Laurance 2009).

### Impacts of expanding oil palm

As enthusiasm for oil palm grows, so do the voices that wish to avoid repeating the mistakes made in Malaysia and Indonesia, such as deforestation, land concentration and displacement of traditional communities (Fitzherbert *et al* 2008). In 2008, the NGO Repórter Brasil published a report analyzing the potential social and environmental impacts of expanding agrofuels in Brazil. In a recent study, Butler and Laurance (2009) point to biodiversity loss and deforestation of untouched forests – as opposed to planting on degraded lands – as potential environmental impacts of expanding oil palm in the Amazon.[20]

According to a thorough literature review by Fitzherbert *et al* (2008), the biodiversity found on conventional oil palm plantations is analogous to that of other tree crops and lower than that of secondary forests. These authors argue that there are four ways in which the expansion of oil palm might potentially lead to deforestation: 1) as a vector for clearing of primary forests; 2) by replacing forests degraded previously by fire or logging; 3) as part of dual-purpose projects that

[19] After 25 years, harvesting is more burdensome due to the height of the oil palm tree.
20 BUTLER, R.A. e William F. Laurance 2009. Is oil palm the next emerging threat to the Amazon? Mongabay.com Open Access Journal - Tropical Conservation Science. Vol.2(1):1-10, 2009. Conservation Letter.

offset the initial cost of new plantations (considered very high) by selling timber products; or 4) indirectly by improving roads and therefore increasing access or due to the displacement of other crops to forest areas.

### 2.4.1 Palm oil in the biodiesel production chain: opportunities and threats

As seen above, the burgeoning interest in this palm tree may be attributed to a wide range of factors, including economic, social, environmental and edafo-climactic characteristics considered well-suited to the Amazon context. (NAE 2005; CAE 2006; COPPEAD 2007; Santos 2008; Villela 2009). Meanwhile, however, some reports and studies have been pointing to the potential threats that oil palm may entail for the landscape and peoples of the region, depending above all on the sort of production models and integration agreements adopted on the new frontier of oil palm cultivation (Repórter Brasil 2008; Butler and Laurance 2009; Fitzherbert et al 2008). This section analyzes these conflicting perspectives regarding the potential positive and negative impacts of oil palm cultivation in the Brazilian Amazon.

In order to shed light on these varying perspectives, we shall first revisit the key players conducting research and promoting the expansion of oil palm in the Brazilian Amazon, institutions that have played a pivotal role in formulating public policies for the sector, as described in Part 1 of this chapter, including:

- The Center for Strategic Affairs within the Presidency of the Republic (NAE)
- Various Embrapa research centers, most notably Embrapa Agro-biology, Embrapa Eastern Amazon (CPATU) and Embrapa Western Amazon (CPAA)
- Ministries of Development, Industry and Trade (MDIC), Agrarian Development (MDA), Agriculture, Livestock, and Food Supply (MAPA) and *Casa Civil* (ministry equivalent to President's Chief of Staff)
- National Petroleum, Natural Gas and Biofuels Agency - ANP
- Universities such as University of São Paulo - USP/ESALQ, Federal University of Rio de Janeiro - UFRJ/COPPE, University of Brasilia - UNB
- National Economic and Social Development Bank - BNDES

### 2.4.2 Economic and environmental advantages of oil palm

These institutions point primarily to the economic advantages of oil palm, including its strategic importance in reducing diesel and vegetable oil imports, hence its contribution to a positive Trade Balance (NAE 2005; ANP 2009). Secondly, biodiesel made from oil palm is lauded for contributing to Brazil's energy mix (COPPEAD 2007; ANP 2009). Moreover, these studies point to oil palm's environmental benefits as compared to petroleum-based diesel since it emits less pollutants into the atmosphere and the trees sequester carbon by absorbing $CO_2$ from the atmosphere. According to Souza (2009), for instance, "1 hectare of oil palm can sequester 35.87 tons of carbon and produce 90 t of dry matter by its fifteenth year". Santos (2008) and Villela (2009) also highlight the importance of oil palm biodiesel for sequestering carbon and reducing greenhouse gas emissions.

First and foremost among the economic advantages of oil palm is its phenomenal yields (in amount of oil/ha), since this crop can produce over 5 tons of oil per hectare after the 7$^{th}$ year of cultivation, an amount ten times greater than other oilseeds such as soy and castor beans (see Tables 2 and 7).

**Table 7.** Comparative yields of oilseeds used for producing biodiesel

| Species | Source of oil | Average oil content (%) | Harvest months | Average oil yields (t/ha) | Production costs (US$/t) | Oil prices (US$/t) |
|---|---|---|---|---|---|---|
| Oil palm (*Elaeis guineensis*) | nut | 26 | 12 | 4,5 | 286 | 450 |
| Canola (*Brassica napus*) | seed | 44 | 3 | 0,7 | 650 | 653 |
| Castor beans (*Ricinus communis*) | seed | 44 | 3 | 0,75 | 720 | 1.040 |
| Peanuts (*Arachis hipogaea*) | seed | 45 | 3 | 0,7 | 1.300 | 1.281 |
| Soy beans (*Glycine max*) | seed | 17 | 3 | 0,4 | 85 | 560 |

Source: Adapted from Bilich, and Da Silva in: *Análise multicritério da produção de biodiesel* (Bilich and da Silva 2006)

What's more, the cost of producing oil palm is considered low, second only to soybeans among the main oilseeds produced in Brazil, and is even comparable to petroleum diesel production costs. However, as shown in Figure 5, the average price of palm oil (R$1.52/Kg) was higher than that of diesel (R$1.36/L), not counting the ICMS (value-added tax), from 2002 to 2007.

The high value of palm oil on the international market is due, among other factors, to the fact that it is free of trans fats and therefore ideal for producing foodstuffs such as margarine, cookies, cakes, etc. and is in high demand by the cosmetics industry (Santos 2008). Indeed, palm oil actually surpassed soybean oil as the most consumed vegetable oil in the world for foodstuffs and accounts for almost 30% of worldwide consumption. This major role of oil palm in international markets creates clear incentives for expanding cultivation but also discourages oil production for biodiesel, since the price paid by the food and cosmetics industries is more attractive for producers, depending on the market value of biodiesel at the time.

Hence, despite its low production costs, the high opportunity cost (which amounts to the price of oil on the international market) raises the need for the government to provide higher subsidies for oil palm-based biodiesel to be economically feasible for producers. The high opportunity cost therefore stands as one of the main hurdles to expanding biodiesel production from oil palm (NAE 2005; Santos 2008).

**Evolution in average price of oil palm** **Evolution in average price of diesel**

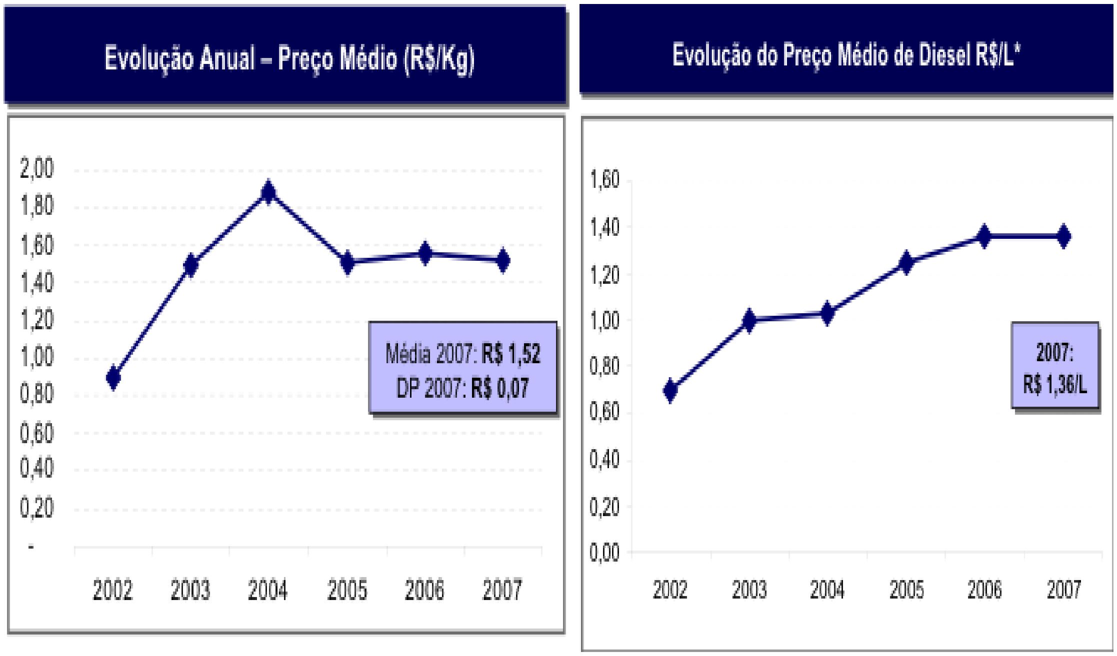


**Figure 5.** Comparison between average price of palm oil and diesel from 2002 to 2007. Source: COPPEAD 2007[21].

Moreover, palm oil producers receive significant fiscal incentives through 100% tax exemptions on PIS and COFINS federal taxes in the North and Northeast of Brazil[22]. This exemption is awarded to biodiesel producers who hold the Social Fuel Stamp, in which case they must purchase at least 10% of raw materials from family farmers during the 2009/2010 harvest season – and 15% as of the 2010/2011 harvest (see Part 1 for more details). Established by the PNPB, this certificate also requires providing technical assistance and negotiating purchase agreements with farmers.

## 2.4.3 Logistical and technical issues

Despite these numerous advantages, expanding oil palm in the Amazon does face substantial constraints including logistical and technical bottlenecks, as well as hurdles related to social and production organization, as suggested by Santos (2008) and NAE (2005), among others. Some of the key logistical and technical constraints are that:

- the oil needs to be extracted no longer than 24 hours after harvesting fruit bunches, otherwise it goes rancid, which means that processing units need to be located close to plantations;
- small-scale plantations must be located close to each other to enable transport logistics and ensure the supply of enough fruits for the plants to be economically feasible;
- although this species is adapted to edafo-climactic and soil conditions found in most of the Amazon, including acidic oils, oil palm is highly demanding in potassium for producing fruit bunches, which means that cultivation is highly dependent on this input;

[21] COPPEAD 2007, *Planejamento Estratégico Tecnológico e Logístico para o Programa Nacional de Biodiesel Relatório Final – Módulos I e II* Rio de Janeiro, November of 2007.
[22] As determined by Decrees 5457 of 2005 and 5297 of 2004.

- initial implementation of oil palm plantations requires extensive investments in the first years and hinges on adequate training for family farmers as well as technical assistance, follow-up and phyto-sanitary monitoring;
- a potentially devastating risk of oil palm is spear rot (known in Brazil as "Fatal Yellowing"), a disease that leads to a high mortality rate. The hybrid variety of oil palm (a cross between African oil palm and *caiauê*, a native Amazonian species) has proven to be resistant to this disease.
- Environmental licensing procedures, access to credit and technical assistance by state agencies, which require land legalization, are technically complex, slow, and set up burdensome procedures for which compliance by traditional communities and family farmers is quite difficult. (Miccolis 2008)

### 2.4.4 Oil palm and family farming

Since oil palm farming practices are highly labor-intensive, this crop holds a great potential for creating jobs and generating income, which makes it promising for planting in the context of family farming. The potential for intercropping oil palm with food crops such as cassava, pineapple, sweet potatoes, and bananas, especially in the first years while the palm trees begin producing fruit bunches, also emerges as a promising path forward for establishing more diverse family-based farming systems. According to an experiment coordinated by the researcher and head of Embrapa Western Amazon (CPAA), Maria do Rosário Rodrigues, at SUFRAMA's Distrito Agropecuário, these secondary crops enabled short-term profits without undermining the growth of the oil palm trees[23]. Even in the densest plantation systems, spacing between oil palm seedlings is at least 8 meters and their canopies take at least 4 years before they begin to meet, which opens up opportunities for planting multifunctional species (food, commercial, leguminous, oilseed, and fruit crops).

Indeed, from a social-economic standpoint, oil palm is considered promising due to its job creation and income generation potential, which is above the national average. According to a survey conducted by CMA, oil palm plantations employ an average of one worker for every ten hectares, including crop management and harvesting activities (Repórter Brasil 2008: 13). This same study reports that "according to the Rural Workers Union of Tailândia municipality, in Pará State, the average monthly wages of oil palm are roughly R$ 600, although they must harvest at least 1000 kg during the harvest season and 600 during the offseason. When labor is performed exclusively by farmers and their families, the estimated net annual income may surpass R$15 thousand. According to estimates reported by Agropalma, the largest oil palm producer in Brazil, this income may even reach R$ 24 thousand per family per year." (Reporter Brasil 2008) As reported by Santos (2008), however, figures about the number of jobs created by oil palm plantations vary, although most estimates suggest an average of one family per 6 hectares, or 0.77 jobs per hectare.

In an article published in the *Harvard Review of Latin America – ReVISTA*, researchers from the University of São Paulo assess Agropalma's Family Farming Project in a very positive light, claiming that "an example of perennial crop production that generates ongoing monthly income has come true in the Amazon region, reducing rural migration and strengthening the community." (Fischer *et al* 2006)

According to this article, though incipient at the time, the project brought numerous benefits to farmers, including increased income, which reached an average of US$ 320 in the first year of production. From the seventh year onwards, the annual family income might reach an estimated US$ 8500, which is far greater than the nationwide average of US$ 108/month in rural areas.

[23] Quoted from on-line article. Embrapa CPAA: 2007.

Additionally, the researchers claim that one of the project's main achievements was the strengthening of the community's social capital – as well as its capacity to deal with the government – since it founded an association. Besides these reports of benefits for the community, the project also brought benefits to the company:

> Furthermore, it enables Agropalma to demonstrate socially responsible conduct to its stakeholders, in addition to providing it with direct benefits such as lower investment expenses, less tied-up capital, higher production volumes and the assurance of obtaining high quality raw material. More specifically, these projects allow the company to expand the production area without tying up capital in land or raising direct employee headcount, which noticeably cuts personnel costs and labor charges. (Fischer et al 2006)

This article stands in stark contrast, however, to an extensive report published in 2008 by the Center for Monitoring Agrofuels (CMA), coordinated by the NGO Repórter Brasil. As discussed in Section 2.4.5, the oil palm production model that currently prevails in the Amazon – and prospects that this model might be adopted on a much wide scale in the region – has been raising eyebrows in studies conducted by NGOs, national and international researchers.

### 2.4.5 The expansion of oil palm: some case studies

Entitled *O Brasil dos Agrocombustíveis*[24] [The Brazil of Agrofuels] (Repórter Brasil 2008), this report by CMA/Reporter Brasil was based on extensive fieldwork and interviews. Divided up initially into four volumes (then expanded to five in 2009), it analyzes the social and environmental impacts of several feedstocks used in biodiesel production, including soybeans, castor beans, jatropha, cotton, sugar cane, babassu, and palm oil. Dedicating an entire chapter to oil palm, the study assesses progress and obstacles towards producing this oilseed through case studies, most notably in the case of Agropalma, the only company currently producing biodiesel from oil palm in the Brazilian Amazon.

Some of the main questions raised in this report include the integration agreements signed between producers and companies, contracts that determine the technological package that must be used for cultivation, as well as the financing and commercial arrangements. Moreover, this study questions to what extent the large monoculture oil palm plantation model as currently practiced is suited to the reality of family farming in the Amazon.

According to this study, the technological package and associated production rules established by the company do not allow intercropping other species (such as, for example, cassava, beans, vegetables, and fruits), which undermines food security and crop diversification, ultimately hindering livelihoods. What's more, the area dedicated to planting oil palm (usually a minimum of 10 hectares/producer, which for smallholders often means most of the land available for farming) and the cultivation systems consume a large portion of the family farmers' resources in terms of labor and other inputs. Consequentially, farmers have little time on their hands to dedicate to other food or cash crops, thus further undermining diversification and making them dependent on oil palm and on Agropalma. (Repórter Brasil 2008)

Although purchase of the production is assured through contracts, according to the CMA, these agreements also require that farmers sell exclusively to the same company for 25 years (the useful lifetime of oil palm trees in commercial plantations), thereby prohibiting farmers from selling to third parties and binding them to prices paid by Agropalma. Additionally, the high implementation costs (approximately R$ 6.4 thousand per hectare of plantation) mean that despite lengthy grace periods for paying off loans, farmers are indebted for several years, since the height of fruit production only begin from the seventh year onwards.

[24] CMA is supported by Cordaid, Solidaridad and DOEN Foundation, Dutch organizations that fund projects on sustainable development, fair trade and sustainable production chains. www.reporterbrasil.org.br/agrocombustiveis/

Besides these difficulties found in the case of Agropalma, the CMA also reports land conflicts with *quilombolas*[25] in another case study, the experience of Biopalma, also in the state of Pará. According to the president of the Associação de Quilombolas de Nova Esperança da Concórdia [Association of Communities of descendants of runaway slaves from Nova Esperança da Concórdia]–Aquinac, the purchase of lands for oil palm plantations in the region "began pressuring lands belonging to *quilombolas*".

Another substantial oil palm project, known as Braspalma, located near Tefé, in Amazonas State, arose in the 1980s through a World Bank-funded project by the *Empresa Amazonense de Dendê* (EMADE). This project was apparently not successful due to "lack of investments and political will, as the government abandoned the area" (Repórter Brasil 2008). In early 2007, the state government conducted studies to assess the potential of restarting the project and in 2008 negotiated the concession of 20 thousand hectares to the Malaysian land development agency (FELDA), represented in Brazil by Braspalma. Although some local stakeholders are encouraged by prospects that the project will create jobs and generate income, some of those interviewed by the CMA study are concerned about the displacement of settlers living on the land conceded to FELDA and fear that the low availability of previously forested lands will lead to encroachment on standing forests in the region. A further stumbling block is the high transport costs to Manaus, which might undermine the project's economic feasibility.

The study also points to other potential environmental impacts stemming from the use of agro-chemicals such as fertilizers and pesticides, which may lead to the contamination of soils and waterways. It underscores the risk of new plantations encroaching on standing forests, which would lead to biodiversity loss, as has been happening most notably in Indonesia and Malaysia.

### 2.4.6 Oil palm in Agroforestry Systems

While the report does not condemn oil palm per se, it does recommend that the oil palm production model be adapted to the reality of family farming in the Amazon context by intercropping oil palm trees with other commercial and foods crops in agroforestry systems (AFS). This palm tree has been cultivated in tropical homegardens for centuries in the Brazilian state of Bahia, in the humid tropics of West Africa (its center of origin), and can be found growing alongside other trees in secondary forests in Indonésia, Malaysia and Papua New Guinea where old plantations used to be.  Nonetheless, research on commercial oil palm cultivation in guilds with other perennial species in agroforestry systems is still fledgling. A pioneering research project (known as Projeto Dendê) was implemented in 2007 by NATURA[26] in partnership with a farmer's cooperative, *Cooperativa Agrícola Mista de Tomé-Açu* – CAMTA, and Embrapa Eastern Amazon. Designed using participatory approaches, the project aims to develop oil palm farming systems in guilds with agroforestry systems so as to enable their economic, social and environmental sustainability.

The first planting began in September of 2007 on three demonstration plots, each of which occupies 6 hectares of degraded lands on properties belonging to members of CAMTA. Part of the land preparation was mechanized and the rest was done manually. These three areas were comprised of oil palm (approximately 90 to 100 seedlings per hectare) and different combinations of up to 17 species.[27] Besides the agronomical aspects regarding development of oil palm and AFS, this research is also assessing biodiversity indicators (microfauna and avifauna) as well as carbon sequestration. Although it is still too early to measure productivity, preliminary findings

[25] In Brazil, "quilombola" communities are Afro-descendants who fled from slavery and established settlements.

[26] A major Brazilian cosmetics company that uses palm oil as a basic ingredient in its products.

[27] Including short-cycle leguminous species, such as pig beans, pigeon peas, fruit trees such as bananas, cacao, açaí palm (*Euterpe oleracea*), bacaba (*Oenocarpus bacaba*), and lianas such as Black pepper and passion fruit, and native timber species, most notably *ipê* (Tabebuia spp.), *jatobá* (*Hymenaea courbaril*), *ucuuba*, (*Virola surinamensis*), and *pracaxi* (*Pentaclethara macroloba*).

show that it is possible to intercrop short-cycle species during the first few years and that there are also opportunities for intercropping other perennial species such as cacao, black pepper, and bananas while also recovering degraded lands with leguminous species and others that produce large quantities of organic matter. (Castellani *et al* 2009)

## 2.5 Some lessons learned

Coupled with our analysis of the current biodiesel production scenario in the Amazon, these case studies point to some important lessons regarding the spread of oil palm in the region. First, one may conclude that the social and environmental sustainability of oil palm hinges on developing farming systems and local production arrangements suited to the Amazon reality, with its phenomenal biodiversity and myriad of traditional peoples. Furthermore, while biodiesel undoubtedly bears a potential for creating jobs, income and generating energy in the Amazon, different feedstocks must be analyzed separately in light of the specificities of each micro-region and of each crop, in order to duly assess and mitigate their varying social and environmental impacts.

A detailed study by Santos (2008) shows that while there is indeed a potential for generating electricity in isolated communities, the economic feasibility of biodiesel for this purpose (as compared to petroleum diesel) hinges on a series of factors affecting production costs, namely: the extent to which production is verticalized, transport distances and infrastructure conditions, and the availability of local processing facilities.

Oil palm has drawn most attention among the various feedstocks being considered for expansion due to its low production costs (on a long-term basis), high potential for creating jobs and generation income, and labor-intensive cropping systems, in addition to the existence of vast expanses of degraded lands suitable for planting this crop. Despite the comparative advantages of oil palm in the Amazon, some of the potential social impacts of setting up large-scale oil palm monocultures include land concentration and less cultivation of food crops, which could potentially undermine food security and amplify vulnerabilities for local communities.

This set of potential impacts raises questions about the sustainability of oil palm production aimed at biodiesel in the Amazon, especially among social groups that don't have sufficient technical capacities, solid financial foundations and minimal social organization mechanisms in place.

## 2.6 "Sustainable" oil palm

In 2005, these questions surrounding the sustainability of oil palm, especially in Indonesia, Malaysia and Papua New Guinea, led the main industry players to draft a series of guidelines for sustainable oil palm production that would enable certifying palm oil according to a series of "best practices". Known as the Roundtable for Sustainable Palm Oil – RSPO, this initiative was founded in 2004 by key players from seven different sectors, including: palm oil producers, processers and traders, manufacturers of goods for human consumption, retailers, banks and investors, environmental and conservation NGOs and social or development-oriented NGOs. This group drafted a series of Principles, Criteria, Indicators, and Orientations, which were submitted to public consultations and adjusted based on field experiences from 2005 to 2007. Table 8 summarizes these Principles and some corresponding Criteria.

As noted by Butler and Laurance (2009), these criteria are important steps towards developing sustainable oil palm production systems, however, they must be effectively implemented through public and private policies and some underlying concepts must be more clearly defined and adapted to national realities. Hence, research in this area should focus on systems for producing raw materials and manufacturing biodiesel that are appropriate for the Amazon context.

**Table 8.** Principles and Criteria for Sustainable Oil Palm

| Principles | Associated criteria |
|---|---|
| 1) Commitment to transparency | • Provide information to stakeholders using appropriate language |
| 2) Comply with national and local laws and regulations | • Abide by land use access rights and ensure prior consent from local communities |
| 3) Long-term economic and financial feasibility | |
| 4) Best production practices | • Increasing soil fertility<br>• Controlling soil erosion and degradation<br>• Quality and availability of water resources<br>• Controlling invasive species and integrated pest management<br>• Seek out alternatives to types 1A and 1B pesticides (which does not mean outright prohibiting their use) |
| 5) Environmental responsibility and natural resource conservation | • Identification and mitigation of environmental impacts stemming from plantation and processing plants<br>• Conservation plans for rare and/or endangered species<br>• Appropriate waste disposal, recycling and reuse<br>• Efficient use of renewable energy resources<br>• Avoid forest fires<br>• Reduce emissions and pollution |
| 6) Social responsibility | • Abiding by human and labor rights |
| 7) Responsible development of new plantations | • Not replacing primary forests<br>• Protecting the rights of indigenous peoples |
| 8) Continuous improvement | • Continuous monitoring and improvement |

Source: adapted by the authors from Roundtable for Sustainable Palm Oil – RSPO (2005 and 2007)[28]

Along the same lines as the RSPO, the Roundtable on Sustainable Biofuels - RSB was founded by the Swiss Federal Institute of Technology in Lausanne - EPFL (one of two federal technology institutes in Switzerland). The Steering Board is comprised of representatives from BP, Bunge, EPFL, the National Wildlife Federation, the United Nations Environment Program, Petrobras, Shell, Swiss and Dutch federal agencies, TERI - India, Toyota, UNICA (the Brazil-based Union of Sugar and Ethanol Producers), the World Economic Forum (WEF) and the World Wild Fund for Nature (WWF). Ever since 2007, working groups have been discussing global criteria and guidelines for producing biofuels sustainably, as reproduced below in Table 9.

**Table 9.** Global principles and criteria for sustainable biofuels production – Version 0

| Principles | Criteria |
|---|---|
| Legality | • Biofuel production shall follow all applicable laws of the country in which they occur, and shall endeavour to follow all international treaties relevant to biofuel production to which the relevant country is a party |
| Consultation, Planning and Monitoring | • Biofuels projects shall be designed and operated under appropriate, comprehensive, transparent, consultative, and participatory processes that involve all relevant stakeholders |
| Climate change and Greenhouse Gases | • Biofuels shall contribute to climate change mitigation by significantly reducing GHG emissions as compared to fossil fuels |
| Human and labour rights | • Biofuel production shall not violate human rights or labour rights, and shall ensure decent work and the well-being of workers |
| Rural and social development | • Biofuel production shall contribute to the social and economic development of local, rural and indigenous peoples and communities |

[28] www.rspo.org

| | |
|---|---|
| Food security | • Biofuel production shall not impair food security |
| Biodiversity | • Biofuel production shall avoid negative impacts on biodiversity, ecosystems, and areas of High Conservation Value |
| Soil<br><br>Water<br><br><br><br>Air | • Biofuel production shall promote practices that seek to improve soil health and minimize degradation<br>• Biofuel production shall optimize surface and groundwater resource use, including minimizing contamination or depletion of these resources, and shall not violate existing formal and customary water rights<br>• Air pollution from biofuel production and processing shall be minimized along the supply chain. |
| Economic efficiency, technology, and continuous improvement | • Biofuels shall be produced in the most cost-effective way. The use of technology must improve production efficiency and social and environmental performance in all stages of the biofuel value chain. |
| Land Rights | • Biofuel production shall not violate land rights |

Source: Version Zero of RSB Global principles and criteria for sustainable biofuels production (2008)

## 3. Ways forward

Based on the perspectives drawn together in this chapter, some of the key factors underlying biodiesel production in Brazil are: clear economic, regulatory, and technological incentives; the high demand for affordable energy in the Amazon (for both electricity and transport); the harsh geographic and logistics reality in the region; and the growing demand for renewable energy sources and economic alternatives based on sustainable natural resource use. Our analysis of these factors has shown that biodiesel production in the Amazon, especially when derived from perennial species such as oil palm, emerges as a potentially promising alternative for producing energy in isolated communities and meeting the burgeoning demand for this fuel in the national energy mix, as long as strict social and environmental safeguards are put in place.

In the specific case of oil palm, the major challenges are a) ensuring that it is effectively implemented on degraded lands and b) establishing cropping systems and agreements with farmers that reconcile the needs of local communities with economic and environmental factors. Soy, on the other hand, is bound to continue playing a central role in biodiesel production nationally and in the Amazon, which will entail continued environmental and social impacts. However, the current Brazilian policy framework, coupled with private sector-led initiatives such as the Soy Moratorium and pressure from international markets for “greener soy”, will apparently tend to thwart the expansion of the soy frontier in the Amazon biome.

In the meantime, research on other palm species, native oilseeds and affordable small-scale oil extraction and biodiesel production technologies begin to emerge as tangible opportunities for harnessing agro-extractive activities in isolated communities, although these initiatives for the most part still need further development. Regardless of these emerging prospects, oil palm is undoubtedly the crop of choice for public agrofuel policies in the Brazilian Amazon, and interest in this plant should continue to grow in coming years.

While, in principle, the Brazilian PNPB is largely in sync with the RSB guidelines, some initiatives such as the CMA are questioning the extent to which the oil palm production chain is actually abiding by these guidelines in practice. Hence, the overarching challenge for the future expansion of biodiesel production on vast expanses of land in the Amazon is that of

implementing the principles regarding biodiversity conservation, access to land, food security, and human and labor rights. While these guidelines already point to potential paths towards achieving sustainable biodiesel production in the Amazon, they must be mainstreamed into public policies and monitored to verify effective implementation on the ground.

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