ASSESSING THE SUSTAINABILITY IMPACTS OF PAVING HIGHWAY BR-163: A LITERATURE REVIEW AND A SUMMARY OF BEST PRACTICES RELATED TO SOY PRODUCTION

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ACRONYMS

BNDES	Social Development National Bank
EIA	Environmental impact Assessment
EMBRAPA	Brazilian Agricultural Research Corporation
EU	European Union
GDP	gross domestic product
ha	hectare
INCRA	Colonization and Agrarian Reform Institute
IPM	Integrated pest management
km	kilometre
m	metres
NGO	non-governmental organisation
PA	State of Pará
PPA	Permanent protected area
PR	State of Paraná
R	Brazilian Real
RIMA	Report on Impact on the Environment
RPPN	Private Natural Heritage Reserve
SA	Sustainability assessment
SEA	Strategic environmental assessment
SP	São Paulo State
WTO	World Trade Organisation
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

This report examines the impacts of the paving of highway BR-163 on sustainability in the Centre-West region of Brazil. Its purpose is to review the relevant literature and present a range of relevant issues that can be explored further in the *Projeto Diálogos*, as well as through a sustainability assessment (SA) that will take into account the role of international trade in the dynamics driving economic activity, and subsequent social and environmental impacts, associated with the highway project.

The purpose of highway BR-163, which was begun 30 years ago and is now being fully paved, is to link the Centre-West region of Brazil to the deep water port of Santárem. The Centre-West includes the fragile ecosystem of the Cerrado as well as the Amazon – areas with among the highest levels of biodiversity in the world. While there is already development in the region, there are likely to be important economic, social and environmental impacts associated with building and operating the highway, as well as indirect impacts associated with the development of further economic activity along its edges and in the surrounding area – almost 1,000 km^2. In the past, highway development in Brazil has led to large-scale deforestation and the exploitation of other natural resources brought about by the improved transportation, activity of logging companies, and land clearing to support new, extensive agriculture. This agricultural activity in the Centre-West region, which includes cattle, soy and other crops, is poised to take advantage of an expanding international market and improved competitiveness for export brought about by lowering transportation costs.

In the past, the Brazilian government has invested heavily to promote large-scale industrial agriculture – for both domestic consumption and for export – at the expense of the small farms, many of which operate on a subsistence basis. Several small landowners were among the first to be expelled from their land as a result of the construction of the highway. With poorly protected property rights and few economic resources these landowners are particularly vulnerable to the activities of speculators and developers. Given the fact that the value of the land surrounding the highway is poised to increase further once BR-163 is paved, the clashes over land tenure could increase.

It is the impacts on conservation that are the focus of this report and include, most importantly, a focus on the major economic activities of forestry and agriculture in the region.

Deforestation is already occurring at an alarming rate in the Amazon region and is likely to accelerate as a result of the paving of the highway. Studies show, *inter alia*, a strong correlation between opening and paving of highways and deforestation. Indirectly the region's forests could also be affected by other economic activities encouraged by the highway production, including agriculture.

There has already been investment in large-scale farming enterprises in the region, although this has not yet developed as rapidly as in other parts of the country, notably Brazil's Southern states. However, international demand is increasing for several of the commodities raised in the literature review, which are relevant for sustainability in the Centre-West region and will be affected by the highway project. For cattle, this has been driven by outbreaks of mad cow disease among other major producers, unused Brazilian capacity and a favorable exchange rate. Improved transportation infrastructure will accelerate this and the trend in cattle and pasture expansion (an important contributor to deforestation) will continue and could be accelerated by the paving of BR-163.

Soy is the most important agricultural crop in the region and has increased rapidly in recent years, both in terms of volume produced and in terms of area under cultivation. Soy production typically requires the use of technology and large economies of scale for profitability. It is a risky crop, and is vulnerable to changes in international prices. Soybean cultivation is poised to continue to expand driven largely by increasing international demand from Asia, as well as the prospect for new applications, such as bio-fuels. This expansion will be encouraged by the paving of the highway to the extent that it will reduce transportation time and costs and make soy destined for export more competitive. One way of helping to ensure that this expansion occurs in a way that does not further compromise the fragile ecosystems in the region is to adopt best management practices, which are well known for soy production.

The literature review yielded a number of other potentially important mitigation strategies that might be adopted in order to promote expansion that is sustainable. These include supporting the role of the traditional small-scale family farms to support rural development and keep people on the land, stemming rural-urban migration. They also include encouraging long-cycle agricultural production, where crops are typically less environmentally damaging than for annual crops. A third mitigation activity is to encourage investment in and dissemination of technologies and techniques, through Brazil's research institutes, which support sustainable production and the

responsible use of agro-chemicals. A fourth activity is to promote agro-forestry and reforestation to support economic activities associated with non-wood forest products, promote the planting of crops in association with reforestation, and improve earnings through plantings such as eucalyptus, which provides high levels of economic return. Finally, the report points to the opportunities to diversify into other economic activities such as organic production, aquaculture and eco-tourism, which may have lower impacts on the natural environment and still generate significant economic returns for local populations.

In order to further explore these issues, and in particular given their relationship to international trade, the report argues that a SA should be undertaken to fully identify the economic, social and environmental issues associated with the highway project, and the complex linkages among these impacts. Such an assessment would consider the impact of paving BR-163 on competitiveness of not only cattle and soy, but also other commodities produced in the region such as cotton, sugar cane and corn, and assess, *inter alia*, possibilities for substitution, based on a growing international market, and relative economic, social and environmental impacts. The main benefit of employing a SA is to take fully into account the role of international trade in the dynamic of agricultural expansion, to consider economic, social and environmental issues in a balanced and integrated way, and to undertake the assessment in a transparent and highly credible way, taking into account the views of all major stakeholders. The result would be to develop policy recommendations aimed at both trade negotiators as well as other domestic policy makers to consider how the highway project can proceed in a way that not only maximizes potential for trade, but helps to ensure that the production of export-related commodities (including agriculture and other natural resources) occurs in a way that maximizes economic benefits for local populations and does not compromise further the fragile ecosystems in the Centre-West region.

A key element of this would be to encourage best practices with respect to soy production, which is already Brazil's major export commodity and is poised to expand in the coming years, in large part as a result of growing international demand. Therefore, attention has been paid to discussing existing best practices that are associated with soy production, in an effort to lay the groundwork for further work. This builds on WWF's initial work in 2003 on export-led soy production in the region, and provides a framework on which to build consideration of other key crops and activities associated with the paving of the highway, that have been raised in this report, and could be further explored in a SA.

Given that the highway project is progressing, there are two key questions that arise from this report and should be considered in further dialogues. The first is how to ensure that the existing enterprises contribute to the conservation of biodiversity and well-being of communities in the Amazon region through soybean and other production that is socially and environmentally responsible. The second question is how to avoid unplanned and unsustainable growth in the future.

Responsible management of farming and livestock can contribute to the conservation or environmental recovery of areas surrounding BR-163 which are under threat, or have already been degraded. The sustainability of soybean agri-business and its relationship to the conservation of natural resources depends on several factors. First, is its use of the technological innovations being development by the research centres in Brazil. A second important factor is with respect to effective environmental legislation, and its enforcement. A third is the role of education which has contributed to changing attitudes and has a role to play in the future. A fourth is considering new management practices and production systems for soybean crops and other crops that might be cultivated in the region. In order to ensure a longer term vision there are several issues that might be discussed among stakeholders in future fora.

- **Undertaking Sustainability Assessment.** A SA should be employed to study the impacts resulting from the paving of the highway and the economic activities that it is likely to encourage in the surrounding area. SA is broad enough to take into account the role of international trade in driving the development in the region and to include economic, environmental and social impacts.
- **Strengthening the analysis of the impacts on economic, social and environmental sustainability of paving BR -163.** The *Grupo Diálogos* should build on the existing literature and develop a clear indication of the short, medium and long term impacts, through a SA, and ensure that priorities are clearly identified.
- **Developing appropriate policy responses.** Policies that can either mitigate negative impacts or promote positive impacts on sustainability should be developed. This should include a focus, in the short term on actions that can be taken immediately, but should extend to the medium and longer terms. Discussion could begin with some of the mitigation actions highlighted in this report that have been derived from the literature.

This discussion should also take into account the policy recommendations put forward for soy in the 2003 WWF study on export-related soy production.

- **Exploring best practices using existing criteria for sustainable production**. The Basel Criteria for Responsible Soy Production, built from the discussion of the *Grupo Articulação Soja* and Soy Roundtable, has proved to be a suitable starting point for discussion and dissemination of appropriate social and environmental practices for soy crops. Important topics for discussion with respect to responsible soybean production include, *inter alia*, high level of losses (20% of production) and employing degraded pastures for cultivation. These should be extended to other relevant agricultural commodities.
- **Expanding the dialogue.** Existing discussions which have occurred largely focused on soybean production should be broadened to include other relevant commodities, the specific impacts of BR-163, and the trade-related aspect of the development of agricultural production, in conjunction with a SA.
- **Mapping the views of stakeholders.** Given the large variety of stakeholders involved in the area surrounding BR-163, it would be useful if a SA included a "stakeholder mapping" exercise in conjunction with the development of the *Grupo Diálogos*.

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1. INTRODUCTION

In 2004 the Government of Brazil put forward a proposal to pave highway BR-163. The paving of the highway is part of the *Plano Amazônia Sustentável* (Sustainable Amazon Plan), which encompasses an area of the Amazon that includes territory in the states of Mato Grosso and Pará. A document produced by Brazil's Inter-Ministerial Group indicates that the highway project will receive over $R1 billion in federal government funding. It is being undertaken by the Brazilian Army and the project is a priority in Brazil's Multi-Year Plan for 2004-2007.

By paving the highway, the Government seeks to encourage development in the region, facilitating transportation of both people and products. The new highway responds to appeals by Brazilian agro-business (crops and livestock) in the region, as a means to improve logistical capacity and reduce transportation costs. It also offers the prospect of raising living standards in rural populations (among the poorest in the country) and improving vital services related to health and education.

However, despite these prospective positive impacts there are concerns associated with the project, particularly with respect to related social and environmental issues in the Amazon. In the past, considerable pressure has been exerted by different groups in Brazilian society and in the international community, which has helped ensure that over eight million hectares (ha) of land in the Amazon region is now protected. Nevertheless, continued vigilance is necessary to protect habitats and biodiversity against the effects of unauthorised roads and illegal farming in the region, and these challenges will increase once BR-163 has been paved. By postponing the paving of the highway, the Brazilian Government has been able to avoid confronting the crucial environmental and social impacts that might arise as a result of the project. Among the most important impacts of the project are accelerated rates of deforestation, caused by both the highway itself, and by the agricultural activity and settlements that it services. Opponents of the project argue that the Amazon forest has already shrunk by 15% since the 1960s with some 85% of deforestation taking place within 50 km of a road. The presence of a highway makes it more profitable to fell trees, first for timber and then for pasture (which is the biggest contributor to deforestation). It is predicted that the paving of the BR-163, which passes through one of the

Amazon's most varied bird habitats, will destroy between 22,000 and 49,000 km^2 of forest within 35 years.[1]

Given the potentially significant impacts that could result from the project, the Brazilian Government has indicated that the highway project should be subjected to assessments addressing its potential impacts on sustainable development. This includes considering how the project would contribute to long-term economic prosperity, social development and environmental protection. It includes non-governmental organizations (NGOs) attempting to ensure social and environmental sustainability of the project and working with industry to achieve consensus on key issues related to the highway.

This study seeks to contribute to that goal. It also seeks to propose an approach that follows the methodology of sustainability assessment (SA), taking into account the important trade-related drivers associated with the economic development of the Centre-West region, including economic, environmental and social considerations, and including a full range of stakeholders in a comprehensive and transparent process. The overall objective of this study is to raise awareness about the potential problems associated with large infrastructure development and in particular impacts of increased agricultural production. The specific objectives of the study are to:

(i) identify key environmental and social challenges resulting from the highway construction;

(ii) show how a sustainability assessment (SA) can help highlight issues and develop options to foster informed multi-stakeholder dialogue and policy recommendations; and,

(iii) identify best practices in agro-environmental production in the agricultural sector

This report will be used as a background document in a series of multi-stakeholder workshops with members of civil society, business organizations, and public sector bodies. These workshops, which are part of a project called *Projeto Diálogos* will take place between 2006-2008.[2] The Project aims to strengthen and support opportunities for discussion and to increase the level of dialogue among stakeholders. This document will also serve as a vehicle for the dissemination of information, including best practices for soy production, an agricultural activity

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

[2] WWF-Brasil is working with the *Instituto Centro de Vida* (ICV- Centre of Life), *Instituto de Pesquisas da Amazônia* (IPAM-Amazon Research Institute), *Centro de Desenvolvimento Sustentável/Universidade de Brasília* (CDS/UNB- Sustainable Development Centre/University of Brasília) and with the International Cooperation Centre in Agronomy Research for Development (CIRAD-*Centre de Coopération Internationale en Recherche Agronomique pour le Développement*).

that will likely be encouraged by the paving of the highway.

The issues raised by the highway project are complex. They must take into account the potential for increased returns from the exploitation of natural resources as well as production activities such as agri-business. These must be balanced with efforts to support conservation from both a biological and an anthropological perspective. Any assessment should also take into account the potentially irreversible impacts of the investment of large amounts of public funds in response to long-standing and sometimes competing expectations of various groups of stakeholders.

The potential impacts of the highway project include those that have already been the subject of widespread publicity through various studies and dialogues on sustainable development in the region, some of which have even been reported in the international media. Such issues include the potential for large-scale and unplanned migration, the increasing exploitation of natural resources, the illegal occupation of public and protected lands, the concentration of land ownership in the hands of a few large holders, increasing crime, large-scale deforestation and the uncontrolled spread of disease.

However, several groups support the infrastructure project. For example, for agri-business in the Centre-West region of Brazil, the paving of BR-163 could have the indirect effect of increasing production, improving competitiveness and contributing to the overall development of both the economy and society. In recent years increased demand for soy has been met in Brazil by increased production and increasing exports. This development has led to calls for improved infrastructure to support export activities. Of particular importance is the construction of new physical infrastructure such as roads, railways, airports, ports, telecommunications, dams, bridges, and irrigation channels. In the Brazilian soy sector the construction or upgrading of transportation infrastructure is perhaps the most sensitive issue from an environmental perspective. The justification to pave roads and establish multi-modal systems of transport (including waterways, railways and roads) is that transportation costs associated with the export of soy need to be reduced to make it more competitive in international markets. While these improvements will assist existing production to become more competitive, such infrastructure has also led to growing areas of large-scale soy production in the past, and the paving of BR-163 could encourage such further growth in the fragile Centre-West region.

In the debate surrounding the paving of BR-163 the agricultural sector is thus a key stakeholder, which can either contribute to, or detract from, efforts to achieve sustainability.[3] Therefore, a focus on agriculture is crucial. This study proposes that the development of a SA can and should provide a basis for dialogue with the agricultural sector in the region surrounding BR-163 and with other stakeholders in the area with the aim of developing and implementing policies to support sustainable economic, social and environmental development in the region. SA is an appropriate tool to employ in this endeavour given its approach that is transparent, comprehensive, and flexible taking into account the views of a range of stakeholders including decision-makers at all levels of government. Moreover, because the highway project is already underway, there are short-term priorities that must be addressed in order to ensure longer-term sustainability. Therefore, this report focuses on observed impacts of past and current activity. A SA would have the benefit of allowing analysts to consider longer-term implications of this project, along with addressing more immediate concerns.

In addition, SA should be undertaken through a multi-stakeholder process. A highly participatory approach that is key to generating awareness, building the capacity of various stakeholders and creating a platform for dialogue on the impacts of trade and its linkages to infrastructure development and agricultural production and the integration of results of the assessment into the decision and policy making processes. Enhanced dialogue can be pivotal when agreeing on short-term practical solutions such as best production and management practices in the agriculture sector.

This report is divided into several sections. Sections 2 to 4 present the results of the literature review which reviews existing assessments of sustainability issues in the context of the development of BR-163, which is currently being paved from Cuiabá, the capital of Mato Grosso, to the deep-water port of Santarém on the Amazon River. The study examines the large body of work that has already been produced examining potential impacts of the highway project. These include economic, environmental and social implications of the highway proposal, particularly in the context of expanding soy production in the Amazon region. Section 2 includes a brief history of the highway and discusses the settlement model used to develop the region. Part 3 highlights the key impacts derived from the literature review, divided generally into the major themes of

[3] This study is part of the Agriculture and Environment Programme's effort to produce materials for uses in future regional workshops by the Dialogue Project, and to develop conservation-targeted actions that are consistent with the concept of sustainable development, principally as it relates to the agricultural sector.

forestry, land tenure, and agriculture. Part 4 presents five potential mitigation activities that are also derived from the literature that could mitigate negative impacts, or enhance positive impacts.

Part 5 of this report introduces the concept of SA and explores the usefulness of undertaking a SA to further identify impacts, and better understand the inter-linkages between economic, social and environmental impacts of the highway project. Part 6 examines best practices on sustainable production in the agriculture sector with a special emphasis on soy crops. Finally Part 7 presents general conclusions of this literature review and recommendations to further the work of the *Projeto Diálogos*. The recommendations will feed into work done by WWF-Brazil's Agriculture and Environment Programme as part of its efforts, through the *Projeto Diálogos,* to encourage Brazilian producers to modify current agricultural patterns, which are considered unsustainable. WWF Brazil seeks to promote the sustainable use of natural resources in the Brazilian Amazon and encourage long-term economic, social and environmental strategies for farming and cattle ranching, which respect and value environmental resources and promote a high standard of living for all stakeholders.

The methodology employed in this report was based on two steps. The first step consisted of exploratory research using secondary data sources. There is a large amount of information and data available that consider the environment, social and economic importance of the highway project. Existing studies were compiled and reviewed.[4] The comprehensive literature review allowed the team to map, at least in a preliminary way, the views of stakeholders, levels of convergence and to highlight where differences existed in views on the highway project.

The second step involved expert advice and consultations with a limited number of stakeholders. During this step, additional sources or primary data were identified, that can be employed in future research. A group of experts held discussions on critical issues related to the paving of the highway, projection of scenarios, choices of best practices available for soy production and actions proposed for the next phase of the work. The project team then focused on the main socio-environmental impacts agreed upon by the experts. A preliminary version of this report was circulated among some key stakeholders to disseminate information on best practices for soy crops in the region, to encourage the debate, and to seek critical contributions as well as recommendations to promote sustainable development in the region. During this step, the

[4] This includes, for example, the Brazilian Government, undertook an EIA-RIMA (which involved NGOs to a certain extent as well as academics).

identification of a range of stakeholders was also undertaken, to be employed in further work. The identification of stakeholders, along with the issues raised in this report, will be important in any future SA, but also to plan the next phase of this work that includes the workshops envisioned by *Projeto Diálogos*.[5]

2. BR-163 AND THE SETTLEMENT OF THE CENTRE-WEST REGION

The original highway BR-163 was built by the Brazilian Army Engineering Battalion at the beginning of the 1970s. Its purpose was to link the Centre-West region of Brazil to the deep-water port of Santarém and to integrate the country through the expansion of the agricultural frontier and the exploitation of natural resources in the Amazon region.

The highway is 1,765 km long and extends across three states (Pará, Mato Grosso and Amazon).[6] Only the stretches between Cuiabá and Guarantã do Norte in the state of Mato Grosso (714 km) and Santarém to Rurópolis in the state of Pará (98 km) have been paved. The highway has not been well maintained and its surface has become degraded and its margins eroded.

The paving of highway BR-163 has the potential to affect 974 thousand km^2. This area extends onto vast tracts of land that is important for several reasons. First, it is important for its social diversity and anthropological interest, as home to traditional populations including Indigenous peoples and *caboclos* (inhabitants of the Brazilian Amazon). Second, is for its environmental wealth, as land characterised by high levels of biological diversity and abundant natural resources. Third, is for its economic potential from activity including agri-business (cattle, soybeans and other crops) and from the extraction of natural resources including timber, minerals, rubber and nuts.

The original settlement of the land was undertaken through three types of arrangements: public, public/private and private/private partnerships. The settlements that were undertaken through partnerships between the public sector and the private sectors at the beginning of the

[5] A subsequent workshop should have the following objectives: contribute to built consensus around the legitimacy of the work with the involved audience; make possible the replication of the workshop in other discussion forums; define participants' responsibilities, clarifying periods, indicators and responsibilities for the results of the discussions; disseminate amongst participants, clarify doubts and seek suggestions on the material to be published; and enrich the publication with contributions by other members of Dialogue Group.

[6] Fifty-two per cent of the affects lands are in the state of Pará, 33% in the state of Mato Grosso, and 15% in the Amazon. Sixty-five municipalities are affected by the highway including 32 in the state of Mato Grosso, 28 in the state of Pará and five in the Amazon.

1970s were undertaken by "colonizing" companies on land that had been purchased from the State. Several of these companies already had experience that had been gained through projects in the west of Pará.[7] In general, those projects had been aimed at creating small and medium-size properties (50 to 1000 ha) that were offered to farmers from the south and southeastern parts of Brazil, who migrated north to escape social tension and agricultural conflict.

With respect to the highway, several projects were approved using a settlement model that was similar to the model that had been employed in the construction of the Trans-Amazon highway. This model was based on three levels of urban settlement: a) a rural municipality, designed to be a regional political and economic center; b) agricultural municipalities, designed to be secondary centers (many of which have since become independent municipal districts, such as *Vera*, *Cláudia* and *Santa Carmem*); and c) agro-villages, which are at the centre of the rural communities. Typically, under this model, the further the plots were from urban centres the larger they were. Also, the managers of the projects in the colonizing model selected settlers according to their ability to cultivate the land. Most of them were of Italian origin and came from the states of Paraná, Rio Grande do Sul and Santa Catarina.

Typically, private colonization occurred based on speculative objectives with little, if any, intervention by the State.[8] For example, the city of Itaúba was created to support the commercial activities involved in timber exploitation and subsequently the establishment of pasture for cattle farms. The Brazilian Government has since attempted to instill some order in the colonization, and ensure benefits for communities involved. For example, the city of Matupá was established through the authorized allocation of land to *Grupo Ometto* – a large agribusiness corporation. However, this came with social obligations, such as the obligation to build infrastructure to house workers. It is significant that over the past 30 years the role of Brazil's Colonization and Agrarian Reform Institute (INCRA) has changed significantly. At the beginning of the 1970s it operated much like a planner and developer with a view to opening up the agricultural frontier through the settlement of public lands. Its role has now shifted to one of regulator and enforcer of laws to

[7] Particularly through the Real Estate Society of Northwestern Paraná (SINOP).

[8] "The presence and performance of the State in agricultural frontier areas, whose common element is land occupation and land-grabbing, is insignificant. Such disordered occupation also generates intense deforestation which could increase in the coming years, worsening the trends already registered in 2002 and reaching new areas such as the south of the Amazon." *The PPA 2004-2007 in the Amazon: new trends and infrastructure investments*. Report of the 19th Meeting of the International Advisory Group (IAG) of the Pilot Programme for the Protection of Tropical Forests of Brazil – World Bank.

prevent the illegal settlement of land, particularly with respect to private property and nature reserves.

The emergence of cities in the region affected by the highway project resulted originally from encampments developed because of the prospecting and logging that occurred in the frontier area. Between 1980 and 1996, 60 new municipalities were created. The predatory nature of development led to initial appropriations whereby some social groups controlled new areas that were opened to occupation. These groups established the conditions necessary for the development of activities, such as ranching. In the southern portion of the state of Pará land appropriation was driven by land ownership as an element of commercial speculation. This intensified the social conflicts over territory in the region.[9] The economy of the frontier expansion is linked to agriculture – notably cattle and soybeans – and in the future sugar cane is poised to become a major crop. It is this agricultural expansion that is largely responsible for the high rates of deforestation.

Finally, spontaneous settlements resulted from activities linked to the exploitation of natural resources, many of them as a consequence of the illegal appropriation of inhabited State land (mainly in the Northern states) and in some cases private property.[10]

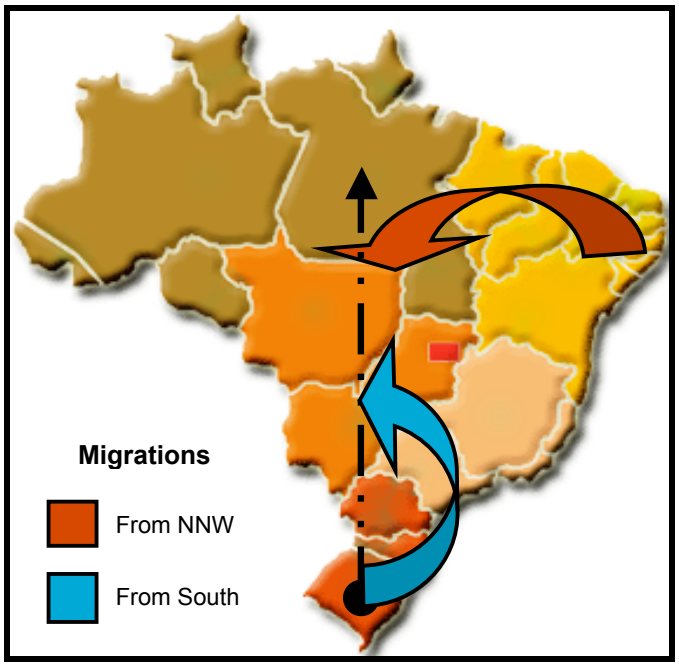
Figure 1 indicates the movements of migrants colonizing the Centre-West region of Brazil. There are significant cultural differences between southern and north-eastern migrants. Southern migrants were pioneers capable of buying land legally because they had sold properties to invest in bigger farms, expand production, and achieve economies of scale. These populations were often of immigrant families with a strong agri-business culture, high levels of education and financial resources. On the other hand, the migrants who moved into the north-eastern area of Brazil tended to be poor, with low levels of education. In some cases migration was made possible because community leaders provided a financial incentive, along with transportation, to prospective migrants to encourage them to settle in the area. These two approaches to land settlement in the region surrounding BR-163 explain different impacts on the local economy and

[9] According to Philip, B. *et al* "…in Rondônia the actual prices of land have increased heavily in response to continuous migration and road improvements and other infrastructure works financed through Polonoroeste". Even in the settlement projects it has been demonstrated that "it is possible for speculators to gain US$ 9,000 through deforestation of 14 ha of forest to convert to pastureland and other subsistence crops for 2 years, and selling the land ownership acquired with such practice". Therefore, land-derived profits in the Amazon are based mainly on population and state investments growing, but they are made possible one way or another.

[10] For example, the city of Novo Mundo in the northern part of the state of Mato Grosso, developed originally as a campground for prospectors and the eventual distribution of plots of land to those willing to work the land.

why migrants from the South are well-established, while migrants from the north and north-eastern communities remain sensitive to pressure from developers.

Figure 1: Migratory occupation of the Northwest, Center West and Southwest regions



3. MAJOR ISSUES RELATED TO BR-163 IN THE LITERATURE

In general, the mere prospect of large infrastructure is enough to generate frontier opening phenomena, which brings with it important impacts on sustainability.[11] This section outlines issues associated with sustainability in the region affected by the highway that have been derived from secondary research.

Highway BR-163 has already been paved from Cuiabá to the boundaries with the states of Mato Grosso and Pará. The section that remains to be paved begins there, and extends 900 km to the city of Rurópolis in the state of Pará. According to local residents, the existing highway in Pará is riddled with dangerous pot-holes and precarious wood bridges that render it impassable during the rainy season. At present, soy produced in the region is exported through the ports of

[11] *The PPA 2004-2007 in the Amazon: new trends and infrastructure investments*. Report of the 19th Meeting of the International Advisory Group (IAG) of the Pilot Programme for the Protection of Tropical Forests of Brazil – World Bank.

Santos and Paranaguá. Once the highway is paved, soy could be exported through the ports of Santarém and Itacoatiara. The use of these ports would reduce the distance over which the soy must be transported by around 600 km (it would also reduce the burden on the ports of Santos and Paranaguá, which are currently working at levels above their optimum capacity). By paving highway BR-163, some estimates indicate that the cost of transporting soy (and other commodities including crops and cattle) from Mato Grosso (a major soy-producing state) to a point from which it could be exported would be reduced by around R$3 per sack. This represents a considerable savings to producers and would increase profits and generate wealth in the region.

Along with generating wealth, the highway project would create employment in the region. The Brazilian Government's Environmental Impact Assessment (EIA-RIMA) estimated that about 1,800 workers would be hired for the four years necessary to complete the work, which includes the paving itself, along with building 64 bridges and around 1,120 culverts. The construction also involves building lodgings for workers and providing equipment along with public services such as energy, water, telecommunications and basic sanitation services. This related infrastructure will require the clearing of land, which will affect existing homes, buildings and other recreational space, such as public squares.[12]

Despite the fact that these prospective economic impacts are on balance positive, the issues related to the settlement in the area surrounding BR-163 are complicated by the environmental diversity, land use and occupation and social aspects. The settlement model encouraged the creation of large companies (many of which enjoyed strong support from the State, such as Embraer and Engesa) and encouraged large-scale agricultural production and the development of medium and large agricultural companies. It also encouraged the development of a production chain in agriculture that would contribute to the national balance of payments while, at the same time, opening up new frontiers for cultivation. The Brazilian Government invested in agricultural research, subsidies and tax incentives to facilitate access to land by large private companies, with important consequences for economic, social and environmental change in the affected areas. Moreover, the intensification of cultivation practices and the proliferation of rural extension courses and agronomy universities resulted in significant increases in productivity for

[12] In the municipalities of Trairão and Novo Progresso in the State of Pará there are already financial agreements being negotiated to acquire buildings and public spaces to allow the highway project to proceed.

agro-industrial crops. Export crops were particularly promoted, and it is in the export-oriented sectors where modernized agriculture is dominant.

However, a lack of planning associated with this development and high levels of economic growth led to serious social and environmental externalities, encouraging concentration in land tenure (which led to conflict), increased rates of deforestation, the social and cultural disorganisation of local communities, flooding of forests and other areas inhabited by traditional populations, and pollution. The exclusion from the policies of traditional family-run agricultural activities resulted in poverty among the rural populations and mass migration to urban centres. These are among the issues related to sustainability that are raised by the highway project in addition to the positive impacts on wealth generation and employment in the region.

Table 1 includes a summary of general potential impacts (positive and negative) of the paving of BR-163, derived from the literature review. Issues highlighted in this study are forestry (deforestation), land tenure, and agriculture, in particular the encouragement of large-scale agriculture including cattle ranching and industrial monoculture in crops such as soybeans.

Table 1: Summary of Potential General Impacts: Highway Construction and Operation

Positive	Negative
• Encourage economic activities (such as farming, forestry, mining and services) and regional development; • Demand created from the development of infrastructure along the highway including regional development generally, but also development of highway support services and maintenance (which will require ongoing investment); • Potential for new public investment and easier access to education and health services; • Increased job opportunities (temporary for construction) but longer term from associated development, with a positive impact on local income; • Increased land value in areas surrounding the highway; • Improved prospects for law enforcement including enforcing environmental law; • Improved transportation in the region which improves communication, the dissemination of information, and facilitates transportation of agricultural and other commodities domestically and for export.	• Increased access to, and potential pressure on pristine land and pressure on biodiversity and habitats; • Potential for increasing illegal roads, logging and the extraction of other natural resources, including minerals; • Increasing agricultural production that may be extensive and unsustainable, as a result of improvements in the transportation infrastructure and improved competitiveness; • Increasing land values could lead to increasing disputes over land and increasing violence • Increased pollution, land degradation and pressure on biodiversity caused by construction, road transportation and accidents; • Improved transportation facilitates illicit activities such as drug-trafficking, smuggling as well as the dissemination of disease and uncontrolled migration; • Increased potential for forest fires.

3.1 Forestry

One of the most widely publicized issues related to the highway is the potential for an increase in forestry activity and resulting deforestation in the Amazon region. It also includes the

indiscriminate use of the Cerrado, an area rich in biodiversity, already impacted by the establishment of settlements on the margins of the highway.

Studies indicate that the dynamics that drive deforestation are complex. Among the causes most commonly associated with deforestation are: the proximity of forests to highways, prices of agricultural commodities, variations in the exchange-rate, availability of credit, population growth, and migration. The evidence indicates clearly the negative impacts of deforestation over the long-term with respect to losses of natural resources, the often irreversible losses of forest-related services, and loss of diversity in forest ecosystems (which exceed those losses in areas that are not forested). Short of full-scale deforestation, the degradation of forests and their fragmentation also have serious negative environmental impacts. Several studies have also shown that proximity to a highway encourages fire.

One article indicates that the most significant factors affecting the Amazon are fire, logging and highways.[13] The article reported that 24.5 million m^3 of forest was cleared in 2004.[14] Much of this is cleared for short-term economic gain. Over 75% of the land is cleared for pasture, much of which is later abandoned. Land is also cleared for soybean cultivation although the average occupation of this land is only around two years.[15]

There appears to be a strong correlation between opening and paving highways and deforestation. While highway paving can bring benefits to the region, these projects must be developed through appropriate planning and monitoring of the development process along the highways. Three quarters of deforestation in the Amazon between 1978 and 1998 occurred along a 100 km strip spanning the region's paved highways. Deforestation along a 50 km strip on each side of three highways in the region shows that between 29 percent and 58 percent of the forests had been cleared by 1991. (Table 2)

[13] *Veja* (December 10, 2005. The article notes that in Brazil approximately 200,000 ha of forest fires are identified annually by satellite. These fires are used as a method of deforestation to expand ranches or to clear land for monoculture. Eighty per cent occur near highways and they represent a loss of US $121 million. Settlements take place along 100,000 km of unauthorised roads, which increase rates of illegal logging. Over 3,000 logging companies undertake destructive clear-cutting.

[14] Assuming a value of R$100 per m^3, this represents a loss of R$ 2.5 billion. Moreover, the CO_2 emissions derived, *inter alia*, from fires makes Brazil one of the five largest global polluters.

[15] When soybean prices are high, the average occupation period for a deforested area is around two years. When the crop is planted immediately following the deforestation (which happens frequently) high sale values are achieved, but production levels are low.

Table 2: Deforestation along paved highways in the Amazon

Paved Highway	Length (km)	Frontier age (years)	Deforested area [1]	
			km^2	%
BR-010 (Belém-Brasília)	1514	~35	47.000	58,0
PA-150 (Abaetetuba-Santana do Araguaia)	991	~20	32.000	37,2
BR-364 (Cuiabá-Porto Velho)	1454	~25	31.000	28,7

[1]Deforested area refers to the 50 km strip on either side of the highway. *Source:* Nepstad *et al.* 2001.

Studies also show that small landowners and settlers were the main drivers of deforestation 20 or 30 years ago. However, this pattern has changed and it is currently large landowners and lumber companies, in conjunction with the 800,000 families in the area, that are responsible for the growing deforestation, which is taking place at an accelerated pace and on a vast scale. In 2004 alone an area the size of Belgium was deforested.

The highway project could also encourage illegal logging, by making the forests more accessible. The profits earned by the illegal logging companies are already enormous, with little repatriated into the local community. One author indicated that the illegal exploitation of eight million m^3 during 2004 produced revenues of around US $1.8 billion.[16] This is equal to the official value of all export revenue for timber in 2003. These huge sums often involve corruption and other illegal activities. Meanwhile, the populations living in the vicinity of this activity live a subsistence lifestyle and tend to be poor, making them easy targets for the developers and the logging companies.

Technology can accelerate the rate of deforestation, through the use of powerful tractors by loggers and farmers, and machines for clear-cutting. The use of defoliants to accelerate the process has also been observed, which results in the degradation of soil, water and biodiversity. Technology has become part of the strategy of some to obtain the largest return possible in the shortest time and to pursue economic development at any cost to the environment and society, behaviour which is ultimately unsustainable.

There have been some efforts to explore the sustainability issues associated with these activities, and to seek the views of stakeholders, and there is a great deal of international interest

[16] Coutinho, L. – "As 7 pragas da Amazônia" – Revista VEJA – Special issue – ed. No. 1926 – year 38 – no. 41 – 12/12/2005 – P.105.

in forest preservation. This has been manifested in over US $500 million in investments directed towards encouraging sustainability.

It is vitally important that information be disseminated widely about the importance of conservation and responsible management of the different forests comprising the Amazon basin. Among other things, these forests have abundant water resources and globally important levels of biodiversity.[17] Less forests leads to less rainfall and less biodiversity (including resources that have not yet been discovered) and ultimately less sustainability. Although there are still some pristine forests in the general region of the highway project, encroaching deforestation is a major threat. Therefore, deforestation is a critical issue associated with the highway that should be discussed in a dialogue among stakeholders.

Table 3: Summary of Potential Impacts: Forestry

Positive	Negative
• Regional development, increased production and possibilities to improve value-added; • Increased job opportunities and opportunities for professional training, both direct and indirect, and improved incomes; • Increased state and municipal tax collection; • Contributions to Brazilian trade surplus; • Improved enforcement of forestry activities and environmental controls; • Improved communication, access to research and dissemination of environmental management practices.	• Improved access to forestry resources could lead to increased deforestation; • Destruction of habitats and pressure on biodiversity; • Increased possibilities for illegal logging and unauthorised building of roads; • Negative health impacts due to increased processing including impacts of sawdust and related chemical products; • Adoption of new technologies could replace manual labour and increase rates of deforestation.

3.2 Land Tenure

Issues associated with land tenure pose a major national challenge in Brazil and affect millions of people.[18] Among the controversial issues surrounding the paving of BR-163 is the existing dispute over land ownership between local residents and developers, particularly in the northern regions of the states of Pará and Amazon. These issues will become more acute as the remaining branches of the highway are paved and land values increase.

Figure 2 illustrates a cycle that prevails in the region and contributes to an ongoing problem, increasing confrontation and the illegal appropriation of State land. This cycle begins with the expectations of new migrants seeking improved living standards. They seek to become landowners and to earn a living farming or collecting forest resources. However attaining wealth

[17] In some regions annual precipitation indexes reach an average of 2.3m.
[18] See Guanzirolli, C.E. National Development Programme, INCRA 1997. Available at www.incra.gov.br.

is very difficult because of long distances from markets and the small-scale of production. Thus they tend to lead a subsistence lifestyle, with no surplus to sell in the market. The next step, speculation, involves demand for the migrant's land for extensive cattle ranching or soy production. The small producers, in no position to resist, sell their land to a speculator who will re-sell it to a large cattle rancher or soy producer. The small producer is thus expelled from the land. This creates a rural exodus, and the cycle begins again.

Problems with land tenure are caused by the poor protection of property rights and typically these conflicts are solved either through violence or payments.[19] This is linked to the paving of BR-163, because some have noted that the value of land surrounding the highway will increase from R$ 50 to R$ 2,000 as a result of the paving of the highway.[20] Typically, the first dwellers to be expelled by developers during the highway construction are the local dwellers of smaller and older family farms. Another concern is that land belonging to groups of small producers will be concentrated into larger holdings for the production of soy, for example, thus encouraging intensive monoculture at the expense of a diversity of small producers. This has already occurred in Brazil's southern states.

Figure 2: Territory occupation conflict cycle

[19] Brazil's Land Pastoral Commission reported that between January and August 2005 there were fewer conflicts although each conflict included a larger number of people. In 2005 there were 794 land conflicts involving 615,260 people. This represents 44% fewer conflicts when compared to the same period in 2004. However data shows that, on average, 774 people were involved in each conflict in 2005 compared with 589 in 2004. This suggests a 31% increase in the number of people involved in each conflict between 2004 and 2005. Brazil's Ministry of the Science and Technology, has noted that appropriation is also influenced by capital derived from illicit activities, allowing their holders to be placed at the basis of political-administrative structures of possible future municipalities, thus, creating new difficulties. http://www.cptnac.com.br/?system=news&action=read&id=1374&eid=8, accessed on November 18 2005.

[20] Melatti, J.C. Indigenous Peoples of South America – Ethographic Areas, available at http://www.geocities.com/RainForest/Jungle/6885/ias.htm. - accessed on November 10 2005.

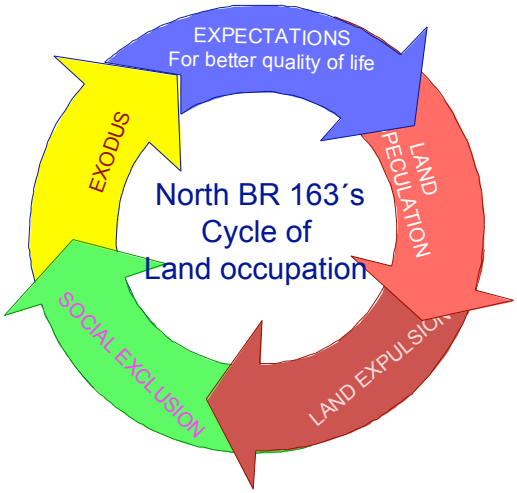


Table 4: Summary of Potential Impacts: Land Tenure

Positive	Negative
• Higher land values near the highway; • Development of legal land business intermediation.	• Small property-holders could come under pressure to sell their land, in order to concentrate production; • Accelerated disorganised migration resulting in increased competition for land and possibly violent clashes; • Improved transportation could encourage increased levels of uncontrolled migration.

3.3 Agriculture

From an environmental perspective, the Brazilian agricultural sector is recognised as both a cause and a victim of unsustainable social and environmental development in the region. It has been the main generator of Brazil's trade surplus owing to favourable conditions for production including access to large amounts of land, long hours of sunlight, abundant supplies of water, and access to technologies. These conditions have led to increasing productivity.[21] However, this activity has come at a cost to the natural ecosystems and to biodiversity.

[21] This success is explained in large part by the history of the settlement of the affected lands. The settlement of Brazil's Amazon was linked historically to geo-political and economic phenomena driven by the search for raw materials for the export market. However, since the 1970s the settlement has responded to the need to expand the frontier and assist growing rural populations from the northeast, south and south-eastern parts of Brazil to escape drought, land scarcity and to improve prospects for the development of mechanised agriculture.

Agriculture (cattle and crops) in the Amazon region is divided into two general production systems. The first is the "mainland" system which includes areas not reached by river flooding.[22] The second is "wetlands" system, which are areas that are affected by river flooding. There are also several micro-climates that exist including areas with high levels of rainfall, and those that are subjected to drought.[23] There are two key activities driving agricultural expansion in the Centre-West region: the expansion of cattle ranching, and the increasing industrial-scale monoculture cultivation of soybeans.

3.3.1 The Expansion of Cattle Ranching

In recent years there has been a rapid growth in ranching in Brazil. This is the result of the devaluation of the Brazilian Real and outbreaks of mad-cow disease in the United States, Canada and Europe. It has been encouraged by the growth in global demand for Brazilian beef and unused capacity in Brazilian production.[24]

One expert has suggested that cattle ranching developed in the region as a result of several advantages that this type of agriculture has over, for example, the cultivation of crops.[25] First, cattle provide a clear way of assuring land tenure, which is a priority in the frontier region. Moreover, in comparison to crops, ranching presents lower risks in terms of the market, trade, price, climactic conditions and weeds. It also requires lower initial and operational investment and very little manual labour and produces higher profits in a shorter period than perennial crops. In short, livestock presents the same benefits as crops, but with a lower level of risk.

Ranching is undertaken on natural and cultivated pastureland in both the mainland and wetland areas of the region. It is undertaken by both small-holders and large landowners who take advantage of the favourable conditions with respect to temperature and rainfall that guarantee year-round pastures. The expansion of cattle ranching is the most significant driver of deforestation and irreversible environmental and social impacts in the Amazon. In recent years,

[22] River flooding is caused by the run-off of the snow in the Andes, as well as heavy rains.
[23] Small-scale, traditional and itinerant crop rotation agriculture is practiced in the mainland areas by Indigenous peoples and *caboclos*. Annual crops are also planted by small pioneering farmers (migrants from other areas), in addition to cattle, perennial crops, mechanized annual crops and horticulture. Small landowners, like riverine populations, practice subsistence agriculture and produce annual cultures on wetlands such as rice, horticulture, fiber crops and cattle and Indian *buffalos*.
[24] Although outbreaks of foot and mouth disease in 2005 have lowered prices and curbed recent expansion.
[25] Sérgio Margulis, economist for the World Bank

the area used for the production of livestock has reached 45 million ha.[26] The biodiversity losses are irreversible and the value of the depleted forest is estimated at US $100 per ha per year.

The existence of the highway has increased the rate of financial return on investment for cattle in both milk and beef production. Indeed, small-scale cattle production for milk can produce even larger returns than extensive cattle ranching for beef. This is significant for the small-scale and even the family farm. Moreover, there are larger financial returns on cattle for beef where new technologies are employed that support more cattle per ha (1.5 to 2 head compared to a national average of 0.55 head per ha, the latter which represents extensive livestock rearing).[27]

At present there is a trend towards intensifying production systems and a general increase in efficiency. This has been driven by global demands to maintain competitiveness, and competition from industrial monoculture of crops such as soybeans and sugar cane. Brazilian ranchers have responded in the more urbanized and developed areas of Brazil by investing in technology and training, yielding positive economic results.[28]

In the region surrounding the highway, the potential also exists to increase value-added in the cattle industry and therefore maintain and even improve farmers' incomes without increasing pressure to continue deforestation and land-clearing. This involves the use of technology and training to make the slaughtering process more efficient, to encourage planning, quality control, rotation of pastures, and investments in irrigation and fertilizer. However, these production trends (including training) are not yet fully established on the agricultural frontier where ranching is still a relatively young enterprise, herds are not yet mature, and pasture and technology management is developing. This could explain the low profits per ha and the need for extensive livestock which still requires land use on a very large scale.

One author contends that the viable development of livestock in the frontier region depends on a reduction in transportation costs, the incorporation and consolidation of

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[26] *Veja* magazine and Sergio Margulis.

[27] By the mid 1980s the traditional cattle sector was not producing satisfactory financial returns while using the traditional technology, except for tax incentive, and profit from land speculation. By the 1990s small-scale cattle of milk became viable with some 12% rate of return on investment. In recent years, returns for traditional extensive livestock production have fallen to between 3% and 5% in some areas, and to 9% for small-scale cattle for milk production located near the highways. Extensive livestock rearing generates a rate of return of between 3% and 20% for large capitalized producers. LIMA, H. in "Dinheiro Antecipado" Safra Magazine – November 2004, p.47.

[28] In some cattle for beef ranches the index of animals per hectare (or unit area – UA) is 1.35. It is as high as 2 UA on cattle for milk ranches. This compares favorably to the national average of 0.55 UA.

technologies appropriate to the area, finding synergies between agricultural production and timber exploitation, on market transformation and urban growth, and on the opportunity costs of opening-up new land versus intensifying the use of current pastures. The author suggests that the rapid incorporation of new areas for livestock (which becomes more profitable and consolidated due to the development and use of technology) will be able to capture markets in the south of Brazil, and international markets, as well as maintaining local markets.[29] This view suggests that the trend in cattle and pasture expansion will continue and could be accelerated by the paving of BR-163.

Demand for Brazilian cattle is high and is increasing. This is due to rapid growth in emerging countries with large populations in Asia, Eastern Europe, the former USSR, Africa and the Middle East. Moreover, the incidence of mad cow disease in the EU means that traditional US and European consumers are seeking new suppliers, which has opened up opportunities for Brazilian producers, despite some problems of their own with foot and mouth disease.[30] The devaluation of the Brazilian Real also means that meat production in Brazil is affordable in these new markets. This, combined with low levels of gross domestic product (GDP) in Brazil and low levels of purchasing power among the population encourages export at the expense of domestic consumption.

Some authors contend that in the next decade there will be a slowing in the rate of horizontal expansion in this sector, as a result of land scarcity, and growth in intensive cattle production. To the extent that this includes attention to increasing value added this growth could occur without increasing the size of herds and expanding pasturelands.

[29] The 2005 Livestock Annual (ANPEC) predicts that over the next decade new growth can be expected that will be based on the intensification of ranching, rather than on the expansion of herds onto new land. ANPEC suggests that the main market will be the international market, to the detriment of the domestic market (which will lose 29 kg *per capita*).

[30] Outbreaks of foot and mouth disease has resulted in the loss of export markets and mass slaughtering of herds leading to the current low-phase in the production cycle (due to recent slaughtering of breeding stocks) and relative "idle capacity" of quality animal production.

Table 5: Summary of Potential Impacts: Cattle Ranching

Positive	Negative
• Reduced costs and increased profits; • Intensive livestock development and development of the production chain and trade chain allowing for increased competitiveness; • Potential to increase value-added; • Direct and indirect employment; • Increased local income and tax collection; • Land concentration with a more efficient resource use. • Increased value added and greater attention to productivity could decrease demand for new land as a result of intensive livestock, which can relieve pressure on forests; • Increased possibilities for export.	• Growth in intensive production of cattle could lead to expansion of pastureland which would encourage deforestation, particularly in the Northern region, and put pressure on habitats and biodiversity; • Increased pasture lands through deforestation. • Increased pressure for land encourages deforestation in the Northern region; Loss of habitats and biodiversity; • Vulnerability to international prices and demand; • Possibility of more rapid spread of disease; • Pressure on Indigenous Peoples to convert their lands into pasture areas for lease.

3.3.2 The Expansion of Soybean Monoculture

In 1970 soybean cultivation began in earnest, primarily in Brazil's southern states. By 1980 it had reached the Centre-West of the country and production grew rapidly making it the most important crop in the region. By 2004 the Centre-West area accounted for 64% of Brazilian production and there is scope for continued growth.

According to a study by the Brazilian Agricultural Research Corporation (EMBRAPA),[31] taking into account the average production rate from 1970 to 2004 in Brazil's Southern states, soybean cultivation increased by 12 times while in the Centre-West the cultivated area increased by some 1.5 times during the same period. Therefore, soybean is the Brazilian crop with the highest increase rates both in production volume and cultivated areas.

There were several causes for this rapid growth. These included, *inter alia*, tax incentives, growing markets, the use of technology and mechanisation (particularly from the United States), a growing interest in a healthier diet (that substituted soybean for animal products), the development of processing facilities, low prices for land in the Centre-West region, incentives to producers to use improved seeds, improvements in transportation systems, and favourable climactic conditions including high levels of rainfall.

Since 2000, cultivation of soybeans has expanded into areas of the Cerrado and into already deforested areas in the states of Amazon, Roraima and Pará, which were previously

[31] EMBRAPA SOJA - Production Systems – Soybean Production Technologies – Centre-West 2005.

degraded pastureland in the area surrounding BR-163. At present, the Amazon region accounts for over one-fifth of all soybean crops in Brazil.

The expansion was facilitated by new technologies developed by EMBRAPA and the growing experience of the producers themselves. This expansion has been made commercially viable with the paving of the highway. Also contributing to the commercialisation of production in the region was the development of canals which established the "Rio Madeira Export Corridor". This was part of the government project to develop the primary economic sector in the state of Amazon and in particular to encourage the production of soybeans. It includes two dry bulk terminals (one in Porto Velho and a second in Itacoatiara) which were built through investment by BNDES and Grupo Maggi.

According to one expert, with respect to potential competition (or substitution) between cattle and crops, there is a trend towards large-scale agricultural production on land that has not previously been "adapted" for crops.[32] This is most commonly the practice for soybeans and is in contrast to techniques used in the past to prepare the soil.

Despite its economic success and its vital importance as an export commodity, soybean is considered a risky crop. In 2004 losses were assessed at around 20% due to a drought in the Southern states and excess rainfall and "Asian Rust" disease in the Centre-West.[33] In addition, it is a commodity that requires the use of appropriate technology and high levels of inputs, including pesticides. Profit margins are low and large economies of scale are required for profitability. It is also vulnerable to changes in the international prices.

This dynamic contributes to the lack of sustainability associated with the crop leading to environmental degradation driven by short-term economic interests and continuing need for new land to cultivate. Highly mechanised farming techniques and the economic risks associated with supplying the export market mean that it is too economically risky for small-holders to participate effectively in soybean production and this leads to rural-urban migration. Poor environmental practices are pursued by farmers who are unconcerned by, or unaware of, the impacts of their behaviour on the natural environment. The development of best management practices and production practices (such as no-tillage agriculture which protects soil, although it still requires

[32] Adapted land is land that has been previously deforested for cattle and then for crops. Land that is not adapted is cleared and then used immediately for crops. In many cases this soil is too acid for efficient production.
[33] Total losses for soybean producers derived from "Asian rust" amounted to US$ 2 billion.

the use of some herbicides) requires an investment in time, resources, and training that many producers have been either unable or unwilling to make.

According to EMBRAPA, demand for Brazilian soy is increasing and soybean cultivation is expected to continue to expand. This expansion will be driven by several factors including, *inter alia*: population growth and increased global purchasing power (particularly in Asia); greater production and consumption of pork and chicken (which require a soy-meal based feed) in part because of "mad cow" disease; the use of soy oil in applications such as to produce bio-fuel, paints, lubricants, and plastics; the growth of domestic consumption; favourable world prices; the increasing export of soybean for processing in importing countries; declining protectionism among major international competitors and the limits on expansion in the territories of their major competitors (United States, Argentina, India and China) due to increasing scarcity of appropriate agricultural land.[34] Based on past experience, the improved transportation infrastructure in the Centre-West region of Brazil is likely to encourage this expansion. However, there remains a lack of value-added in Brazilian soy production. Moreover, the considerable acreage of degraded pasturelands across the region should be employed in its production.

One impact of increasing demand may be to put pressure on producers to open up Brazilian soybean production to the use of transgenic varieties in order to reduce costs. In general the impacts of increasing production are mixed, as indicated in Table 6. However, the adoption of best management practices, the use of new pest-resistant varieties, and the increased value-added through processing could slow the rate of agricultural expansion.

[34] According to EMBRAPA, in the Cerrado ecosystem alone Brazil has over 90 million ha of natural lands that can be incorporated into the soybean productive process, with potential irreversible losses of priority conservation areas.

Table 6: Summary of Potential Impacts: Soy Production

Positive	Negative
• Regional development, new business development; • Positive impacts on income (direct and indirect); • Increased demand for infrastructure and machinery and professional services, including training; • Contribution to Brazil's trade surplus; • Increased state and municipal tax collection. • Development of production chain, including inputs; • Greater availability of food and improved nutrition; • Improved dissemination of best practices and new sustainable cropping technologies; • Best practices including no-tillage management can assist recovery of degraded land in the medium term; • To the extent that development occurs in areas that are already degraded and cleared as pastureland, the pressure on the forests could be relieved.	• Concentration of land and intensification of production and high levels of mechanisation without appropriate attention to sustainability; • Increasing dependence on high-risk monoculture; • Pressure to expand into new areas that can encourage deforestation in the Cerrado and Amazon which results in habitat and biodiversity loss; • Improved transportation could lead to increased dissemination of disease; • Increased dependence on agro-chemicals as a result of intensification and potential negative impacts on ecosystems (contaminate watersheds, fauna, flora and damage biodiversity) and human health (without proper management); • Use of irrigation that can provoke hydrological unbalances and water table depletion; • Increased dependence on global prices for traded commodities; • Pressure on Indigenous Peoples to convert their lands to agriculture areas.

4. MITIGATION ACTIONS HIGHLIGHTED IN THE LITERATURE

This section presents some of the proposals and reflections that emerge from the literature review on the sustainability issues surrounding BR-163. It focuses on actions that could be taken to improve conservation on a regional scale.[35] These include, supporting the role of traditional small-scale family farms, encouraging long-cycle agriculture, investing in technologies that support sustainable production, promoting reforestation and agro-forestry projects, and

[35] The fundamental recommendations developed by Task-Force on Environmental Sustainability, in the United Nations Millennium Project are applicable generally to this study. They include, among others:

- Reducing adverse environmental impact of agriculture by seeking sustainable cultivation techniques, restoring depleted lands and protecting the natural habitat around agricultural areas
- Reducing forest destruction through encouraging the legitimate exercise of income generation activities that depend on the maintenance of healthy forests. This can be achieved by guiding the enterprising spirit of those providing agricultural products - including timber companies, wood sculptors and gatherers and hunters - towards sustainable, and yet, profitable practices
- Taking advantage of the clean water resources by focusing the most efficient use of water in agriculture, establishing and enforcing pollution reduction targets for water tables and surface waters, establishing appropriate levels for the level and flow of the rivers, and controlling invasive species.
- *Environment and human well being: a practical strategy,* elaborated by the Task-Force on Environmental Sustainability, in the United Nations Millennium Project.

diversifying into other activities such as organic production, aquaculture and ecotourism, provided they are pursued in a sustainable way.[36]

4.1 Promoting Small-Scale Family Agriculture

The role of small-scale family agriculture in Brazil is vital. This sector involves over four million families and generates approximately 38% of the farming-livestock GDP, making use of over 75% of the labour in rural areas.[37] Traditional migratory and itinerant agriculture is probably the most important land-use system in the Amazon region, not only from an economic perspective, but also given the number of people who are directly or indirectly dependent on this type of agriculture. Small-scale family agriculture is concentrated in subsistence crops such as rice, corn, beans and cassava.[38] This sector faces serious sustainability problems including:

- Low productivity due to little scientific and technical knowledge on good management practices currently required for market integration
- Little knowledge of the economic benefits that could be derived from the paving of BR-163;
- Little or lack of access to capital;
- End of fallow practices due to economic pressures and increase of regional demographic density resulting in increased land prices; and
- Restrictions on deforestation.

Given these constraints, where possible family production has turned to short-term monoculture or livestock. Both of these activities depend on the availability of credit and technical support. As a result, new demands have been created that include debt repayment, the intensification of production – which have negative impacts on the community (forcing work off the farm and the sale of land in some cases), degrade the soil and have other negative environmental impacts.

According to some sources, the family sector is increasingly reorienting itself to including mixed production systems that include a range of crops in addition to livestock. These activities involve deforestation and the cultivation of native crops. The rearing of livestock by family

[36] "Long-cycle" agriculture refers to production that requires over two years from planting before it can be harvested.
[37] Valter Bianchini, (secretary of Family Agriculture SAF / MDA) http://www.biofach-americalatina.com.br/05-portbf03sept26.htm.
[38] The regional production of rice involves slash and burn of dense forests and of *capoeirão* (secondary vegetation over 5 years old). Other crops include*, inter alia*, mallow, jute, fruits and cotton.

farmers is undertaken in part as a supplement for food and as a means of "savings" that a family can call upon if it faces financial difficulties.

This mixed agriculture has been shown to have the potential for generating positive economic, social and environmental impacts. However, the income generation is not continuous thus keeping the farmers in a subsistence level. In general, the families alternate between wealth accumulation and deprivation of capital, where timber exploitation or livestock contribute to their improved cash flow.

Small-scale family farms contribute to regional rural development, keeping people working the land and slowing migration to the cities. However, there are still a large number of subsistence farmers (originating from the settlements) who are not considered to add economic value to the region and are thus targets for land appropriation.

Table 7 presents the estimated costs of externalities between ecological agriculture and extensive agriculture.[39] It considers five agricultural systems.[40] It shows that the small ecological producers and the organic companies have the largest profitability and ability to renew (per area unit). This generates jobs, produces higher quality produce and respects the natural environment,

[39] Table 4 does not present demand growth projections, consumer profiles and other information to delineate the relative attraction of traditional and organic products.

[40] **Ecological Agriculture System**: an agricultural production system the objective of which is to obtain maximum nutritious and organoleptic quality foods, respecting the environment and without using synthetic chemical products (pesticides, hormones, antibiotics, etc.) or GMOs.

- **Traditional agriculture**: this is a system that is based on cultivation techniques that have been employed for centuries by traditional populations. These techniques prioritise natural resources and the use of labour. They are widely practiced by small-holders, family farms and indigenous communities engaged in subsistence farming, and can produce a wide variety of products.
- **Organic agriculture**: this system refers to modern organic production practices mainly on medium and large-scale farms. This production does not employ highly soluble chemical fertilizers and pesticides (apart from growth regulators and synthetic addictive for animal feed). It is based on the use of natural fertilizers, crop rotation and biological pest control to maintain soil structure and protect the ecological balance.
- **Extensive Agriculture System**: a monoculture-based system characterized by the intensive use of external inputs, use of heavy machinery, poor soil management, use of chemical fertilizers and pesticides. These systems tend to lead to the excessive consumption of inputs and the financial, technological and biological dependence of the producer on seed companies. Moreover, the use of heavy machinery damages the soil and displaces workers.
- **Agro-chemical**: a system based on agrochemical employs large amounts of external inputs including chemicals fertilizers, pesticides, and heavy machinery. Unlike traditional agriculture, this modern system is not sustainable because of the damage that it ultimately inflicts upon the soil, the land and the surrounding biodiversity.
- **Herbicide Agriculture**: The "new green revolution" introduced in the last two decades is based on techniques implemented by the green revolution (heavy machinery, intensive agriculture, etc.) associated with no-tillage technique with herbicides use before or after seed blooming (pre-emerging and post-emerging) and the use of chemical inputs or commonly used synthetic.

without depending on industrial inputs. However, this production depends on consumer awareness and their willingness to pay a price premium.

Table 7: Estimated costs of externalities (US$/ha/year)

Externalities/ System	Ecological Agricultural System		Extensive Agricultural System	
	Traditional Agriculture	Organic Agriculture	Agro-chemical	Herbicide Agriculture
Unemployment (mechanization and use of herbicides)	0	20	40	40
Medical treatment (intoxication)	0	0	50	50
Effluent treatment (pollution)	0	0	50	50
Recovery of degraded environment	0	20	20	20
Loss of environmental services	0	20	20	20
Subtotal	**0**	**60**	**180**	**180**

Source: Adapted from ORTEGA, E. – "*Soja no Brasil: Modelos de produção, custos, lucros, externalidades, sustentabilidade e políticas públicas*" Available on the Internet.

The author suggests that the best option for sustainable agriculture in Brazil is an agricultural system that is based on small family farms that grow organic crops. This ecologically sensitive production would ensure an adequate standard of living and the responsible use of natural resources. Also, an economically viable agricultural system that is based on small plots of land enables a people to remain on their land, thus avoiding rural-urban migration. There could even be the return of populations from the cities, back onto the land, which would reduce the social pressures created by the growing number of urban poor in Brazil's major urban centres. The organic or agro-ecological productive systems favour family agriculture by reducing contamination risks for the producers and their environment, besides reducing production cost and increasing trading margins and favouring local developments and general improvements in the standard of living for these farmers.[41]

In order for small scale farming to be viable, there needs to be attention paid to promoting education and training, health, and improving access to credit. At present the dissemination of technology that could promote sustainability is limited because of insufficient education and training. Therefore, improving the educational level is a key growth factor for improving the

[41] Valter Bianchini, (secretary of Family Agriculture SAF / MDA) http://www.biofach-americalatina.com.br/05-portbf03sept26.htm.

workforce and transforming low productivity agriculture and typical family agriculture in the region surrounding BR-163 into small enterprises capable of driving to wealth accumulation. Such investments will help improve incomes and create wealth and opportunities for present and future generations.

Moreover, access to credit for small producers should be improved. During the 1990s agricultural credit policies encouraged cattle breeding among family farmers, along with high international prices. However, low technical standards and little care in management led to outbreaks of disease, such as foot-and-mouth disease, which had previously been controlled. Credit policies subjected the small family-run farms to pressure, leading them in some cases to abandon traditional extractive activities (such as harvesting Brazil nuts) and resulted in unplanned expansion and degradation.

Financing plays a major role in the decision-making of large-scale producers, particularly with respect to activities that could improve the value-added of their products, take pressure off the land, introduce best practices, and comply with social and environmental legislation. Financing policies should encourage technical support as a fundamental element for the implementation of sustainably responsible production, as well as assure the linkage between cultivation and technical support. To address this, Brazil's Social Development National Bank (BNDES) (in conjunction with the Ministries of Agriculture, Livestock and Provisioning and Agrarian Development, and Finance) has developed specific credit policies aimed at encouraging sustainable behaviour in the farming and livestock sectors with a view to promoting sustainable development in the region surrounding BR-163.[42]

4.2 Investing in long-cycle agriculture

Some 20,000 small, medium and large-scale producers, mainly in the states of Pará, Rondônia and Mato Grosso, carry out the cultivation of long-cycle crops geared towards agro-industry. The mains crops are palm oil, rubber, *guaraná*, cocoa, black pepper and coffee. Citrus fruits, in

[42] Several of these are worth highlighting including: Agriculture Financing Special Programme; Family Agriculture National Programme (PRONAF); Programme for the Modernization of the Agriculture Fleet of Lorries and Associated Implements and Harvesters (MODERFROTA); Irrigation and Storage Incentive Programme (MODERINFRA); Agriculture Modernization and Natural Resources Conservation Programme (MODERAGRO); Commercial Cultivation and Forest Recovery Programme (PROPFLORA); Cooperative Development for Livestock Production Added Value Programme (PRODECOOP); Agribusiness Development Programme (PRODEAGRO); Fruit Culture Development Programme (PRODEFRUTA); Agriculture Inputs Refinancing Programme; the Integrated Amazon Programme (PAI) and the Centre-West Programme (PCO).

particular oranges and lemons, are also cultivated near large urban centres.

In general, this type of agriculture is relatively sustainable; impacts on the environment tend to be minimal, economic returns tend to be adequate and jobs are created. Several of these crops are already being grown in the state of Pará in the region surrounding the highway, including, in particular, cocoa and palm oil.

Viable cocoa production has existed in the state of Pará since the 1970s at the time of the original settlement program. Despite producers' complaints about low prices, cocoa represents an important source of income. Improvements in the quality of the cocoa would allow it to compete more effectively on the international market, which is currently dominated by Asian producers.

During the 1990s the palm oil crop expanded rapidly in the Amazon region. In 1997 the state of Pará produced 80,000 tons or palm oil, which represented 85% of Brazil's national production. Global forecasts suggest that the production of palm oil (which is nutritious and can also be used to produce bio-diesel) will overtake the production of soy oil in the future.[43] The production of palm oil has important impacts related to sustainability because it is a very labour-intensive crop, harvested by hand, generating one job per year for every five ha of production, with few negative environmental impacts.

Initiatives in the palm oil industry, and its support for small-scale farmers, provide a good example of the application of a development model that supports sustainability. Brazil's largest palm oil producer, the *Grupo Agropalma*, has been investing in important socio-environmental activities in the Amazon region. In partnership with the municipality of Moju (some 50 km from Belém and with 60,000 inhabitants), EMBRAPA, the State Government of Pará, and the Bank of the Amazon, the company designed a Palm Oil Agriculture Pilot Project, an initiative involving 50 families at present and that will include another 100 families by the end of 2006. Twelve ha of land was donated to each family by the Land Institute of Pará. *Agropalma* supplied seedlings and provided training on appropriate techniques for palm cultivation with a view to extracting its oil (used largely the cosmetic and food industries worldwide) and bio-diesel. There are several other crops where a smaller-scale, sustainable approach shows promise and where a similar model for development could be applied through public/private partnerships.[44]

[43] Global production of palm oil reached 17 million tons in the 1996-1997 harvest, approaching levels of soy oil, which stood at 20.3 million tons.

[44] Black pepper is one possibility, although that crop has lost some competitiveness during the lat decade due to low international prices. Another crop that could be expanded in Pará is the *cupuaçu,* whose planted area during harvest

The paving of BR-163 would encourage this production of long-cycle crops by providing an opportunity to access key markets in Brazil and abroad by facilitating transportation. In this way, provided the appropriate development models are in place, it could support the continued viability and sustainability of small-scale family agriculture.

4.3 Technology

Technological development in the agricultural sector can be used to reverse pressure on forests and the over-use of natural resources to protect and conserve biodiversity, soil and water. There are several investments in agricultural technology already taking place in the region. In particular, EMBRAPA is making a contribution through its research on seeds, the application of agro-chemicals and the dissemination of knowledge with respect to aquaculture, perennial crops and technical advice on cultivation techniques for mainland areas and *várzea* areas (fertile valleys near rivers).[45] Research on technological alternatives that enable diversification into wetland crops (such as corn and beans) can also be pursued, ensuring the use of the best adapted techniques for specific agricultural systems.

Technology can also play a role in reducing the need for further deforestation by improving the productivity of land that has already been cultivated. Thus, technology can help replace the current unsustainable cycle associated with traditional agriculture whereby cultivated areas have low productivity and where large tracts of land need to be left in fallow to regenerate, during which time they are unproductive.

The technology developed by Brazil's research institutes can be used to conserve the forests and other areas of the Cerrado and increase productivity in areas that have already been

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time should saturate the national market. Other perennial crops that present opportunities for expansion are the passion fruit (one-third of the national production is in the Northern region) and *urucum* (the state of Pará is the third largest national producer). Orange production has expanded in northeastern Pará, to the points where imports from the South and other regions in the northeast of the country have been halved. Research is are being conducted to develop the *curauá* crop in the area of Santarém and peppers in the northeast of Pará. Some market niches are emerging for the *acerola* crops, with a view to supplying the local market, besides *durian, rambutã* and *mangostão* supplying the market in the south of the country. Another crop emphasized in development proposals, is the cashew for nut production, a highly commercial product abroad. The second most important crop from a national perspective is the pineapple.

[45] Owing to their specific characteristics, the exploitation of food crops in wetland areas requires differentiated and careful management, especially considering the potential for damaging fragile wetland ecosystems. Rice crops using flood-irrigation techniques in wetland fields in the *Médio Amazonas Paraense* became a landmark in the exploitation of those areas by using more productive crops and by reducing environmental aggression due to the incorporation of dense forest areas and of *capoeirão* for planting *sequeiro* rice (dry plantation), a typical product of that type of management.

cultivated. This would help avoid unplanned expansion, reduce pressure on water resources, soil and biodiversity and assist small-scale farmers to implement sustainable production from an economic, environmental and social perspective. It is therefore important that research institutes (such as EMBRAPA) engage in discussions of the potential social and environmental benefits of technology.

4.4 Agro-forestry and reforestation

Reforestation projects (particularly with eucalyptus) are one option for increasing profitability of rural properties. Reforestation is a highly intensive activity as regards land and labour. However, the value of products such as firewood, cellulose and vegetable coal make is a viable economic activity.[46]

According to Brazil's 2005 Livestock Annual, the demand for forest products is poised to grow and can improve producers' earnings. As indicated in Table 8, eucalyptus plantations produce the highest return per hectare per year of major crops. Moreover, reforestation projects have the added environmental benefit of providing sinks for carbon sequestration.

Table 8: Profitability of Major Crops

Crop	R$/ha/year
Eucalyptus	1,000
Sugar cane	700
Citrus	600
Soybean	200
Corn	130
Beef cattle production	120

Source: ANUALPEC 2005 – Instituto FNP.

Despite these positive impacts, reforestation and agro-forestry should be pursued in a way that supports sustainability. For example, projects should be developed on land that has already been deforested, degraded or abandoned and should not involve the clear-cutting of existing forests. The reforestation of land with eucalyptus is monoculture and while a good option for degraded pastureland it does not replace the rich diversity found in pristine and varied native forest ecosystems. While it may produce short-term economic gains, the introduction of monoculture in forestry will translate into biodiversity losses that are much greater than the losses represented by the trees alone.

[46] This has been shown in Paragominas and Altamira, and Grupo Orsa's certified extraction, in Jarí.

Sustainable reforestation and agro-forestry involves planting trees alongside agricultural crops, allowing the reforestation of the area and possible future use and sustainable management of these resources and the sale of agricultural products in the short-term. Agro-forestry lends itself to the maintenance of small communities and the genetic resources of valuable species while improving the quality of the soil, or protecting and assisting agricultural crops such as cocoa or shade coffee. Research indicates that community-based forest use and controlled management is one of the most promising strategies to slow rates of deforestation in tropical areas.

Therefore, public and private incentives directed towards the recovery of native forests are important, as are those that encourage newly-planted forests to recover sites that have already been exploited in Private Natural Heritage Reserves (RPPNs). Incentives should be designed to focus specific attention on achieving sustainability through the maintenance and regeneration of biodiversity and improving soil quality.

4.5 Promoting Diversified Economic Activity

There are several other economic activities that could be developed on a small-scale and that offer the potential for economic growth in the region without extensive use of land and resources. These are relatively high value products that can be developed by small farmers as well as larger producers. Those highlighted in the literature include, in particular, organic production, aquaculture and eco-tourism.

Organic Production. In 2003 the area under organic production in Brazil was estimated at over 840,000 ha.[47] There are currently over 7,000 Brazilian producers certified as organic, by a variety of non-profit organisations including, *inter alia*, the Association of Biological Farmers of Rio de Janeiro, the Biodynamic Institute and the Association of Organic Agriculture.[48] Attaining such certification allow products to be exported into a growing global market for organics valued at around US$ 25 billion.

[47] Organic agriculture combines traditional methods (such as no-tillage) with the use of modern techniques (such as biological pest control). The organic production chain involves the production of inputs, farming-livestock production, primary and secondary processing, distribution, institutional consumption and certification, and generates employment along that production chain although there is no data on employment generated by organic production.

[48] These organizations provide labels that certify products as "organic"—produced without the use of pesticides and chemical fertilizers in a production system that maintains the balance of an ecosystem, and protects biodiversity and human health.

At present organic products still represent a niche market and tend to appeal mainly to urban professionals with relatively high levels of education who are willing to pay a price premium. However, demand for organic products in Brazil is forecasted to reach over US$ 220 million in the coming years. The existence of the paved highway would help ensure the efficient and timely flow of production to large national markets as well as international markets with the potential to support the production small farmers, among others.

In markets willing to pay for additional value-added, a model that emphasizes organics and preserves cultural heritage and community well-being should be pursued. This might be feasible in Brazil's southern states. On the other hand, the dominance of this type of system may not be feasible, at least for soy production, where profit margins are slim and economies of scale are necessary for production to be viable.

Aquaculture. Aquaculture is more profitable, per unit of land, than ranching. There are varied national and international markets for aquaculture products ranging from freshwater fish for food to ornamental fish.[49] At a global level aquiculture is growing by some five percent per year and offers opportunities to produce a high value product for the global market. Brazil is the steward of 13.8% of the world's freshwater and the aquaculture industry is already growing in the south-western region of the country. Freshwater fish for food is cultivated primarily in the Southern region of Brazil, where 43.2% of the market is dominated by small-holders. A favourable climate and an abundance of water in the Centre-West and the Northern regions of Brazil mean that there are opportunities for growth in this sector in these regions, both for local consumption and for export. The paved highway BR-163 would enable producers to access markets more efficiently. Timeliness of transportation is critical when dealing with such a perishable product. Moreover, this could disproportionately be of benefit to small farmers as a characteristic of Brazilian aquaculture (with the exception of sea-shrimp) is that the sector tends to be structured around small-holders.[50]

However, there are some important environmental considerations associated with aquaculture that must be taken into account in conjunction with any development in this sector. These include investment in water re-use and recycling technologies to maintain the high levels

[49] With respect to ornamental fish, production is still in its infancy and there are, as yet, no standards and public policies to guide production and research and development.

[50] According to Elizabeth Criscuolo Urbinati, Director of the Aquiculture Centre of the *Universidade Stadual Paulista*, the challenge lies in creating effective mechanisms that assure the continuity of projects enabling the maintenance and continued development of the community independently.

of water quality necessary for production, and the responsible management of surrounding animals and birds that might feed on young fish that are being farmed.[51] Specific legislation must be put in place to govern the activities of large producers and ensure respect for the surrounding ecosystems and biodiversity.

Ecotourism. At the global level, eco-tourism is growing at a rate of 20% per year. Ecotourism addresses themes such as socio-cultural, environmental and economic impacts, environmental education and the integration of local communities into the planning and management of activities. It represents an economic, social and ecologically balanced alternative to promote the Amazon development as well as that of the surrounding of BR-163 while at the same time helping to ensure conservation or biodiversity and natural resources. The development of eco-tourism is dependent on the political will of the Brazilian government and the interest in society at large to promote activities that can be a source of income for traditional communities without destroying their natural resources. At present a lack of interest and incentives to pursue eco-tourism is a wasted opportunity to link conservation with improvements in economic wealth and standards of living in the region as well as the generation of foreign exchange for Brazil.

5. THE ROLE OF SUSTAINABILITY ASSESSMENT

It is evident that the construction of the highway will have an impact on the environmental and social fabric of Brazil. Existing studies identifying those potential effects have not been developed in a manner that has promoted the creation of a process to engage all the different actors involved. Moreover, these assessments have not looked at the synergies between trade, infrastructure development and agricultural production policies. In spite of the controversy surrounding the highway development, plans for building the road are likely to move forward with consequent impacts on accelerating development. In this context, it is key to identify practical solutions that can help put agricultural production on a more sustainable path. There are several issues that could be explored further in a SA related to the highway construction, trade and sustainability.

Work already undertaken on the soy sector showed that trade policies and agreements affect

[51] Fish in the breeding tanks are a cornucopia for birds and reptiles and one author of this study witnessed the slaughtering of *socós, seriemas*, and other birds that were feeding in these fattening tanks.

sustainability in that sector in a variety of ways.[52] A report produced by WWF-Brazil in 2003 found that high tariffs imposed on processed soy products in importing countries favour the export of grain.[53] The result was an over-reliance on soy production, leading to deforestation, destruction of species and habitats, the loss of ecosystem functions and services, and significant impacts on the social structures. In addition, further weakening of the processing industry reduces Brazil's chance for improving the competitiveness of processed soy products. The study recommends a set of policies that can be taken at the international and domestic level to ensure that further expansion of the soy sector is done in a sustainable manner. These include: removal of tariff escalation practices, reduction of production related subsidies, zoning and land-use planning, restructuring of tax related policies, establishment of legal reserves and protected areas among others.

As indicated in this report, the paving of highway BR-163 is a critical component of Brazil's trade competitiveness for products originating in the Centre-West region of the country. The strong link to trade, through improved transportation infrastructure for commodities and the potential industrial expansion of agriculture necessitate further consideration and the development of policies and strategies to mitigate potential negative impacts and contribute to positive impacts on environmental and social sustainability. This includes exploring the mitigation activities referred to in the previous section. SA is an appropriate tool through which to develop such policies given its link to trade, its inclusion of economic, environmental and social impacts, and its emphasis on public participation and transparency.

SA follows the same logic as an EIA and Strategic Environmental Assessment (SEA), however, unlike EIA and SEA, SA tends to be more encompassing as it puts equal emphasis on evaluating non-trade effects of trade policy along with trade-related impacts. It examines the

[52] In the soy sector, for example, Brazil is the second largest soy producer (26 percent of world production in 2003) after the United States (38 percent). Moreover, Brazil stands second only to the United States in exports of soy grain and second to Argentina in exports of soy meal. A number of policies in Brazil and its major trading partners favour this specialization in grain. First, Brazil's processing industry is not as competitive as the industries of its main rival Argentina, which benefits from a favourable tax climate for processors and where the industry employs state-of-the-art technology. Second, grain destined for processing industry is subject to taxes that reduce profit margins in the soy-crushing industry in Brazil. These taxes are not imposed on grain and therefore encourage its production. Third, tariff escalation policies on processed soy products in importing countries favour the export from Brazil of grain, rather than meal and oil. This combination of domestic and international trade- related policies coupled with the increasing demand for soy from European and other markets contributes to the unsustainable development of the soy sector.

[53] *Sustainability Assessment of Export-led Growth in Soy Production in Brazil*, 2003 available from website: http://www.panda.org/trade.

interlinking of the three major dimensions of sustainable development – economic, environmental and social – with a view that the effects of trade rules and policies are not only contained in the trade arena but spill over to other development policy areas (e.g. infrastructure development) which in turn can have an affect on a particular production sector (e.g. agriculture). The analysis seeks to identify the linkages and inter-linkages among the various programmatic and policy drivers behind the development of a particular sector.

In addition, SA's main objective is to create a multi-stakeholder process to guide the assessment and to influence policy issues through the integration of the results in the decision and policy-making processes. To this end, it follows a highly participatory approach that is vital to generate awareness, build the capacity of various stakeholders and create a platform for dialogue on the impacts of trade and its linkages to infrastructure development and agricultural production. These processes can be pivotal when agreeing on short-term practical solutions such as best production and management practices in the agriculture sector.

The issues raised in the literature review concerning the development of BR-163 could usefully be explored further in a SA that examines the specific short, medium and long-term impacts of the highway project on economic, social and environmental sustainability in the Centre-West region of Brazil. The results of the literature review and consultations suggest that agriculture presents strong opportunities in the medium term. The results of a SA should help policy makers determine which initiatives should go forward and under what conditions, and where reforms to a policy of program might be required in order to mitigate potentially adverse effects on sustainability. The literature review indicates that there have been several SA-type reports, although few provide concrete examples of the integration of economic, social and environmental elements. Neither do they involve a full range of stakeholders throughout the process.

A SA is more comprehensive than an EIA (already required for major projects) because it prioritises long-term sustainability in its analysis and includes a crucial social dimension. In this case, the medium and long-term perspective is vital, particularly with respect to trade. The 2005 Brazilian Agriculture Annual projected that agriculture will be driven by international demand. In particular, the main forces will be greater demand for food in developing countries as a result of global economic growth, the recovery of agricultural production (including crops and cattle) in developed countries and the lifting of temporary credit restrictions such as those imposed by the

Government of China on imports of soybean and soybean derivatives. Moreover, it is projected that high international prices for crude oil will increase demand for bio-fuels resulting in the increased production of ethanol from corn and bio-fuels from soybean, palm oil and sugar cane.

Farmers in Brazil and in the Centre-West region typically grow two crops in agricultural production, or mix crops with ranching. Therefore, in addition to cattle ranching and soybean cultivation, the relative impacts on sustainability of the mix of crops are important to take into account in an assessment. Table 9 indicates generally some impacts associated with the major crops in the region: sugar cane, cotton and corn. For all of these commodities, demand for Brazilian production is high and is increasing. International trade is among the dynamics driving this demand, as a result of, *inter alia*, increased global economic growth, the removal of agricultural subsidies in developed countries, and increasing possibilities to use sugar cane and corn for bio-fuels.

Table 9: Summary of Potential Impacts: Related Crops

Positive	Negative
Sugar Cane	
• This is a mid-cycle crop which tends to be less damaging to the environment than short-cycle crops. • Increased price of alcohol due to a drastic reduction in crude oil supply, increasing demands for raw materials that replace hydrocarbons; • Increased production by some 48%, reaching 557 m tons for the 2013/2014 harvest.	• Pressure for agricultural expansion leading to new deforestation; • High use of agricultural pesticides that require proper management; • Loss of biodiversity.
Cotton	
• Using recently opened areas of the Cerrado that will undergo soil correction within 5 years, high productivity and generation of profits with high level agricultural performance; • Prices should increase; • Technological advances will improve productivity beyond what is currently observed.	• High use of agricultural pesticides that require proper management; • Loss of biodiversity.
Corn	
• Prices will increase; • The global market will expand; • Brazilian exports will increase; • Could replace soybean as the major crop.	• Large use of agro-chemicals and resulting pollution; • Loss of biodiversity.

Source: Adapted from: 2005 Brazilian Agriculture Annual.

It is in the medium and long term, that the impacts of BR-163 could become most evident. These impacts include a decrease in agricultural expansion over pasture areas, migration from high-risk crops to other crops with better liquidity or safety in agronomic terms, and pressure to liberalize transgenic soybean owing to possible reductions in production costs.

The relationship among the different crops produced in the Centre-West region, and

possibilities for substitution should be taken into consideration in a SA in order to explore the relative impacts on sustainability of different agricultural production. For other agribusinesses that exist in proximity to the highway – sugar cane, cotton and corn – demand is also increasing.[54] Current high levels of global demand driven by, *inter alia*, uncertain supply of crude oil and the search for alternatives, as well as the removal of subsidies by the World Trade Organisation (WTO) for some commodities mean that demand is projected to continue up to at lease the 2013-2014 harvest.[55] Some of this production is already located in the Centre-West regional of Brazil (such as sugar cane) including the Cerrado (cotton) and will be affected by the highway and increasing exports. Increased production will also have environmental impacts, increasing pressure on expansion of agricultural lands, pressure on biodiversity, intensive practices employing high levels of agrochemicals. As a mid-cycle crop sugar cane tends to be less damaging than, for example, cotton or corn.

SA is also distinguished from EIA in that rather than simply evaluating policies, it makes policy recommendations on ways to promote sustainability. It thus requires the involvement of all relevant stakeholders and a relevant dialogue from the outset in order to ensure that policies being proposed have the support of the relevant partners. Moreover, SA is intended to reach concrete results, rather than serve as an instrument to encourage debate alone. It can involve defining the value of projects and policies proposed by governments and civil society, and employ a cost-benefit analysis to identify the trade-offs between economic, environmental and social dimensions associated with a policy or project relationship.

There are several potential impacts that have been identified in the literature and that deserve further attention in a SA. There are also several issues linked to international trade that could be explored in a SA. Expansion in soy is being driven by, *inter alia*, international trade and behaviour in major export markets. Demand from European markets has risen as a result of protein substitution from meat towards soy and other proteins. This is due in part to bans on the

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[54] For sugar cane, there are low levels of world supply, the removal of agricultural subsidies, scarcity of crude oil and increased demand for bio-fuels and increased Asian economic growth. In cotton, there are opportunities for Brazil as a result of the gap in the international market left by Australia which is suffering from water shortages. Moreover, the largest producers (China, India, Pakistan and Uzbekistan) do not have the area of the technology to expand their production and generate new markets and North American producers have been discouraged by the end of subsidies under the WTO. For corn, demand is high and increasing due to global demand that is higher than global supply, and increased markets for bio-fuel, such as ethanol.

[55] 2005 Brazilian Agriculture Annual. For sugar cane, for example, production is expected to increase by some 48%, reaching 557 m tons for the 2013/2014 harvest.

use of meat and bone meal in animal food in the European Union (EU) as a result of recent outbreaks of *Bovine Spongiform Encephalopathy* ("mad cow" disease). Since its accession to the WTO, China has become a major importer of Brazilian soy which is putting further pressure on the sector and encouraging unsustainable production practices.[56]

Increased liberalisation in the soy sector is likely to encourage existing trends in production, with potential negative environmental and social effects. While opportunities offered by liberalisation should be seized, the Brazilian government also needs to develop and enforce policies to manage the expansion of soy production in parallel with efforts to promote exports. This will require strong and effective environmental and social policies.

A study undertaken by WWF in 2003 identified several policies associated with international trade that are relevant for soy production. Moreover, the study indicated that this expansion was contingent, in part, on improved transportation infrastructure. The paving of BR-163 can therefore be expected to encourage the process of expansion of soy production in the Centre-West region of Brazil. One of the central findings of the WWF study was that a SA should be undertaken, that examines trade policies, to develop concrete environmental and social policies to help ensure that further development in the soy sector is undertaken sustainably. This should be extended to the major economic activities affected by the highway project.

A key element of SA is the meaningful inclusion of a wide range of stakeholders including both direct and indirect actors. The literature review highlighted several relevant stakeholders, indicated in Table 10. A supplementary list should be elaborated together with the *Grupo Diálogos.* A comprehensive list of stakeholders will facilitate a full and transparent SA.

Table 10: Preliminary List of Stakeholders

Indigenous peoples; Traditional settlers; Leaseholder/ Invaders; Timber companies; Prospecting; Mining companies; Ranchers; Family Agriculture Units; Monoculture agribusiness; Unconnected employees;	Brazilian Environment Institute (Ibama); Incra – Local Land Institutes; Public Bodies and Ministries; National Health Foundation (Funasa); National Indigenous Foundation (Funai); Army; Research Institutes; Landless Movement (MST); NGOs; Others: seed and agriculture inputs and machinery suppliers etc.

[56] Soy exports account for around 25 percent of Brazil's total exports to China. According to the Chinese authorities, approximately 30 percent of all the soy imported by the country comes from Brazil. In 2005, Brazil exported a total of US$1.7 billion in soy beans to China..

6. SOYBEAN PRODUCTION: BEST PRACTICES

The high rates of deforestation in the Amazon region, brought about in part by the growing demand for agricultural commodities, including soy beans, and encouraged by improving transportation through projects such as the paving of BR-163, suggest that it is vital to identify and implement best practices in the agricultural sector to curb deforestation, pollution and the depletion of natural resources. Not only will such an approach support conservation efforts, but will ensure the future sustainability of agricultural production in the region. Therefore, the aim of this section is to identify measures that can be taken to promote sustainable agricultural production for soy in areas that are already deforested, or lands that have been abandoned.

The discussion on environmental impacts derived from the paving of BR-163 has focused in the past on the advantages and disadvantages of the frontier occupation with large-scale monoculture such as soybean, and whether such occupation should be inhibited or encouraged. However, the reality is that this occupation exists and is increasing in a disordered fashion. In order to promote sustainability, this expansion and growth must be tempered, or reversed, particularly in the Amazon region. Soy bean production is likely to continue to dominate Brazil's agricultural mix in the foreseeable future.

This section presents several strategies that could contribute to the conservation of biodiversity of the Amazon through environmentally responsible soybean production. These could be examined further in the context of a SA, which considers the sustainability impacts of the highway, and in particular its relationship to industrial agriculture (soy and related agricultural activities). The expansion of agricultural production, benefiting from lower transportation costs and higher economies of scale could involve significant expansion of agricultural land, encroaching on pristine land, degrading habitats and natural resources, increasing pollution and compromising the natural functioning of fragile ecosystems.[57]

[57] There is existing evidence of the role of the transportation network with respect to soy production. In South Maranhão, up until the early 1990s soy production was insignificant. With the construction of the Northern export corridor, which allowed for product transportation through the Itaquí port in the north, and the partnership between EMBRAPA, the Vale do Rio Doce Company and other institutions, soy expansion increased and became a key economic activity in South Maranhão. By 2000, the South Maranhense geographical meso-region recorded a cultivated area of 176.4 thousand ha. Moreover, the initial development of soy in adjoining areas, particularly in Tocantins and Piauí States, was also observed.

There are several studies on the use of best agricultural practices that can contribute to soil conservation, avoiding erosion and pollution, the sustainable use of water, and seeking to halt the disordered expansion of production that results in the destruction of biodiversity. A 2003 WWF study on export-related expansion of the soybean sector identified a series of policy recommendations to improve sustainability, with a focus on trade. Table 11 indicates general policies related to best practices that were included in that study and were aimed at domestic policy-makers in Brazil.

Table 11: Some best practices related to soy production

Best agricultural environmental management practices	
Adopt a series of incentives and command and control policies to encourage best agricultural management practices.	Avoid and reduce environmental impacts (particularly over soil and water) and increase land-use efficiency; Improve environmental conditions in production-related areas.
Incentives should be encouraged with a view to enhance the adoption of soil management conservation practices thus discouraging the use of conventional systems.	Avoid erosion and other soil damage.
The association between farming and livestock should be encouraged.	Promote the economic development of large areas of degraded pastures in the Centre-West region of Brazil; Respond to growing market demand; Decrease pressure to convert natural habitats; Decrease poverty related to extensive livestock breeding practices in the Cerrado.

Source: WWF. 2003. *Sustainability Assessment of Export-related Soybean Expansion in Brazil.*

Best practices need supporting policy environment to be successful. These include the enforcement of environmental legislation to ensure that there is effective environmental legislation in place that requires the maintenance of the native vegetation, riparian forests, and encourages the development of conservation units and legal reserves as Permanent Protection Areas (PPAs).[58] A second area of support is research and technology. Available technology and technologies that may be developed in the future can reduce the impacts of monoculture on the

[58] Brazil's environmental legislation requires that in rivers of up to 10 meters, an area of forested riparian forest of 30 meters, should be maintained at its edges. From 10 to 50 meters of width, the forested riparian area should be of 50 meters. From 50 to 200 meters of width, the forested riparian area should be of 100 meters. According to the law those areas can not be used in any way. As for the legal reserve, the Brazilian environmental law defines that in the South and Southeast regions of Brazil (mostly the Atlantic Forest), 20% of the private property should be maintained forested. In the Centre and Centre-West regions (the Cerrado and transition areas), 35% or 50% of the private property should be conserved. In the Legal Amazon, which includes the states of Acre, Amapá, Amazonia, Pará, Rondônia, Roraima and part of Mato Grosso, Tocantis and Maranhão, 80% of the standing forest should be maintained for the legal reserve. Those areas can be managed in a sustainable way with guarantees by Ibama. The PPAs should be preserved untouched, according to the legislation.

environment, including issues such as soil degradation resulting from erosion and/or alteration of physical properties and/or fertility loss or salinisation; and of soil, water and air pollution through the use of agricultural pesticides. Education and training of farmers are also key for achieving sustainable production. This includes sensitivity to the importance and value of sustainability, as well as with respect to the use of best practices. Achieving sustainable agricultural production also requires a long-term strategy on the part of the Brazilian government to implement this vision.

WWF's 2003 study identified several useful policy avenues to support efforts to achieve sustainable production in Brazil, in conjunction with encouraging the pursuit of best practices. These policies are summarised in Table 12 and, along with a comprehensive consideration of best practices, these policies could, *inter alia*, be used as a basis for discussion with stakeholders and/or adopted for a broader examination of the agricultural sector and the impact of BR-163.

Table 12: Additional policy proposals to support best practices and promote conservation in the soy sector

Policy Proposal	Benefit
Legal Reserves and Protected Areas	
Urgently identify and create new protected areas.	Land tenure valuation; Conserve ecologically important habitats; Slow rates of biodiversity loss;
Encourage landowners to legalize their legal reserves.	Land tenure valuation; Conserve ecologically important habitats; Slow rates of biodiversity loss.
Provide incentives for protected areas located in properties through the Green Protocol;	Increase the number of protected areas.
Monitor protected areas more efficiently and effectively.	Decrease levels of biodiversity loss.
Management of Water Resources	
Strengthening water management institutions;	Water resources maintenance;
Adoption of pest integrated management.	Prevent water pollution by agro-chemical products; Prevent production losses.
Development of restoration policies for the Permanent Preservation Areas.	Provide an incentive to restore riparian forests. Reduce levels of deforestation; Improve rates of recovery of degraded areas.
Research and Development	
Research and extension programmes should be geared towards impact reduction over the natural resources as well as reduction of the negatives social implications of soy production, allied to improvements in productivity and production conditions.	Find solution and methods of prevention for environmental problems; Increase the application of technology; Optimise the use of soils.
Settlements and social development	
Develop and implement more efficient models for agrarian reform.	Decreased land concentration and decreased expansion to preserved areas; Encouragement to co-operatives.
Awareness and Education	

Encourage public awareness and mobilization efforts that encourage soy crop sustainability as well as soy and soy products processing.	Increase cost-benefit in the soy sector; Strengthen international and domestic negotiations.
Encourage society to value the multiple aspects of biological diversity.	Raise awareness on the major issues involving environmental sustainability related to soy production; Decrease levels of deforestation; Reduce risks to human health.
Governance	
Promote a long-term integrated vision and structuring of an action plan for the conservation and development of the agricultural sector, including sustainability-related strategies and taking into account the different roles and responsibilities of the federal, state and municipal levels.	Decrease additional agricultural expansion in the Cerrado and in the Amazon; Strengthen the country in the context of the international economy.
Development of a coordinated structure with a view to managing sustainability-related activities in the soy sector, through a participatory way.	Coordinate agreed activities; identify, gather and mobilize interest groups; Delegate roles and responsibilities; Assure cooperation amongst all government levels, the private sector and other civil society representatives; Monitor progress through indicators of measurable targets.
Improve land-use planning and zoning.	Reduce levels of generalised deforestation and pollution; Reduce land-tenure conflicts; Clearly define production areas and areas that should be prioritised for environmental conservation, urban expansion or other uses; Increase conservation awareness.

Source: WWF. 2003. *Sustainability Assessment of Export-related Soybean Expansion in Brazil.*

The adoption of a program to ensure sustainability in the development of agricultural production in the Centre-West region is vital. There are several agricultural practices that can contribute to such a sustainable approach. In some cases these must be varied from product to product and region to region, in a country the size of Brazil.

Managing Pests and Disease. As in all monoculture, one of the main problems in soybean production is the outbreak of pests, such as insects, fungi and micro-bacteria and the invasive plants that compete for energy and nutrients. In using chemical inputs, soybean production impacts both the natural resources and humans. To combat the use of agrochemicals, Integrated Pest Management (IPM) and organic production are two suggested best practices.

IPM is a strategy for the multiple control of infestations based on ecological control and on natural mortality factors. This strategy is not aimed at eliminating the agents, but at reducing their population so that their natural enemies act upon their preys favouring the return of the natural balance disturbed by the plantation and by the use of agricultural pesticides. In so doing,

the strategy requires the understanding of the plantation system as a whole and knowledge of the ecological interlinkages between aggressor insects, their natural enemies and the environment where the plantation is inserted. The primary elements of IPM are detailed in Box 1. Properly administered, IPM limits the potentially harmful effects of chemical pesticides.

Box 1: Main Elements of Integrated Pest Management

Use of resistant seeds - Some varieties of plants have developed defence mechanisms and became resistant or tolerant, so they repel or are less *preferred* by the infestations. The advantages of this tactics include facility to use, compatibility with other pest control tactics, low cost and cumulative impact over the pest with minimum negative environmental impact. On the other hand, the development of pest-resistant soybean varieties require considerable time and investments, and the obtained resistances are not always permanent.
Control through agricultural practices - The adoption of certain agricultural practices makes crops less favourable to infestations. Examples of that include crop rotation, selection of planting areas, planting trap-cultures, and adjustment of planting and harvesting to seasons less favourable to infestations.
Physical controls – The use of physical barriers, such as ditches and plastic cover hinder the movement of insects towards the plantation. Other appropriate techniques include the use of plastic traps, adhesive strips, among others.
Biocontrol - Biocontrol refers to the use of chemicals which occur naturally, or the use of beneficial organisms to prevent, reduce or eradicate the infestation of pests and diseases, including weeds. In the case of organisms it is sought to attract or introduce in the plantation the pest or disease natural enemies; insects, viruses, protozoa, fungi or bacteria can be used as predators, parasites or pathogenic agents; or to introduce sterilized males of the harmful species. Some advantages are related to some reduction in environmental accidents and public safety, resulting from the use of agro-chemicals as an economic alternative to certain insecticides, in preventing economic losses of plantations, less environmental impact and on the quality of water. On the other hand, the main disadvantages are related to the need of better planning and intensive agriculture management, which take longer time, with costs sometimes are higher than the use of agricultural pesticides, requires patience and a monitoring and recording system, in addition to education and training.
Chemical controls - Under IPM the use of agricultural pesticides are justifiable only when the previous tactics are ineffective to control the infestation in the plantation. In many crops, particularly soybean crops, insecticides and herbicides are still the main means of pest control and they have their advantages: they are relatively cheap and easy to apply and transport and they are versatile, as they can be presented in different forms, such as, powders, aerosols, liquids, granulated, baits, and of slow liberation. The insecticides are classified through different manners, but the active ingredient method prevails, for example, the organophosphorates, the piretroydes and others. There is, also, the conventional and bio-rational categories - in the first one the pesticide action spectrum is quite wide while in the second prevails the specialized action, either on the feeding habits or in the life cycles of the infestation. In general, the category of bio-rational pesticides is less aggressive. New application technologies, in the so-called precision agriculture, ally the application of pesticides and the necessary inputs with high-technology remote sensing and the use of Geographic Information Systems (GIS).

In addition, there are several other best practices associated with soybean production that can involve a minimum use of inputs and be pursued even in the absence of IPM or organic production. These include, *inter alia*:

Choice of appropriate cultivars. The soybean is sensitive to photoperiod variations, therefore, cultivars should be chosen based on planting latitudes. Other aspects that should be taken into

account while choosing cultivars include outbreaks of pests or diseases, chosen species for crop rotation, and rates and distribution of rainfall.

Choice of seeds. Seeds should include Seed Warranty Certificates. In addition, they should be submitted to a treatment seeking to incorporate important inputs for the success of the crop. There are studies aimed at seeking to decrease the use of such inputs to the lowest level. This work suggests that wider field studies are necessary to seek the lowest leels of use or even the cessation of use of toxic agrochemical inputs.

Choice of sowing season. The ideal soybean-sowing season depends on the regional distribution of rain. The indications are made taking into account the average of years of pluviometric observations, however, due to possible annual variations it is necessary for the producer to be certain of the humidity of the soil when sowing.

Choice of cultivation system. Currently, the no-tillage system is recommended and it is based on sowing without previous soil preparation and on permanent land cover through crop rotation practice, with two annual crops. It presents advantages as regards the reduction of erosion losses and of soil sub-superficial horizon compacting problems, it improves the use of fertilizers and the conservation of organic matter and surface water, and reduces production costs. The no-tillage practice cannot be used while breaking virgin soils, as the acidity of the soils of the region requires liming. However, once the acidity is corrected, no-tillage techniques can be used for some years before requiring levelling to re-apply lime.

Crop rotation. Crop rotation is essential for enabling the use of a no-tillage system, effectively managing pests and diseases and conserving the soil quality.

Soil correction and fertility maintenance. A qualified professional, following the soil analyses of the property, should carry out soil liming and fertility maintenance; organic production is recommended.

Weed control. Weeds are detrimental to crops because the compete with the cultivated plant. With a no-tillage system, the application of herbicides may be necessary to control weeds. However, when badly applied, herbicides can have negative impacts on water, soil and human health. The correct identification of the invasive species, the use of appropriate products in suitable dosages, the alternation between herbicides of different effects to avoid resistance selection in the combated species, the use of good-origin seeds, the cleaning of machines and equipment and the combat to the first invasive focuses are some practices that can reduce the need for herbicides and reduce negative environmental impacts.

Safe use and handling of agrochemicals. It should be used only products properly registered with the Ministry of Agriculture, Livestock and Provisioning for soybean crops and for the pest, disease or weed needing control. Those applying such products should use appropriate individual protection equipments, should not mix different products, observe the valid date and discard the used containers as provided for in the legislation. Pesticide pulverization should be avoided on windy days, not to increase environmental pollution.

Inter-cropping and the integration of crop cultivation and livestock. Integrating low-tillage (or no-tillage) farming with livestock, or agro-forest systems, are considered best practices in soybean cultivation, promoting the maintenance, recovery and development of improved soils while assuring higher income and lower levels of risk. Benefits derived from integrating farming and livestock include the following:

- Taking advantage of the dry season for animal production;
- Decreasing fertilization costs with pastures due to post-harvest residual fertilization;
- Lower agricultural risks due to diversification of activities;
- Increased income through synergy amongst activities, particularly when considering soybean and meat price increasing estimates for the next years.[1]

In the 2005-2006 harvest-plan the Brazilian Government adopted an encouraging position by allowing, through BNDES, the possibility of obtaining some additional 15% resources and independent limits between the agricultural and cattle costing for producers that adopt environmental preservation practices, animal traceability and farming-livestock integration and others.

The role of small-scale farming. Research undertaken for this study has shown that small-scale farmers have an important role to play in supporting sustainable agriculture in Brazil. Table 13 further suggests that production systems that are based on sound ecological principles and that exist on a relatively small scale have the most success in achieving ecologically and socially sustainable patterns of production.

Table 13: A Comparison of Production Systems and Technological Options for Soy-bean Production

Technological Options		Production system					Risks
		Family 3ha	Family 30ha	Family or corporate 300 ha	Corporate up to 3,000 ha	Corporate Over 3,000ha	
Intensive fossil fuel options							
Herbicide agriculture	Chemical fertilisers Herbicides Less ploughing Transgenic seeds No-tillage				Families from PR and Rs that go/went to the agricultural frontier		Soil erosion Genetic erosion Social exclusion Loss of biodiversity
Agro-chemical	Chemical fertilisers Intensive use of pesticides Intensive use of machinery Certified seeds			Farm models in PR, RS and MT			Soil erosion Genetic erosion Social exclusion Loss of biodiversity
Biological options, renewable energy use							
Organic agriculture	• Organic fertilisers • Integrated Pest Management • Less use of machinery • Organic seeds • International certification			Organic farms in RS, PR and MT			
Traditional agriculture	• Ecological inputs • Biological controls • Few industrial inputs • Manual labour • Organic seeds • Participatory certification		Traditional properties of migrants from RS and PR				Risk of losing competitiveness where prices for organics are low.
Current situation		Ecological and economic levels are quite low.	Good patterns of production for sustainability.	Can achieve ecological and social sustainability. Need more sophisticated production and employ family members in production. High profit.	Ecological sustainability but not social sustainability. High scale production and high profits.	Low social and ecological levels. Excessive profits.	

Source: Adapted from Ortega.E. "Soja BRASIL: Modelos de produção, custos, lucros, externalidades, sustentabilidade e políticas públicas" Available on the Internet .

The use of international standards and criteria to support best practices. Coop, a Swiss retailer of sustainable/responsible products has developed, with the support of WWF-Network, a series of criteria for the production of responsible soybean – the Basel Criteria for Responsible Soy Production.[59] Table 14 indicates that the best practices that have been identified in this report, are supported by favourable ratings in terms of the Basel criteria.

Table 14: Convergence between Best Practices for Soybean Cultivation and the Basel Criteria

Best Practice		Basel Criteria
Choosing adequate cultivars		2.1
Seed treatment		2.3
Sowing season		2.1.2
Choosing sowing system		2
Sowing population and density		2.3.2
Crop rotation		2.1.2
Soil liming and fertility maintenance		2.1
Weed control		2.2
Pest and disease control		2.2
Integrated pest management strategy	Use of resistant seeds	2.2
	Control through agricultural practices	2.2
	Physical and mechanical control	2.2
	Bio-control	2.2
	Chemical control	2.2.1
Safe use and maintenance of agricultural pesticides		2.2.2
Agricultural production financing policy should encourage technical support to crops		ND
Crop associations		2.1.2

7. CONCLUSIONS AND RECOMMENDATIONS TO BE DISCUSSED DURING THE STAKEHOLDER DIALOGUES

The purpose of paving the final stages of highway BR-163 is to link the Centre West region of Brazil to the deep water port of Santárem. The Centre-West includes the fragile ecosystem of the Cerrado, as well as the Amazon with among the highest levels of biodiversity in the world. There is already development in the region. However, experience shows that the paving of the highway is likely to increase that development. Therefore, there are impacts associated with building and operating the highway, as well as indirect impacts associated with the development of economic activity along its edges and in the surrounding area – almost 1,000

[59] The Basel criteria can be found at the following website: http://www.proforest.net/publications.

km^2. In the past, highway development has led to large-scale deforestation, and the exploitation of other natural resources, already a problem in the region, brought about by the improved transportation, activity of logging companies, and land clearing to support new, extensive agriculture. This agriculture, which could include cattle, soy and other crops is poised to take advantage of an expanding international market and improved competitiveness for export brought about by lowering transportation costs.

Achieving sustainability requires a balance among the economic, environmental, social issues associated with the development in these areas. This will require the adoption of new practices and policies to guarantee a balanced relationship between economic productivity, the health of communities and conservation of the environment. In particular these practices and policies should focus on:

- minimizing negative impacts on the natural environment;
- improving the quality of life for families and rural communities;
- optimizing production with a minimal use of external inputs; and,
- Encouraging a collective improved awareness of the importance of conservation.

In order to promote sustainable investments, it is important to create credit policies that take into account economic, social and environmental issues.[60]

A review of this literature indicates that the paving of BR163 is complex for several reasons. First, is related to the size of the project itself and the amount of land that it impacts directly. A second is related to the important conservation and anthropological characteristics associated with that land, and the direct impacts that the paving of the highway will have on fragile ecosystems and communities. A third, indirect impact, is the impact of the highway on related extractive and productive sectors in the region, and the accelerating economic activity (and profits) brought about by the improvement in the transportation corridor, particularly as it related to growing agribusiness, particularly soybeans. There are several associated social and environmental issues including, *inter alia*, development of public land, land tenure, crime, the

[60] In the livestock costing system the most common instrument for anticipating resources has been the Bill of the Rural Producer, in spite of restriction factors such as ignorance or lack of culture while issuing such papers and the interest rates incompatible with the activity (something around 2%/month plus guarantee tax) that could explain the possible producer capitalization/non-capitalization cycle. The Banco do Brazil is the major surety of those titles representing, currently, 22.55% of the portfolio. It is important to assure best socio-environmental policies and banking practices when the bank anticipates resources for agriculture or rural producers.

quality of life of local rural populations, deforestation, and ecological and environmental degradation.

Some solutions lie in **new management practices and production systems** for soybean crops. Techniques that emphasize no-tillage and ecological agriculture practices, are already having positive impacts by reducing damage related to soil, water, air quality and lowering levels of contamination caused by the irresponsible use of agro-chemicals.

There has also been a change in attitude among some farmers and agri-business managers who recognize that the sustainability of their production is critical for the survival of their businesses. This has come about in part as a result of information disseminated by **research institutions** (such as *Embrapa, Embrapa Meio Ambiente, Fundação MT* and others). There has been some considerable success achieved in influencing public policies and development and disseminating information on sound social and environmental practices, in particular with respect to soybean cultivation. This has extended to the development of criteria which can guide sustainable practices and lead to a future certification process (*Grupo Articulação Soja-Brazil*, WWF-Brasil, and Basel Criteria for Soybean Production, ProForest/WWF). The importance of continuing to improve relations among technology and research centres, agribusiness, cooperatives and family farms and policy makers is vital.

The **role of education** has also contributed to changing attitudes and has a role to play in the future. Low-income, rural populations and little education tend to be unaware of available programs on rural extension, training, business, which have a strong environmental component. The development of, and improved access to, these programs will assist the understanding and dissemination of information and techniques that can continue to change attitudes and improve environmental performance.

The discussion of the environmental impacts derived from the paving of BR-163 centres on the advantages and disadvantages of occupying frontier lands for the purposes of large-scale monoculture systems, and in particular soybeans. Despite the discussions around whether or not such occupation should be encouraged or discouraged, the fact is that it already exists, and is growing. Thus, the discussion must include consideration of how to ensure that the existing enterprises contribute to the conservation of biodiversity and well-being of communities in the Amazon region through soybean production that is socially and environmentally responsible. The second question is how to avoid unplanned and unsustainable growth in the future.

Responsible management of farming and livestock can contribute to the conservation or environmental recovery of areas surrounding BR-163 which are under threat, or have already been degraded. The sustainability of soybean agri-business and its relationship to the conservation of natural resources depends on several factors. First, is its use of the **technological innovations** being development by the research centres in Brazil. The available technology can reduce impacts on crops when proposing measures focused on reducing some of the main environmental problems associated to the monocultures, as soil degradation resulting from erosion and/or alteration of the physical properties and/or fertility loss or salting; and of soil, water and air pollution through the use of agricultural pesticides.

Another important factor is with respect to **effective environmental legislation**, and its enforcement. Legislation should address issues including, inter alias, the maintenance of the native vegetation alongside water courses (riparian forest), conservation units and of the legal reserve, as well as measures that can reduce the environmental impacts of monoculture (related to *inter alia*, the protection of biodiversity, and policies to reduce siltation and the alteration of waterways).

It is clear that the fundamental differences in settlement schemes—public/private and private/private—used since the 1970s in the area surrounding BR-163 (including the State of Mato Grosso) have produced different results. The public/private colonization stands out as the most effective model, generating urban and regional development, production capitalization and better quality of life. However, it is controversial regarding some problems, particularly, those related to incentive financial lines for grain production (rice, soy) and livestock and disorganised migrations and rural exodus explained by the lack of vision of the socio-environmental impacts caused by those agricultural policies. Therefore, it is necessary to pursue alliances and partnerships with the three sectors in seeking solutions for the problems in the studied area because it is the most effective and appropriate tactics.

The dialogue should continue to explore the issues raised in this literature review with respect to forestry, agriculture and land tenure. Of particular importance is the role of the family farm and best practices for agriculture land use and production. Important topics for discussion with respect to responsible soybean production include: high level of losses (20% of production) and employing degraded pastures for cultivation.

Soils in degraded pastureland are known to recover as a result of sustainable cultivation of soybean and other leguminous crops. Although soybean cultivation employs highly mechanized technologies it presents possible positive environmental impacts as it employs more manual labour than does livestock production, it requires expertise, and in terms of salaries, earnings are higher which explains the ability of agribusiness to attract migrant workers.

In addition to the above, the following more specific recommendations should be taken up during the dialogue phase:

Undertaking Sustainability Assessment. A SA should be employed to study the impacts resulting from the paving of the highway and the economic activities that it is likely to encourage in the surrounding area. With respect to the highway, a SA can propose appropriate policies to put in place to accompany the paving project that can help to ensure environmental and social sustainability. SA is broad enough to take into account the role of international trade in driving the development in the region and to include economic, environmental and social impacts.[61]

Develop appropriate policy responses. Policies that can either mitigate negative impacts or promote positive impacts on sustainability should be developed. This should include a focus, in the short term on actions that can be taken immediately, but should extend to the medium and longer terms. Discussion could begin with some of the mitigation actions highlighted in this report that have been derived from the literature. These include the importance of small-scale family agriculture, research development and technology, long-cycle agriculture, agro-forestry and reforestation, and diversification of economic activities. This discussion should also take into account the policy recommendations put forward in the WWF's 2003 study on soy.

Strengthening the analysis of the impacts on economic, social and environmental sustainability of paving BR -163. The *Grupo Diálogos* should build on the existing literature and develop a clear indication of the short, medium and long term impacts, through a SA, and ensure that priorities are clearly identified. Once the dynamics are concluded, the Group could establish the criteria to deal with the most urgent problems evidenced, or to reinforce the scope

[61] The study undertaken by ProForest could serve as a guide.

lines of each participant or the group of involved stakeholders. These and other issues that should be discussed with stakeholders might be facilitated through an electronic forum.

Exploring best practices using existing criteria for sustainable production. The Basel Criteria for Responsible Soy Production, built from the discussion of the *Grupo Articulação Soja* and Soy Roundtable, has proved to be a suitable starting point for discussions and disseminations of good socio-environmental practices for soy crops through supplemental publications with different audiences: producers, schools and students and researchers.

Expanding the dialogue. Dialogues among stakeholders have already taken place on the issue of responsible soybean production. Between February and May 2004 the *Articulação Soja - Brasil* promoted a debate involving Brazilian organizations and social and environmental non-governmental organisation, aimed at creating parameters and means of decreasing negative socio-environmental impacts, derived from the production of soybeans for the international market, using market-based mechanisms. The discussion took place through a series of meetings and on the Internet. It sought to achieve consensus among the several propositions presented to address the social and environmental problems that arise as a result of large-scale production of soybeans. In short, it sought to establish a set of sustainability criteria for the agri-business production chain.[62] These discussions should be broadened to include other relevant commodities, the specific impacts of BR-163, and the trade-related aspect of the development of agricultural production, in conjunction with a SA.

Stakeholder mapping. Given the large variety of stakeholders involved in the area surrounding BR-163, it would be useful if a SA included a "stakeholder mapping" exercise in conjunction with the development of the *Grupo Diálogos*. This could take place in a specific meeting, and could focus on plotting various impacts on groups of stakeholders, along with areas of consensus and areas of disagreement with respect to the economic, social and environmental issues that

[62] The report summarising these discussions, that was prepared in November 2004 by ProForest in cooperation with WWF can be found in the ProForest website. The report has interpreted the Basel Criteria for Responsible Soy Production in the context of Brazil and includes themes such as legal compliance, technical management, environmental management, social management, continuous improvement and traceability, criteria relationship, indicators and verification means that guide the targets of achieving the potential socio-environmental maturity of the soybean industry as well as of other crops.

have been raised, with the aim of identifying priority actions in the short, medium and longer terms for specific stakeholder groups. The stakeholder mapping should provide a perspective on the different actors and their collaborative or conflicting relationship. The *Grupo Diálogos* can develop new maps for the different stakeholders with a view to understanding their relationship and constructing their profiles as well as developing a process that makes possible their effective management.

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