

Managing the Soy Boom: Two scenarios of soy production expansion in South America

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Summary

Soy is an important commodity, supplying one fourth of vegetable oils and over half of global oil meals globally. In 2003/04, 186 million tons of soy were produced. With growing and increasingly affluent populations, the global demand for soy and derivatives (vegetable oil, animal feed) will remain strong and demand for soy is expected to increase 60% to over 300 million tons per year in 2020. Over the past decades, impressive yield increases have not been sufficient to meet demand growth. Consequently, the soy planted area steadily increased at the expense of other crops and natural ecosystems. As China and the US have little arable land reserves, future expansion will be accommodated primarily in South American producer countries: Argentina, Bolivia, Brazil and Paraguay.

The expansion of agriculture with soy as a dominant crop has led to the near disappearance of the Atlantic Forest in South Brazil in the 1970s and 80s. Currently, the Atlantic Forest in Paraguay is threatened by soy expansion, as are the lower Yungas and Chiquitano forests of Argentina and Bolivia. All these forest types combine high levels of biological diversity with high rates of endemism, and are unique globally. Soy is an important indirect threat to the Amazon forests, through infrastructure development and the capitalisation of cattle ranchers – cattle ranching being the most important cause of direct conversion of rainforests. More than rainforests, the bush savannah biomes of South America are threatened by soy expansion. Unlike forests, savannahs can be converted directly to soy plantations, and millions of hectares of Argentine Chaco and Brazilian Cerrado have been converted to soy plantations in the past decade.

Beside loss of natural habitats soy expansion is causing erosion, water pollution and health problems. Although soy generates wealth, this wealth is often poorly distributed and many environmental and social costs are not internalised. Food security and land rights of the poorer classes in society have often not improved in soy expansion areas.

Two scenarios have been elaborated that sketch future developments. Under the Business as Usual scenario, soy continues encroaching on natural savannahs and existing pastures, ‘pushing’ cattle ranchers and small farmers into the forest. This is expected to result in conversion of nearly 16 million hectares of savannahs and nearly 6 million hectares of tropical forests by 2020. Under the Better Policies and Practices scenario, soy farming and cattle ranching are integrated.

This form of intensification is expected to reduce conversion for soy to 3.7 million hectares, and is able to accommodate over 23 million heads of cattle on soy growing land by 2020.

Successful implementation of alternative land uses requires a paradigm shift with producers, governments, buyers, investors and regulators. Local governments will need commitment and support of players in the soy production and marketing chain to promote more sustainable practices. The adoption of sourcing criteria and development of producer guidelines through a multi-stakeholder body are a necessary complement to legal measures to reduce the identified negative impacts of the soy production sector on valuable ecosystems and local communities.

The Better Policies and Practices scenario shows that implementation of soy-cattle rotation under the so-called Integrated Crop Livestock Zero Tillage system can significantly reduce deforestation. However, many social issues related to soy cultivation and expansion are not addressed by this model. Therefore, buyers who want to ensure that their raw materials are ecologically and socially acceptable, should consider buying a substantial part of their soy from smallholder cooperations that have adopted Agro-ecologia or similar concepts, in which socio-economic criteria are better represented.

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Introduction

This document presents overview of impacts of soy cultivation with focus on conversion of forest and savannah ecosystems.

Section 1 describes the global dynamics of soy production, trade and consumption. The demand for soy determines the expansion of this crop in South America.

Section 2 describes the impacts of soy cultivation and expansion on country level for the four main South American production countries Brazil, Argentina, Paraguay and Bolivia. To assess how future demand for soy can be met, two scenarios are elaborated.

The Business as Usual scenario (section 3) calculates the loss of key natural habitats based on extrapolation of past trends, current plans and policies, existing practices and perceived impacts. The Better Policies and Practices scenario (section 4) assesses the impacts of various forms of improvement and intensification of land use that are currently experimented with in producer countries.

It should be realised that both scenarios are developed within a liberalised free trade context which serves as a boundary condition for the scenarios. The scenarios – or this report- should not be seen as a justification of massive expansion of soy in South America in order to feed the world. Rather, it sketches two possibilities under the currently dominant model. The sustainability of this model itself is rightfully questioned by many social and environmental groups that advocate other development models to meet global food demand such as regional self-sufficiency or consumption reduction.

1 Analysis of global soy production and consumption

Soy: a key global commodity

Soybean (*Glycine max*) is an annual crop, grown in temperate, sub-tropical and tropical regions. Soy yields the protein rich soybeans, which contain up to 50% protein. With a yield of up to 3,600 kg / ha per crop cycle, it is the highest yielding source of vegetable protein globally. In addition, soy protein in its amino acid composition resembles animal protein much more than corn or other vegetable proteins, making it an ideal diet component for people and livestock. Soy is by far the most important protein in animal feed, and soy oil is the most consumed vegetable oil in the world.¹

The global average yield per hectare of soybeans is 2.4 tonnes, but there are strong differences between countries. Italian farmers on average record the highest yield: 3.6 tonnes per hectare. Argentina and Brazil also have higher than average yields (2.8 t/ha in 2003/04). Most of the global soy production (88%) is crushed to yield soy oil and soy meal. The rest is used as seed or processed as whole beans. Soy covers 60% of the world's demand for protein-rich *oil meals* and supplies 25% of the world's edible oils.²

Global production of soy

Soybeans are traditionally grown in temperate and subtropical regions world wide, and is currently expanding into tropical regions. Brazil is the second biggest producer (51 million tons or 27% of world production in 2003/04¹) world wide, after the US (35%). Argentina, Paraguay and Bolivia have market shares of 17%, 2% and 1% respectively. Other big producers are China and India (9 and 2% respectively),³ but their entire production is consumed domestically. The US, Brazil and Argentina are the dominant suppliers of soy to the world market, accounting for almost 90% of supply in 2003. Due to their continuing production growth, Argentina and Brazil have steadily increasing market shares, and Brazil took over the leading position of the USA as the world's biggest soy exporter in 2003. Brazil had a 31% market share in 2003, the USA and Argentina have shares of 29% and 28% respectively.⁴

¹ Refers to the growing year 2003/04, comprising the soy harvested in late 2003 in the Northern Hemisphere (USA) and the early 2004 harvest in South American countries. Where calendar years are mentioned in this report they refer to Southern Hemisphere harvest seasons.

Global consumption of soy

The EU is the main global importer of soy, followed by China which is experiencing strong import growth. In 2003, the EU imported 36.9 million tons of soy beans and meal. China imported 19.4 million tons of soy products, of which 18 million tons soybeans and 1.4 million tons soy oil. Japan, Mexico, Taiwan, Thailand, Indonesia and South Korea are other main importers of soy beans and meal; main soy oil importers are Iran, Bangladesh, Russia, Morocco and Egypt.⁵ Driven by population growth and increase of per capita income, global demand for soy is expected to rise with 60% to 300 million tons by 2020. By that time, China and the (enlarged) EU will each be importing over 40 million tons of soy products annually.

Global trade relations

The United States have traditionally been the leading supplier of soy to both Europe and Asia. Total exports have been stable over the last years as production growth has been absorbed by growing domestic consumption. With over 80% of the US crop being genetically modified (GM)-soy,⁶ the US share of European soy imports has declined. Brazil, where planting of GMOs is severely restricted, has seen its market share rise and is now supplying 63% of the EU soybean imports.⁷ Argentina (at least 98% GM-soy production) supplies the half of the European imports of soy meal but nearly ceased exporting soy beans to Europe; nearly all of its bean exports in 2003 were directed to Asian markets. New EU GMO labelling requirements for animal feed may reduce the European demand for Argentine soy meal and increase the demand for Brazilian GMO-free meal.

Global actors in soy trade and processing

The global trade and processing of soybeans is concentrated with a small number of multinational commodity traders. Archer Daniels Midland, Bunge, Cargill (US-based) and Louis Dreyfuss from France control 43% of crushing capacity in Brazil and almost 80% in the European Union.⁸ The three American companies control 75% of the US soy market.⁹ The crushing companies sell soy oil and meal to a large group of food and animal feed producers, as well as to the chemicals and detergents industries.¹⁰

2 Impacts of soy production in South America

2.1 Production systems

Soy originates from Asia and was introduced in South America by Japanese migrants in the early 20th century. After the Second World War, the Brazilian Government started promoting the cultivation of soy to become self sufficient in vegetable oils. Initially, soy was largely produced on small to medium sized family farms (5-50 hectares) in South Brazil. With increasing adaptation of soy to tropical climates and the opening of the Centre-West and Northern regions for agriculture starting in the 1960's, large scale, fully mechanised soy farming (farms ranging from 300-10,000 ha) became the dominant production practice.¹¹ This is also true for Argentina, Bolivia and Paraguay, but contrary to these latter three countries, in Brazil a significant -though declining- proportion of soy is still produced by smallholders. This share was about 30% in 1996,¹² and is estimated to have declined to 15-20% in recent years.¹³ In the 1990's, soy became an export commodity and in recent years it has become the single most important agricultural export product of all four countries.

Smallholder soy farming

Smallholder soy farming is practised in rotation with annual crops such as rice, corn, tobacco and cotton, often in a mosaic with pasture and permanent crops such as coffee and oranges.¹⁴ Farm sizes average 30 hectares¹⁵, although family farms in the frontier regions in Central Brazil and the Amazon can be up to 200 ha. Cultivation is partially or fully mechanised with mechanised labour shared or rented. In Brazil, smallholder agriculture generates one job per 8 hectares.¹⁶



Smallholder soy farm, Santa Catarina, Brazil © J.M. Dros



Demonstration of large scale mechanised soy harvesting, Mato Grosso, Brazil. Source: www.koeller.com

Large scale soy farming

Large scale soy farming has become the dominant production practice in South America since the 1980s. Average farm size in Argentina and Brazil's main producer state Mato Grosso is 1,000 ha,¹⁷ but some 10-50,000 hectare farms have recently been established in Mato Grosso to benefit from economies of scale.¹⁸ On average this type of agriculture generates only one job per 200 hectares.¹⁹ Three main production practices can be discerned:

- Traditional (GMO and non-GMO) soy planting using tillage. Soy is the main crop, followed by a second crop of sorghum or corn, or soy in some regions in Argentina. If irrigation is practised, soy or cotton can be planted in the dry season. Tilled soy cultivation requires relatively high machinery investments.²⁰ Significant erosion and reduction of soil organic matter are drawbacks of this method.²¹
- No-till planting of conventional (non-GMO) soy. With this method, soy is directly sown and soil structure remains more natural compared to tilled agriculture. A second crop can be planted, or the crop residues are left as forage for cattle. Zero-tillage results in significantly lower erosion and organic matter oxidation rates.²² Generally, costs for (pre-treated) seeds and herbicides are higher.²³ This method is increasingly adopted in South and Centre-West Brazil. Total Zero-Tillage cropping in Brazil has exceeded 7 million hectares, most of which is under soybean cultivation.²⁴
- No-till planting of genetically modified soy. In Argentina and Paraguay, no-till cultivation of Monsanto's herbicide-tolerant Roundup Ready soy is practised on 50 to 60% of the total soy planted area.²⁵ More often than in the systems described above two soy crops are cultivated annually, instead of rotations with other crops. In 2001, savings on machinery costs and easier weed control lead to savings that outweigh the lower market prices for GMO-soy.²⁶ Weed control under this cultivation system is easy but indiscriminate application of Glyphosate used in combination with GMO-varieties has serious environmental and health impacts.²⁷

2.2 Drivers for soy expansion in South America

The main driver for expansion of the area planted with soy is the increasing global demand, as illustrated in the preceding section. Even with increasing per hectare yields (from current 2.5 tons/ha in the USA and 2.8 tons/ha in South America to an estimated 2.8 and 3

tons/ha respectively in 2020), the current area under soy cultivation will not be sufficient to meet this demand. Thus, additional cropland will be required to accommodate soy production. Globally, areas for significant expansion of cropland are only available in Sub-Saharan Africa and South America, most notably in Angola, Argentina, Bolivia, Brazil, Colombia, Congo and Sudan. Thirty percent of this ‘reserve’ is covered with forests.²⁸ As land is getting scarce in Asia and Europe soy planted areas are expected to decline or remain stable in these regions. The availability of cheap land, the favourable climate and presence of transport and financing infrastructure will encourage the expansion of soy in South America at the expense of natural areas.

Other factors that lead to increasing conversion in South America are:

- Poor law enforcement, facilitating illegal or irregular acquisition of (public) land, illegal deforestation, payment of below-minimum wages and failure to meet environmental regulations, i.e. the externalisation of social and environmental costs;
- ‘Perverse incentives’ that favour the production of raw materials over processed products, e.g. the Brazilian Kandir Law that promotes exports of soy beans but taxes exports of processed soy products;
- Global trade arrangements and trade barriers such as the EU trade barriers for meat vis-à-vis zero percent tariffs for soy beans;
- Access to cheap international capital market credit by soy traders makes that the ‘technology packages’ provided by soy traders are economically attractive to producers even where soy is not the most suitable crop from an ecological or food security perspective. More appropriate crops destined for the domestic market may not be economically feasible because of high domestic interest rates.

Figure 2.1 shows how soy productive area has developed in the four main producer countries in South America.

Box 1: The relation between soy, cattle and deforestation

Recent studies have shown that deforestation in the Amazon basin is primarily caused by cattle ranching.²⁹ Until the late 1990s the deforestation rate was closely correlated to Brazilian economic growth, illustrating the investment made in land clearing under favourable circumstances, driven by increasing domestic demand. Rising interest rates inhibited investment in clearing land for cattle ranching.³⁰ This trend has been reverted in recent years, showing increasing deforestation figures even with declining or negative growth, as cheap

credit can be obtained for export commodities traded in US dollars such as soy. When this credit is used to acquire land from cattle farmers or other landowners, these are capitalised and can expand their areas without depending on expensive domestic loans.³¹ Public and private investment in road infrastructure, such as the BR-163 highway to facilitate soy exports from Mato Grosso, also enable cattle ranchers' access to forests for ranch development.³²

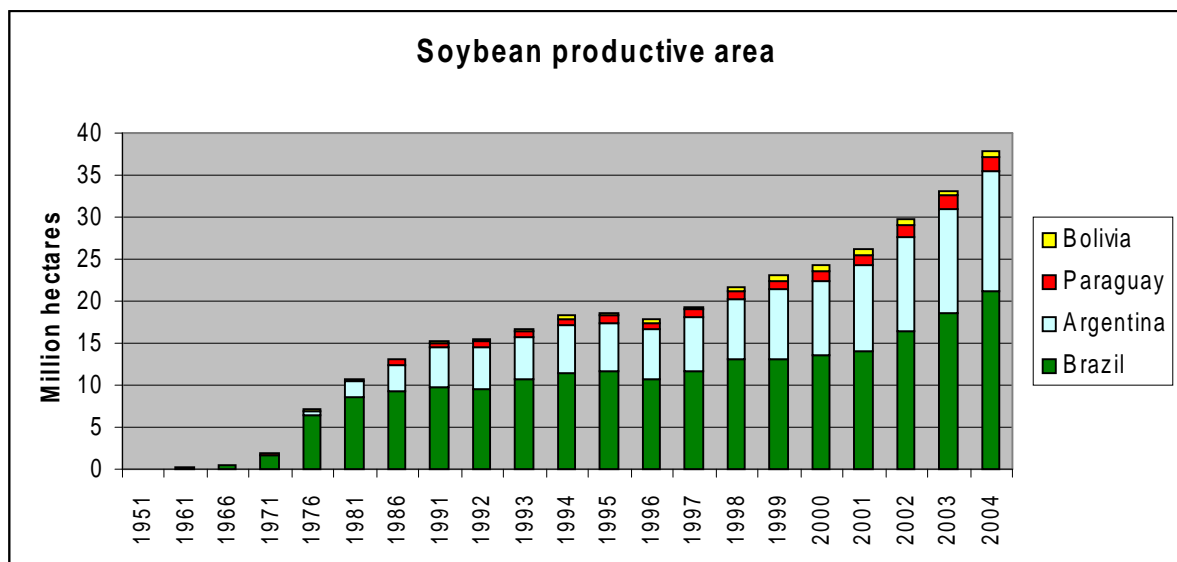


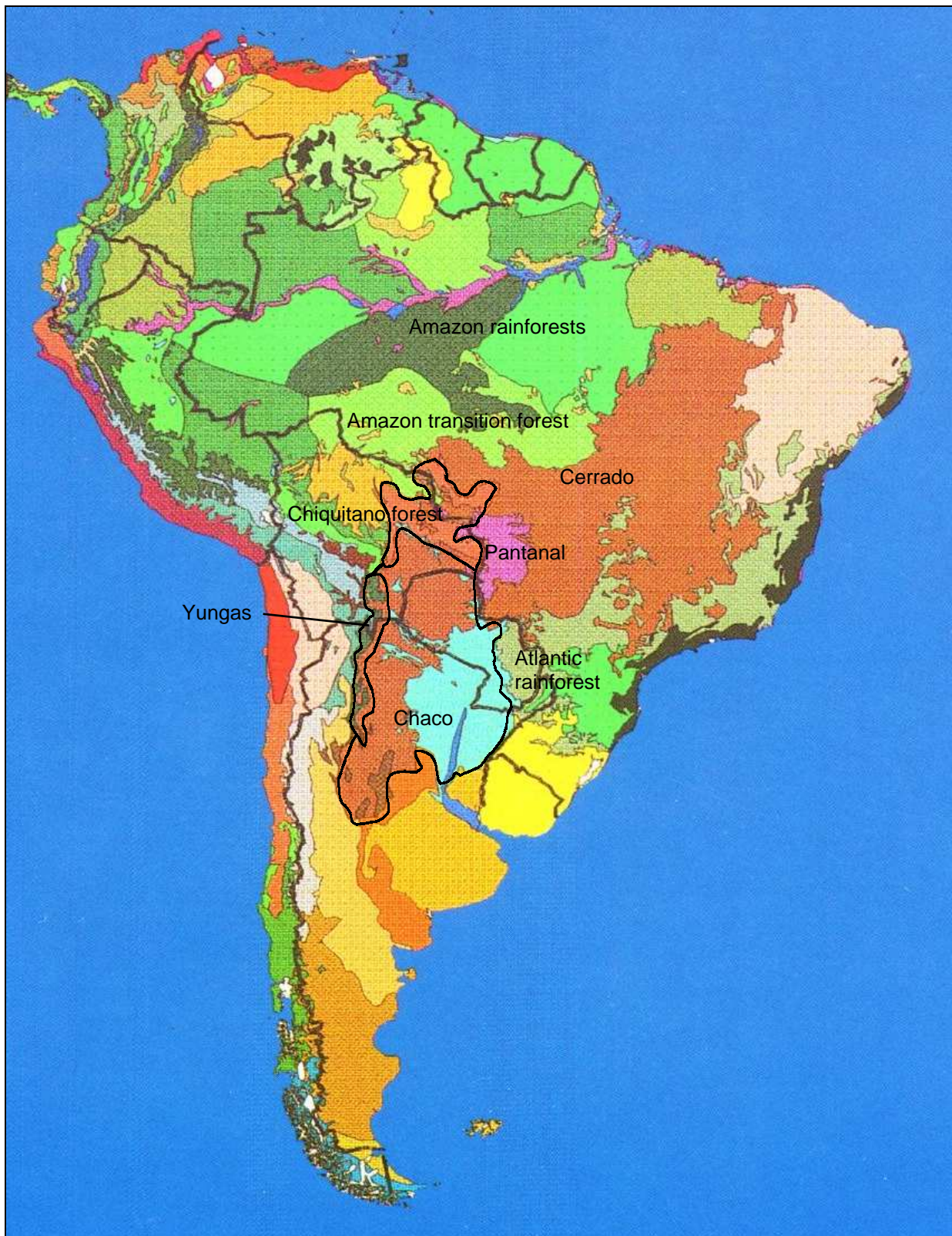
Figure 2.1

The growth of soy planting in South America 1950/51-2003/04. Five year intervals until 1990. Sources: FAO, CONAB, ISTA Mielke, Agriculture Ministries Argentina and Paraguay.

Outlook tot 2020

Current high soy prices and export oriented economic policies have led to the adoption of ambitious soy expansion plans in all four producer countries. Realisation of all current short to medium term plans (2005-2012) will lead to oversupply of the global market in a few years. This may lead to a price collapse, loss of investments and abandonment of recently cleared sub-optimal or remote areas.

2.3 Ecosystems map of South America



Original extent of selected South American habitats affected by soy expansion. Source: WWF / World Bank Conservation assessment of the terrestrial ecoregions of Latin America and the Caribbean (1995).

2.4 Argentina

Introduction

Soybean cultivation in Argentina started in the 1970's and until 1998 around 90% of the planted area has been located in the three central agricultural provinces Buenos Aires, Cordoba and Santa Fe³³. Since the late 1990's, macro-economic developments (the Peso-crisis) have stimulated the production of export commodities (fig.2.2). At the same time genetically modified herbicide tolerant soy has been adopted at a wide scale. As a consequence, Argentine agriculture is now dominated by mechanised production of soy. Since 1998, production has expanded rapidly into the provinces of Entre Rios, Chaco, Santiago del Estero, Salta and Tucumán (figures 2.3 and 2.4). In 2003/04, a total of 14.3 million hectares of soy were harvested. Soy now occupies more land in Argentina than all other crops added together. The majority of total Argentine soy exports (sum of beans, meal and oil) are destined for Asian markets, but for soy meal, the EU was by far Argentina's most important export destination, importing 11 million tons (or 60%) of Argentine soy meal.

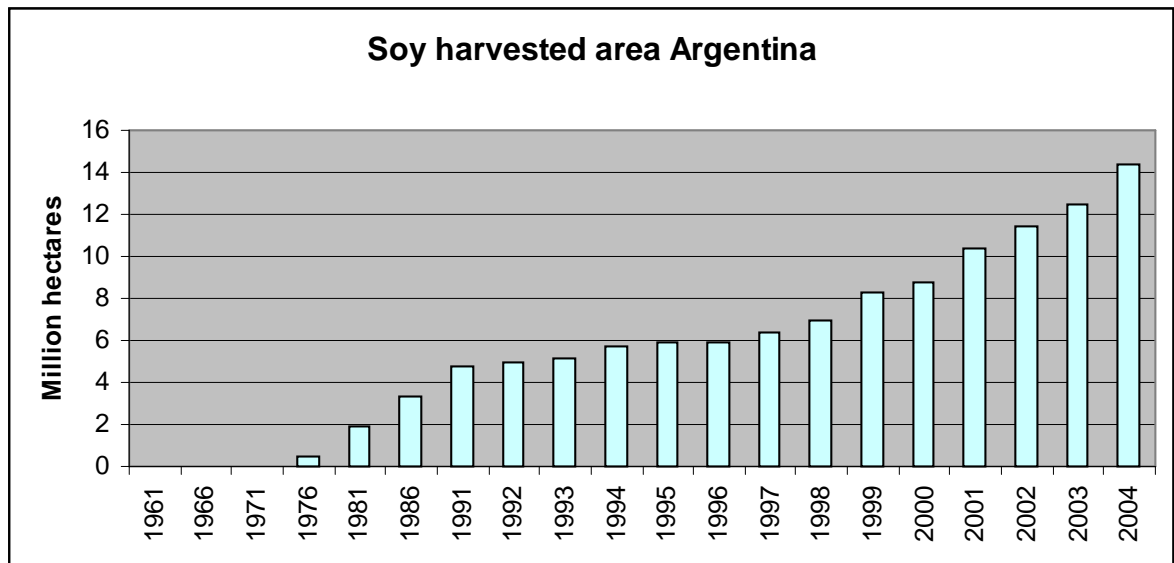


Figure 2.2

The growth of soybean harvested area in Argentina. Source: SAGPyA

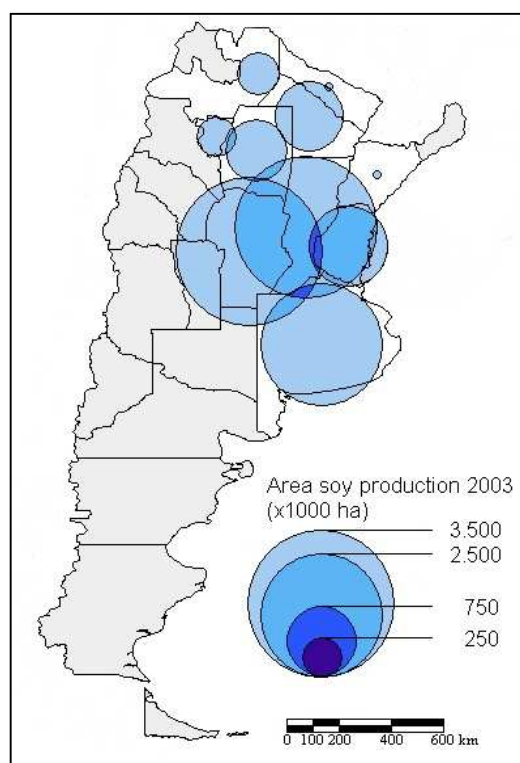


Figure 2.3
Main soy production areas crop year 2002/2003.
Source: SAGPyA

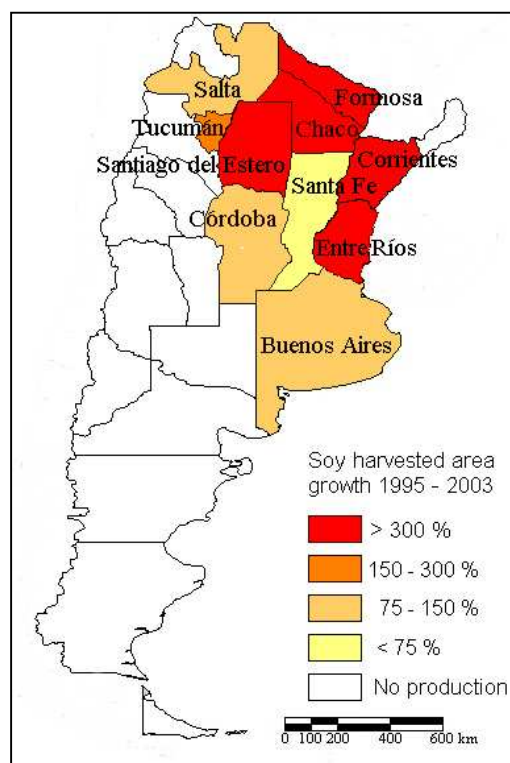


Figure 2.4
Growth of soy production 1995-2003.
Source: SAGPyA

In the three Central provinces, area growth since 1995 has been strong (38-127%) but mostly at the expense of pastures and other crops. Between 1995 and 2003 growth outside the traditional area has been most significant in the provinces of Entre Ríos, Chaco, Santiago del Estero, Tucumán and Salta (table 2.1).

| Province | Area growth 1995/96-2002/03 | Harvested area 2002/03 (x 1000 ha) |
|---------------------|-----------------------------|------------------------------------|
| Entre Ríos | 728% | 1,100 |
| Chaco | 465% | 740 |
| Santiago del Estero | 526% | 260 |
| Tucumán | 188% | 160 |
| Salta | 76% | 290 |

Table 2.1
Soybean harvested area growth in non-traditional soy planting provinces. Source: SAGPyA

Since 2001, the area expansion in these non-traditional soy growing areas is bigger than in the Central provinces.³⁴ This growth has occurred at the expense of the Chaco bush savannahs and Yungas moist montane subtropical forests.³⁵

Most future expansion of soy production is expected to occur in the Chaco region.³⁶

Loss of natural habitats

By 2000, Argentina had lost 46% of its original closed canopy forest. At that time, 7.4 million ha or 2.7% of the total land area remained. The deforestation between 1990 and 2000 has been estimated at 10%.³⁷ In 2000, Fundacion Vida Silvestre indicated that soy is a major threat to biodiversity in the Chaco and Atlantic rainforest ecosystems.³⁸ Greenpeace started a campaign to protect the Yungas moist subtropical forests in 2003, citing soy expansion as one of the main drivers of deforestation of this highly threatened ecosystem.³⁹

The Yungas

The **Yungas** moist forest covers almost 5 million hectares on the Andean footslopes in the Northern, subtropical part of Argentina. Yungas forests are found between 400 and 3.000 meters above sea level. Together with the Atlantic Rainforest it has the highest biological diversity and highest degree of endemism (occurrence of unique plants and animals) of Argentina.⁴⁰ With current deforestation rates of 10,000 hectares per year, the forests in the lower ranges of the Yungas (the so-called *Selva pedemontana* below 600 metres) will have disappeared by 2010.⁴¹ Until 2000, the *pedemontana* forest was predominantly cleared to give way to sugar, tobacco and tree plantations. Recently, soy has become the most important driver of deforestation in the Salta and Tucumán Yungas forest.⁴²

The Chaco

The Chaco consists of dry and moist savannah ecosystems covering 70 million hectares one-fourth of Central and Northern Argentina or approximately. Although biological diversity is lower than in the Yungas forests, this ecosystem has been classified as the single highest priority area for conservation, because of its limited current protection, fragile soils and hydrology and eminent threat of conversion for agricultural purposes.⁴³ Even within the few protected areas, conversion for soy cultivation has been reported, for example in the Copo Provincial Reserve in Santiago del Estero.⁴⁴

Argentine government statistics show that in the provinces of the Chaco and Yungas regions soy is by far the most expansive

crop. The expansion of soybean cultivation in the provinces in the Chaco and Yungas biomes^{II} totalled 2.36 million hectares since 1995, compared to an expansion of approximately 0.3 M ha of wheat and 0.1 M ha of corn, the two other main annual crops.⁴⁵ The conversion of *pedemontana* (or lower) Yungas habitats for soy is unlikely to be higher than 30,000 ha over the past five years, which is critical given the limited extent of this forest type. As overall arable agriculture expanded in the region, it can be concluded that 2.33 M ha of dry and humid Chaco vegetation have been cleared for soy cultivation since 1995. This area was formerly in use as extensive grazing lands with very low cattle densities (0.1 head/ha).⁴⁶

Atlantic rainforest

Until 2003 expansion of soy in the Atlantic rainforest, only present in the province of Misiones, has been negligible. The conversion that is occurring there is mostly due to smallholder farming of high-value cash crops such as tobacco.⁴⁷

Other ecological impacts

During the first ‘soy boom’ in Argentina in the 1980s, pasturelands in the Pampa provinces were converted to arable agriculture. Ploughing resulted in widespread erosion and degradation of soils, with consequent adverse downstream impacts of sedimentation and floods. To remedy this problem, zero-tillage techniques were introduced. However, weed control proved difficult especially in a system of continuous cultivation of annual crops. When genetically modified herbicide-tolerant (GMO) soy was introduced in 1998, it was rapidly adopted by Argentine farmers.⁴⁸ The resistance of GMO soy to glyphosate facilitated weed control and by 2002, the adoption of GMO soy neared 100%. Between 1994 and 2003 the use of glyphosate rose from 1 to 150 million litres.⁴⁹ The widespread and often indiscriminate use of glyphosate has caused dozens of cases of intoxication and is blamed for the destruction of soil microbial life, leading to sterile soils where crop residues are no longer decomposed. Weeds that have developed glyphosate resistance require cocktails of highly toxic herbicides such as atrazine to control. Intoxication of rural workers and neighbouring communities have been reported throughout the soy producing provinces.⁵⁰ The expansion of soy cultivation in the Chaco

^{II} Chaco, Salta, Santa Fé, Santiago del Estero and Tucumán.

region with its fragile and degradation prone soils⁵¹ is also blamed for the increased incidence of floods, such as the dramatic flood that hit Santa Fé in 2003.⁵²

Socio-economic impacts

Beside loss of natural habitats the explosive growth of soy cultivation in Argentina has had other severe socio-economic consequences. Food and dairy production for the domestic market dropped, the use of agrochemicals, human intoxication and water pollution increased. The combination of economic crisis and expulsion of small farmers and rural workers by mechanised soy farming has led to a decrease in food sovereignty increased poverty and hunger.⁵³

Soy expansion plans

In 2003, the Argentine agricultural sector launched the plan to increase grain and oilseed production with 50% to 100 million tons over the next decade, mainly in Santiago del Estero, Chaco, Salta and Tucumán provinces.⁵⁴ Currently 50% of the total area of arable crops is planted with soy, up from 24% in 1997.⁵⁵ As global demand growth for soy is much higher than for cereals, most of the production increase required to attain this target is expected to be covered by soy.⁵⁶

2.5 Bolivia

Introduction

Soybean cultivation in Bolivia started in 1967 but was very modest until the late 1980s, when the World Bank sponsored Lowlands Development Project commenced.⁵⁷ As a result of this programme, mechanised agriculture, dominated by soybean planting, steadily expanded in the Santa Cruz department to reach a planted area of over 600,000 ha by 2000.⁵⁸ Since then, the planted area has stabilised (Fig. 2.5).⁵⁹ The increase of agricultural area in the 1990s has mostly taken place at the expense of Chiquitano forest and Gran Chaco bush savannah vegetation.⁶⁰

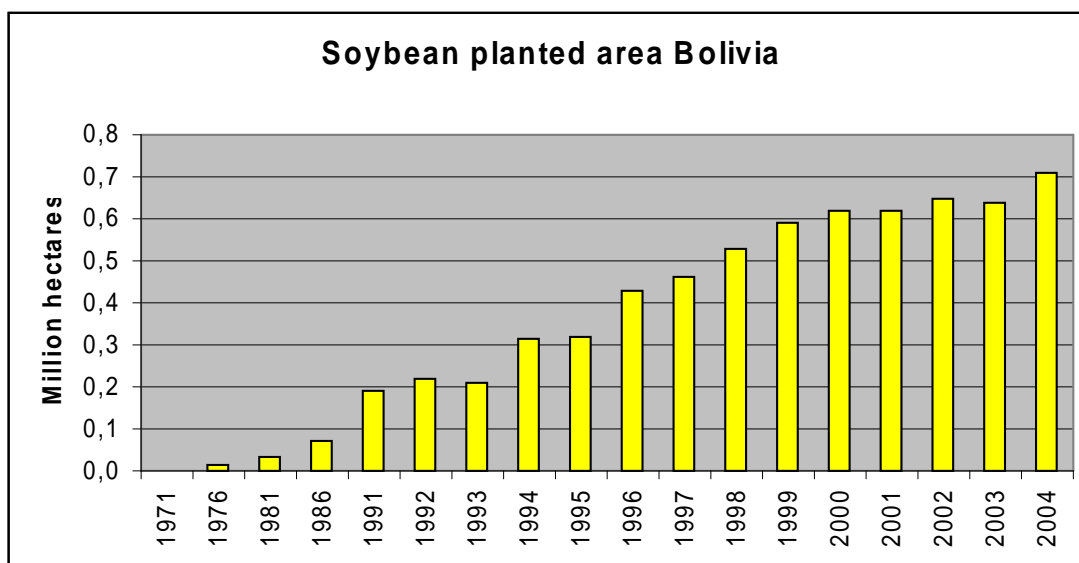


Figure 2.5

Soy harvested area Bolivia. Source: FAO, ISTA Mielke

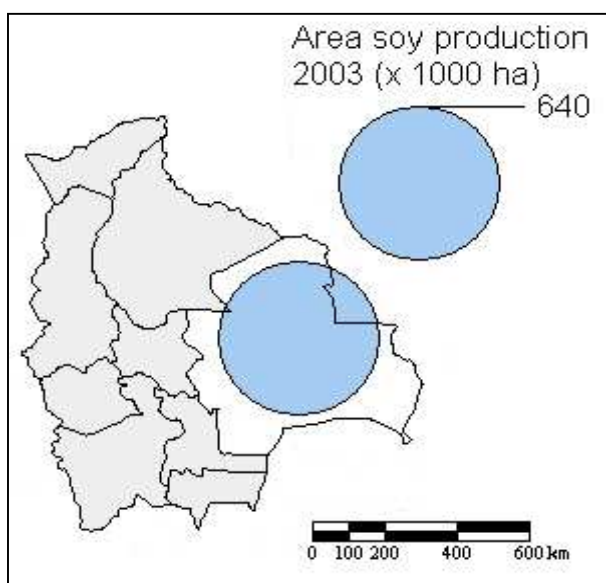


Figure 2.6

Main soy production areas in Bolivia.

Source: ISTA Mielke, INCAE

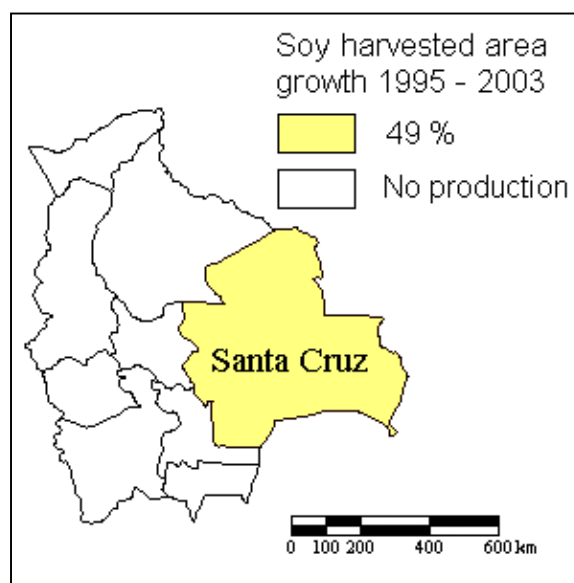


Figure 2.7

Growth of soy area in Bolivia 1995-2003.

Source ISTA Mielke.

Soy is by far the single most important agricultural export commodity of Bolivia and accounts for 27% of total export revenues. Of total exports, 92% are destined to the Andean Community, mainly Venezuela, Colombia and Peru through Puerto Suarez and the Hidrovía Parana-Paraguay and then overseas to these countries' ports.⁶¹ The moderate growth of soy

production in Bolivia between 1999 and 2003 reflects the economic difficulties of the country and its main export destinations in the first years of this century. This contrasts with the explosive growth of its neighbour producer countries supplying the EU and Asian markets. Lack of access to credit has been the main constraint to further development of soy production in Bolivia. Bolivia has ended official research programmes on GMOs and is studying the possibility to market the entire production as GMO-free.⁶²

Loss of natural habitats

Between 1978 and 2001 Bolivia lost 2.4 million hectares of forest and 0.6 million hectares of bush savannah.⁶³ Until the 1980's, small scale farming, unsustainable forestry and cattle ranching were the main drivers of deforestation and annual deforestation averaged 168,000 hectares per year between 1975 and 1993.⁶⁴ After 1984, medium to large scale soy cultivation became the main driver of Bolivian deforestation.⁶⁵ In Bolivia's Santa Cruz department alone, annual deforestation increased to more than 200,000 ha in the 1993-2000 period. The 1.42 M ha deforested comprised 0.53 million hectares of Gran Chaco wooded savannahs, 0.43 M ha Chiquitano dry forests, 0.25 M ha Amazonian rainforests and 0.16 M ha of Chiquitano savannahs (equivalent to Brazilian Cerrados). Expansion of soy occurred predominantly in the Chiquitano and Gran Chaco ecosystems, Northeast and Southeast of Santa Cruz city respectively.⁶⁶

Chiquitano forest

The Bolivian Chiquitano forest is the largest remaining block of South American deciduous forest and has been identified as the most endangered in Bolivia.⁶⁷ This forest is among the richest dry forest ecosystems in the world. The plant and animal life is distinct from Amazonia, the Chaco, and the Cerrado and contains many endemic species.⁶⁸

Gran Chaco

The Gran Chaco thorn scrub, with poorer soils and drier climate extends into Paraguay and Argentina. Because of the presence of an aquifer and abundant natural gas deposits, the Chaco has a potential for irrigated agriculture similar to that of the United States great plains.⁶⁹

Other ecological impacts

One fourth or 150,000 ha of the soy planted area in Bolivia is estimated to be degraded because of poor soil management.⁷⁰ Beside causing lower soybean yields, erosion affects downstream ecosystems and water quality.

Socio-economic impacts

The Bolivian soy boom has made Santa Cruz the economic capital of Bolivia, but so far the development of mechanised commercial export agriculture, dominated by soy, has not brought structural improvements to the poor. In 2000, one third of Bolivian soy output was produced on large plantations by Brazilian immigrants. It has aggravated unequal income distribution like in Paraguay.⁷¹ Bolivia ranks second on the global list of countries with most unequal distribution of income; the richest 20% of the population earns over 60% of the national income, whereas the poorest 20% (all indigenous communities) earn less than 2%.⁷²

Expansion plans

Under the *Bolivia Competitiva* plan, Bolivia aims to double its soy exports in ten years. The plan foresees to increase average yields with almost 60% in that period, which would limit the need for additional planting area to 130,000 ha.⁷³ However, in stark contrast with Argentina, Brazil and Paraguay, soy yields have been decreasing in Bolivia over the last decade and at current productivity soy planted area would have to increase by 1.2 million hectares to achieve the objective of *Bolivia Competitiva*.

2.6 Brazil

Introduction

Soy was introduced as a livestock feed crop in South Brazil in 1914. In 1941, soy first appeared in national agricultural statistics (640 ha planted). In the 1960s and 70s, soy production increased dramatically, stimulated by government subsidies. By 1980 soy had become one of the main agricultural products of

Brazil with a production of 15 million tons on 8.8 million hectares. In this period 80 % of production still originated from the three Southern states Rio Grande do Sul, Paraná and Santa Catarina.⁷⁴

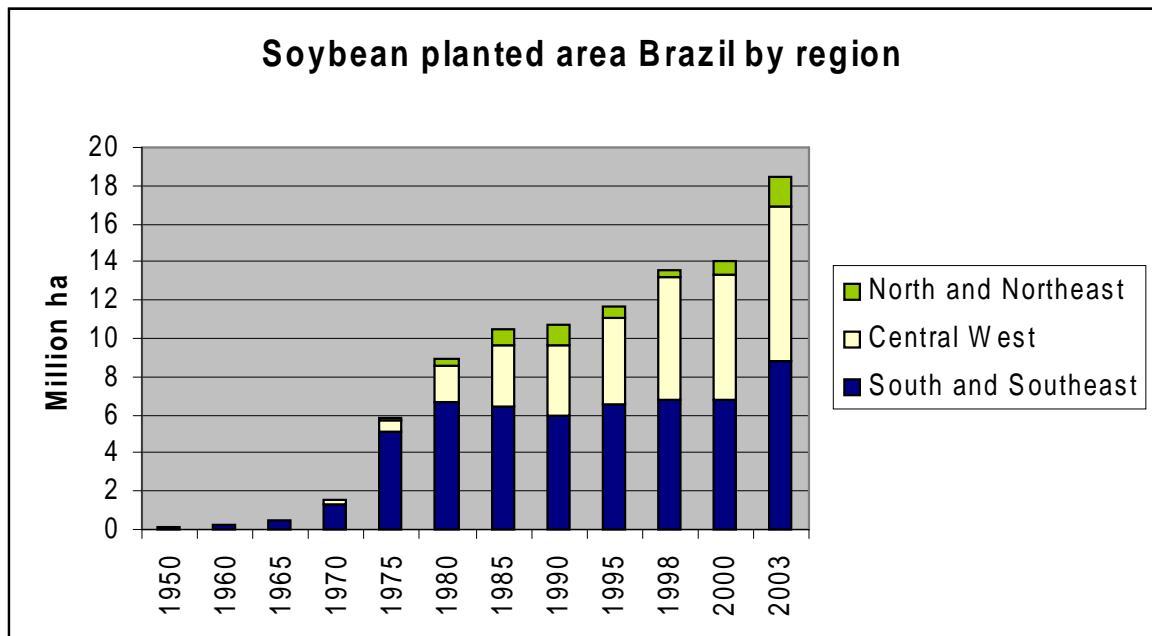


Figure 2.8

Development of soybean area in Brazil: the traditional south, the current main production region Centre-West and the frontier North and Northeast. Sources: FAO, CONAB, ISTA Mielke, Bickel and Dros.

Throughout the 1980s and 90s, soy expanded into the Centre-West region. Through the development of high-yielding tropical varieties and the availability of vast areas of Cerrado land, 60% of Brazilian production is now coming from the tropical states, with Mato Grosso the single biggest producer (figure 2.9 a). Between 1995 and 2004, soy area increased 77% in the entire Centre- West region, and 89% in Mato Grosso state. Growth in the Southeast and South was 31 and 38 % respectively over the same period. In the Northeast, soy planted area grew with 117% to 1.43 million ha. In the North, soy expanded 767% to 317,000 ha (figure 2.9 b).

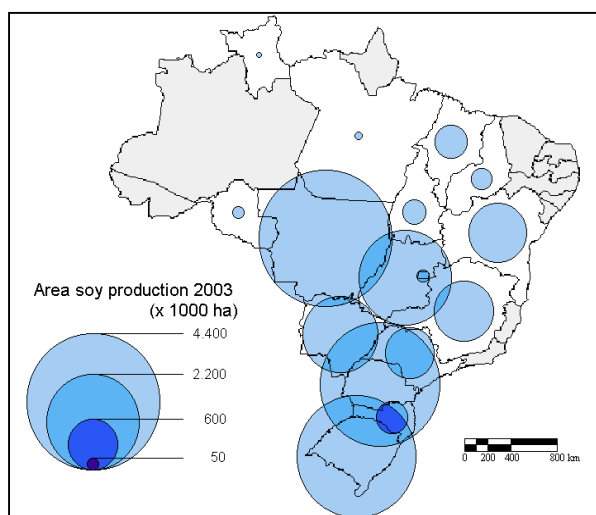


Figure 2.9 a
Soy planted area in Brazil 2003.
Source: CONAB

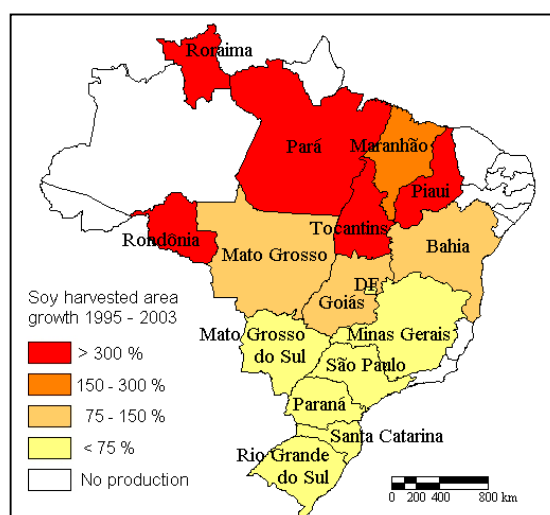


Figure 2.9 b
Growth of soy planted area Brazil 1995.
2003 Source: CONAB

Loss of natural habitats

The development of soy farming in Southern Brazil through the 1950's-1980's has contributed to the near extinction of the Atlantic Forest in this region, but its exact contribution and relative importance vis-à-vis other forms of agriculture, industrial tree plantations and cattle ranching is hard to establish. The expansion of soy in the Central-West and Amazon region has mostly affected the Cerrado ecosystem. In the Amazon, there is increasing pressure on transitional and rainforests.

Atlantic Forest

In 2004, 8.2 million hectares were planted with soy in the three Southern states, mostly in areas that were originally covered with Atlantic Forest. The Atlantic Forest in South Brazil is now limited to hilly and mountainous areas not suitable for mechanised agriculture and a few protected areas.⁷⁵ In Rio Grande do Sul, soy has also been planted on former natural grasslands (*Campos Sulinos*, comparable to the Pampas of Uruguay and Argentina). Currently, soy is expanding in the two largest biomes of Brazil, the Cerrados, where the majority of soy expansion in the 1990's and early 200's took place, and the Amazon forests which is developing as a new, still relatively minor expansion area.

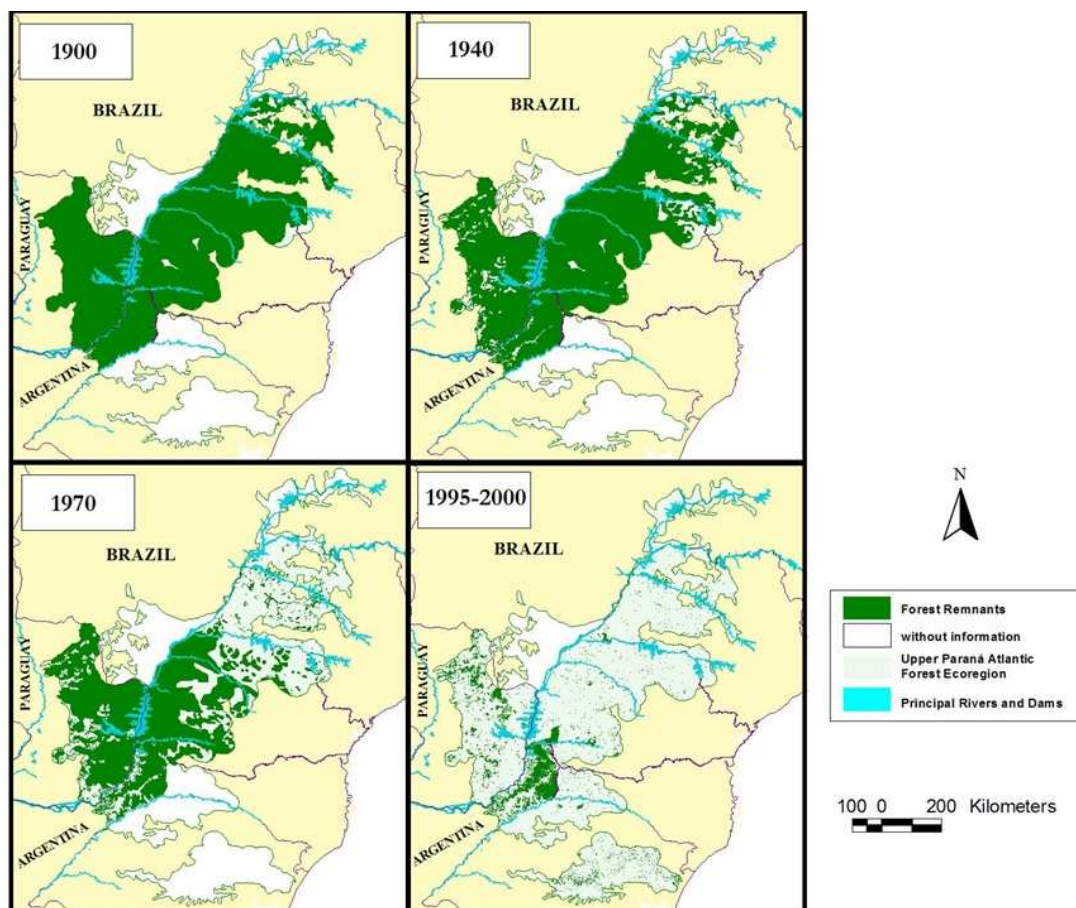


Figure 2.10

Retreat of the Interior Atlantic Forest 1900-2000. Source: WWF

Cerrado

In the decades after opening of the Brazilian interior in the 1960's, more than half of Brazil's Cerrado, originally covering approximately 200 million hectares, has been converted to pastures and, to a lesser extent, agricultural fields (figure 2.11). Originally, the Cerrado was used for cattle raising on natural pastures, with some smallholder farming and extractivism. The Cerrado is regarded as the most biologically diverse savannah in the world, with a high diversity of vegetation types (ranging from *Campo Limpo* short grasslands through a variety of shrub- and woodlands to *Cerradão* woodlands), and exceptional numbers of birds and plants. In the 1970's and 80's, large areas of Cerrado vegetation were replaced by planted pastures, mostly in the Central and Southern states of Mato Grosso, Mato Grosso do Sul, Minas Gerais and Goiás.⁷⁶ The Northern Cerrados of Mato Grosso, Tocantins, Maranhão, Piauí and Bahia have been undisturbed for long because of inaccessibility and their extremely acid, poor and degradation-prone soils.

Commercial agriculture is only possible with substantial lime and fertiliser application.

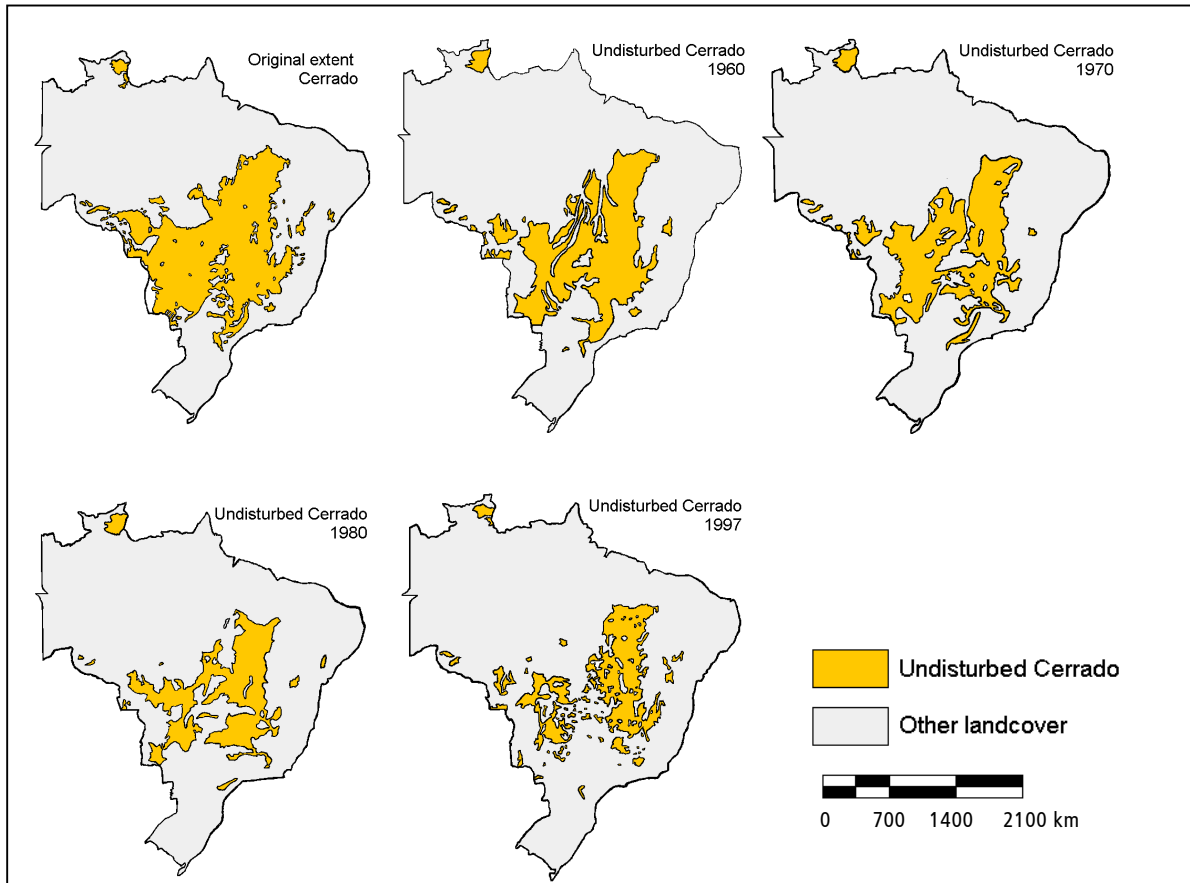


Figure 2.11

Retreat of undisturbed Cerrado, 1900-1997. © AIDEnvironment, based on Atlas Nacional 2000, IBGE

Figure 2.11 shows the advance of the agricultural frontier in the Cerrado biome. By 1997, nearly 80% or 160 million hectares of the Cerrado had been *antropized*.⁷⁷ It should be noted that areas defined as ‘antropized’ include different degrees of disturbance, ranging from fire management of natural pastures through planted pastures to full conversion to mechanised agriculture. It is estimated that within the ‘antropized’ area, 90 million hectares had been completely cleared in 1997.⁷⁸ Of the remaining 110 million ha, only 40 million hectares were considered in pristine state in the late 1990s. Protected areas cover only 1.7 % of the Cerrado compared to 4.6 % in the Amazon.⁷⁹

The Brazilian Forest Code allows owners of Cerrado lands to clear a much larger proportion of their area (65-80%) than owners of forest land in the Amazon region (20% in

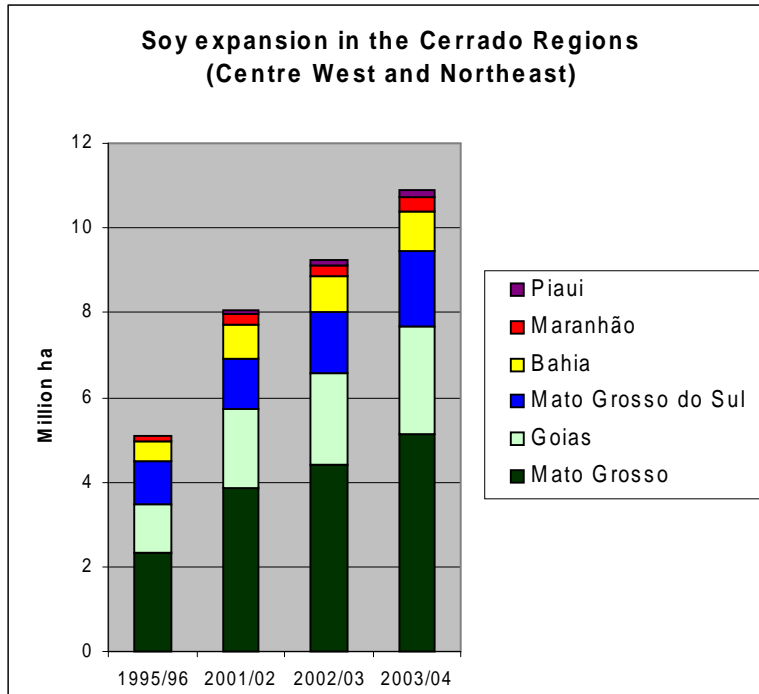


Figure 2.12

Soy expansion in the Cerrado states of Brazil. Source: CONAB, IBGE

rainforest and 50% in transition forest).⁸⁰ Currently, the last remaining blocks of undisturbed Cerrado are found in Tocantins, Maranhão, Piauí and Western Bahia, all areas with explosive development of soy cultivation (see figure 2.12).⁸¹ Cerrado remnants in Mato Grosso, Goiás and Minas Gerais are also threatened by conversion. Soy currently occupies 9.5 million hectares in the Centre West, 1.43 M ha in the Northeast and 0.32 M ha in the Northern (or Amazon) region.⁸² Out of the total 11.3 M ha of these three regions, at least 4.5 M ha are estimated to have been established in the Cerrado since 1996.

Comparison of deforestation figures of IBGE (that exclude Cerrado) and the Mato Grosso forest monitoring agency FEMA (that include Cerrado) lead to the conclusion that in Mato Grosso alone 800,000 ha of Cerrado were cleared in 2002/03.⁸³ The soy planted area expanded 570,000 ha in Mato Grosso in that season.⁸⁴

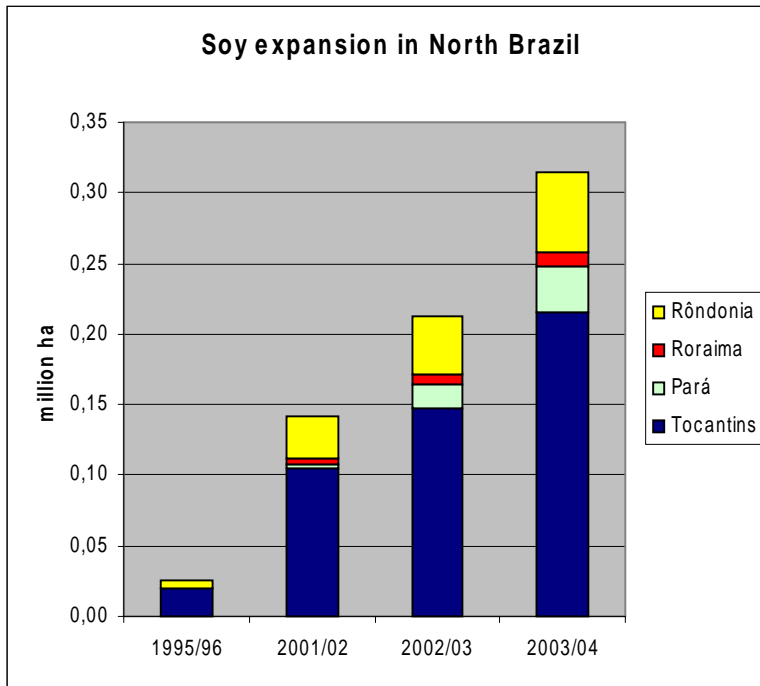


Figure 2.13

Soy expansion in the Amazon states of Brazil. Source: CONAB

Amazon transition and rainforest In the late 1990s soy cultivation reached the Amazon basin^{III}.

Between 1996 and 2004 soy planted area in the Amazon states in the Northern Region increased from 25,000 hectares to 317,000 ha, mostly in Rond nia and Tocantins, but generally at the expense of Cerrado vegetation. For the 2002/2003 season, a total deforestation of 2.37 million hectares of Amazon transition and rainforest was recorded for the Legal Amazon, excluding Cerrados.⁸⁵ The majority of this area was cut to accommodate cattle ranching expansion and, to a lesser extent, smallholder farming. Soy is an important push factor for

III The word Amazon is used to define many different areas in Northern Brazil. The Amazon Basin is the water catchment of the Amazon river and its tributaries. The Amazon Biome comprises the tall rain- and deciduous forests in the Amazon Basin (and excludes the Cerrado and Cerrad o bush savannah); Amazonia Legal (the legal Amazon) is an administrative grouping that comprises the states of the Northern Region, Mato Grosso and Western Maranh o.

deforestation; the money received by subsistence farmers and cattle ranchers from soy farmers is often used to buy forest land or clear forest properties.⁸⁶ As soy and cattle farming are expanding in all states in the Legal Amazon (except Amapá and Roraima) it must be concluded that where soy replaces pastures, new pastures have to be opened elsewhere to relocate the cattle. Given the high prices paid for land that is suitable for soy production, it can be assumed that substantially more than one hectare of new pastureland may be cleared for every hectare of pasture converted to soy.

The development of soy storage and transport facilities in Mato Grosso, Pará and Rondônia increases pressure on deciduous transition forests, between the drier Cerrado ecosystem and the Amazon Rainforest. Due to the longer dry season the transition forests are more vulnerable to fire, and its soils more suitable for agriculture.⁸⁷ According to the Brazilian Forest Code 50% of a property under transition forest can be cleared, whereas only 20% of rainforest is allowed to be cleared.⁸⁸ The transition forest overlaps with the infamous 'Arc of Deforestation' along the southern and eastern edge of the Amazon Basin. 60% of the transition forest is estimated to be lost to mostly cattle farming. It is these areas that are increasingly converted to soy.⁸⁹ As most Amazon ecosystems, these forests are very rich in biodiversity, very similar to the Chiquitano forests of Bolivia.⁹⁰

So far, direct conversion of natural habitats in the Legal Amazon has been limited to the Cerrados of Tocantins and Rondônia⁹¹, *Campos Naturais* or poorly drained savannahs in the Humaitá region of Amazonas state⁹² and the *Lavrado* savannahs of Roraima.⁹³ Where soy has been planted in former transition- or rain forest, mostly in Pará, Mato Grosso and Tocantins, this has so far been in areas previously cleared for cattle production or subsistence farming.⁹⁴ Figure 2.14 shows the distribution of soy farming and cattle raising in the various Amazon biomes in 1994, illustrating the concentration of soy production in the Cerrado biome. The rapid expansion of soy in Santarém shows that the humid Amazon climate does not inhibit soy cultivation. The presence of Cargill storage facilities and low land prices are an incentive to plant soy; so far 40,000 hectares of soy have been established in a rice-soy sequential cropping system.⁹⁵ The soy planted area is expected to expand exponentially over the coming years.⁹⁶ The establishment of the soy terminal leading to acquisition of smallholder farms by

immigrants, establishment of monocultures and rising land prices and the have resulted in large public demonstrations.⁹⁷ With the upcoming paving of the highway BR-163 scheduled for 2004/05, soy farming is expected to spread further into the Amazon forests of western Pará. Conversion of 2.2 to 4.9 million hectares of rainforest for pasture and agriculture development is foreseen if the establishment of the road is not accompanied by rigorous spatial planning and environmental enforcement measures.⁹⁸

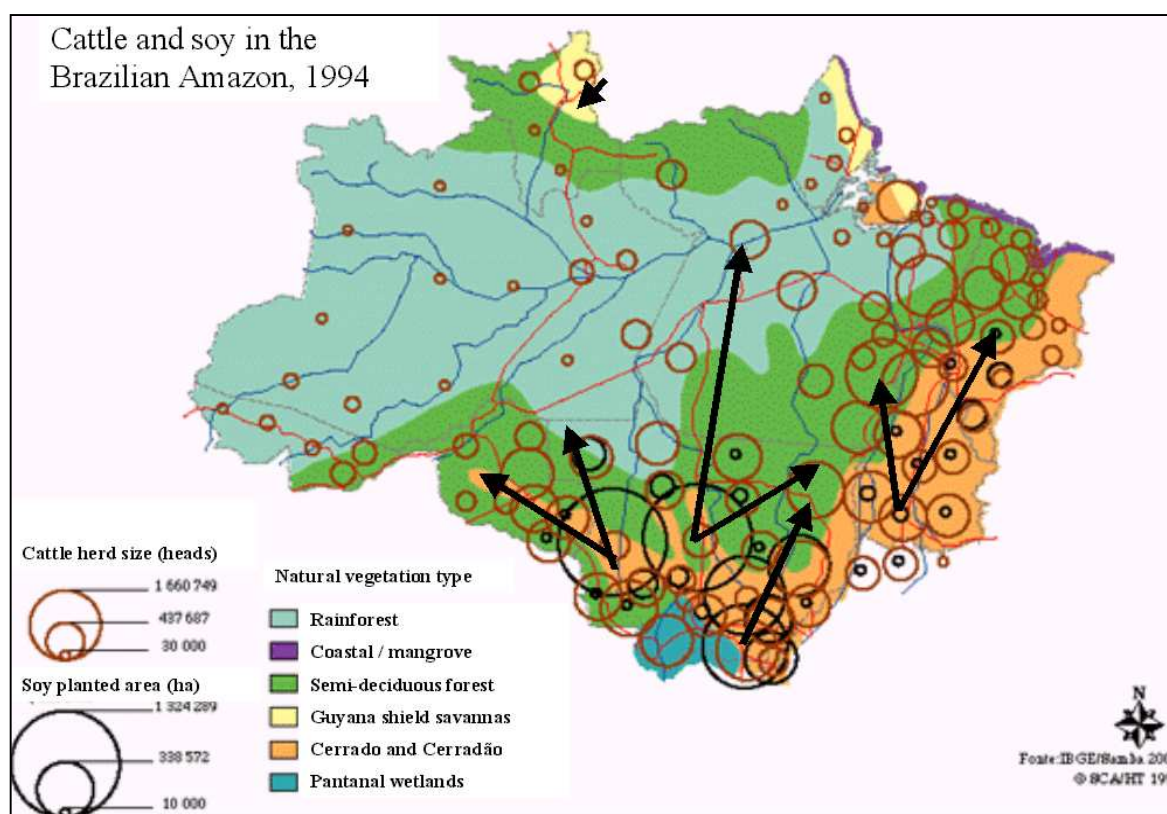


Figure 2.14

Cattle herd and soy planted area per municipality in the Brazilian Amazon region in 1994. Black arrows indicate current expansion corridors. Source: IBGE

Other ecological impacts

Erosion and subsequent siltation of rivers and wetlands is a serious and widespread problem in the Cerrado region. Main cause is the indiscriminate clearing of vegetation along waterways. This is aggravated where tilled agriculture is practised. Pollution of surface water with pesticides threatens human populations and aquatic life.⁹⁹ Indigenous populations depending on fish for sustenance and river water as drinking water source are especially vulnerable. The advance of the

agricultural frontier is claimed to give rise to climate change, decreasing precipitation in the Central West and south-western regions.¹⁰⁰

Socio-economic impacts

Most of the soy expansion areas are relatively empty, but given the very low rural employment opportunities in soy production, displacement of rural populations is expected to occur in relatively densely populated areas such as the colonisation areas in Rondônia and Mato Grosso.¹⁰¹ The individual short-term benefit of land sale result in medium to long term decreasing food security.¹⁰² Labour conditions during land preparation are generally poor. Many cases of slave labour have been reported in the North and Northeast Regions. Recently, 120 'slaves' were liberated on a state-of-the art Mechanised soy farm in Mato Grosso.¹⁰³ Brazil ranks fourth in the World Bank list of countries with most unequal distribution of income; the richest 20% of the population earns over 63% of the national income, whereas the poorest 20% (rural workers and indigenous groups) earn less than 2%.¹⁰⁴

Expansion plans

Soy is the main agricultural export and an important source of foreign currency for Brazil. Consequently, numerous federal government programmes exist to support its growth. In addition, state and regional development programmes have discovered soy as interesting opportunity for local economic development. To remove infrastructural constraints, the previous Brazilian government launched the *Avança Brasil* infrastructural programme to lower transportation costs from the Brazilian interior to main domestic and export destinations which is currently being implemented with financial support from the agro-industry sector. It includes the development of roads, waterways, railways that link the Central-West region with main ports in the Amazon and the Northern coast of Brazil, reducing shipping costs to the EU and Asia (figure 2.15).¹⁰⁵

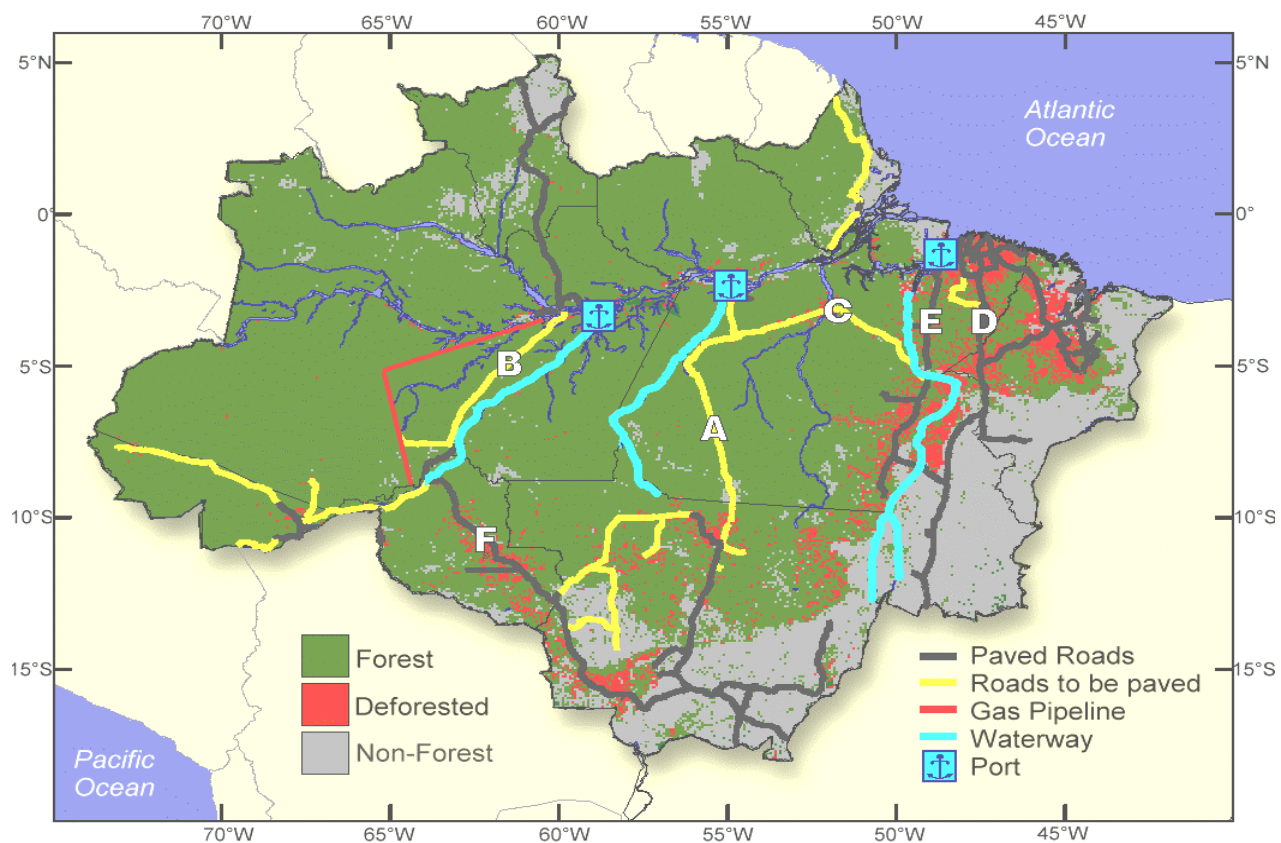


Figure 2.15

Roads and waterways proposed under the Avança Brasil Programme. A (Cuiabá-Santarém road), B (Porto Velho-Manaus waterway) and E (Araguaia-Tocantins waterway) are planned to become main soy export corridors.

A summation of regional and state inventories of lands deemed suitable for soy reveals that Brazil considers 70-100 million hectares.¹⁰⁶ Of this, currently 21 million are under soy cultivation, an estimated 30-40 million are under virgin or lightly disturbed natural cerrado vegetation¹⁰⁷, 7 million are forested and the remaining 12-32 million are planted pastures. Mato Grosso and the North-eastern states of Maranhão, Piauí and Bahia are planning substantial increases in soy planted areas in the coming years, focusing on the Cerrado areas. It is therefore expected that most area growth will occur in these states.

2.7 Paraguay

Introduction

Soybean cultivation in Paraguay started in the early 1970's in the province of Itapúa, at that time still largely covered with

Atlantic rainforest. In the early 1980's the Paraguayan economy boomed and soy expanded to Alto Paraná and Canindeyú, covering some 650,000 hectares¹⁰⁸. Between 1985 and the early 1990s the planted area decreased slightly, to increase again from the mid- 1990s to an estimated 1.75 million ha in 2003/04 (fig. 2.16)¹⁰⁹. Recently strong growth occurred in Caazapá and Caaguazú, but in 2001 83% of the planted area was still located in the before mentioned Eastern Paraguayan provinces Itapúa, Alto Paraná and Canindeyú (fig. 2.17).¹¹⁰

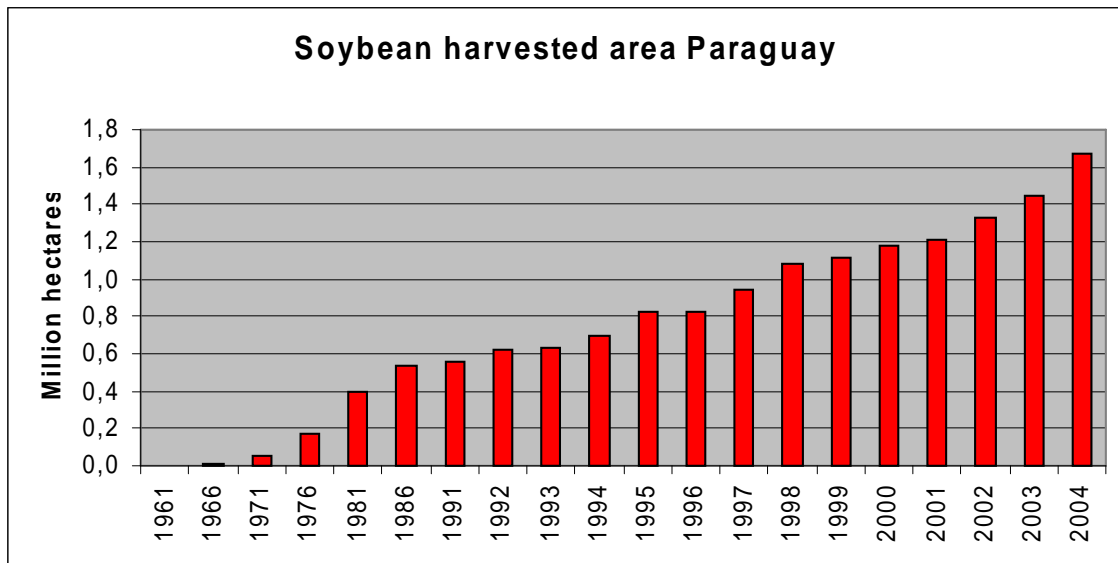


Figure 2.16

Soy planted area Paraguay. Sources: FAO, Ministeria de Agricultura y Ganaderia, USDA-FAS, ISTA-Mielke

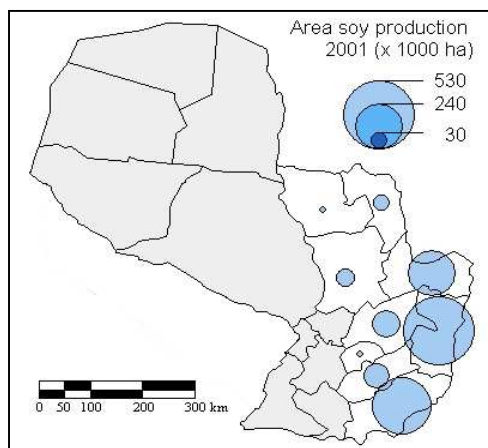


Figure 2.17

Main soy production areas crop year 2000/2001.
Source: MAG, Paraguay

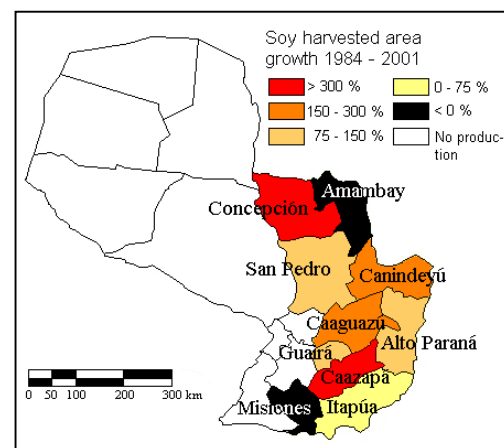


Figure 2.18

Growth of soy planted area 1984 - 2001.
Source: MAG, Paraguay

The planted area is expected to grow with another 250,000-350,000 ha next year. Expansion is foreseen in San Pedro, Alto Paraná, southern Canindeyú and western Caaguazú and in the Chaco region of Alto Paraguay.¹¹¹

Brazilian immigrants and their descendants are a dominant producer group, owning 1.2 million ha of land in East Paraguay. They profit from Brazilian tax exemptions when re-exporting their crops to Europe through Brazil.¹¹² In 2003 Paraguay legalised the cultivation of GMO soy, in reaction to a situation where an estimated 80% of soy planted was genetically modified.¹¹³

Loss of natural habitats

Atlantic Forest

The Atlantic Forest is one of the richest tropical moist forests on Earth. Large proportions of the animals and plants (50% of plants and 92% of amphibians) are endemic to the Atlantic Forest ecoregion - long isolated from the Amazon Basin by the drier Cerrado. Furthermore, many species occur only in limited areas within the region.¹¹⁴ The main remaining block of intact inland Atlantic Forest is found in Argentina's Misiones province. In Brazil, the remaining Atlantic Forest is highly fragmented and confined to the coastal mountain ranges. The extent of Atlantic Forest in Paraguay has decreased drastically in the past forty years. The forest, that covered 55% or 8.8 million ha of East Paraguay in 1945¹¹⁵ has been reduced to 800,000 ha, only 7 % of its original extent (figure 2.19).¹¹⁶

Chaco and Pantanal

Although current soy planted areas are negligible, strong expansion is expected in the Chaco's of Alto Paraguay, and the Ñeembucú wetlands bordering the Pantanal.¹¹⁷

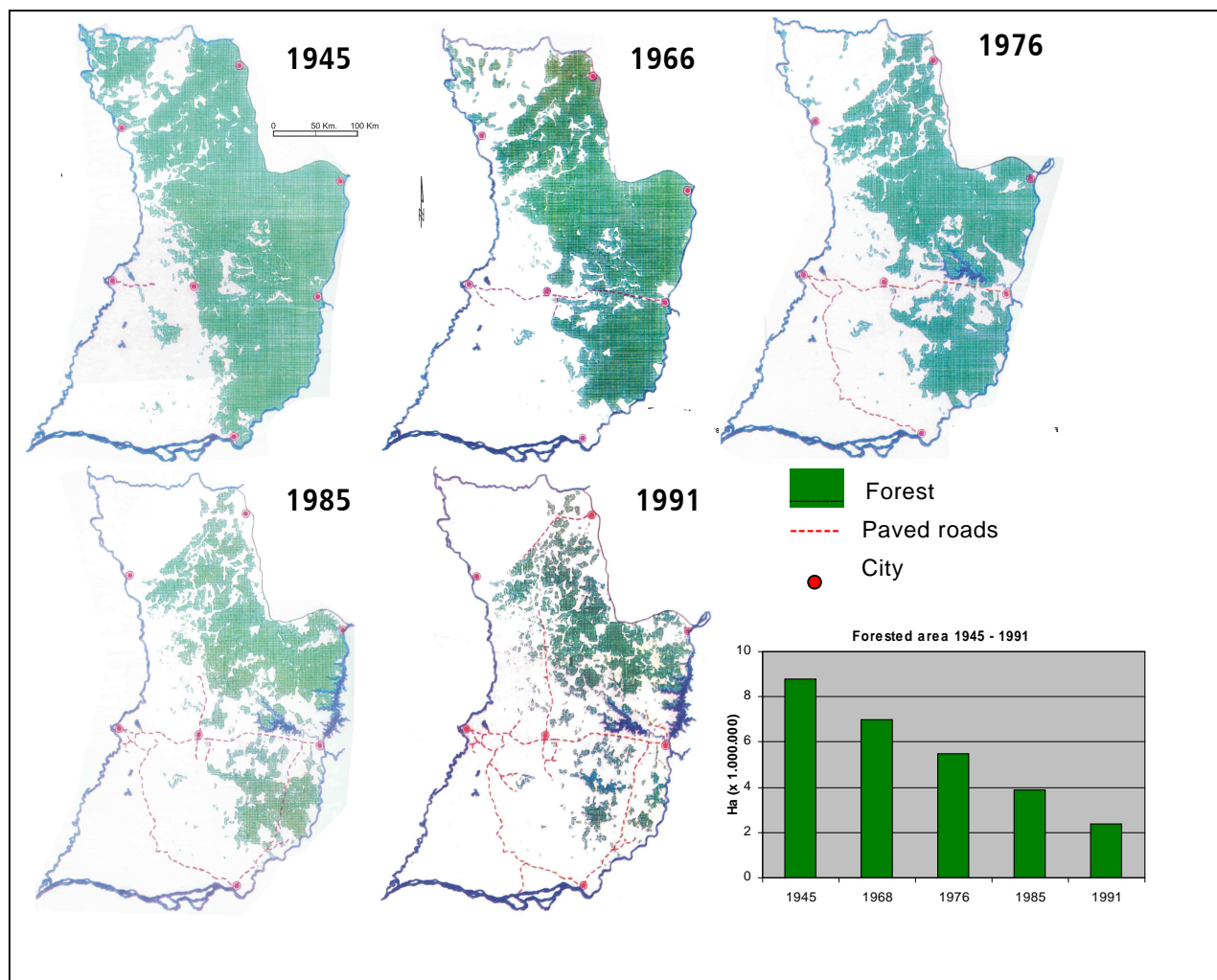


Figure 2.19

Deforestation in Eastern Paraguay 1945-1991 Source: Ministeria de Agricultura y Ganaderia Paraguay and GTZ.

Other ecological impacts

Although historically forestry (1930s-60s) and cattle raising (1960s-80s) have been the major causes for deforestation,¹¹⁸ the expansion of mechanised soy farming has been the single most important driver for deforestation in the past decades.¹¹⁹

Conversion is also taking place inside protected areas such as the San Rafael Reserve, the largest remaining block of Atlantic Forest in Paraguay.¹²⁰

As almost all available forest land has been converted in Eastern Paraguay, soy production is now finding its way into the Chaco's and wetlands of Western Paraguay.¹²¹ This is where the majority of growth is expected to occur in the coming decades. Like described for Argentina, the large scale adoption of soy monoculture has lead to soil degradation and water pollution.¹²² The widespread adoption of GMO soy has lead to

high and often imprudent use of glyphosate herbicides. Hundreds of cases of human intoxication have been reported.¹²³ Protests against this practice have led to violent clashes between unarmed small farmers and the Paraguayan police, resulting in the death of two unarmed farmers in March 2004.¹²⁴

Socio-economic impacts

The development and strong growth of mechanised commercial export agriculture, dominated by soy, has not resulted in poverty reduction and has aggravated unequal income distribution.¹²⁵ Paraguay ranks third in the list of countries with most unequal distribution of income; the richest 20% of the population earns over 60% of the national income, whereas the poorest 20% (mostly indigenous communities) earn less than 2%.¹²⁶

Expansion plans

The Paraguayan producers' association CAPECO aims to increase soy planted area to 2 million hectares by 2006 and to double it to 3.5 million hectares by 2008. Although CAPECO plans to accommodate the expansion in current cattle raising areas, legal and illegal deforestation for soy is common practice in Paraguay, and in the 2003/04 crop season soy planted area expanded almost 200,000 hectares.¹²⁷

2.8 The future of soy in South America

Notwithstanding the eminent negative impacts of large scale adoption of soy monocultures in South America, the world demand for this commodity is expected to grow. The preceding sections have illustrated that most of this demand growth will be met by South American producers. In the following section, the impacts of foreseen growth of soy production are sketched under two scenarios: Business as Usual and Better Policies and Practices. Both scenarios are based on increased liberalisation of international trade. The removal of trade barriers will increase the reliance of densely populated consumer markets to commodities imported from areas where land is cheap. Based on population and income growth forecasts, future soy demand has been calculated by industry analyst Mielke.¹²⁸ Subtracting forecast production of other main producer countries determines the amount of soy to be produced annually by the four producer countries under both scenarios. The Business as Usual scenario (section 3) calculates the loss of key natural

habitats based on extrapolation of past trends, current plans and policies, existing practices and perceived impacts. The Better Policies and Practices scenario (section 4) assesses the impacts of various forms of improvement and intensification of land use that is currently being experimented in most producer countries. These systems integrate crops (i.e. soy) with livestock, reaching higher per hectare yields and stocking rates through better utilisation of soil and fodder resources.

A worrying observation is that realisation of the soy expansion plans of the four producer countries will lead to much larger export volumes of soy than the forecast absorption capacity of the world market. This means that it is likely that land will be cleared unnecessarily, prices are likely to drop as a result of oversupply and that the most marginal (and often most vulnerable) lands will be abandoned shortly after having been cleared. Better planning and co-ordination are required to avoid such a 'tragedy of the commodities'.

3 The Business as Usual scenario

In this section, the impacts of foreseen growth of soy expansion are sketched under a Business as Usual scenario. Before describing the scenario, global market demand is forecast to determine the amount of soy to be produced annually by the four producer countries under both scenarios.

3.1 World demand for soy 2005-2020

The market for soy is determined by demand for soy meal, by far the world's most important oil meal. Global oil meal consumption is estimated to rise from 182 million tons in the 1996-2000 period to 335 M tons between 2015 and 2020¹²⁹. Notwithstanding the rising supply of palm kernel meal, Industry Analyst Mielke estimates soy to increase its market share from current 55% to 57% by 2020. This translates in an annual demand of 303 million tons of soybeans by 2020 (fig. 3.1).¹³⁰ Of the eight main producer countries (US, Brazil, Argentina, China, India, Paraguay, Canada and Bolivia), only the four South American countries have sufficient land reserves to expand soy production area significantly.¹³¹ Soy production increases in the other main producer countries will be more than compensated by increased domestic demand, leading to decreasing exports or increasing imports. Of the foreseen production growth of 110 million tons, more than 80 million is expected to be covered by the four South American producers.

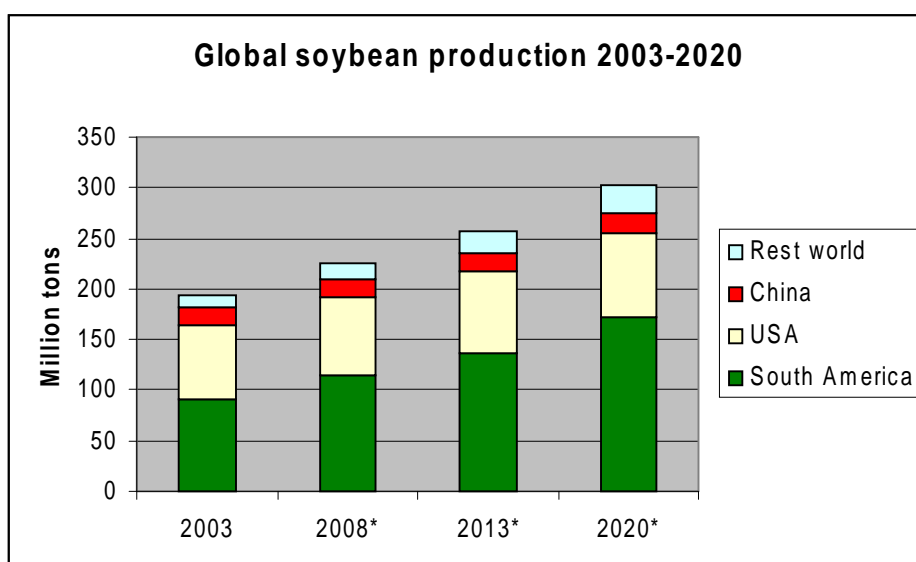


Figure 3.1

Global soy production per producer region. *indicates forecasts. Sources: AIDEnvironment, ISTA Mielke

3.2 Assumptions

Based on available statistics, government and industry plans the following assumptions were made to quantify the impacts of soy expansion on natural habitats in the four production countries. It should be noted that *direct conversion* refers to conversion of (more or less) intact natural ecosystems to soy fields. *Indirect conversion* refers to substitution of existing human land use by soy, which causes conversion of natural habitats elsewhere by migration of the previous land use, typically smallholder agriculture or cattle ranching.

- Global demand for soy in 2020 is forecast to be 303 million tons. This is based on demand projections in Mielke's Oil World 2020 adjusted upward for additional demand growth unforeseen when Oil World 2020 was published in April 2002. This additional growth is expected to be covered fully by South America.¹³²
- Soy production forecasts outside South America are based on Mielke's Oil World 2020.
- Increases in soy yields in the USA, Brazil and Argentina are based on extrapolations of logarithmic trend lines over the 1989/90-2003/04 period. This results in annual yield increases of 0.025 tons/ha/yr for Brazil, 0.014 tons/ha/yr for

Argentina and 0.012 tons/ha/yr for the USA. For Bolivia and Paraguay, where no clear trends were visible, an annual increase of 0.01ton/ha has been assumed.¹³³

- For Bolivia and Paraguay annual production growth of 150,000 and 300,000 tons per year are forecast, based on extrapolations of recent growth and government and industry association projections.¹³⁴ Argentina and Brazil together meet the rest of global demand, rising from nearly 100 M ton in 2004/2005 to almost 160 M ton in 2020. Brazil is estimated to supply 60% of this amount, Argentina 40%.¹³⁵
- In Brazil, the expansion will be realised by the conversion of cerrado habitats in the North-eastern region and the states of Minas Gerais and Goiás, and by conversion of cerrado and transitional forest in Mato Grosso, Rondônia, Pará and Tocantins. Where soy expands into pasture areas it is assumed that the replaced cattle farmers will shift to newly converted natural areas, resulting in the same net conversion.^{IV}
- In Paraguay, half of the expansion of soy will be realised by the conversion of Atlantic Forest; the remainder will occur in the Chaco (savannah) biome of Alto Paraguay surrounding the Pantanal.
- In Argentina 17% of the soy area growth is forecast to take place in the traditional agricultural provinces of Buenos Aires, Cordoba and Santa Fé. This expansion is assumed not to lead to direct or indirect conversion but to replace other, less profitable export crops such as wheat or corn. Of the expansion in Entre Rios, 50% is not expected to cause deforestation for the same reason. Of the remaining area growth 90% will be at the expense of the Chaco biome, mostly through direct conversion in the Chaco, Santiago del Estero, Entre Rios, Corrientes and Formosa provinces; some indirect conversion through replacement of cattle or

IV It is well possible that the capital obtained through the sale to soy farmers is sufficient to increase pastures elsewhere in much larger quantities than the 1:1 ratio assumed in this scenario. The dramatic increase in cattle herds in Pará, Mato Grosso and Rondônia in the past years seems to support this, but a more accurate estimation of this effect requires further study that goes beyond the scope of this report.

other crops may occur. The remaining 10% are realised through direct or indirect conversion of Yungas and Atlantic Forest biomes in the Salta, Tucumán and Misiones provinces.

- In Bolivia, soy will expand by direct or indirect conversion of Gran Chaco bush savannahs (50%) and Chiquitano dry forests (50%) in the province of Santa Cruz.

3.3 Impacts under the Business as Usual scenario

Conversion of natural habitats

Based on these assumptions, soy planted area in South America is expected to increase from 38 million ha in 2003/04 to 59 M ha in 2019/20 (Figure 3.2). Total production of the four countries will rise 85% to 172 million tons or 57% of world production.

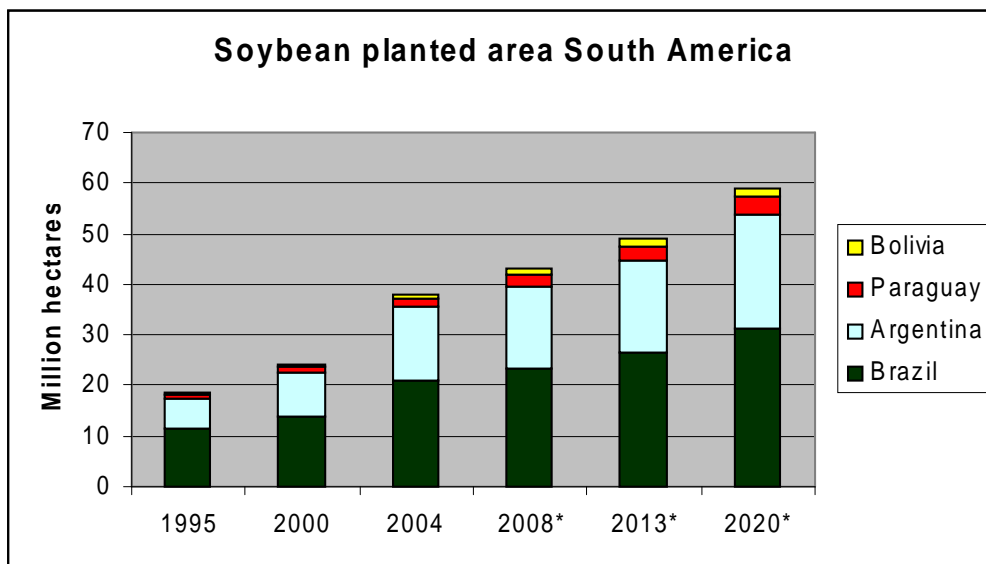


Figure 3.2

Soy planted area of the four main producer countries under the Business as Usual scenario; * indicate forecasts.

Figure 3.3 shows the main areas of soy production growth between 1995 and 2003 per province or state for the four main producer countries. Arrows indicate the direction of foreseen expansion until 2020. Habitats with greatest predicted area loss are the Cerrado (9.6 million hectares), dry and humid Chaco (6.3 M ha) and Amazon transition and rainforests (3.6 M ha). Most threatened habitats are the Argentine (lower) Yungas and Paraguayan Atlantic Forest. It should be noted that in the

Brazilian Cerrado soy expansion is fragmenting the last remaining contiguous blocks in the Brazilian north-east.

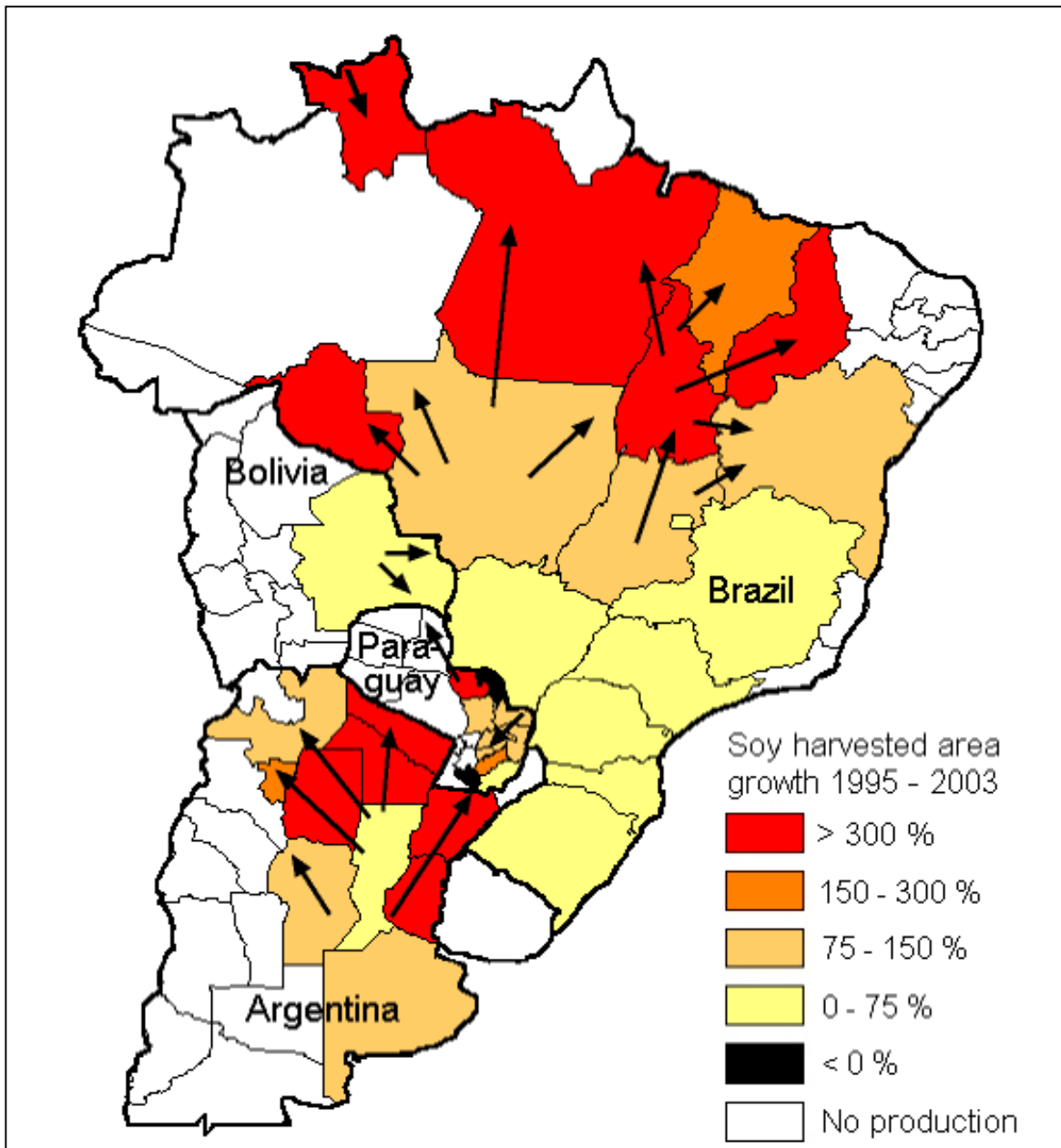


Figure 3.3

Soy area growth 1995-2003. Data for Paraguay are interpolated / extrapolated from 1984-2001 data. Arrows indicated expected expansion.

Direct and indirect conversion of natural habitats to accommodate this expansion amount to 21.6 M ha (figure 3.4). 2.5 M ha of current soy planted land are abandoned (mostly in urbanised regions in Brazil) by 2020. The vast majority of direct conversion takes place in the Argentine Chaco and Brazilian Cerrado. Indirect conversion is mostly attributable to capitalisation of cattle farmers and to a lesser extent smallholder farmers, both moving into natural savannah and forest habitats.

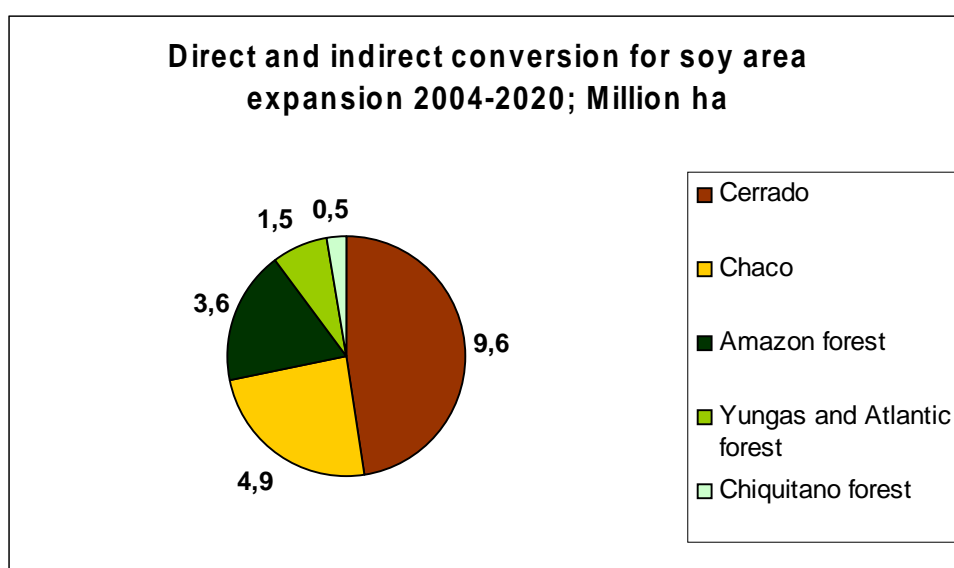


Figure 3.4

Direct and indirect conversion of natural habitats in South America from 2004 till 2020, according to the Business as Usual scenario.

When assessed on country level, conversion is proportional to the producer countries' market shares. In Brazil, relatively much (Amazon) forest is threatened due to the vicinity of large areas of transitional and rainforest to soy-related infrastructure. Although many threatened areas are not suitable for soy, expansion of soy in surrounding cerrado areas is expected to increase deforestation for cattle raising in Rondônia, Mato Grosso and Pará.

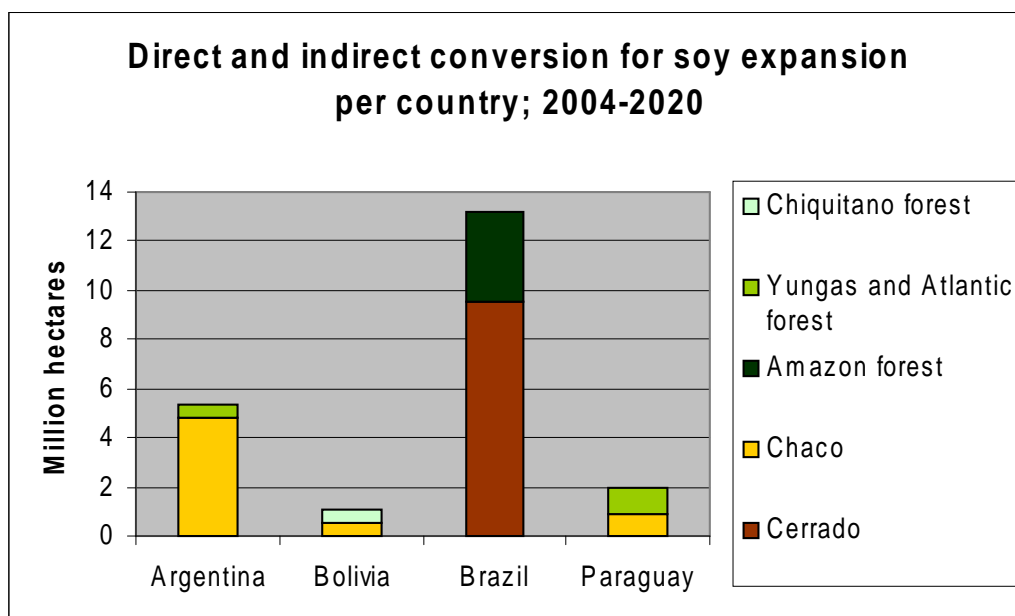


Figure 3.5
Conversion per habitat type in Argentina, Bolivia, Brazil and Paraguay.

| Country | Forest type | Estimated conversion 2004-2020 (x 1,000 ha) |
|------------------|------------------------------------|---|
| | | |
| Argentina | Atlantic Forest | 300 |
| | Chaco | 4,850 |
| | Yungas | 200 |
| Bolivia | Chiquitano Forest | 550 |
| | Chaco | 550 |
| Brazil | Amazon Transitional and Rainforest | 3,600 |
| | Cerrado | 9,600 |
| Paraguay | Atlantic Forest | 1,000 |
| | Chaco | 900 |
| Total | | 21,550 |

Table 3.1
Estimated conversion 2004-2020 of major forest habitats in soy production countries

Due to the expected increased competitiveness of soy planted in the Central West and North-eastern regions, soy planted area is expected to decrease in several southern Brazilian states. This will result in the abandonment of 2.5 million hectares of soy in Sao Paulo, Rio Grande do Sul and Paraná, areas likely to be cultivated with other crops.

Other environmental impacts

Erosion and siltation are expected to increase, especially in the Chaco and Cerrado with pronounced dry and rainy seasons. Adoption of zero tillage has traditionally been lower in these regions than in the more established agricultural areas such as the Pampa and Paraná.¹³⁶ Under the Business as Usual scenario, the planting of large scale soy monocropping systems is expected to further increase. In Argentina and Paraguay most of this is expected to be herbicide tolerant GMO soy. Currently perceived problems with pesticide application and pollution of soil and water resources are expected to exacerbate, especially when this system is going to be applied on a wider scale in Brazil as well, affecting the Pantanal and Amazon basins.

The impacts of soy related infrastructure and capitalisation

The calculated loss of natural habitats is based on the areas occupied by soy or the conversion caused by previous land use shifted to natural habitats on a one-to-one ratio. The effects of increased access and legal or illegal occupation of land through the presence of soy-related infrastructure have not been factored in, but have been estimated at an *additional* 5 million hectares for the Cuiabá-Santarem road in Brazil alone.¹³⁷ In addition, capitalisation by soy farmers enables cattle ranchers to buy and / or clear much greater areas of forested land along these roads than the area originally occupied, as per hectare prices are lower. The establishment of roads thus leads to disproportionate deforestation and unevenly distributed economic gains.¹³⁸ Such effects are expected on the short term along the main highways connecting the Brazilian Central West region with the Amazon and North-east Brazilian ports, and along the roads connecting the Chaco regions of Argentina, Bolivia and Paraguay to the coast and river ports. If the planned route to the Pacific is paved, similar effects would be visible there.

4 The Better Policies and Practices scenario

4.1 Intensification of land use

This scenario explores the possibility to substantially increase soybean production in South America without conversion of valuable natural ecosystems. To achieve this, three lines of action are required:

- 1) Land use planning, including the identification of valuable habitats, corridors and degraded areas to be recuperated. National or even supra-national planning of agricultural expansion areas to prevent excessive clearing and planting leading to overproduction.
- 2) Monitoring and enforcement of environmental and spatial planning laws and regulations, including land titling.
- 3) The development of more efficient and intensive yet ecologically sustainable forms of land use. The abundance of cheap land and low population densities in the region have provided little incentive for intensification. Intensifying production along existing roads and near existing population centres will reduce the need to expand additional frontiers and investment in costly infrastructure projects.

This scenario assumes that planning, monitoring and enforcement will be sufficiently implemented over the next years to ensure no critical habitats are converted. Several anti-deforestation plans and monitoring initiatives have been launched by the new government, but successful implementation is still very much dependent on the good will of local law enforcement and the producers themselves. In this scenario, clients and financiers of soy producers are assumed to support (local) governments by requesting producers to comply to mutually agreed producer guidelines or criteria, and monitor the implementation.¹³⁹ Such market mechanisms are expected to be more effective than ‘command and control’, as long as enforcement capacity is low.¹⁴⁰

Mechanised soy cultivation is a highly intensive form of land use. Intensifying land use in a broader sense requires taking into account cattle farming as main cause of direct conversion

of South American forests – most notably in the Amazon.¹⁴¹ Cattle raising is also by far the most extensive human land use in the region with over 300 million hectares of managed planted and natural pastures in the four countries covered by this report – over five times the size of France.¹⁴² In the Brazilian Cerrado alone 70 million hectares of pasture have been planted, predominantly with African grasses such as *Brachiaria*.¹⁴³ Consequently, these areas have lost most of their original biological diversity. Stocking rates are generally below one animal unit (AU) per hectare, and millions of hectares of degraded pastures are lying idle.¹⁴⁴ As has been demonstrated in the preceding chapter, the acquisition of suitable pastureland by soy farmers enables cattle ranchers to expand their extensive operations into ‘virgin’ forest, Cerrado or Chaco lands.

With proper management, rotation of annual crops (especially legumes like soy) and cattle can increase the carrying capacity for cattle and prevent soil exhaustion for annual crops. Such livestock – crop rotations were common practice in the Pampa region of Argentina before the area was permanently planted with annual crops because of higher profitability.¹⁴⁵ Currently, various farmers’ organisations are implementing the integration of zero-tillage soy cultivation with cattle raising (hereafter Integrated Crop – Livestock Zero Tillage or ICLZT systems) on medium- to large scale, mechanised farms.¹⁴⁶ Under this system, soy farmers rent or lease –rather than buy – pastureland from cattle ranchers. Through rotation cropping on part of the pasture, soils are improved and the cattle ranchers can raise the cattle density. Although field trials show the model is economically viable, cultural differences between farmers and ranchers, legal, technical and educational constraints inhibit the ‘automatic’ adoption of such practices on a large scale.¹⁴⁷ It should be noted that although widespread adoption of this model of intensified soy-cattle production does reduce the conversion of natural habitats for soy, it is still a form of large scale, industrial agriculture with potential adverse social and ecological effects. The implementation of producer criteria to limit and mitigate impacts, the development of economic alternatives for the landless and smallholders and the identification of indigenous, extractive and nature reserves are essential complements to ensure sustainable development.

A concept currently being developed by small farmers' organisations in South Brazil is Agro-ecologia, a diversification programme to integrate self-sufficiency in food production with the generation of income with organic or GMO-free cash crops sold at premium prices. As small farmers cannot 'out-compete' large scale mechanised soy farming, they seek niche markets with added value.

4.2 Assumptions

This scenario calculates how adoption of the ICLZT and Agro-ecologia concepts can contribute to achieve the foreseen demand for soy through 2020 in current cattle raising areas. The calculations are based on the following assumptions:

- In Brazil (Minas Gerais, the Central-West and Northeast regions) and Argentina (Pampa and Chaco regions) adoption of ICLZT on existing pasturelands starts with 40,000 ha (or approximately 20 farms) in 2004/2005 with adoption rates increasing 60,000 ha/yr, resulting in annual adoption of nearly one million hectare by 2020.¹⁴⁸
- Adoption rates in Paraguay and Bolivia are 100,000 ha and 50,000 ha annually, in line with national industry plans to make soy production more competitive.¹⁴⁹
- ICLZT can accommodate 1,5 animal units per hectare (AU) in Transitional forest, Cerrado, Chiquitano forest and Pampa biomes and 1 AU in Chaco biomes.¹⁵⁰
- In the Amazon region (*Amazonia Legal*) idle lands are not brought under ICLZT farming but left to regenerate to forest or Cerrado.
- Adoption of Agro-ecologia is foreseen for areas with substantial smallholder populations and developed transport and storage infrastructure. In Brazil, it is assumed that currently 250,000 ha is under Agro-ecologia, and that the area will grow with 20,000 hectares in 2004/05 with adoption rates increasing with 5,000 ha per year, leading to adoption rates of nearly 100,000 ha / year in 2020.¹⁵¹
- In Argentina, 100,000 ha are assumed to be under Agro-ecologia currently in Santiago del Estero, Tucumán, Salta,

Entre Ríos and Corrientes, with adoption of 20,000 ha annually until 2020.

- Agro-ecologia integrates one Animal Unit per hectare.
- Under ICLZT, one crop of soy is grown annually. Under Agro-ecologia, one third of the farm area is planted with soy.¹⁵²
- Remaining soy demand growth is accommodated by growth of regular soy production on planted pasture areas.
- Displacement of cattle by regular soy expansion subtracted from cattle accommodation by ICLZT and Agro-ecologia. The resulting net accommodation is presented as ‘conversion prevention’ where 1 AU accommodation translates into 1 ha conserved.¹⁵³
- Yields under ICLZT are equal to those assumed under the Business as Usual scenario. Increased yield effects due to the prevention of ‘soil exhaustion’ by the inclusion of cattle rotations is offset against possible decrease effects caused by lower soil quality of existing pastures compared to ‘virgin’ soils exploited in the Business as Usual scenario.
- Yields under Agro-ecologia are set at 2 tons/ha due to lower degree of mechanisation and limited use of agrochemicals. Annual yield increases due to implementation of improved varieties and improved management are similar to yield increases in ICLZT and regular soy.

4.3 Impacts under the Better Practices scenario

Under these assumptions, the total soy planted area will increase from 38 million ha in 2003/04 to 59 million ha in 2019/20, equal to the Business as Usual scenario. Most expansion of soy production until 2020 will take place on existing idle lands and pasture lands in the form of integrated soy-livestock systems (fig 4.1). After 2007, the forecast annual demand increases can be produced in areas converted to integrated soy-livestock systems and the ‘push’ of cattle into natural habitats by soy expansion comes to a stop. Until 2020, a total of 23.6 million heads of cattle can be accommodated on productive soy land in this way. As a reference, the annual

increase of the cattle herd in the Brazilian Amazon amounted to 2.5 million heads per year between 1990 and 2002.¹⁵⁴

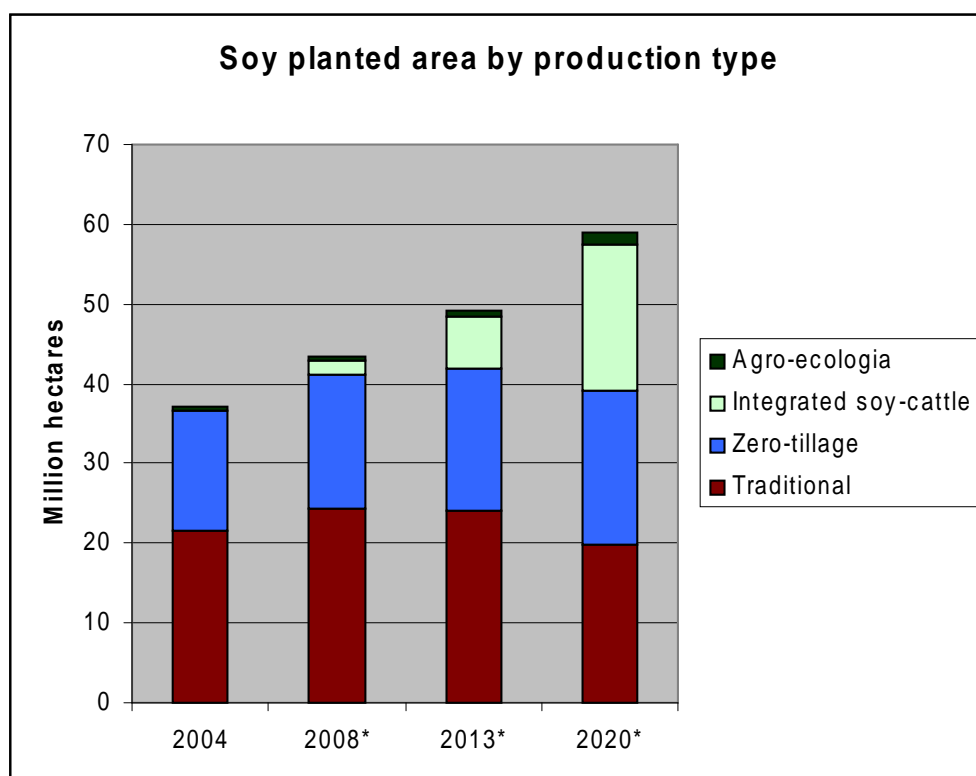


Figure 4.1

Adoption of ICLZT and Agro-ecologia under the Better Practices Scenario, 2004-2020.

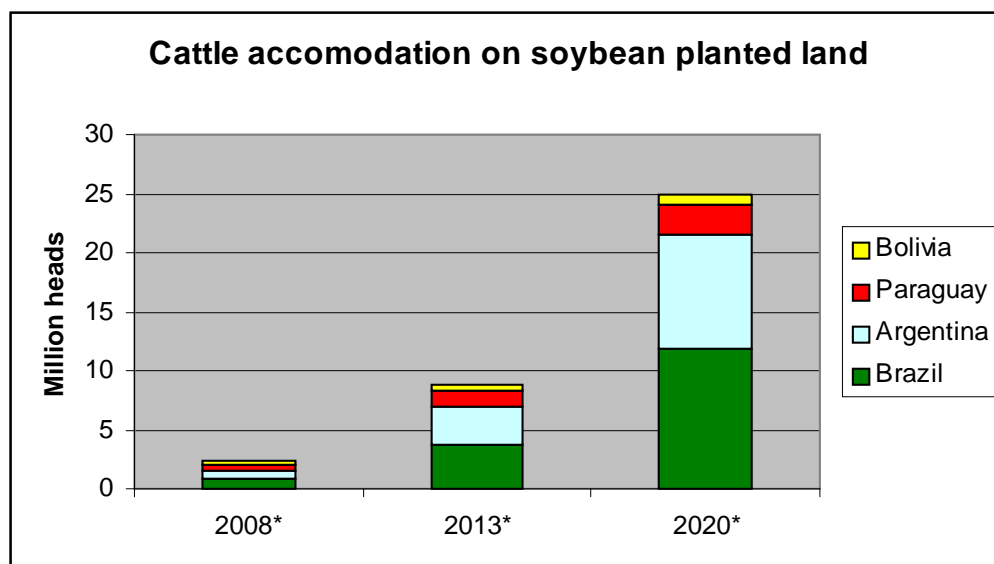


Figure 4.2

Accommodation of cattle on soy planted area under the Better Practices Scenario until 2020.

Impacts on natural habitats

Under the above assumptions, adoption of integrated soy-pasture systems and Agro-ecologia will be able to fully absorb cattle displaced by soy cultivation in Bolivia by 2005 and in Argentina, Brazil and Paraguay in 2007. Table 4.1 summarises the indirect conversion of natural habitats by replacing cattle per country until 2007. As after 2007 no indirect conversion will take place, this can be compared to the conversion figures under the Business as Usual scenario.

| Country | Ecosystem | Estimated conversion 2004-2020 (x 1,000 ha) Better Practices scenario | Estimated conversion 2004-2020 (x 1,000 ha) Business as Usual scenario |
|--------------|---------------------------|---|---|
| Argentina | Atlantic Forest | 0 | 300 |
| | Chaco | 1,300 | 4,850 |
| | Yungas | 100 | 200 |
| Bolivia | Chaco | 0 | 550 |
| | Chiquitano Forest | 0 | 550 |
| Brazil | Cerrado | 1,200 | 9,600 |
| | Transition and rainforest | 500 | 3,600 |
| Paraguay | Atlantic Forest | 280 | 1,000 |
| | Chaco | 0 | 900 |
| TOTAL | | 3,380 | 21,550 |

Table 4.1

Conversion 2004-2020 under the Better Policies and Practices and Business as Usual scenarios. Note that conversion under the Better Practices scenario will predominantly take place in the near future (2004-2007).

As can be observed in figure 4.2, integrated soy-livestock adoption can accommodate nearly 12 million heads of cattle in Brazil and nearly 10 million heads in Argentina. This would significantly reduce pressure on Chaco, Cerrado and Amazon forest biomes. Capitalisation effects, as described in the Business as Usual scenario, are to be expected however as rental incomes are likely to be reinvested elsewhere.

Other ecological impacts

Figure 4.1 shows that under the assumed integrated soy livestock adoption rates the area under tilled and traditional Zero Tillage management still increase. This means that curbing erosion and sedimentation will in large part depend on

protection of vegetation along streams. Substantial reduction of erosion potential would require higher adoption rates of Zero Tillage than assumed in this scenario. Integrated pest management is a central component of ICLZT that aims to reduce pesticide use relative to tilled and traditional Zero Tillage soy farming with 15-25%.¹⁵⁵ Total area growth is considerably larger, so pesticide use in absolute terms is bound to increase. Agro-ecologia preferentially applies biological controls, which are obligatory under organic production, and is thus expected to have lower impacts.

Social impacts

Intensification of land use through integration of soy with livestock raising reduces rural displacement and increases employment on area basis. This effect should not be overvalued as both mechanised soy farming and cattle ranching are very labour extensive. The integrated system brings substantial benefits to medium to large scale producers of soy and cattle but is not expected to contribute to (more equal) distribution of currently very unequal incomes. Benefits include increased land value, lower mechanisation and fuel costs, reduced fertiliser and pesticide costs. Agro-ecologia provides a diversified farm income, which is more secure – although not necessarily higher- than cash crop monoculture or pure subsistence farming. It provides food security and opportunities for added value such as on farm processing of produce and recreation.

5 Conclusions

Successful implementation of alternative land uses requires a paradigm shift with producers, investors and regulators. Local governments will need commitment and support of players in the soy production and marketing chain to promote more sustainable practices. The adoption of sourcing criteria and development of producer guidelines through a multi-stakeholder body are a necessary complement to legal measures to reduce the identified negative impacts of the soy production sector on valuable ecosystems and local communities.

The better policies and practices scenario shows that implementation of soy-cattle rotation under the so-called Integrated Crop Livestock Zero Tillage system can significantly reduce deforestation. However, most social issues related to soy cultivation and expansion are not resolved by this model. Therefore, buyers who want to ensure that their raw materials are ecologically and socially acceptable, should consider buying a substantial part of their soy from smallholder co-operations that have adopted Agro-ecologia or similar concepts, in which socio-economic benefits are better integrated.

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