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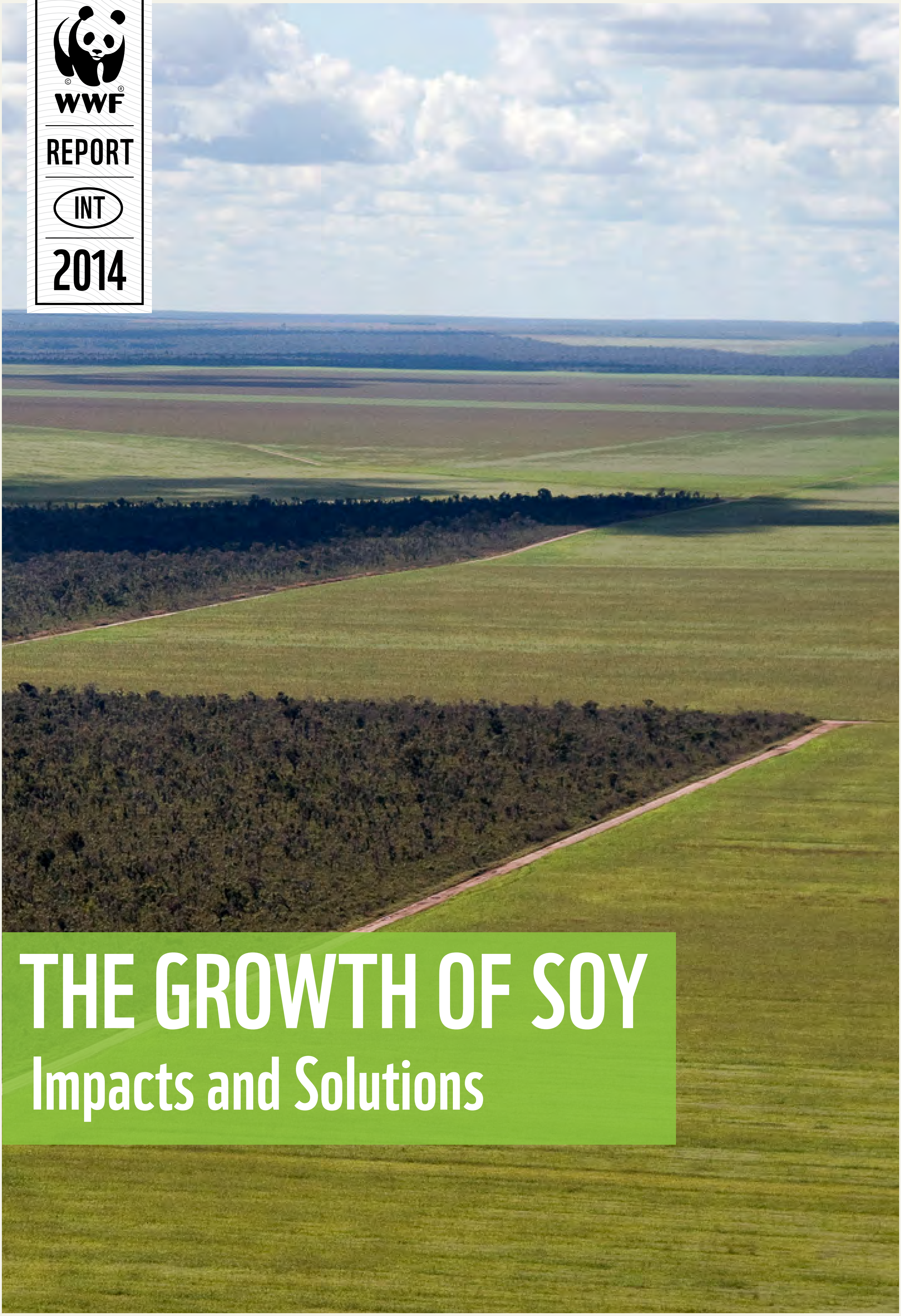

THE GROWTH OF SOY

Impacts and Solutions

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Impacts and Solutions

WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

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Cover photo: Aerial view of unpaved roads dividing a soy monoculture from the native Cerrado, in the region of Ribeiro Gonçalves, Piauí, Brazil. © Adriano Gambarini/WWF Brazil

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EXECUTIVE SUMMARY

Over recent decades, soy has undergone the greatest expansion of any global crop, threatening forests and other important natural ecosystems. This report explains the extent of the problem, the drivers behind it and how we all have a role to play in implementing solutions.

High in protein and energy, soy is a key part of the global food supply. But its growth has come at a cost. Millions of ha of forest, grassland and savannah have been converted to agriculture, either directly or indirectly, as a result of the global boom in soy production. With demand continuing to rise, more natural ecosystems will be lost – unless we take action urgently. Everybody can contribute to the transition toward a more responsible soy industry, including soy producers; traders; buyers in feed, meat and dairy, food processing and retail sectors; financial institutions; governments in producer and consumer countries; NGOs; and consumers.

IN THE LAST 50 YEARS, THE AREA DEVOTED TO SOY HAS GROWN TENFOLD, TO OVER 1 MILLION SQUARE KILOMETRES - THE TOTAL COMBINED AREA OF FRANCE, GERMANY, BELGIUM AND THE NETHERLANDS.

Soybeans have been cultivated for thousands of years in Asia, but over the last century cultivation has expanded dramatically. In the last 50 years, the area devoted to soy has grown tenfold, to over 1 million square kilometres – the total combined area of France, Germany, Belgium and the Netherlands. The fastest growth in recent years has been in South America, where production grew by 123 per cent between 1996 and 2004. And this expansion shows no sign of stopping: the Food and Agriculture Organization of the United Nations (FAO) suggests soy production will almost double by 2050.

Soy produces more protein per hectare than any other major crop. It is also one of the most profitable agricultural products. Around 270 million tonnes were produced in 2012, of which 93 per cent came from just six countries: Brazil, United States, Argentina, China, India and Paraguay. Soy production is also expanding rapidly in Bolivia and Uruguay. The main importers are the EU and China, while the US has the greatest soy consumption per capita.

Uses of soy

While soybeans can be eaten directly by humans, most are crushed to produce protein-rich soy meal, along with vegetable oil and by-products such as lecithin, a natural emulsifier. The meal is used primarily as livestock feed. Soy oil is used in food and other consumer goods, such as cosmetics and soaps, and as a biofuel.

Feed: Increasing meat consumption is the main driver behind soy's continuing expansion. Around three-quarters of soy worldwide is used for animal feed, especially for poultry and pigs. Between 1967 and 2007 pork production rose by 294 per cent, egg production by 353 per cent and poultry meat by 711 per cent; over the same period, the relative costs of these products declined. As the world's largest source of animal feed, soy is a key component of the industrial farming model that has enabled this.

Food: Some 6 per cent of soybeans are eaten directly, mainly in Asian countries, as whole beans or in products such as tofu and soy sauce. Soy is used as an ingredient in many baked and fried products, as margarine, in frying fats, or bottled as cooking oil. Lecithin derived from soy is one of the most common additives in processed foods, found in everything from chocolate bars to smoothies.

Fuel: Soybean oil can be used to produce biodiesel. Although this remains a small proportion of global soy production, use of soy as a fuel is driving expansion in countries such as Argentina.

Growing demand
Soy production is expected to increase rapidly as economic development leads to higher animal protein consumption, especially in developing and emerging countries. Recent FAO projections suggest an increase to 515 million tonnes by 2050; others project a 2.2 per cent increase per year until 2030. Soy consumption in China doubled in the last decade, from 26.7 million tonnes in 2000 to 55 million tonnes in 2009, of which 41 million tonnes were imported; China's imports are projected to increase by 59 per cent by 2021-22. Markets in Africa and the Middle East are also expected to expand rapidly in the next decade.

The challenge is clear: we are going to be growing more soy, and will need more land to grow it on.

IN TOTAL, THE AREA OF LAND IN SOUTH AMERICA DEVOTED TO SOY GREW FROM 17 MILLION HA IN 1990 TO 46 MILLION HA IN 2010.

Loss of natural ecosystems
Over the last few decades, vast areas of forest, grassland and savannah have been converted to agriculture. In total, the area of land in South America devoted to soy grew from 17 million ha in 1990 to 46 million ha in 2010, mainly on land converted from natural ecosystems. Between 2000 and 2010, 24 million ha were brought into cultivation in South America: soybean production expanded by 20 million ha in the same period.

While this has helped to increase meat production and brought economic benefits to the countries that produce and trade it, converting natural ecosystems carries a heavy cost. Biodiversity is in decline, forest loss is a key factor in climate change, and as ecosystems are destroyed or degraded, we lose many of the ecological services we rely on, from clean water and healthy soils to pollination and pest control.

Soy production poses a threat to forests, savannahs and grasslands of global importance:
- The *Amazon* is home to one in every 10 animals on Earth, and plays a vital role in regulating the global climate. Soy has contributed to deforestation in the Brazilian and Bolivian Amazon, both through direct conversion and in some cases by displacing cattle production to the forest frontier.
- The *Cerrado* holds around 5 per cent of the world's biodiversity and is one of South America's most important water sources. But in the last 40 years, around half of the Brazilian Cerrado has been converted to agriculture and pastures. Soy cultivation now takes up around 7 per cent of the Cerrado biome, or an area the size of England.
- Though the *Atlantic Forest* has been reduced to a fraction of its original extent over the centuries, it remains immensely rich in biodiversity, with over 8,000 endemic species. Soy has been a leading driver of deforestation. Legal protection has limited this in recent years, though existing laws are being threatened.
- Agricultural expansion, largely driven by soy, is the biggest threat to the *Gran Chaco*, a species-rich, sparsely populated plain that straddles Argentina, Paraguay and Bolivia. The region is undergoing one of the fastest rates of conversion in the

world, with half a million ha of native vegetation cleared between 2010 and 2012.
- Bolivia's *Chiquitano* forest is the world's largest tropical dry forest, one of the most endangered ecosystems on the planet. Soy production is expanding rapidly in Bolivia, accompanied by high rates of forest clearance.
- Soy has also replaced natural grassland, including in the Uruguayan *Campos*, the *North American prairies* and the Argentinian *Pampas*.

CARRYING ON WITH "BUSINESS AS USUAL" WILL MEAN FURTHER LOSS OF NATURAL ENVIRONMENTS, LEADING TO HUGE AND IRREVERSIBLE LOSSES OF BIODIVERSITY.

Steps toward responsible soy
Demand for soy will continue to rise over the coming decades, at a time when the world's population and consumption of natural resources is growing to unprecedented levels. Carrying on with "business as usual" will mean further loss of natural environments, leading to huge and irreversible losses of biodiversity. The natural capital and ecosystem services that underpin not only agriculture but the entire global economy will be further eroded: ecological processes could be pushed beyond tipping points, leading to catastrophic failures. Increased carbon emissions will exacerbate the already formidable challenges of climate change.

But we do not have to follow this pathway. Solutions exist that will allow us to meet the need for soy and other agricultural commodities while conserving biodiversity and crucial ecosystems.

Producer country legislation: Policies to conserve forests and native vegetation have the potential to contain the irresponsible expansion of soy and other agricultural production – though in some cases, these policies have merely displaced problems to other areas. While most governments have established protected areas to conserve a proportion of their country's native ecosystems, regions such as the Cerrado and the Gran Chaco lack adequate protection. Legislation is also needed to support conservation outside protected areas, including on farms and other privately owned land. Just as importantly, all of these policies need to be implemented effectively.

Land-use planning: WWF wants to see all countries introduce transparent, systematic planning processes for balancing different land uses with conservation of natural environments. Various tools exist to identify "go" and "no go" zones – areas suitable for production, such as degraded lands and low-productivity pasture, and areas of high conservation value (HCV) that should be protected from development.

Market responses: Private companies have begun to take steps to reduce the environmental impact of soy. Responses include individual and collective pledges to avoid deforestation, such as the Soy Moratorium in the Brazilian Amazon, and voluntary certification schemes developed in collaboration with civil society organizations, such as the Round Table on Responsible Soy (RTRS). The RTRS standard does not allow the conversion of any native forests, as well as non-forest habitats such as grasslands and wetlands of high conservation value.

Consumer country responses: Consumer countries have an important role to play in influencing the shift to more responsible soy production practices. The Netherlands – the second-largest soy importer in the world – is aiming for 100 per cent of soy for the Dutch market to be certified to RTRS standards, or equivalent, by 2015. Similar initiatives exist or are under way in other European countries, including Switzerland, Belgium, Denmark and Sweden. Public procurement policies that favour responsibly produced soy could be another important tool.

Better Management Practices (BMPs): BMPs can help farmers improve soil health and productivity, reduce the use of inputs such as agrochemicals and water, and mitigate negative environmental impacts. In areas where yields are low, such as India and China, BMPs can help soy producers to increase yields without expanding production areas. Yield increase in one area can contribute to less expansion in others. Similarly, increasing livestock productivity in areas of very low-intensity grazing could free up land for soy cultivation: the cattle sector in Brazil recognizes that it could increase beef production even with 30-40 per cent less land.

Payments for Ecoystem Services (PES): Converting forests to soy is usually more profitable in the short term than conserving them. PES schemes can help to balance this by rewarding those who conserve natural ecosystems and the services they provide: a new PES law in Paraguay, and Brazil's revised Forest Code, for example, will allow landowners who conserve more than the legal minimum forest cover to sell certificates to those who are not in compliance. Climate finance mechanisms such as REDD+ and carbon markets also offer incentives for conserving and restoring natural vegetation.

Responsible investment: Financial markets can help to shape the future of the soy industry by diverting capital away from projects that threaten natural ecosystems toward sustainable production. Investors in agricultural commodities such as soy are waking up to the fact that environmental risks can have a material impact on profitability. Increasingly, banks are providing better terms for clients that meet credible certification standards, such as those of the RTRS: this will influence traders and processors, as well as producers.

Reducing consumption and reducing waste: Reducing waste and eating fewer animal products could keep soy demand in check. Opportunities exist to reduce waste at every step of the soy supply chain, from farm to consumer. Developed countries adopting a healthy, balanced diet with animal protein consumption in line with nutritionists' recommendations could reduce the pressure on natural ecosystems: a recent report from WWF-Germany suggests that if all Germans reduced their meat consumption to levels recommended by the German Society for Nutrition, it would reduce the amount of land needed for agricultural production by 1.8 million ha, including 826,000 ha used to produce soy as animal feed, predominately in South America.

While there is no single solution, all of us, from companies that produce, buy and finance soy to consumers of soy and meat products, have the power to make choices that will help build a more responsible soy industry.

But we need to act urgently in order to reduce the pressure on the Amazon, the Cerrado and the Chaco, and other rich and valuable ecosystems that are vital to the health of the planet and people.

CONVERSION OR CONSERVATION?

A lone tree stands as a reminder of the Atlantic Forest that once covered 100 million hectares in Brazil, Argentina and Paraguay. Around it, soy monocultures stretch into the distance.

Demand for soy – mostly for animal feed – has risen dramatically in recent decades. In South America, vast areas of natural forest, savannah and grassland have been cleared to make way for soy production. And as the world's appetite for the products made with soy increases ever further, more and more land will be needed.

So will more natural habitats be destroyed to make way for soy fields? Or can we find ways to produce more soy while conserving forests and important ecosystems?

Naranjal, Atlantic Forest, Paraguay

1. INTRODUCTION

Soy has become one of the world's most important crops, but we urgently need to produce it more responsibly

A century ago, the soybean was practically unknown outside Asia. Today, hundreds of millions of people around the world eat meat, eggs and dairy products from animals fed on soy, and traces of soy are found in countless processed foods. In the last 50 years, the area of land devoted to soy has grown tenfold, to over 1 million square kilometres – equivalent to the total combined area of France, Germany, Belgium and the Netherlands. And this expansion shows no sign of stopping: the United Nations Food and Agriculture Organization (FAO) suggests soy production will almost double by 2050 (Bruinsma, 2009).

Soy is fast growing and highly nutritious, producing more protein per hectare than any other major crop. Capable of being grown in many environmental conditions, it has the potential to play a key role in addressing the challenge of global food security. As the largest source of animal feed in the world, soy is a valuable commodity, which has forged powerful trade links across continents while making major contributions to the economies of the countries that grow, export and trade it.

But soy's growth has come at a cost. Huge areas of forest, grassland and savannah in South America, as well as large swathes of North American prairie, have been converted to agriculture, either directly or indirectly, as a result of the global boom in soy production. Given high meat consumption in developed countries, rapidly rising meat consumption in growing economies and the potential for increased use of soy oil as a biofuel, natural ecosystems will come under increasing pressure.

Several forests of global importance for conservation are affected by soy production, including the Amazon and the Atlantic Forest. Important savannahs and mixed landscapes, such as the Cerrado and the Gran Chaco, and natural and semi-natural grasslands are also being lost, and there's a danger that efforts aimed at forest conservation will push even more production into these under-valued, under-protected non-forest habitats.

We urgently need to find ways to produce soy more responsibly, or these natural ecosystems could be lost forever, along with the priceless biodiversity they support and the vital services they provide. WWF believes that it is possible to produce soy without destroying forests and other important ecosystems. But this will require a concerted effort from many quarters: all along the soy value chain from producers to feed companies to manufacturers to retailers; from policymakers to financers to consumers.

This report presents an overview of the soy industry and the issues around it. We outline the uses of soy, chart its extraordinary rate of growth, and present the data on where soy is produced and consumed. We explore those regions most at risk from the expansion of soy production, as well as discuss its other environmental and social impacts. Finally, and most crucially, we look at some possible solutions for reducing soy's footprint – and what you can do to help.

IN THE LAST 50 YEARS, THE AREA OF LAND DEVOTED TO SOY HAS GROWN TENFOLD, TO COVER AROUND 1 MILLION km²

Natural ecosystems affected by soy

Forests: are areas spanning more than 0.5ha, with trees at least 5m high and a canopy cover of at least 10 per cent (FAO definition). Forests covered in this report include the Amazon, the Atlantic Forest and the Chiquitano Dry Forest.

Savannahs: are grassland areas that include a significant number of trees and woody plants, but not so densely spaced as to form a canopy. Much of the Cerrado and the Gran Chaco fall under this category, though both also contain forest areas.

Grasslands: are dominated by grasses and other herbaceous plants. Examples include the North American prairies, the Argentinian Pampas and the Campos in Uruguay. This report distinguishes between natural grasslands and cultivated pastures, which have been sown with a small number of often non-native grass species.

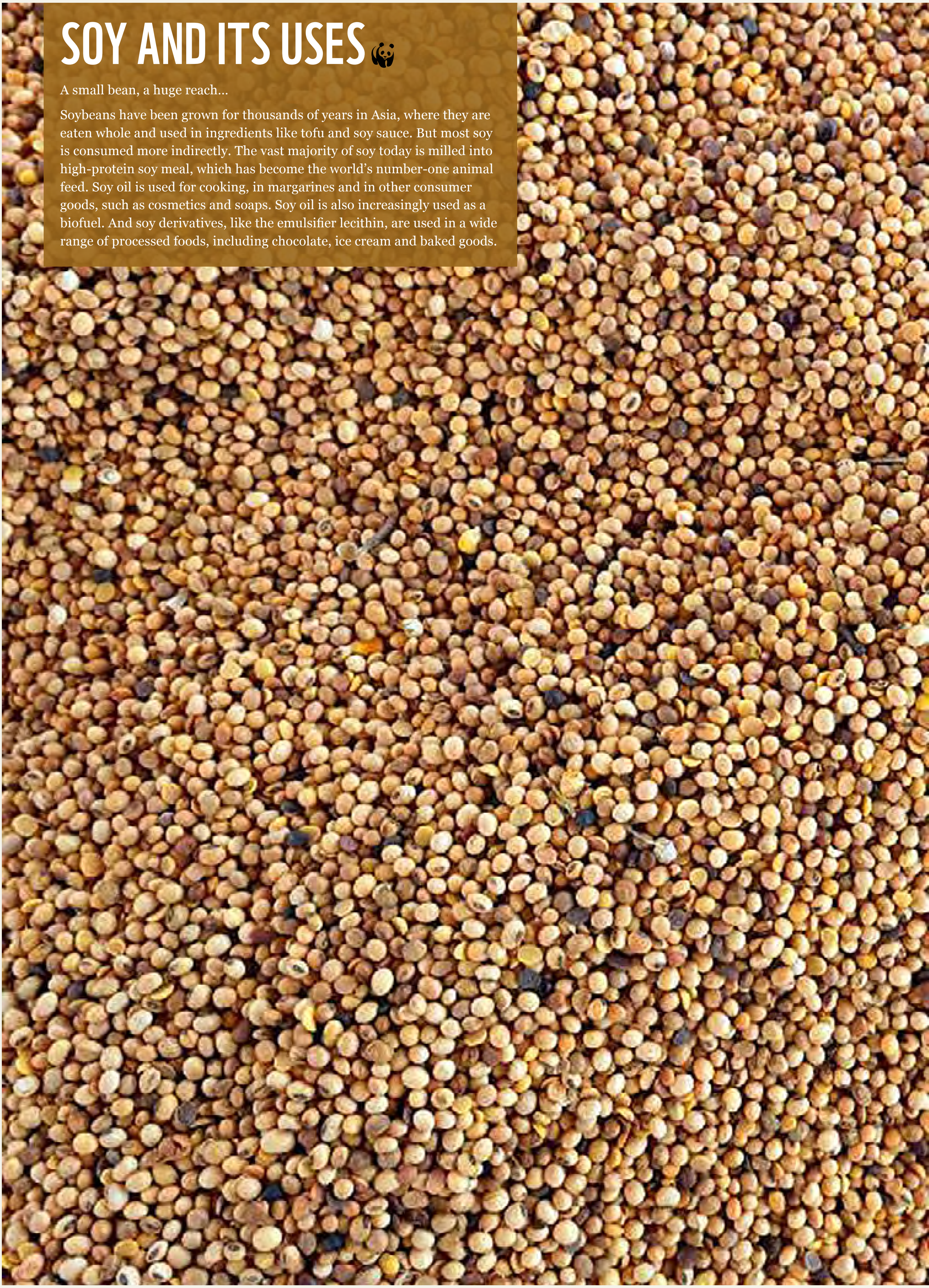
Landscapes at risk from soy expansion

Figure 1
Ecoregions impacted by soy in South America
As production continues to expand across South America, soy poses a threat to some of the most remarkable and biodiverse places on the planet. We look at the key ecoregions at risk in more detail later in this report.

SOY AND ITS USES

A small bean, a huge reach...

Soybeans have been grown for thousands of years in Asia, where they are eaten whole and used in ingredients like tofu and soy sauce. But most soy is consumed more indirectly. The vast majority of soy today is milled into high-protein soy meal, which has become the world's number-one animal feed. Soy oil is used for cooking, in margarines and in other consumer goods, such as cosmetics and soaps. Soy oil is also increasingly used as a biofuel. And soy derivatives, like the emulsifier lecithin, are used in a wide range of processed foods, including chocolate, ice cream and baked goods.



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2. SOY AND ITS USES

From animal feed to fuel, the soybean has become an integral part of everyday life

Soybeans have been grown for thousands of years in Asia, where they are eaten whole and used in ingredients such as tofu and soy sauce. But most soy is consumed more indirectly. The vast majority of soy today is milled into high-protein soy meal, which has become the world's number-one animal feed. Soy oil is used for cooking, in margarines and in other consumer goods, such as cosmetics and soaps. Soy oil is also increasingly used as a biofuel. And soy derivatives, such as the emulsifier lecithin, are used in a wide range of processed foods, including chocolate, ice cream and baked goods.

93%

OF THE WORLD'S SOY COMES FROM JUST SIX COUNTRIES: BRAZIL, UNITED STATES, ARGENTINA, CHINA, INDIA AND PARAGUAY

Soy or soya (*Glycine max*) is an annual legume grown for its edible bean. It has been cultivated for thousands of years in its native Asia, but over the last century cultivation has expanded dramatically. Soy is a source of both protein and energy: it has about 40 per cent protein and 20 per cent vegetable oil by weight in its seeds (Boucher et al., 2011). It produces more protein per hectare than any other major crop, and has a higher percentage of protein than many animal products: dried soybean contains 35.9g protein per 100g, compared to 34.2g for cheese and 21.1g for pork (RIVM, 2011).

Crop breeding has made the soybean adaptable to a wide variety of climatic conditions, which means that it can be grown in both temperate and tropical countries. Today it is one of the world's major agricultural commodities, and one of the most profitable for producers and traders. Around 270 million tonnes were produced in 2012, of which 93 per cent came from just six countries: Brazil, United States, Argentina, China, India and Paraguay (USDA statistics, 2013). Soy production is also expanding rapidly in Bolivia and Uruguay.

While soybeans can be eaten directly by humans, most are crushed to produce protein-rich soy meal, vegetable oil and by-products such as lecithin, a natural emulsifier. The meal, which is the end-product of three-quarters of the world's soy, is used primarily as a protein feed for livestock. Soy oil is used both in food and, more recently, as a biofuel.

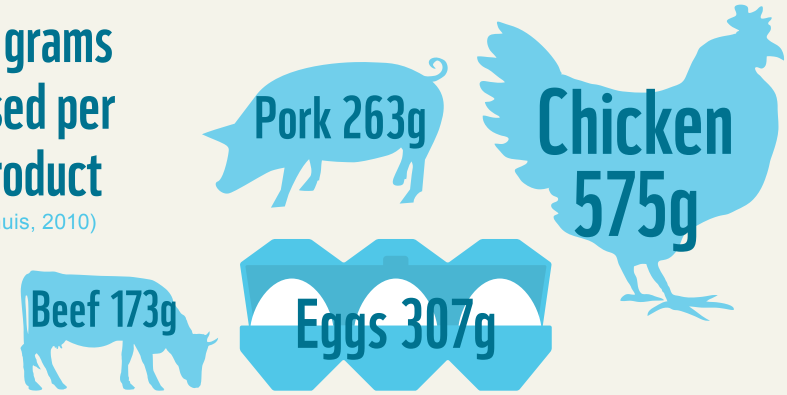
Soy for feed

Around three-quarters of soy worldwide is used for animal feed. As global demand for cheap meat and dairy products has grown, so has the demand for soy meal as a high-protein livestock feed. And that demand will be likely to continue to rise.

Between 1967 and 2007 pork production rose by 294 per cent, egg production by 353 per cent and poultry meat by 711 per cent (FAO, 2011); over the same period, the relative costs of these products declined. Soy meal has been an essential component in this. The combination of rapidly rising production and falling costs has only been possible through the use of industrial farming: most pigs and poultry are kept indoors and rely on protein-rich feed to speed growth rate. Increased production of livestock is particularly noticeable in countries with a high demand for soy, with China producing over 50 million tonnes of pork in 2010, almost half the global total (Schneider, 2011).

Average grams of soy used per kilo of product

(Hoste and Bolhuis, 2010)



Soy for food

Few of us are aware of quite how much soy we eat. A typical beefburger, for example, can contain meat raised on soy meal, margarine containing soy, mayonnaise with soy lecithin and soy additives in the bread bun.

THREE-QUARTERS OF THE WORLD'S SOY IS USED AS ANIMAL FEED, MAKING IT THE WORLD'S LARGEST PROTEIN SOURCE FOR THE ANIMALS WE EAT

Some 6 per cent of soybeans are used directly as food (Dutch Soy Coalition, 2012), mainly in Asian countries such as China, Japan and Indonesia. Whole beans may be eaten as a vegetable, or crushed and incorporated into tofu, tempeh, soy milk or soy sauce. Two per cent of the meal is further processed into soy flours and protein additives. Soy is used as an ingredient in many baked and fried products, as margarine, in frying fats, or bottled as cooking oil. Lecithin derived from soy is one of the most common additives in processed foods, found in anything from chocolate bars to smoothies.

While the majority of soy production is destined for animal feed, the proportionate economic value of soy oil is significantly larger. So while feed constitutes 79 per cent and oil 19 per cent of the volume of crushed soy, the economic value of feed is 57 per cent and soy oil is 36 per cent (van Gelder and Kuepper, 2012).

Soy for fuel

FEW OF US ARE AWARE HOW MUCH SOY WE EAT. A TYPICAL BEEFBURGER CAN CONTAIN MEAT RAISED ON SOY MEAL, MARGARINE CONTAINING SOY, MAYONNAISE WITH SOY LECITHIN AND SOY ADDITIVES IN THE BREAD BUN

More recently, soybean oil has also been used to produce biodiesel, although this remains a small proportion – just 2 per cent – of total soy production. Proponents argue that as the majority of the soy crop is used for livestock feed or directly in human food, using the remaining soybean oil for energy represents less of a trade-off between food and fuel than for other biofuels (United Soybean Board, 2008).

Nonetheless, interest in soy as a source of fuel is helping to drive expansion in countries such as Argentina, which overtook Brazil as a producer of soy biodiesel in 2011 (Biofuels Digest, 2011). Argentina's biodiesel production for 2013 was projected to reach 2.8 billion litres – around 40 per cent of its total soy oil production (Joseph, 2012) – with most of this exported to Europe. Soy is predicted to supply about 10 per cent of EU biofuel production by 2020 (Laborde, 2011). Biofuels will continue to drive demand for soy; analysts predict that a sharp rise in production will be needed by 2025 (Hart Energy, 2013).

In the United States, about 3 billion litres of biodiesel annually comes from soybeans, compared with 34 billion litres of corn ethanol (Martin, 2010). In 2012 biodiesel used 5.7 per cent of the US soy crop (United Soybean Board Market View Database, 2012).

Products derived from soy

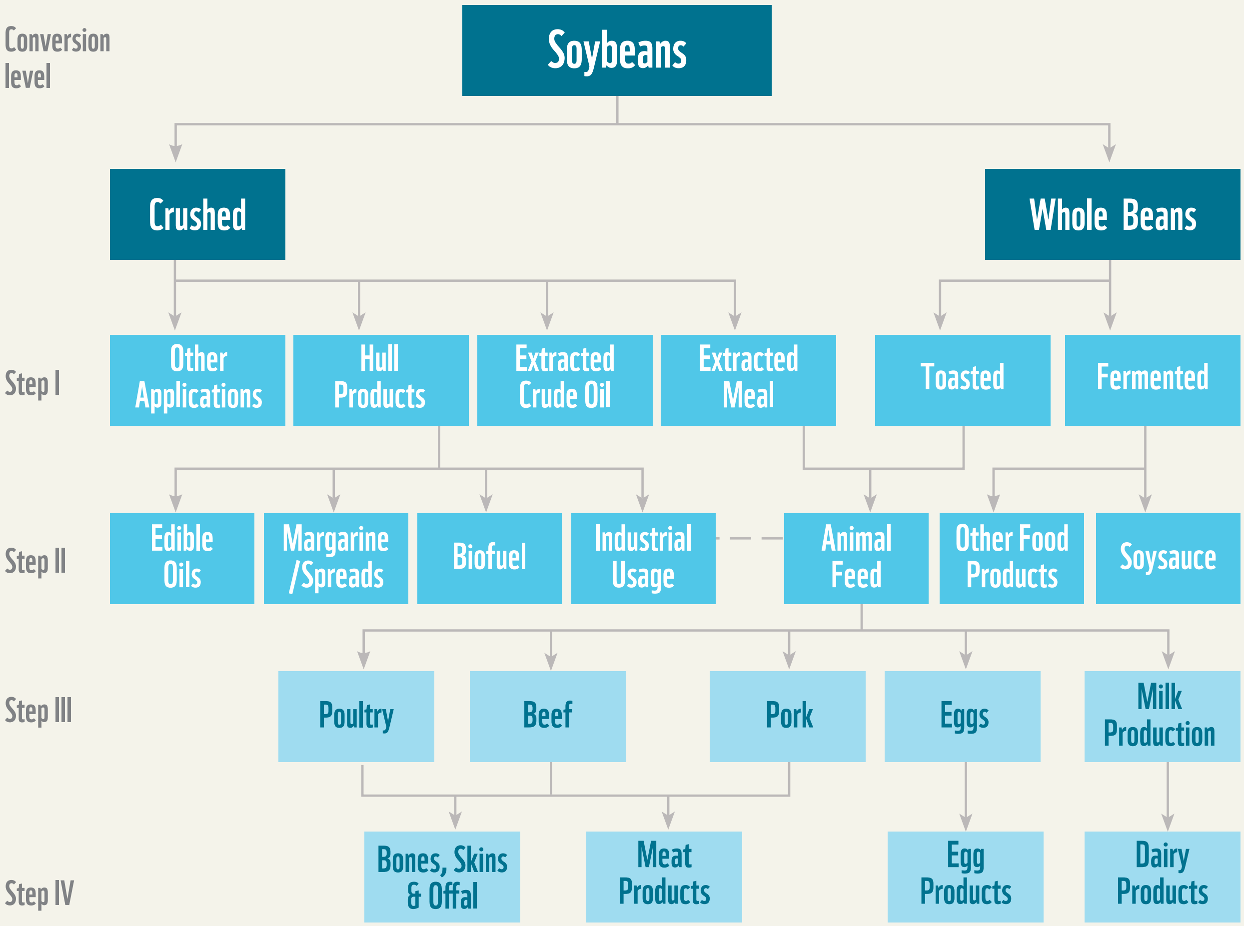


Figure 2
Soy product flows
1. KPMG analysis of soy balance in focus country
2. Endres, 2011
3. Hoste and Bolhuis, 2010

Growing global demand for meat has led to growing demand for soy as livestock feed – and that demand continues to rise

THE CONTINUING RISE OF SOY

Millions of hectares of land are given over to soy for chicken feed, allowing the world to consume more than four times more eggs and eight times more poultry meat than half a century ago.

With the rise of industrial-scale livestock farming, soy has undergone the largest expansion of any crop. Since 1970, the area of land devoted to cultivating soy has more than tripled. And demand continues to increase, particularly in China: projections suggest that global soy production could almost double by 2050. The challenge is clear: we are going to be growing more soy, and will need more land to grow it on.

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3. THE CONTINUING RISE OF SOY

Soy production has more than doubled over the last two decades, and is continuing to increase at a rapid rate

Over recent decades, soy has been undergoing the greatest expansion of any global crop (Agralytica, 2012). The area of land devoted to cultivating soy has grown from less than 30 million ha in 1970 to over 100 million ha today (Agralytica, 2012). Global output grew by 58 per cent between 1996 and 2004, from 130 million to 206 million tonnes (FAO, 2007) and reached almost 270 million tonnes by 2012 (USDA, 2013). The fastest growth in recent years has been in South America, where production grew by 123 per cent between 1996 and 2004. Growing demand from the EU and, more recently, from China, is the main driver behind this expansion, though domestic markets are also significant. Soy consumption in Brazil and Argentina is growing, for meat production for domestic consumption and export, while the United States has the highest meat consumption per capita.

Soy production continues to increase rapidly. Recent projections from FAO suggest an increase to 515 million tonnes by 2050 (Bruinsma, 2009), while other projections suggest a 2.2 per cent increase per year until 2030 (Masuda and Goldsmith, 2009). While the scale of some of these projections has been questioned (e.g., Grethe et al., 2011), there is no doubt that soy demand is continuing to increase. Along with ever-increasing demand from China, the markets in Africa and the Middle East are projected to expand rapidly in the next decade (USDA, 2012). World population growth and dietary trends will have a major influence on future demand for soy. Other factors include issues relating to demand and source of fuel, and the policies, agreements, market tools, corporate commitments, regulations and directives related to soy's many uses. But the key challenge is clear: we are going to be growing more soy, and will need more land to grow it on.

Intensification of cattle grazing can free up degraded pastures for soy production

Table 1
Area and yields of soybean – projections to 2050
Source: Bruinsma, 2009

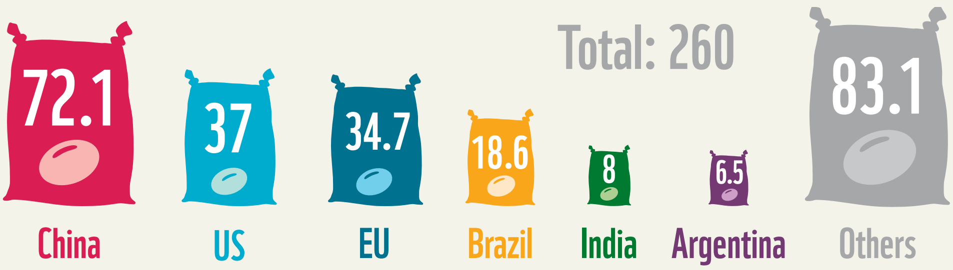
	1961-63	2005-07	2050
Soybean production (million tonnes)	27	218	514
Harvested area (million ha)	24	95	141
Yield (tonnes/ha)	1.14	2.29	3.66

Table 2
Soybean production 2008-13 in thousand tonnes
Source: United States Department of Agriculture, Foreign Agricultural Service. Data as of January 2013

	Soybean Production				
	2008-09	2009-10	2010-11	2011-12	2012-13
Brazil	57,800	69,000	75,300	66,500	82,500
United States	80,749	91,417	90,605	84,192	82,055
Argentina	32,000	54,500	49,000	40,100	54,000
China	15,540	14,980	15,100	14,480	12,600
India	9,100	9,700	9,800	11,000	11,500
Paraguay	3,647	6,462	7,128	4,357	7,750
Canada	3,336	3,581	4,445	4,298	4,930
Other	9,464	10,605	12,211	13,798	14,079
Total	**211,636**	**260,245**	**263,589**	**238,725**	**269,414**

Domestic use of soy by country (in millions of tonnes)

Source: ISTA Mielke, Germany, oilworld.de. Domestic use includes both domestic consumption and animal production for export



Soy cultivation: the search for land
Soy has been cultivated for thousands of years in East Asia, and was considered sacred in ancient Chinese mythology. Though it was introduced to Europe and North America in the 18th century, mainly as a forage crop, soy wasn't grown on a significant scale outside Asia until relatively recently. Large-scale soybean production took off in the United States after World War II and by 1970 it was producing three-quarters of the global crop. But after years of expansion, the United States had few options for bringing new land into production, and soy began its march into South America. Initial expansion in the 1970s was in the Atlantic Forest and the cooler, temperate regions of southern Brazil and Argentina, where expansion occurred at the expense of natural grasslands or cultivated pasture.

By 1975 Brazil had overtaken China to become the world's second largest producer, with soybean production concentrated in the states of Rio Grande do Sul, Santa Catarina, Paraná and São Paulo where natural soil fertility was relatively high. Here soy could grow without heavy application of chemical fertilizers, an uncommon technology in Brazil at that time. Production pushed northwards into the Cerrado savannah when the use of agricultural lime and chemical fertilizer became available to producers, allowing sustained cropping on soils previously thought too poor for intensive agriculture. In the late 1990s, development of new soy varieties suited to lower latitudes allowed for further cultivation in the Cerrado and Amazon. By 2005, Brazil had become the largest soybean exporter in the world (Boucher et al., 2011).

The geographical reach of soy continued to grow, moving north in Argentina into the Chaco, to Mato Grosso and other central, north and northeastern states in Brazil, into the Bolivian lowlands in eastern Santa Cruz and to the Chaco region in northern Paraguay (Pacheco, 2012). The area harvested for soy in Argentina increased dramatically, with production rising from 8.5 million ha in 1999-2000 to 19.5 million ha in 2012-13 (USDA, 2013). Soybean production in Bolivia, although small compared with the major producers, is projected to reach 1.3 million ha by 2014. However, Bolivia is already the sixth largest soy producer in the Americas and the 8th largest globally, with rapid increase in production (ANAPO 2012; FAO, 2007). More recently, soy has also been expanding in Uruguay, with almost 1 million ha already in production (MercoPress, 2012).

In total, the area of land in South America devoted to soy grew from 17 million ha in 1990 to 46 million ha in 2010, mainly on land converted from natural ecosystems. Conversion has not always been direct: often land would be cleared for cattle pasture initially, then planted with soy later. In total, some 24 million ha were brought into cultivation in South America between 2000 and 2010, while soybean production expanded by 20 million ha in the same period (Pacheco, 2012).

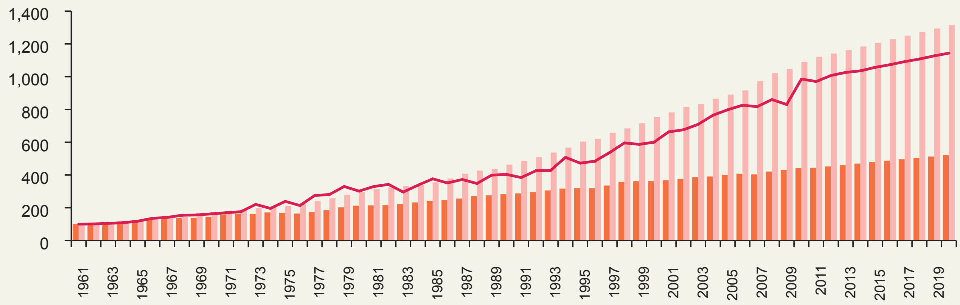


Figure 3
Current and projected development of soy bean and meat production: 1961-2020
(Source: KMPG, 2013)

Key

Pork
Poultry
Soybean

Burning is used to clear land for soy cultivation in the Argentine Chaco: the harvested area devoted to soy has increased fourfold in Argentina in the last 25 years

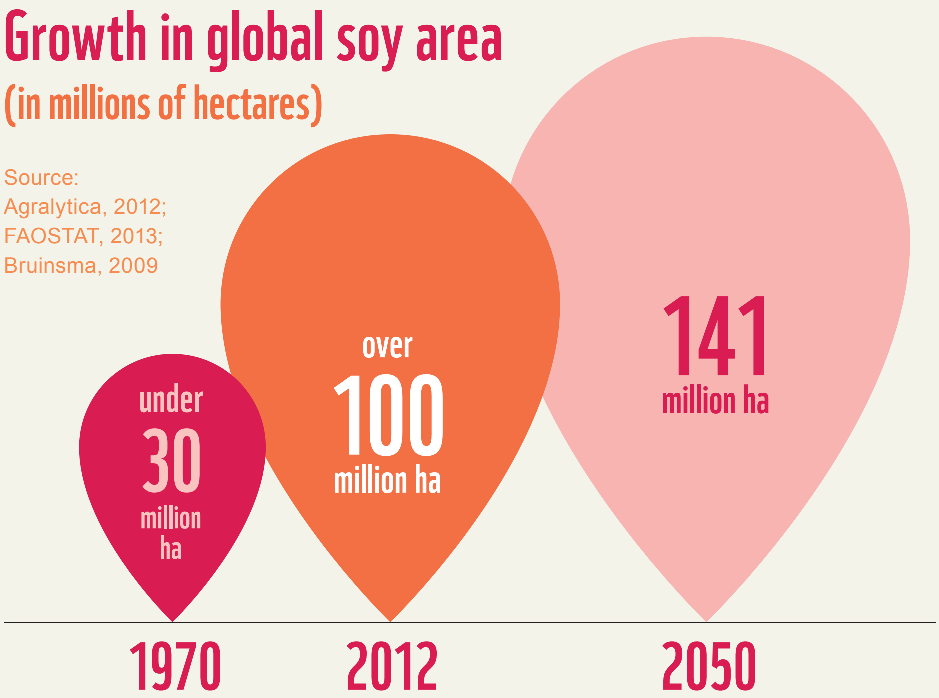


Table 3
Soybean major harvested areas
Source: FAOSTAT, 2013

	Area harvested (thousand ha)			
	1990	2000	2010	2012
Argentina	4,962	8,638	18,131	19,350
Bolivia	143	617	1,086	1,090
Brazil	11,487	13,640	23,293	24,938
Paraguay	900	1,176	2,671	3,000
Uruguay	29	9	863	1,130
China	7,564	9,307	8,516	6,750
USA	22,869	29,303	31,003	30,799
Other	9,235	11,673	17,050	19,568
World total	57,209	74,363	102,613	106,625

Where next?
Part of the future demand for soy can be met by increasing productivity. Since the 1960s soybean yields have doubled (Masuda and Goldsmith, 2009). Projections have suggested they could rise by a further 50 per cent globally by 2050 (Bruinsma, 2009), but this will be hugely challenging. Brazil and Argentina have invested heavily in research and crop breeding to increase yields, but the large productivity gains they have experienced are expected to tail off sharply. In other developing producer countries yields remain relatively low; in Bolivia, for example, poor road infrastructure combined with heavy rains during the summer growing seasons lead to significant loss of beans in the field, while seasonal drought in the winter growing season constrains yield. Irrigation, fertilizer management and extension support for smallholders would all boost yields. In China and India, most soy is grown by smallholders, and there is potential to increase productivity considerably – particularly in India (see box). However, there is a risk that improved productivity in soy production will in fact accelerate expansion of soy by making it even more profitable and more competitive with other land uses, especially those that involve conserving natural areas.

Even with higher yields per hectare, however, FAO calculates that by 2050 the soy-growing area will need to increase by almost half as much again (up to 141 million ha from 95 million ha in 2005-07). And this doesn't include the potential rise in soy for biofuel, which could further add to demand (Bruinsma, 2009). While Brazil, Argentina, China and India, along with the United States, will continue to dominate the market, other countries are starting to develop soy production, including Nigeria, Mozambique and Ukraine. Large-scale expansion in these countries poses its own problems, of course. In Mozambique, for example, the ProSavanna project supported by Japan and Brazil aims to use the experience of developing the Cerrado to facilitate agricultural expansion in a vast area of savannah. Farmers' groups and NGOs have accused the project of encouraging land grabs (GRAIN, 2012, 2013).

National projections tell a similar story. In Brazil, for example, the Ministry of Agriculture projects an expansion of soy plantations from about 23 million ha today to 26.5 million ha by 2018-19. It projects that this will be met by an annual increase in productivity of 2.43 per cent and an annual increase in production area of 1.95 per cent, primarily in the Cerrado and Amazon regions. This will mean both replacing livestock or other crops with soybeans, and converting native vegetation (Brown-Lima et al., undated). Argentina plans to increase the area of soy by 3.7 million ha this decade, from 18.3 million ha in 2010 to 22 million ha in 2020 (Argentine Ministry of Agriculture, 2011).

Local producers for the global market

Soy is produced for the international market by growers varying from smallholders to some of the world's largest agribusinesses. The rapid growth of the soy business has brought a shift toward progressively larger farming units which are more competitive in the commodities markets. Soy has developed into a commodity traded at almost unique levels. Five of the seven largest bilateral trade flows in agriculture and food products include soy: 1. United States to China; 2. Brazil to China; 3. Brazil to EU; 6. Argentina to China; 7. Argentina to EU (Lee et al., 2012). Most soy is bought from producers, then exported by a handful of international traders, though some producers are starting to organize themselves into groups and exporting directly. The trade remains changeable: a wet summer in Canada and a drought in Brazil and Argentina in 2010 increased the price of soy by 50 per cent (McLaughlin, 2012). Soybean derivatives (oil and meal) are also traded on futures markets. Soybean growers often make forward-sales (at planting time) to companies in return for seed, fertilizer and chemicals. This model gives the companies indirect control over large amounts of land and production without having to internalize long-term environmental costs (Pacheco, 2012), but it also reduces risk for small growers, allowing them to participate in global supply chains.

The market for soy in Europe

Europe relies on soy, most of it imported from South America, to meet demand for meat and dairy products. The EU produces less than 1 million tonnes of soy a year, but imports around 35 million tonnes (extrapolated from EU, 2012). Demand for soy within the EU uses an area of almost 15 million ha, 13 million in South America. To give some idea of the scale of Europe's dependence on imported soy, this is equivalent to 90 per cent of Germany's entire agricultural area (von Witzke et al., 2011). The main European importers of soy are countries with large industrial-scale pig and chicken production.

Under European agricultural policy, tariffs on animal feed are lower than for many other agricultural products, so soy meal is a relatively cheap import (EC, 2011). Demand

Soy global trade flows

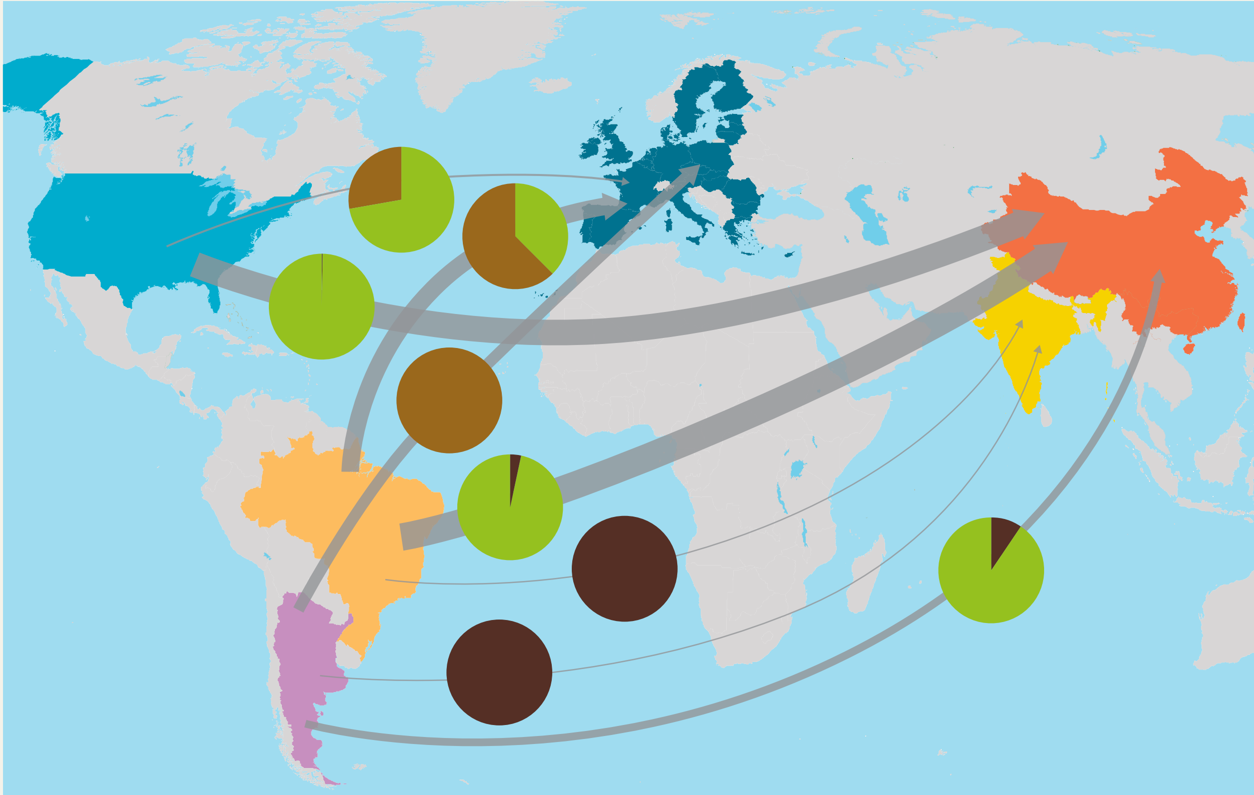


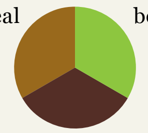
Figure 4
Soy global trade flows for key regions
(Source: Soy trade: ISTA Mielke, Germany (oilworld.de). 2011-12)

Key

Total trade flows mMT*

- US to EU: 1.9
- US to China: 24.2
- Brazil to EU: 16.6
- Brazil to China: 25.9
- Brazil to India: 0.3
- Argentina to EU: 10.8
- Arg. to China: 7.3
- Arg. to India: 0.9

Composition of trade flows



Global

Production	240 mMT
Consumption	260 mMT
Traded volumes	161 mMT

United States		EU27		China	
Production	84.2 mMT	Production	1.3 mMT	Production	13.8 mMT
Consumption	37 mMT	Consumption	34.7 mMT	Consumption	72.1 mMT
Import	0.8 mMT	Import	35.1 mMT	Import	60.8 mMT
Export	47.9 mMT	Export	1.7 mMT	Export	2.7 mMT

Argentina		Brazil		India	
Production	40.1 mMT	Production	66.8 mMT	Production	10.6 mMT
Consumption	6.5 mMT	Consumption	18.6 mMT	Consumption	7.7 mMT
Import	0.0 mMT	Import	0.2 mMT	Import	1.3 mMT
Export	37.8 mMT	Export	52.9 mMT	Export	4.1 mMT

*millions of Metric Tonnes

From smallholders to agribusiness: the relative size of soy farms in different countries

Argentina: Almost all soy is grown by large- and medium-sized producers with at least 150 ha.

Bolivia: Farm sizes vary, from large corporate farms of 500-5,000 ha to smallholdings of around 40-100 ha.

Brazil: In the Cerrado, most soy farms are medium (300-2,000 ha) or large (2,000-30,000 ha). Soy farms in the Amazon are predominantly large (more than 3,000 ha). Only in the Atlantic Forest region is soy grown by smaller farmers (5-300 ha).

Paraguay: 44 per cent of farms are more than 1,000 ha, 43 per cent are between 100 and 1,000 ha, and 13 per cent are less than 100 ha.

China: Around 40 million smallholders grow soy, usually on less than half a hectare, but organized into collectives.

India: Some 5 million smallholders grow soy on 1 or 2 ha each.

CURRENTLY THE UNITED STATES, BRAZIL AND ARGENTINA PRODUCE AROUND FOUR-FIFTHS OF THE WORLD'S SOYBEAN CROP AND ACCOUNT FOR NINE-TENTHS OF GLOBAL SOYBEAN EXPORTS

for soy grew following the ban on processed animal proteins in animal feed, such as meat and bone meal, as a result of the bovine spongiform encephalopathy (BSE or "mad cow disease") outbreak in the 1990s. It has risen further because fishmeal, another potential animal feed, is increasingly used in fish farming. European soybean imports also surged after the World Trade Organization was formed in 1995, removing many restrictions on international trade. The increase in support for the production of biofuels is also a factor in the soy imports into Europe.

Big players in the soy market

A relatively small number of big companies control large volumes of the soy value chain. These include crushers and traders, meat and dairy companies, and retail and catering businesses. They have a considerable influence on soy producers, and have the potential to play a prominent role in ensuring soy expansion doesn't come at the expense of natural ecosystems (all information from WWF internal report, based on various sources).

Crushers/traders: A small group of multinationals controls much of the crushing and trading of soy. US companies Archer Daniels Midland (ADM), Bunge and Cargill, and Louis Dreyfus Commodities from Switzerland (CH) are among the major players in all regions, including China. A growing role can be seen for Asian companies involved in trade and/or crushing in China, such as Wilmar (Singapore), Marubeni (Japan) and China Agri/COFCO (China). These companies can be crucial players in transforming soy markets.

Pork, poultry and dairy: Most soy meal is used as feed for chickens and pigs, so ends up in pork and poultry products. In the northern hemisphere meat processing is concentrated in large-scale companies. In Europe most are national, with a tendency to grow toward multinational companies. These include, for pork, Danish Crown (Denmark), VION (Netherlands) and Tönnies (Germany); for poultry, LDC and Groupe Doux (France) and Plukon Food Group (Netherlands). In Brazil, pork and poultry processing is concentrated: JBS, Brasil Foods and Marfrig have a joint

DEMAND FOR SOY WITHIN THE EU USES AN AREA OF ALMOST 15 MILLION HA, 13 MILLION IN SOUTH AMERICA

market share of around 30 per cent for poultry. Similarly, the top three poultry processors in the United States – Tyson Foods, Pilgrim's (a subsidiary of JBS) and Perdue – have a 45 per cent market share. For pork, Smithfield is by far the largest player, followed by Tyson Foods and JBS; together, they control more than half the US market. Smithfield has recently been acquired by the Chinese Shuanghui (Shineway) Group (though at the time of writing the deal had yet to be approved by regulators), in the largest ever takeover of a US company by a Chinese company. Shineway is the largest player in the China pork industry, though its market share is only 4 per cent. The trend, however, seems to be toward increasing concentration. Soy is also used as feed for dairy cows. Leading dairy companies are Fonterra (NZ), Kraft Foods (USA), Dean Foods (USA), Unilever (UK and NL), Nestle (CH), FrieslandCampina (NL) and Arla (Denmark); Yili and Mengniu are key companies in China.

Retail, fast food and food service: Being closest to the end consumer, retailers are sensitive to public opinion, and can have a major influence throughout their supply chains. In terms of revenue, the biggest retailers in the world are Walmart (US), Carrefour (France) and Tesco (UK). Fast-food chains and food service companies, including those supplying institutions such as schools and hospitals, play a similarly important role. Measured by number of outlets, the world's biggest fast food companies are McDonald's, Subway and Yum Brands (KFC, Taco Bell and Pizza Hut) (all US-based companies), while some of the biggest food service companies are Compass (UK), Aramark (USA) and Sodexo (France). While meat consumption is growing fast in China, most meat is still sold via independent outlets rather than large brands.

Smallholder soy production in India and China

India cultivates about 10 million ha of soy. Almost all of this is grown by some 5 million small farmers, each with just 1 or 2 ha. Soy is a profitable crop, and provides them with around two-thirds of their income. But with unpredictable rainfall, old varieties and low investment, yields are low (Mondal, 2011): the average yield is around 1 tonne per hectare, compared to over 2.9 tonnes per hectare in Brazil, Argentina and the United States. Some producers who have received technical assistance have already increased yields by 50 per cent.

China also has a large domestic soy production, concentrated in the northeast. Around 40 million farmers grow soy, with the average farm size being around 0.2-0.3 ha. Average yields are below the global average, at around 1.7-1.8 tonnes per hectare, because of continuous cultivation without rotation, low-yield seed, poor nutrient and soil management, and environmental stresses. However, state farms in Heilongjiang province have much higher average yields (2.67 tonnes per hectare in 2005) (calculations by WWF-China programme).

Technical assistance to increase yields in China and, particularly, in India could in theory help to meet demand for soy while reducing pressure on land in other parts of the world. However, with millions of small farmers involved, improving production practices will be a major challenge.

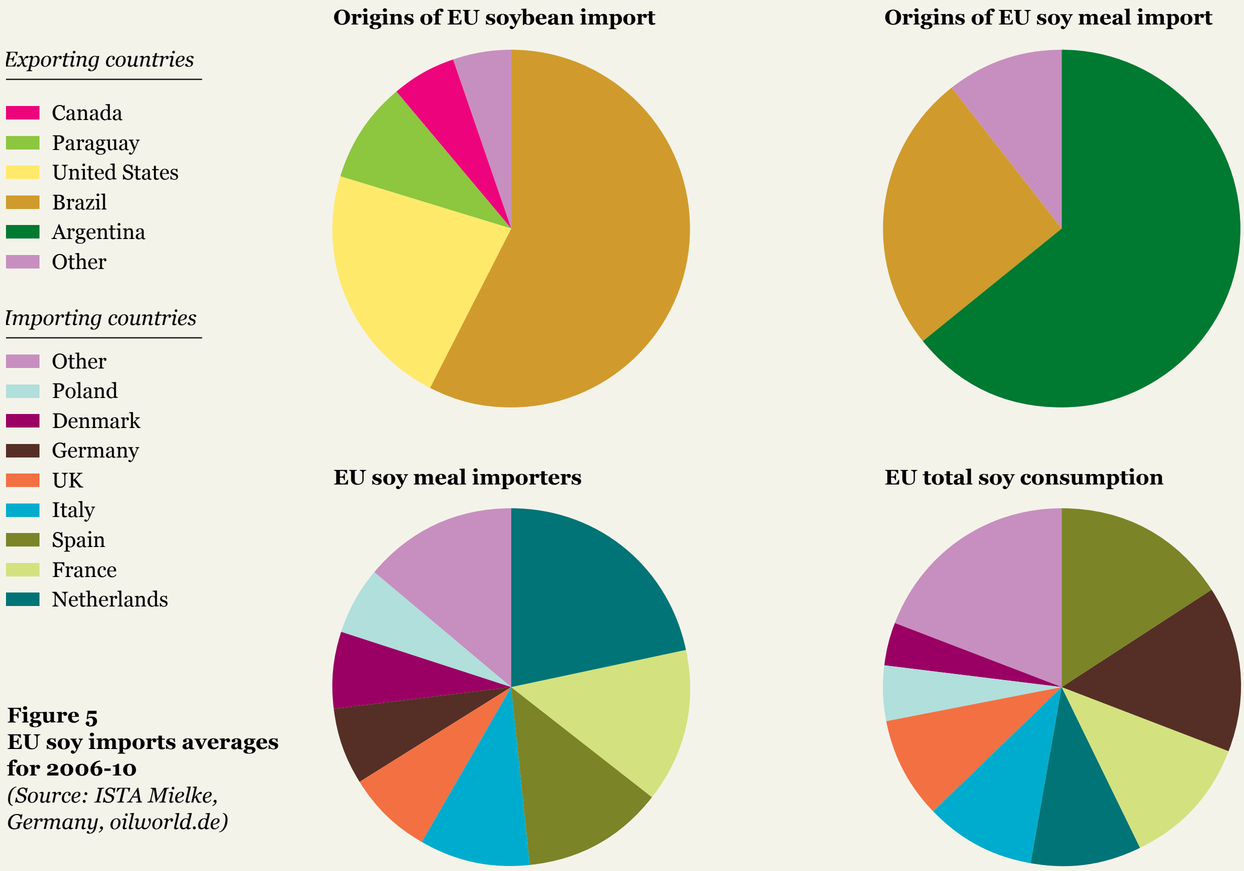


Figure 5
EU soy imports averages for 2006-10
(Source: ISTA Mielke, Germany, oilworld.de)

Moving markets: China from exporter to importer

As with many other natural resources, the future of soy will be increasingly dominated by the demands of the Chinese market. China's economic development is leading to higher meat consumption, which is coupled with a serious shortage of cropland. The country used to be an important exporter of soy, but has been a net importer since the 1990s: it now imports 70 per cent more than the EU. Soy consumption in China doubled in the last decade, from 26.7 million tonnes in 2000 to 55 million tonnes in 2009, of which 41 million tonnes were imported (Brown-Lima et al., undated). China's imports are projected to increase by 59 per cent by 2021-22 (USDA, 2012).

Trade between China and Brazil is particularly significant. Between 2000 and 2010, trade between the two countries increased tenfold (Lee et al., 2012). More than half of Brazil's soy exports go to China: Brazil's bilateral trade with China is worth over US$20 billion, with soy representing 31 per cent of total exports. If current trends continue, by 2019-20 China's demand could account for over 85 per cent of all soybean traded internationally. While China's influence on global trade is indeed huge, it should be noted that this statistic on its own exaggerates China's share of global trade, as it does not account for soy meal. Europe, for example, imports predominantly soy meal. Nevertheless, China's increasing demand will lead to even larger exports from Brazil and the United States, as well as from other producers such as Argentina and Paraguay (Brown-Lima et al., undated), and potentially African countries such as Mozambique.

The changing destination of trade could have political and environmental impacts as well. In recent years, pressure from European consumers and environmental organizations has helped to check the spread of soy into natural ecosystems, notably the Amazon. To date Chinese consumers have not demonstrated the same concern over deforestation that has influenced European buyers. However, because of its importance to food security, the long-term sustainability of soy and the effects of climate change on soy productivity and soy prices could be important issues for China in the future.

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Soymeal ready to be transported in Brazil, the world's largest exporter of soy

	Soybean Imports				
Country	2008-09	2009-10	2010-11	2011-12	2012-13
China	41,098	50,338	52,339	59,231	63,000
EU 27	13,213	12,674	12,474	11,810	11,300
Mexico	3,327	3,523	3,498	3,400	3,350
Japan	3,396	3,401	2,917	2,759	2,750
Taiwan	2,216	2,469	2,454	2,285	2,300
Indonesia	1,393	1,620	1,898	1,922	2,000
Thailand	1,510	1,660	2,139	1,906	1,950
Egypt	1,575	1,638	1,644	1,600	1,550
Vietnam	184	231	924	1,225	1,230
Turkey	1,076	1,648	1,351	1,057	1,200
Other	8,403	7,636	7,158	5,882	5,880
Total	77,391	86,838	88,796	93,077	96,510

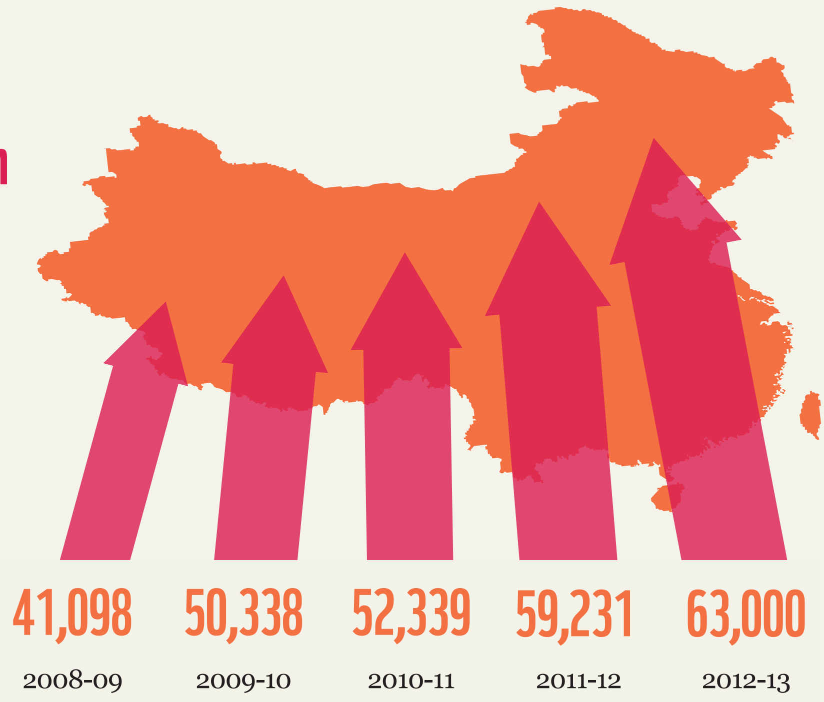
Table 4
Soybean importers 2008-13 in thousand tonnes
Source: USDA, 2012

Country	Soy (million tonnes)			
	Beans	Meal	Oil	Total
China	52.6	0.2	1.2	54
EU	13.2	23.3	0.7	37.2
Indonesia	2.1	2.9		5.0
Japan	2.8	2.2		5.0
Mexico	3.4	1.5		4.9
Thailand	2.0	2.4		4.4
Other	15.9	27.6	7.3	50.8

Table 5
Largest soy-importing countries/regions
Source: ISTA Mielke, 2012

China's Growth in Soybean Imports

(thousand tonnes)



SOY AND DEFORESTATION

A truck transports soy across the Brazilian Cerrado. Around half the native savannah and forest of the Cerrado has been converted to agriculture since the late 1950s.

Vast areas of forest, savannah and grassland have been cleared across South America over the last few decades as soy production has expanded. And forests and other natural ecosystems are coming under ever greater pressure as production continues to grow. As these ecosystems are lost, so are the wildlife they support and the vital ecological services they provide, like clean water and healthy soils. Deforestation also fuels climate change and threatens the way of life of many indigenous people who rely on forests for their livelihoods.

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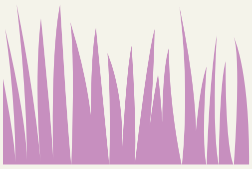
4. SOY AND DEFORESTATION*

Millions of hectares of forest, savannah and grasslands have been lost in recent decades, threatening biodiversity, depleting ecosystem services and emitting vast amounts of carbon dioxide. Today, soy continues to put pressure on forests including the Amazon, the Atlantic Forest and the Chiquitano Dry Forest, as well as mixed landscapes, savannahs and natural grasslands such as the Cerrado, the Gran Chaco, the Pampas in Argentina, the Uruguayan Campos and the North American prairies.



Soy, deforestation and the loss of valuable ecosystems
As more and more land is given over to soy production, important natural ecosystems in South America are coming under increasing pressure.

Over the last few decades, vast areas of forest, grassland and savannah have been converted to agriculture, largely in developing countries. This has helped to feed the world's escalating population and brought economic benefits to the countries that produce and trade it. But converting natural ecosystems carries a heavy cost. Biodiversity is in decline: according to WWF's Living Planet Index, species

Zero Net Deforestation and Degradation and deforestation fronts

Nine out of 10 land-based species of animals and plants live in forests – the vast majority of them in the tropical forests of South America, Africa and Southeast Asia. Close to 1.6 billion people, including 60 million indigenous people, depend on forests for food, shelter, fuel and livelihoods. Forests provide vital ecosystem services, such as regulating water cycles, preventing soil erosion and helping to keep our climate stable: growing forests absorb and store carbon, but when they're cleared, large amounts of carbon dioxide are released into the atmosphere.

Half of the world's tropical forests have been destroyed over the last century, and natural forests are continuing to decline in many parts of the world. WWF is campaigning for *Zero Net Deforestation and Forest Degradation (ZNDD) by 2020*. That means no overall loss of forest area or forest quality, while allowing for some flexibility to meet local needs. Within ZNDD accounting, like must equal like – a new, heavily managed plantation doesn't offset the loss of pristine rainforest habitat. WWF wants to see the rate of loss of natural or semi-natural forest to near zero.

WWF has identified 10 *deforestation fronts* – regions where large-scale deforestation or severe degradation is projected between now and 2020. These areas are generally at risk of losing more than 3 million ha in the next 10 years. Soy production has an impact on three of the fronts: the Amazon, the Cerrado and the Atlantic Forest/Gran Chaco.

*For ease of communication, WWF uses the term "deforestation" in this chapter to denote not only the conversion of forests to soy but also the conversion of other ecosystems such as savannah and grasslands to soy.

populations in tropical regions have fallen by an average of 60 per cent since 1970. Forest loss is a key factor in climate change, accounting for up to 20 per cent of global greenhouse-gas emissions (Taylor, 2011a). As ecosystems are destroyed or degraded, we lose many of the ecological services we rely on, from clean water and healthy soils to pollination and pest control.

Clearing forests and other ecosystems also has a social impact. The forests of South America are home to many indigenous communities, providing them with food, shelter, fuel, medicines and livelihoods. Soy has been implicated in the eviction and displacement of indigenous communities in Argentina (Kruglianskas, undated) and Paraguay (Hobbs, 2012).

The soy boom has been one of the main driving forces behind the loss of natural ecosystems in South America in recent years. The initial growth of soy production on the continent coincided with large areas of forest, grassland and savannah being cleared for agriculture. Domestic concern about forest loss and pressure from consumer countries has resulted in a series of temporary or permanent moves to protect remaining forests from direct conversion to soy, particularly in the Atlantic Forest in Paraguay and the Brazilian Amazon. An unfortunate side effect of these developments has been to encourage the expansion of soy into other natural ecosystems, particularly the Brazilian Cerrado and the Gran Chaco in Argentina, Paraguay and eastern Bolivia. “Amazon-free” claims on soy products have convinced retailers, particularly in Europe, that they are buying products that are environmentally benign, but this is not always true. Today, in terms of direct land-use change for soy, the largest and most destructive impacts are being felt in grasslands, savannah and dry-forest ecosystems such as the Cerrado and most of the Chaco.

Planting soy on land that has already been converted to crops or pasture can be a way of reducing the impact on natural ecosystems. Indeed, evidence shows that increasingly soy is found in areas previously degraded by cattle rather than in newly cleared forest (Soares Domingues and Bermann, 2012). The increased competition for land can push cattle ranchers to become more efficient: freeing up land by increasing productivity on under-stocked pastures is potentially a key part of the solution for sustainable soy expansion, and is discussed on page 79.

However, the danger remains that the pasture displaced by soy will be established elsewhere by conversion of other natural ecosystems. In Paraguay, for example, there is a clear correlation between soy replacing pasture land in the Atlantic Forest and conversion of the Gran Chaco to cattle ranches. Several modelling exercises in the Amazon have linked this indirect land-use change to deforestation, and calculated that displacement of pasture by crops such as soy will continue to cause forest conversion (Barona et al., 2010; Lahl, 2010; Lapola et al., 2010; Arima et al., 2011), though better land-use planning and more intensive grazing could reduce this risk. There are also suggestions that ranchers selling their land to soy farmers at high prices appear to be reinvesting in forested land (Lambin and Meyfriodt, 2011).

Industrial-scale soy production requires a large supporting infrastructure, including transport links, processing mills and workers’ facilities, which can lead to further loss of natural ecosystems. Building roads is both a response to and in some cases a stimulus for soy production; for example the network of roads built into the Cerrado was the stimulus to deforest much of the area.

Brazil has introduced a series of infrastructure development projects to make its soy exports more competitive. New highways have been built connecting soybean farms to domestic markets in southern Brazil, to new deep-water ports at Itacoatiara and on the Amazon River at Santarém in Pará, and to the country's largest cargo port, Itaqui in Maranhão state. Improved infrastructure will help Brazil to transport commodities such as soy more efficiently, helping to reduce cost and greenhouse-gas emissions. But with weak governance in frontier regions it is likely to exacerbate deforestation, especially along newly paved highways seeking to integrate the Amazon with the rest of the continent (Killeen, 2007).

Over the following pages, we consider the areas most at risk from soy expansion: the Amazon, Cerrado, Atlantic Forest, Gran Chaco and Chiquitano Dry Forest, as well as the grasslands of the Pampas, Campos and North American Great Plains.

The expansion of soy farms can have a devastating impact on natural ecosystems like the Cerrado savannah in Brazil

Deforestation in Argentina

Argentina has lost forests at an alarming rate over the last few years, as measured by government figures (Dirección de Bosques, 2008)

Table 6
Forest lost in Argentina, 1998-2008

Period	Area deforested (ha)	Annual rate of deforestation (%)
1998-2002	432,827	0.98
2002-06	806,027	1.93
2006-07	316,943	3.21
2007-08	136,081	1.41
Total: 1998-2008	1,691,878	1.63

Included within these general statistics are considerable forest losses associated with soy, particularly in the Gran Chaco and Atlantic Forests as described, and also in the lower Yungas forests (Gaspari et al., 2008). Soy is the main driver of an enormous expansion of the agricultural frontier, by 5.5 million ha from 1988 to 2002, with growth continuing since (Banco Mundial, 2006).

Grassland has also been affected to a major extent: large areas of the flat inland and the rolling Pampas, in particular, have been converted to arable land (Baldi and Paruelo, 2008), with soy the dominant crop.

Landscape at risk
THE AMAZON

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The Amazon contains one third of the world's tropical forest

Despite some successful initiatives to reduce its impact, soy continues to pose a threat to the world's largest rainforest.

One-third of the world's tropical forest is found in the Amazon, which stretches across parts of Brazil, Bolivia, Peru, Ecuador, Colombia, Venezuela, Guyana, Suriname and French Guiana. Its intricate web of life is home to one in every 10 species on Earth, from more than 100,000 types of insects and nearly 40,000 plant species to endangered mammals such as jaguars and the pink river dolphin. Over the last decade, scientists discovered new species of plants and animals at a rate of one every 3 days. More than 30 million people live in the region, and many depend on the forest and its rivers for their livelihoods.

As Earth's largest river basin, the Amazon is the source of around one-sixth of all the water that flows into the sea from the world's rivers. The Amazon also plays a huge role in the Earth's climate – not just as a massive store of carbon, but in the way it affects rainfall patterns. Climate models suggest Amazon deforestation could lead to droughts and crop failures across the Americas, and possibly in other agricultural regions as far away as Europe.

Around four-fifths of the Amazon remains intact today. During 2000-10, around 3.6 million ha of forest were lost per year (FAO, 2011). Degradation is also a major problem (Foley et al., 2007). Soy production is one of a number of drivers of deforestation in the Amazon, along with pasture expansion for cattle rearing (Wassenaar et al., 2007); fires (Nepstad et al., 1999); legal and illegal logging (Asner et al., 2005); opening up paved roads (Kirby et al., 2006; Southworth et al., 2011); and degradation due to climate change (Phillips et al., 2009). The complex underlying causes of forest loss include land tenure issues, crime (direct and through money laundering), poverty and population growth (Fearnside, 2008).

The soy factor

Until recently, the Amazon was considered unsuitable for soy production, but crop breeding and other advances have increased production potential. Rapidly growing soy production has been identified as a driver of forest conversion (Kaimowitz and Smith, 2001; Bickel and Dros, 2003; Brown et al., 2005), mainly in Brazil and Bolivia.

ALONG WITH DIRECT CONVERSION, SOY CONTRIBUTES TO DEFORESTATION IN THE AMAZON BY PUSHING CATTLE RANCHING INTO THE FOREST

As well as direct conversion of Amazon rainforest to soy, much soy expansion in Brazil now occurs on land previously used for cattle grazing. While this has the potential to be part of the solution (see page 79), there is the danger that it can contribute indirectly to deforestation by pushing cattle production – the leading cause of deforestation in the Amazon – into the forest.

Soy production was also partly responsible for an extremely rapid rate of deforestation in parts of the **Bolivian** Amazon in the 1990s and through into the 21st century (Hecht, 2005). In eastern Bolivia, soy was second only to cattle ranching as a cause of deforestation (Killeen et al., 2008). Off-site impacts of soy, such as pollution of watercourses from agrochemicals and soil erosion, have also had an impact on natural ecosystems (Arvor et al., 2010).

If deforestation rates seen over the last few decades continue, nearly one-quarter of the remaining Amazon forest could be lost within the next 30 years, and 37 per

The Amazon is home to one in 10 species on Earth, including the jaguar

cent within 50 years (Soares-Filho et al., 2006). More pessimistic estimates suggest that more than one-half (55 per cent) could be lost in the next 20 years as increased demand for agricultural commodities exacerbates a vicious circle of climate feedbacks, such as increased drought and forest fires (Malhi et al., 2007).

There are some positive signs that catastrophic forest loss may yet be avoided. In **Brazil**, a moratorium on soy grown on land cleared from Amazon forest has resulted in a sharp downturn in direct impacts (see page 73). New legal controls have also contributed to the deforestation rate declining by 70 per cent (Hecht, 2012), to 0.7 million ha/year in 2009 (Assuncao et al., 2012). In 2012, overall forest clearing reached its lowest level since annual record-keeping began in the late 1980s.

But the reduction in forest loss remains fragile, and there are fears that changes to Brazil's Forest Code (Tollefson, 2011), which came into force in mid-2012, could see deforestation rates rise again. According to Brazil's National Institute for Space Research's near-real-time tracking system, at least 61,500 ha of rainforest were cleared in the Brazilian Amazon between November 2012 and February 2013. This deforestation rate continues to accelerate: between August 2012 and July 2013 more than 200,000 ha of forest were cleared, 92 per cent more than the previous year (Martins et al., 2013).

Deforestation in the Amazon

Key

- Forest 2010
- Nonforest
- Deforestation
- Rivers & lakes
- Major cities

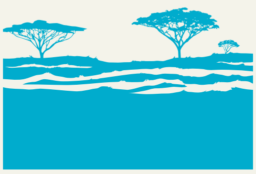
Deforestation (1988-2010) data source: Brazil National Institute for Space Research (INPE)

Forest cover source: WWF Germany, derived from Townshend et al., 2011

Landscape at risk
THE CERRADO

The Cerrado savannah, which lies mostly in Brazil, has never received the same attention as its more glamorous neighbour the Amazon – and its unique biodiversity and vital ecosystem services are suffering under the continued march of soy.

A vast, diverse mosaic of dry grassland, woodland, forests and wetlands, the Cerrado once covered nearly one-quarter of Brazil. It holds around 5 per cent of the world's biodiversity, including over 800 bird species; giant anteaters (*Myrmecophaga tridactyla*) and armadillos are among its 60 vulnerable animal species, 12 of which are critically endangered. Of its more than 11,000 plant species, nearly one-half are found nowhere else on Earth, and many are used for food, medicine and handicrafts; among the most spectacular are a number of types of *Tabebuia* tree, with their brilliant flowers of pink, yellow, white and purple.



The Cerrado is also extremely important as a source of water. Of 12 major hydrological regions in Brazil, six have sources in the Cerrado, including the Pantanal, the world's largest wetland. Nine out of 10 Brazilians use electricity generated by water from the Cerrado. The region also locks up a deceptively large store of carbon, as its small trees have deep root systems: around 70 per cent of the biomass of this "upside-down forest" is underground, and recent studies suggest it may hold some 265 tonnes of carbon per hectare (Castro and Kauffman, 1998). Annual CO_2 emissions from converting the Cerrado are around 250 million tonnes – equivalent to one-half the emissions of the UK.

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The Cerrado once covered over 200 million ha, but around half the natural vegetation has been lost since the late 1950s (Sawyer, 2008; Jepson, 2005; Jepson et al., 2010), when the ultra-modernist capital Brasilia was conjured out of the heart of the region. According to the Brazilian government, 53 per cent remains relatively intact (MMA, 2010), though other estimates are as low as 35 per cent (Klink and Machado, 2005; Durigan et al., 2007) and 21.3 per cent (Conservation International, 2012). Remaining areas are severely fragmented (Ribeiro et al., 2011), and there are few contiguous areas over 1,000 ha (Durigan and Ratter, 2006). Just over 11 million ha are under protection, though less than 3 million ha – 1.4 per cent of the total area – is classified under the strictest levels of protection, IUCN categories I-IV (Conservation International, 2012; Klink and Machado, 2005).

The soy factor

With high acidity and toxic aluminium levels in the soil, the Cerrado was once thought to be unsuitable for agriculture. But new technologies and techniques have allowed farming to spread rapidly over the last 40 years. Initially this was largely driven by cattle ranching, with over 50 million ha being converted (Klink and Machado, 2005). But since 2000 soy, along with other crops such as maize, cotton and sugarcane, has expanded into extensive areas. The pace of this change can be seen in a detailed study that suggests 12 per cent of the Cerrado had been cleared by 1980, 44 per cent by 2000 and 55 per cent by 2005 (Brannstrom, 2009). WWF-Brazil estimates that soy cultivation now takes up around 13-15 million ha (WWF-Brazil, 2012) – around 7 per cent of the Cerrado biome, or an area the size of England.

Vagafogo Sanctuary, Pirenopolis, Brazil: just 1.4 per cent of the Brazilian Cerrado is strictly protected

The conversion of the Cerrado continues at a rapid rate as Brazil's soy production expands. If vegetation change were to continue at 2004 rates – some 2-3 million ha per year (Klink and Machado, 2005) – the natural ecosystem of the Cerrado could virtually disappear within the next three decades. Assessment by WWF (WWF-UK, 2011) found that municipalities with the highest rates of vegetation change, concentrated in the northern region, also had large numbers of new soy plantations. The western part of Bahia state, for instance, expanded its area of soy from 380,000 ha to over 1 million ha between 1993 and 2002.

The Soybean and Corn Advisor, a consultancy firm, gives an indication of the low value the industry has tended to place on the native Cerrado: "*In Brazil, the potential for soybean expansion is nearly unlimited … Cerrado vegetation consists of low twisted trees interspersed with native grasses, sort of a scrubland or savanna. This vegetation is easily cleared and converted to row crop production. There are an estimated 200 million acres of cerrado* [80 million ha] *that could still be cleared in Brazil*" (soybeansandcorn.com/Frequently-Asked-Questions).

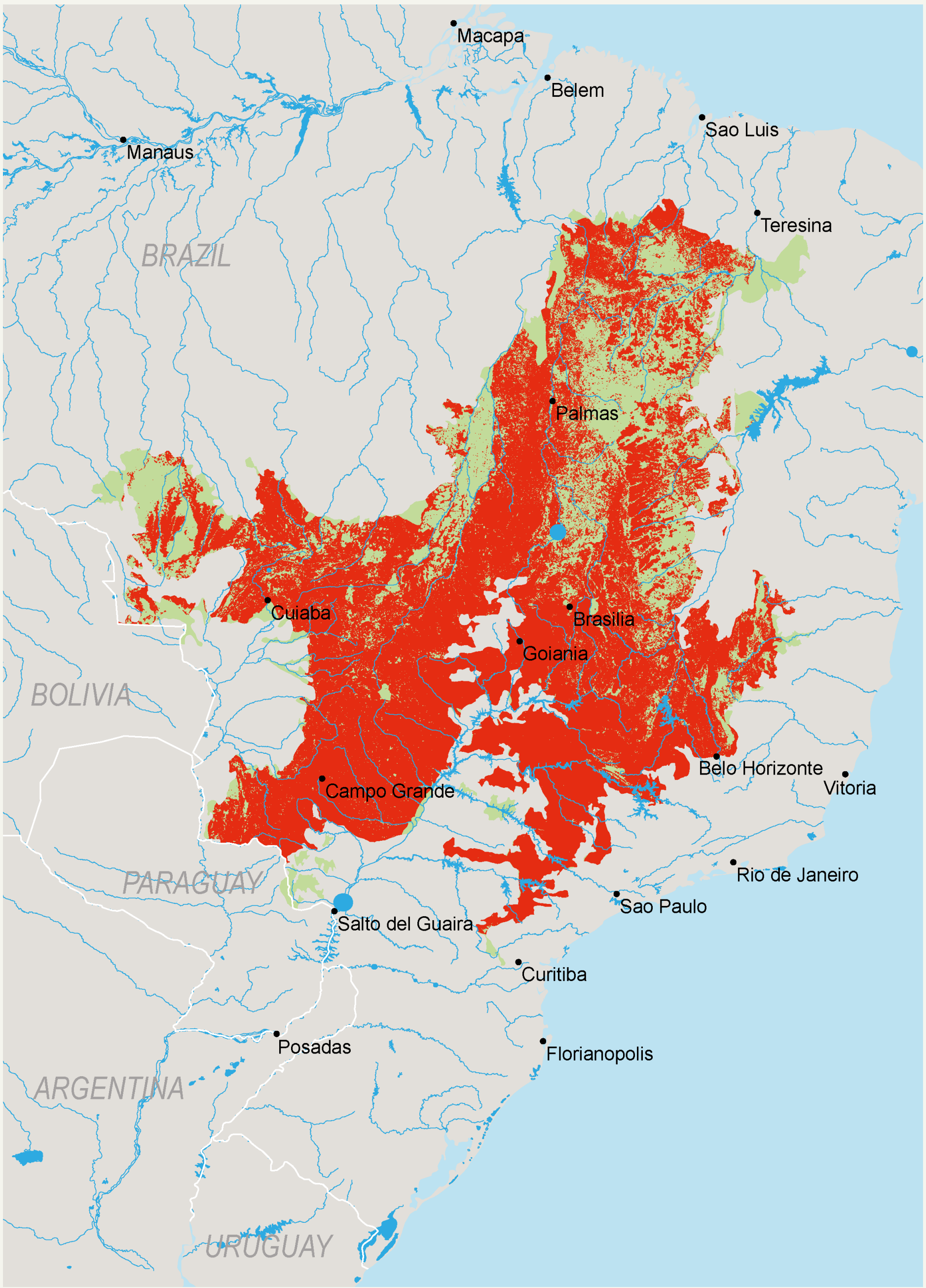
Encouragingly, though, efforts to integrate conservation policies into agricultural development are gathering pace. The Brazilian environment ministry, together with WWF and others, has recently updated its map of priority areas for conservation in the Cerrado; organizations such as the International Finance Corporation (IFC) have incorporated this map into their policies.

Deforestation in the Cerrado

Key

- Natural landcover
- Deforestation
- Rivers & lakes
- Major cities

Deforestation (1988-2010) data source: Brazil Ministry of Environment (Ministério do Meio Ambiente, MMA)



Landscape at risk

THE ATLANTIC FOREST

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Red brocket in Carlos Botelho State Park, São Paulo, Brazil: the remaining Atlantic Forest in Brazil is protected by law

Despite strengthened protection in Brazil and Paraguay, soy production remains a threat to the remaining Atlantic Forest, one of the most vulnerable and diverse forests on Earth

The Atlantic Forest was once one of the world's great forests, covering over 100 million ha along the coast of Brazil and into eastern Paraguay and northeast Argentina. Centuries of forest clearance have reduced it to a fraction of its original area. Nonetheless, it remains immensely rich in both biodiversity, with over 8,000 endemic species (Tabarelli et al., 2004), and diverse human cultures. Two of the world's great cities, São Paolo and Rio de Janeiro, lie within the region, and the remaining forest helps to protect watersheds and provide other important environmental services.

The Atlantic Forest's spectacular wildlife includes jaguars (*Panthera onca*), tree anteaters, tapirs (*Tapirus terrestris*) and 22 endemic species of primates such as the golden lion tamarin (*Leontopithecus rosalia*), as well as more bird species than are found in the whole of Europe. It's also home to 263 species of amphibians found nowhere else on Earth. Over one-half the forest's tree species are unique to the region, and as many as 450 types have been found in a single hectare.

But this incredible biodiversity is fragile. The eight Brazilian species considered to have become extinct in modern times were all endemic to the Atlantic Forest (Mittermeier et al., 1999). Over 530 species occurring in the forest are under threat at biome, national or global level. Many have never been recorded inside protected areas, leaving them particularly vulnerable (Tabarelli et al., 2004).

SOY CULTIVATION NOW TAKES UP MORE THAN 7 PER CENT OF THE CERRADO, EQUIVALENT TO AN AREA THE SIZE OF ENGLAND

The Atlantic Forest in Brazil is originally thought to have covered around 130 million ha (Moratello and Haddad, 2000). The original area has been greatly reduced, with estimates for remaining forest ranging from 11.4 to 16 per cent (Ribero et al., 2009) to 7-8 per cent (Galindo-Leal and de Gusmão Câmara, 2003). Today, most of this is in isolated fragments of fewer than 50 ha (Ribero et al., 2009), although there has been some regrowth of young secondary forest (Teixeira et al., 2008) and efforts at restoration (Rodrigues et al., 2009). In 1993, the Atlantic Forest in Brazil was granted legal protection, and further clearing was banned 10 years later.

Paraguay's Atlantic Forest had, by 2000, shrunk to less than one-quarter of its original 8.7 million ha (Huang et al., 2007; Huang et al., 2009) and losses continued: WWF's more recent estimates suggest that just 13 per cent of the original forest remains (Di Bitetti et al., 2003; Hutchison and Aquino, 2011).

Argentina contains the largest remaining intact areas of Atlantic Forest, with more than 1 million ha in both public and private lands (Izquierdo et al., 2011); nonetheless, almost half a million ha were lost between 1973 and 2006 (Izquierdo et al., 2008).

The soy factor

There have been multiple drivers of forest loss in the Atlantic Forest, including agriculture, ranching, forestry, conversion to tree plantations (Zurita et al., 2006) and road building (Freitas et al., 2010), with soy becoming increasingly significant as earlier crops diminished (Richards, 2011). Agricultural expansion, for crops including soybeans as well as cattle ranching and tree plantations, is the major

OVER ONE-HALF OF THE ATLANTIC FOREST'S TREE SPECIES ARE UNIQUE TO THE REGION, AND AS MANY AS 450 SPECIES HAVE BEEN FOUND IN A SINGLE HECTARE

underlying cause of the fragmentation of the forest. The relative importance of the various drivers differs regionally: until recently, soybean plantations have been a leading cause of forest loss in the southern Brazilian states and in eastern Paraguay, but not in the Misiones province of Argentina (di Bitetti et al., 2003).

While the Brazilian Atlantic Forest is no longer being cleared to a significant degree, in Argentina the Atlantic Forest is still undergoing rapid deforestation through agricultural expansion, ranching, logging, conversion to tree plantations and road building. Soy is not grown to any significant degree in the region, but as Argentina's main agricultural crop, it is inextricably linked with changes in land use. In Paraguay, the government legislated a 2004 moratorium on forest conversion in the east of the country which has reduced deforestation rates in the Atlantic Forest by 90 per cent (Hutchison and Aquino, 2011). The moratorium has been extended several times, most recently to 2018.

Una Biological Reserve, Bahia, Brazil: half the Atlantic Forest's tree species are unique to the region

Deforestation in the Atlantic Forest

Key

- Forest
- Nonforest
- Deforestation 2008-2012
- Rivers & lakes
- Major cities

Data source: Fundação SOS Mata Atlântica, 2012

* Data not available for Paraguay and Argentina

Landscape at risk
THE GRAN CHACO

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Agricultural expansion, largely driven by soy, is the biggest threat to the natural vegetation of the Gran Chaco

The Gran Chaco was one of the last frontiers in South America – but agricultural development, largely driven by soy, is gathering pace

To the Quechua people, the name Gran Chaco spoke of productive hunting grounds. Today game mammals such as peccaries, tapirs, deer and armadillos still roam across much of this sparsely populated region, which straddles Argentina, Paraguay and Bolivia – but things are changing fast.

A hot, dry plain of around 100 million ha, the Gran Chaco comprises a range of habitats from dry thorn forests and cactus stands to palm savannahs that are flooded in the wet season. The Gran Chaco has high levels of biodiversity, containing around 3,400 plant species, 500 birds, 150 mammals and 220 reptiles and amphibians (TNC et al., 2005). There are more types of armadillo here than anywhere else, with 10 species in the Argentinian Chaco alone. Its central location in South America makes it an important refuge for many migrating birds.

The Chaco has been gradually converted over long periods, but the rate of conversion of natural vegetation has accelerated in recent years. Around 12 to 15 per cent of the natural Chaco landscape has been converted into agricultural uses. This is concentrated in a narrow strip of the sub-humid Chaco, where agricultural uses have replaced up to 80 per cent of original cover in areas such as some quebracho forests (OAS, 2009).

In Argentina, some 1.2-1.4 million ha (85 per cent of the national deforestation total) was cleared in 30 years, a deforestation rate of 2.2 per cent per year (Zak et al., 2004; Gasparri and Grau, 2009). As controls have tightened on felling Atlantic Forest remnants, particularly in Paraguay (see page 77), pressure has mounted on the neighbouring Gran Chaco. From 2010 to 2012, for example, a total of 823,868 ha was cleared in the three main countries, three-quarters in Paraguay (Monitoreo Ambiental del Chaco Sudamericano, 2012). In Bolivia, the heart of Gran Chaco is protected by the Kaa-Iya del Gran Chaco National Park and indigenous area. But land to the north and west, where the soil is extremely fertile, is being cleared for agriculture.

The soy factor

Agricultural expansion, largely driven by soy, is the biggest threat to the natural ecosystems of the Gran Chaco. In Argentina, agricultural expansion, and soy cultivation in particular, is the main cause of deforestation. Growing market demand, coupled with innovations such as GM, zero-tillage and other technological changes (Zak et al., 2008), have made cultivation in drier and less productive areas more viable.

While detailed statistics relating specifically to the Gran Chaco are hard to find, Argentina's total cultivated area increased by about 45 per cent between 1990 and 2006; during this period, soy became Argentina's dominant crop, accounting for over one-half the cultivated area in the country by 2006 (Aizen et al., 2009). There is a clear correlation between soy expansion and the loss of forests and grasslands. Between 1987 and 2010, 6.4 million ha of forest and 1 million ha of grassland in the north of Argentina were converted to agriculture; during the same period, the soy area expanded by around 11 million ha, with other crops remaining mostly static (UMSEF 2007, 2008, 2012; CNA 1998, 2002). In the province of Salta, within the Gran Chaco, one-quarter of the forest was removed between 1977 and 2008 (Paruelo et al., 2011).

EXPANSION OF AGRICULTURE AND CATTLE RANCHING, LARGELY DRIVEN BY SOY, IS THE BIGGEST THREAT TO THE NATURAL ECOSYSTEMS OF THE GRAN CHACO

Before 2004, Paraguay had the second-highest deforestation rate in the world, with over 7 million ha of forest destroyed in 40 years, including large parts of the Chaco (Hutchison and Aquino, 2011). Most of this forest was cleared for agriculture and livestock, particularly soy (Baldi and Paruelo, 2008) and cattle (Abril et al., 2005). Since the government legislated the 2004 Forest Conversion Moratorium, also known as the "Zero Deforestation Law" in order to protect the Atlantic Forest in Paraguay, soy in the region has increasingly been grown on land previously used to raise cattle. As the law pertains only to the protection of forest and not to other landscapes such as savannahs, an unexpected result has been that cattle ranching has expanded massively into the Gran Chaco. Some soy is also now being cultivated directly in the Paraguayan Chaco. A report in *The New York Times* suggested that almost half a million ha had been cleared in the 2 years up to March 2012, to make way for cattle and soybean (Romero, 2012).

Pressure on the Gran Chaco seems set to continue to increase, with infrastructure in the region developing rapidly. Argentina's paved road network has increased by 10 per cent in the last 7 years, while the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA) plans to link the Chaco with Pacific ports in Chile, opening up better links to Asian markets; as part of this, reconstruction of the Belgrano cargo railway in Argentina is already under way. In Bolivia, intensive agriculture has been limited historically by the semi-arid climate, but this is changing as farmers adopt irrigation technology.

© MALENE THYSSEN

The giant anteater is one of 150 mammals native to the Gran Chaco

Deforestation in the Chaco

Key

- Forest
- Nonforest
- Deforestation
- Rivers & lakes
- Major cities

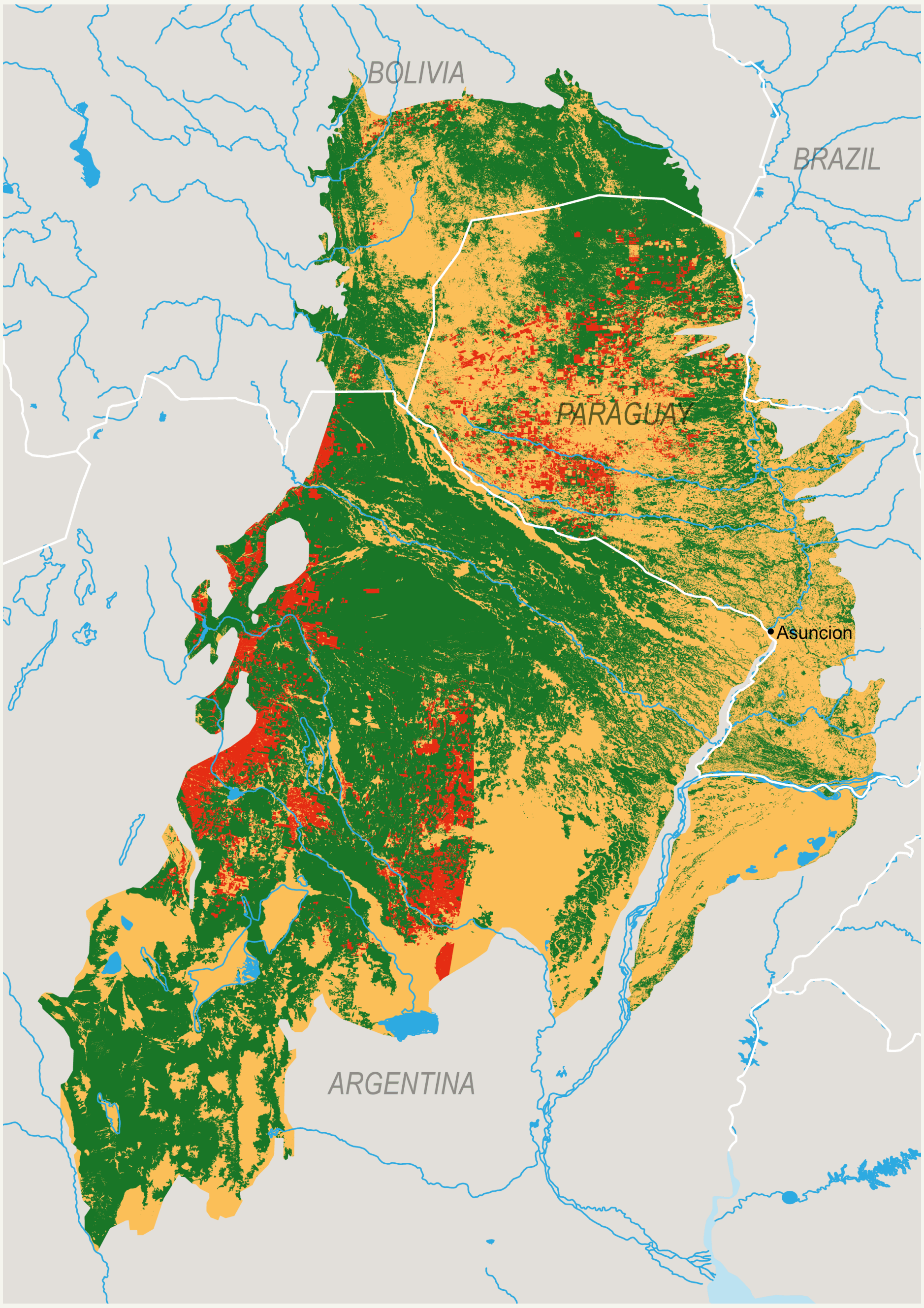
Deforestation data NW Argentina (2000-2007) source: J.N. Volante, et al., 2012

Deforestation data outside NW (2004-2013) Argentina source: CIAT Terra-I. Data downloaded from CIAT-Terra-i website (www.terra-i.org), Reymondin et al.

Deforestation Brazil (1988-2010) source: Brazil National Institute for Space Research (INPE)

Forest cover Argentina (2001): Secretaria de Ambiente y Desarrollo Sustentable, Ministerio de Salud y Ambiente de la Nacion, 2005.

Forest cover Brazil (2010): WWF Germany, derived from Townshend et al., 2011



Landscape at risk
THE CHIQUITANO FOREST

The ancient and unique Chiquitano forest shelters a wide range of species, including this Jabiru stork

Bolivia’s little-known dry forests contain exceptional biodiversity, and are targeted for soy expansion

Tropical dry forests are among the most endangered ecosystems on the planet – and the Chiquitano forest is the largest patch of healthy dry forest ecosystem alive today. Located at a crossroads where the humid Amazon meets the arid Chaco, the trees of the Chiquitano shed their leaves in the dry season, and have evolved to withstand both fires and floods. Most intact Chiquitano forest is found in Bolivia, though small patches remain in Brazil and Paraguay.

This ancient and unique ecoregion is one of the richest dry forests on the planet, sheltering a wide range of species, including a large number of threatened mammals. Wildlife includes puma (*Puma concolor*), maned wolf (*Chrysocyon brachyurus*) and the giant armadillo (*Priodontes maximus*), the last of which is categorized as vulnerable on the IUCN Red List. Much of the Chiquitano has yet to be studied, including the Sunsas Ridge limestone caves, which contain rich bat colonies.

The Chiquitano forest once covered around 12.5 million ha. Around 15 per cent had been converted before 2001. The mean annual rate of forest loss in Santa Cruz was estimated at about 100,000 ha between 1990 and 2000, which grew to 220,000 ha between 2000 and 2005 (Killeen et al., 2007a). The main threat to the Chiquitano forest comes from cattle ranching and mechanized agriculture (Killeen et al., 2007a), although mining is also an important agent of change (Vides-Almonacid and Justiniano, 2011).

During the last decade deforestation in Bolivia claimed about 0.5 per cent (around 250,000ha) of forests each year. This puts Bolivia at risk of continued loss of valuable ecosystems and deforestation. (Source ABT: 2010- official data).

The soy factor

Mechanized agriculture in Bolivia began in the 1960s. During the 1960s and 1970s, the government promoted commercial agriculture in Santa Cruz in the Gran Chiquitano region with infrastructure investments, subsidized credit and resettlement programmes designed to promote migration of small-scale farmers from the overcrowded regions of the high Andes and Altiplano (Klein, 1982). The large-scale cultivation of soy took off in the early 1990s, an explicit objective of a development project financed by the World Bank.

Soy cultivation in Bolivia has continued to increase rapidly, by nearly 6 per cent every year: in the country as a whole, it is now grown on over 1 million ha (Pacheco, 2012). FAN (Fundación Amigos de la Naturaleza) has estimated that mechanized intensive agriculture will increase by more than 1 million ha in the next 25 years (WWF-Bolivia, 2013). In Bolivia, soy production accounts for around 90 per cent of mechanized agriculture. Land and labour are cheap compared to other South American countries and these factors have contributed significantly to the increasing expansion of soy production. In recent years, these costs have increased substantially, which may limit future expansion of soy. Over half the soy production in Santa Cruz is on land owned by non-Bolivians, with one-quarter of the land owned by Brazilians (Mackey, 2011).

The rise of soy has been accompanied by accelerating deforestation rates. Annual deforestation in Tierra Bajas rose from 8,700 ha per year from 1975 to 1984, to

16,500 ha from 1984 to 1990, to 89,000 ha (a rate of loss of 4.56 per cent per year) from 1990 to 1998 (Steininger et al., 2002). This trend has continued, and forest clearance accelerated markedly between 2007 and 2008 (Redo et al., 2011). One author has attributed the loss of 650,000 ha of the Bolivian Chiquitano since the 1950s specifically to soy production, noting that this deforestation has shown little respect for previous land use, protected areas or indigenous territories (Catacora, undated).

Soy in the Uruguayan campos

Natural grasslands, or campos, cover much of Uruguay; grazing has been the main activity for generations. For some decades until 2000, establishing tree plantations was the main cause of land-use change in the campos. This century, however, soybean has become an increasingly important crop, with the cultivated area increasing by over 5 per cent per year in some western counties (Paruelo et al., 2006). Soy cropland grew from virtually zero to 7 per cent of Uruguay's cropland between 2002 and 2012, with almost 1 million ha now under cultivation. During 2012, soy became Uruguay's main export crop, worth over 1 billion dollars (MercoPress, 2012). Soy is replacing other crops, former pasture and high conservation value grazing land, especially along the banks of the River Uruguay. Here, where the most fertile soils are found, soy covers around 60 per cent of the land (Rios et al., 2010).

Along with land conversion, there are concerns about the rapid increase in the use of pesticides and fertilizers. Around the Estero de Farrapos e Islas del Río Uruguay, a national park and Ramsar wetland site of international importance, this is having an impact on fish, bees and terrestrial animals, and algal blooms are becoming more common (Rios et al., 2010).

As in other South American countries, soy expansion in Uruguay has led to small farmers being replaced by large agribusinesses: socio-economic studies found that as soy production increased, the number of producers occupying the land declined steeply (Narbondo and Oyhantçabal, 2011).

© GUSTAVO IBARRA/WWF BOLIVIA

Land is cleared by burning in the Chiquitano: up to 650,000 ha of Chiquitano dry forests may have been lost to soy production in Bolivia

Deforestation in the Chiquitano Forest

Key

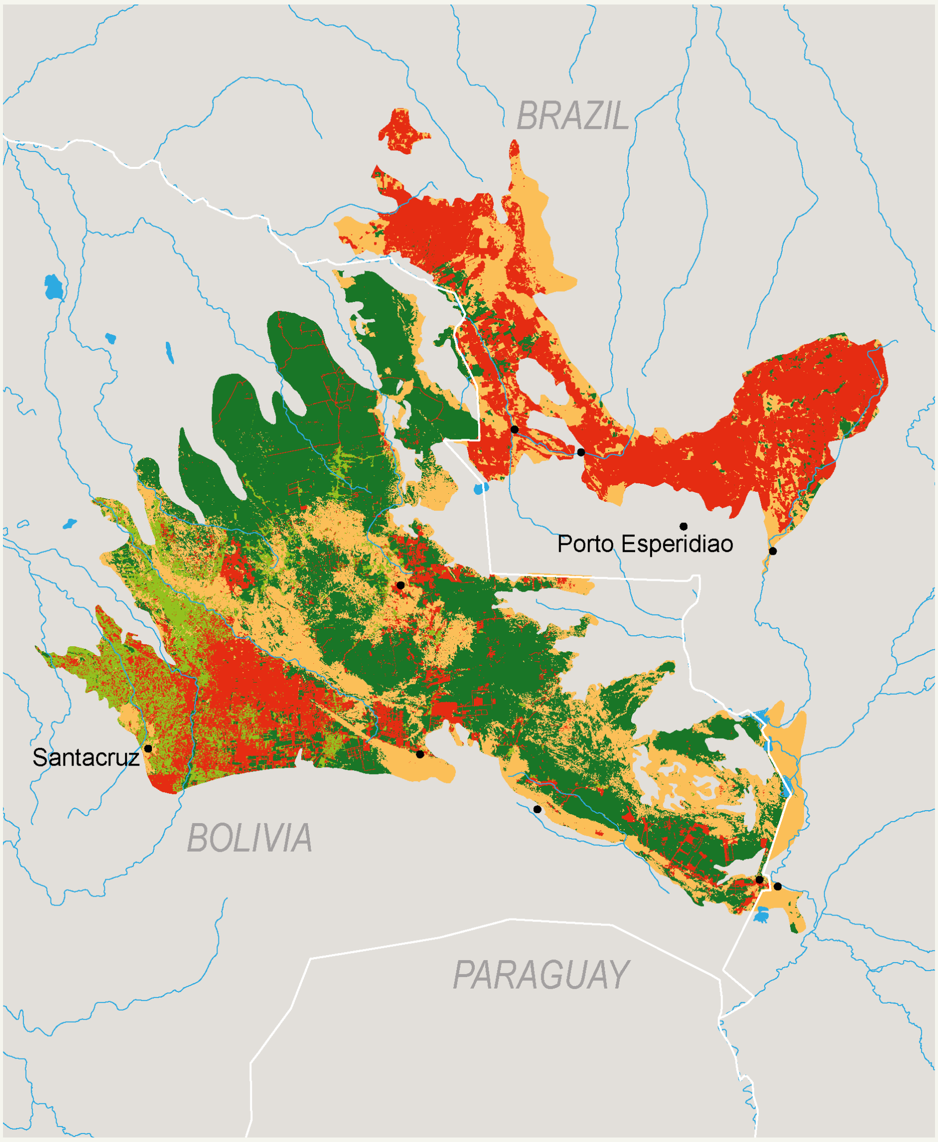
- Forest
- Nonforest
- Deforestation
- Regeneration
- Rivers & lakes
- ● Major cities

Deforestation Bolivia (1990-2010) source: Noel Kempff Mercado Museum of Natural History

Deforestation Brazil (1988-2010) source: Brazil National Institute for Space Research (INPE).

Forest cover Bolivia (2010) source: Noel Kempff Mercado Museum of Natural History

Forest cover Brazil (2010) source: WWF Germany, derived from Townshend et al., 2011.



Landscape at risk

NORTH AMERICAN PRAIRIES

Centuries of land conversion mean that the large majority of US grasslands have already been degraded or converted to other uses

Grassland once covered around one-half of the landmass of the 48 contiguous states of the United States. From west of the Mississippi River, the great prairies stretched for some 400 million ha. People managed the land long before European settlement, using interventions, particularly fire, to maintain huge areas of grassland as habitat for wild bison.

From 1850 to 1950, before the soy boom, over 100 million ha of grassland were lost, mostly converted to cultivated cropland. A similar area was lost between 1950 and 1990, with roughly two-thirds ploughed up for crops (Conner et al., 2001). Conversion of these highly erodible lands into production is in part what led to the Dust Bowl in the 1930s. During the drought in 2012, there were sporadic dust storms in Oklahoma and Kansas due to soil tillage.

The soy factor

The soy story in North America began with World War II, when a shortage in domestic oil and fat supply followed decreasing imports of East Asian oils. One US Department of Agriculture pamphlet issued during the period called on farmers to "*Grow More Soybeans for Victory*" (Shurtleff and Aoyagi, 2007). As domestic soy production increased, the United States became a major exporter of soy products to Europe and Russia. Soy has remained an important crop in the United States ever since; until 2012 it was the largest single producer in the world.

© RAB CUMMINGS/WWF

Today nearly all the highly productive tallgrass prairie ecosystem in the Corn Belt (the Midwestern United States) has been converted to agricultural land uses. Conversion of some parts of the mixed-grass prairie to the west, particularly along the Missouri Coteau, exceeds 70 per cent (Wright and Wimberly, 2013). Conversely, in the Northern Great Plain Ecoregion as defined by WWF, approximately 70 per cent of the area is either in protected areas or used for ranching.

CENTURIES OF LAND CONVERSION MEAN THAT THE LARGE MAJORITY OF US GRASSLANDS HAVE BEEN DEGRADED OR CONVERTED TO OTHER USES

The conversion is continuing. Current high corn and soybean prices, and the demand for biofuel feedstocks and the Renewable Fuels Standard, are credited as driving some of the most significant changes in land use in recent US history. Between 2006 and 2008 the area on which corn and soybean was harvested in the United States increased by more than 3.2 million ha; nearly one-third of this increase came from converting grass-dominated land (Wright and Wimberly, 2013).

Federal government policies to support agricultural production in the United States through protection or subsidies, coupled with periods of high prices for agricultural commodities, have long provided incentives to convert grasslands to crop production. More recently, expanding federal crop insurance and disaster relief programmes such as the 2012 Farm Bill mean that farmers in drought-prone areas are able to risk growing highly profitable but rainfall-dependent crops such as soybeans (Wright and Wimberly, 2013).

Recent grassland conversion in the United States

The Prairie Pothole Region of the eastern Dakotas is under substantial pressure from agricultural development. Between 2001 and 2010, cropland replaced over 1.25 million ha of grassland, or 16.9 per cent. Three crops constituted the vast majority of this new cropland in about equal proportion: corn, soybeans and wheat (Johnston, 2012).

In the Western Corn Belt (North Dakota, South Dakota, Nebraska, Minnesota and Iowa), grassland was converted to corn or soy at an annual rate of 1.0-5.4 per cent between 2006 and 2011. This has resulted in a net decline of grasslands, in particular those in close proximity to wetlands, of nearly 530,000 ha (Wright and Wimberly, 2013).

© DIANE HARGREAVES

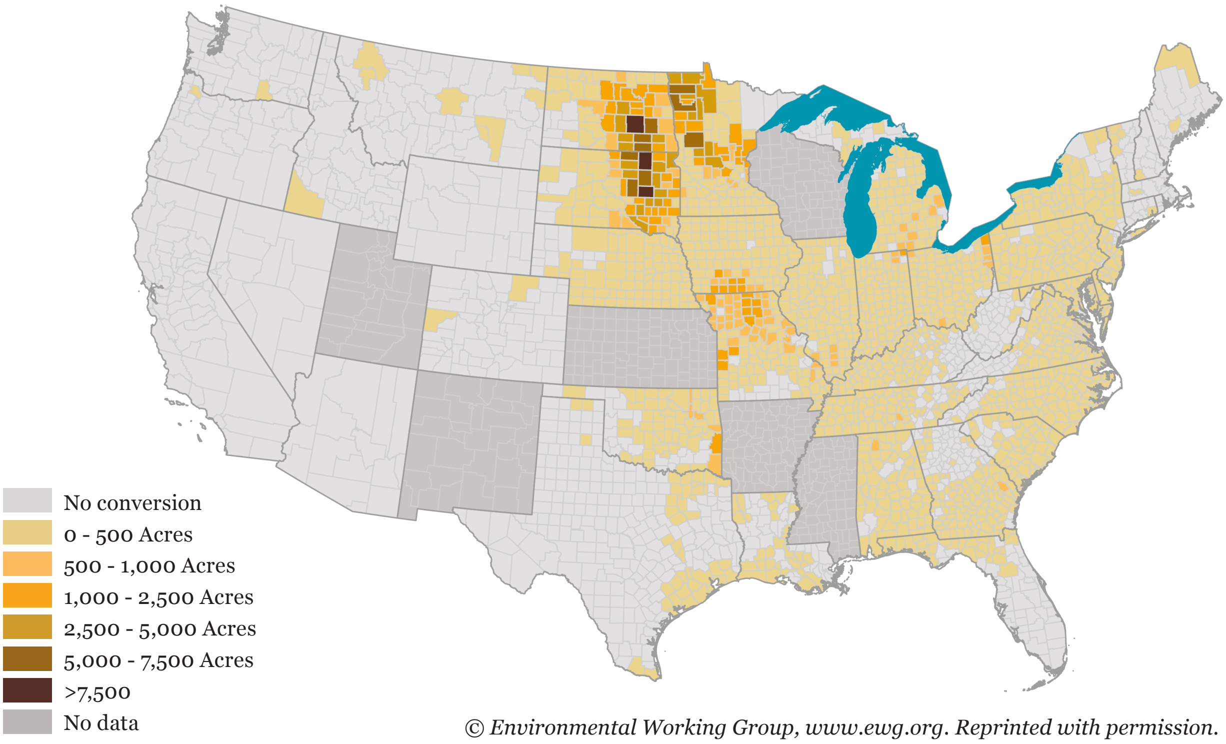
Changes in the Northern Great Plains ecoregion

Between 1978 and 2008, the average annual increase in crop acreage within the Northern Great Plains (NGP) was 0.9 per cent or some 445,154 ha over the 30-year period. Growth in soybeans, corn and wheat accounted for most of the increase, with corn and soybeans increasing from 1998 to 2008. The soybean area has grown substantially over 30 years, with an average annual growth rate of 14.5 per cent, totalling 1.2 million ha, although most of this came from soy replacing other crops and only 12 per cent from conversion of rangeland.

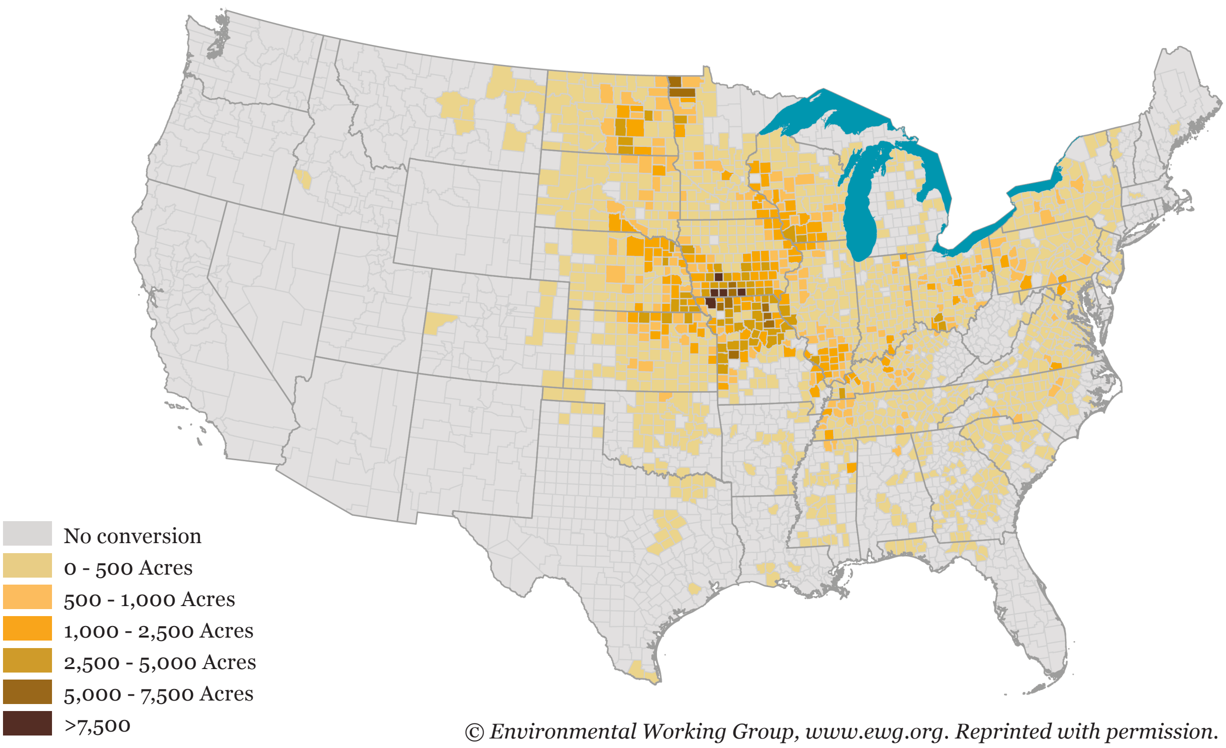
Preliminary results of a recent modelling exercise suggest that an increase in crop prices would lead to an increase in conversion on all but the poorest soil quality areas. Specifically, a 10 per cent increase in crop prices increases the probability of converting from grassland to cropland by 0.3 per cent, while a 25 per cent increase in crop prices will lead to a 0.9 per cent increase in the probability of conversion; the latter translates to over 400,000 ha converted across the US portion of the NGP. The probability of conversion increases dramatically with soil quality along the eastern edge of the ecoregion in North and South Dakota.

Similarly, changes in government payments (e.g., crop insurance, disaster payments) would also substantially change the probability of converting grassland to cropland, particularly on more marginal soils in the western portions of North and South Dakota and eastern portions of Montana and Wyoming (Schrag and Olimb, 2012).

Wetlands converted to soy 2008 - 2012



Erodible land converted to soy 2008 - 2012



5. SOY CONTROVERSIES

Along with the loss of natural ecosystems, soy production raises a number of environmental and social issues

The issues outlined briefly here are not the focus of this report, and are explored in greater detail elsewhere. However, any attempts to reform soy production and guide its expansion need to address these concerns alongside the conversion of forests and other ecosystems.

Soy, soil, water and resource use
Soy is an intensively grown crop, with high demands for resources: particularly energy, water, agrochemicals and soil. Any change from natural vegetation or grazing lands to crops is likely to increase soil erosion and change the hydrological cycle.

Soil: Life cycle analysis of soy production in the Cerrado, Brazil, found annual soil erosion losses of 8 tonnes per hectare, compounded by loss of organic matter, compaction and acidification (Mattsson et al., 2000) and greatly impacting the quality of water courses. Over the last decade, the use of no-till methods has increased, with a consequent decrease in erosion. However, these methods are not used everywhere, and erosion can be as high as 19-30 tonnes per hectare per year depending on management, slope and climate, with the boom in soy markets encouraging farmers to plant on more erodible soils (Altieri and Pengue, 2006).

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Erosion on recently deforested land, Brazil: any change from natural vegetation is likely to increase erosion

© PETER CATON/WWF

Water: The impact of soy production on the water cycle varies greatly between countries and regions. Soybean used 4 per cent of global irrigation water in 1997-2000 but this use is not evenly spread; soy is mainly a rain-fed crop in South America but much more heavily irrigated elsewhere (Hoekstra and Chapagain, 2006). Research shows that higher rainfall interception in soybean fields than in transitional tropical forests, combined with faster run-off due to soil compaction in these fields, reduces the amount of water percolating into deeper soils and groundwater. It can be inferred that wide conversion to intensive soy cultivation will therefore reduce water availability in the long term (Bäse et al., 2012). Water quality and quantity is also very much impacted by soil erosion and agrochemical residues.

Agrochemicals: Modern farming technology requires intensive use of fertilizers, pesticides and herbicides. The use of agrochemicals (pesticides and chemical fertilizers) is one of the main environmental threats linked to soy production, regardless of farm size, causing soil contamination as well as huge impacts on water quality and its biodiversity. Agrochemicals use can also affect human health: a study in Mato Grosso, for example, tested 62 samples of breast milk and found traces of one or more toxic agrochemicals in all of them (Palma, 2011). The vast soy monocultures and warmer year-round climate in South America increase the likelihood of severe pest attacks. The Brazilian Institute of Geography and Statistics (IBGE) estimates that 35 per cent of all pesticides used in Brazil are for soy farming. Most soy in South America uses inoculation of *Rhizobium* into soy seeds to fix

© PETER CATON/WWF

nitrogen, creating a low dependency on nitrogen fertilizer, although phosphorus, potassium and other macro- and micro-nutrients are still required. In Argentina, where there is less use of *Rhizobium* inoculation, large off-site leakage of both nitrogen and phosphorus has been estimated from soybean crops (Pengue, 2005), with potential impacts on downstream water quality.

Monoculture: The scale of soy monoculture is unprecedented. As with any system of production that cultivates single crops over vast areas, soy monocultures minimize ecological services and become more dependent on chemicals to control pests such as insects and fungi. The scale of the monoculture itself creates ecological risks, including new or growing pest and disease problems such as soybean rust, which has risen dramatically in Brazil (Altieri and Pengue, 2006).

Soy cultivation: Social impacts
Large-scale land-use change creates social change, along with many claims and counter-claims about the costs and benefits of development. Despite a lot of talk and publicity, there have been relatively few detailed social research projects into the impacts of soy expansion. A recent working paper found that soy expansion in the Amazon region has reduced several poverty indicators and raised median rural incomes, but at the same time has increased levels of inequality and continued a process of consolidation of land holdings into the hands of fewer people (Weinhold et al., 2011). Despite the large growth in Argentina's soy exports, one of the few studies available found no systematic relationship between soy expansion and improved living standards of the local populations (Banco Mundial, 2006).

Land concentration: Most soybean production in North and South America operates on an industrial scale, which tends to disadvantage smallholders – although efficient cooperative systems in some areas allow smallholders to remain competitive. The expansion of medium- and large-scale producers can stimulate land concentration, which may in turn displace local people and take away their

A soy farm surrounded by native Chiquitano forest, Bolivia livelihoods (Pacheco, 2012). The majority of the land used for soy in the Cerrado and Amazon in Brazil is controlled by a few major owners, with many farms averaging 1,000 ha and some reaching 10,000-50,000 ha (Brown-Lima et al., undated). In Chaco province, Argentina, where soy has replaced typical smallholder crops such as cotton, the number of farmers of fewer than 100 ha fell by 80 per cent while the number of farms over 1,000 ha increased by 230 per cent between 1998 and 2002 (Dal Pont and Longo, 2007). By contrast, most soy in China and India is grown by smallholders; while productivity is lower, the economic benefits are spread much more widely.

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Traditional village in the Chiquitano: soy has been associated with land grabbing in several South American countries

Employment: The impact on agricultural labour depends on what soy production is replacing. Employment opportunities are likely to be higher in soy farming than in cattle ranching, but lower where soybean displaces traditional cultivation activities (Rathman et al., 2012; Goldfarb and Zoomers, 2013). In the Americas, although exceptions exist, income tends to benefit a small group of larger enterprises rather than a large number of smaller farms (Pacheco, 2012). It has been estimated that conversion to soy has eliminated four out of five farm jobs in parts of Argentina (Garcia-Lopez and Arizpe, 2010). In India and China, by contrast, soy provides an important source of income and employment for several million smallholders.

Human rights: Local and international NGOs have reported land evictions, misuse of pesticides and, in Paraguay, violent suppression of land protests related to soy (Semino et al., 2006, Dutch Soy Coalition, 2006). Greenpeace has documented illegality and use of slaves in soy farms in the Amazon region, with workers being duped into coming to ranches where their papers are taken away and they are forced to work. The Brazilian government keeps a 'dirty list' of farms successfully prosecuted: in 2004, for example, it intervened in 236 cases of slavery in soy farms involving over 6,000 labourers including 127 children (Greenpeace, 2006). The problem, once exposed, has now largely been addressed. The NGO GRAIN has documented cases of land grabbing associated with soy in Argentina, Bolivia, Brazil and Paraguay (GRAIN 2012, 2013). Eviction of indigenous communities has also been reported from northwest Argentina (Kruglianskas, undated) and eastern Paraguay, where indigenous groups which have depended on the forest for centuries have been displaced and now live in poverty in the cities of Ciudad del Este and Asunción (Hobbs, 2012). A study in Argentina's Chaco region documented 224 land conflicts, including a number related to soy, affecting 127,886 people on more than 2.7 million ha: one-quarter of the families were evicted (Redaf, 2013).

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A soy worker in the field: conversion to soy has eliminated four out of five farm jobs in parts of Argentina

Genetically modified soy

Genetically modified (GM) soy was first introduced onto the market in 1996, principally to make soy crops resistant to herbicides. Although resisted in some regions, notably Europe, GM soy is now grown in many parts of the world. Much of the soy in Latin America is genetically modified to tolerate glyphosate herbicide; this means soy can be sprayed several times with this total herbicide during the growing season. All other plants will be killed, and only the soy plant will survive. Recently more and more weeds have become resistant to this herbicide. As a consequence, new GMO soy variations have been developed, with resistance against more than one herbicide. By 2009, 77 per cent of global soy production was from GM seed, covering 69 million ha, an increase of 4.9 per cent on 2008. Countries such as Argentina and the United States are now almost entirely given over to GM soy. Conversely, China aims to be the world's largest producer of non-GM soy for both internal use and export (Anon, 2012); India is also a GM-free producer. Both GM soy and non-GM soy are planted in the geographic regions discussed in this report.

WWF does not promote or endorse the use of GMOs; applies a precautionary approach to the introduction of GMOs; and advocates the retention of non-GMO options for all relevant commodities.

Children in a Chiquitanan village: soy expansion does not always lead to improved living standards for local people

Table 7
Proportion of GM soy grown in countries considered in this report
Source: GMO Compass, 2010; Céleres, 2012; Guereña, 2013; IBCE, 2011

Country	% GM soy
United States (2009)	91
Argentina (2009)	99
Brazil (2010)	88.8
Paraguay (2010)	95
Bolivia (2011)	93
India (2009)	0
China (2009)	0

STEPS TOWARD RESPONSIBLE SOY

The world's population and consumption of natural resources is growing to unprecedented levels – and demand for soy continues to rise. Without a change of course, vast areas of forest and other habitats in South America will disappear in the coming decades.

But an alternative future is possible. From government policies and farming practices to commitments by big buyers and investors, solutions are emerging that will allow us to meet the need for soy while conserving biodiversity and crucial ecosystems.

This farm, in Paraná, Brazil, uses no-till cultivation, which can improve soil quality and carbon levels, and reduce erosion and chemical inputs.

6. STEPS TOWARD RESPONSIBLE SOY

How can we meet rising demand for soy without contributing to deforestation and habitat loss?

The production and consumption of soy has grown phenomenally over the past few decades and, in the process, imposed an extraordinarily high cost on nature. In the coming decades, demand for soy will continue to rise. This is happening at a time when the world's population and consumption of natural resources is growing to unprecedented levels. Carrying on with "business as usual" will mean further loss of natural environments such as those discussed earlier. We will see huge and irreversible losses of biodiversity. The natural capital and ecosystem services that underpin not only agricultural production but the entire global economy will be further eroded: ecological processes could be pushed beyond tipping points, leading to catastrophic failures. Increased carbon emissions will exacerbate the already formidable challenges of climate change.

But we do not have to follow this pathway. Alternatives exist that will allow us to meet the need for soy and other agricultural commodities while conserving biodiversity and crucial ecosystems. Here, we present some current and possible solutions for moving toward a more responsible soy industry. These include legislative initiatives in both producer and consumer countries, market incentives to reward progressive producers and voluntary mechanisms to catalyse change. On the supply side, BMPs and responsible investment policies can increase the sustainability of the production, while limiting the irresponsible expansion of the industry. On the demand side, initiatives to curb waste and over-consumption can ensure that the need for expansion is real, rather than profligate.

CHARLOS CHIAVARINI

Soy mapping project, Brazil: systematic land-use planning can enable soy production to expand responsibly

1. Market responses

In response to the concerns of customers and shareholders, NGO advocacy, and long-term reputational and supply risks to their business, private companies have begun to take steps to reduce the environmental impact of soy. Responses include making individual and/or collective voluntary pledges to avoid deforestation, and certification schemes developed in collaboration with civil society organizations.

WWF challenges and supports companies to purchase only soy that has been produced according to strict environmental and social safeguards. WWF works with individual companies as well as broader industry initiatives (see below) to transform the market, so that responsibly produced soy that does not damage ecosystems becomes the norm.

THERE IS NO SILVER BULLET – WE NEED COMPLEMENTARY INTERVENTIONS FROM A WHOLE RANGE OF ACTORS, INCLUDING GOVERNMENTS IN SOY PRODUCING AND CONSUMING COUNTRIES, COMPANIES ALL ALONG THE SOY SUPPLY CHAIN, FINANCIAL INSTITUTIONS, CIVIL SOCIETY ORGANIZATIONS AND CONSUMERS

Consumer Goods Forum: The Consumer Goods Forum, which represents 400 leading global manufacturers and retailers, has pledged to use its influence and mobilize resources to help achieve zero net deforestation by 2020. It has committed to working through individual company initiatives and in partnership with governments and NGOs to "develop specific, time bound and cost effective action plans for the different challenges in sourcing commodities such as palm oil, soya, beef, paper and board in a sustainable fashion" (theconsumergoodsforum.com/sustainability). It has specific working groups, including one on soy, and advises companies to choose soy certified by the RTRS.

Voluntary certification: Certification schemes and "ecolabels" for products that meet environmental and social standards are becoming increasingly mainstream. Well-known examples include those of the Forest Stewardship Council (FSC) for sustainable forest management, the Marine Stewardship Council (MSC) for responsible fisheries, the Fairtrade label and various organic accreditations. Voluntary standards can help to raise industry norms, influence national policies or even become legal requirements. To be credible, these schemes need to be developed through a multi-stakeholder process and compliance needs regular independent, third-party verification.

For producers, certification can provide added value such as price premiums, access to growing markets for certified soy and access to discounts on agricultural inputs and finance. Meeting certification criteria can also help to improve productivity, restrict the use of harmful agrochemicals and other inputs, and reduce social conflicts and legal problems. A KPMG study suggests that with a combination of benefits, including a price premium of US$1.5 per tonne, the average payback period for producers' investment may be as little as 3 years (KPMG, 2013). Certification also allows manufacturers and retailers to make verifiable claims about the sustainability of their products, and provides assurance for customers wanting to make responsible choices.

Round Table on Responsible Soy: The certification scheme with the most potential for shifting the soy sector toward sustainability is the RTRS. Established in 2006, the RTRS is a multi-stakeholder initiative with over 150 members from more than 20 countries. These include producers and retailers from the mainstream soy industry, environmental and social NGOs (including WWF), commodity traders, consumer goods manufacturers, the feed industry and banks. Its aim is to produce globally applicable standards to help build a market for responsible soy. The first certificate for responsibly produced soy according to RTRS principles was issued in May 2011. Producers have been certified in Brazil, Paraguay, Argentina, Uruguay and India, and national standards are being developed in Bolivia, China and Uruguay. Certificates are issued by accredited third-party auditors. The RTRS reached its first 1 million tonnes of responsibly certified soy in January 2013 – though this represents less than 0.5 per cent of total global soy production at the time of this report's writing. The RTRS standard (RTRS, 2010), which has been formulated through a rigorous, transparent multi-stakeholder process, bans the conversion of any native forests as well as non-forest habitats such as grasslands and wetlands of high conservation value. It also demands legal compliance, requires conservation and where needed restoration of riparian vegetation areas, promotes best management practices, ensures fair working conditions and respects land tenure claims.

RTRS also promotes chain-of-custody certification along the supply chain to make sure that claims about products containing responsible soy in the marketplace can be verified – though for soy "embedded" in animal products, so far this only reaches as

RTRS Brazil mapping project

Limiting expansion into natural habitats is a crucial role of RTRS. But defining which areas are suitable for soy expansion and which should be off limits can be a challenging process.

In Brazil, RTRS has been involved in a mapping project with a multi-stakeholder group including producers, buyers, financial institutions, civil society organizations (including WWF), and mapping and biodiversity conservation experts. The process has created broad-scale maps for responsible soy expansion in Brazil, and guidance for identifying areas of high conservation value and defining biodiversity-friendly practices at a site level. The methodology used will allow similar maps and guidance to be produced in other countries.

While the mapping project is intended primarily to serve soy producers seeking RTRS certification, it has a potentially far wider scope as a tool to protect natural habitats under threat from cattle ranching, crops and other land uses.

GM soy production in the RTRS

The RTRS has been criticized for certifying genetically modified soy production as "responsible", and WWF's participation in the Round Table has been questioned as a result.

WWF does not promote or endorse genetic modification. We think more research is needed into the impacts of GM organisms, that no GM products should be released into the environment without a transparent, comprehensive environmental impact assessment and that strong safeguards need to be in place. We also believe that non-GM alternatives should be available for all commodities. However, the fact remains that GM soy accounts for over three-quarters of global soy production. In most of North and South America, the proportion is even higher, reaching 99 per cent in Argentina and 89 per cent in Bolivia.

RTRS aims to become a mainstream standard for the soy industry. To have any chance of preventing the conversion of the natural ecosystems highlighted in this report, all producers – GM and non-GM – need to be on board. At the same time, WWF has worked with the RTRS to establish a separate supply chain for certified responsible non-GM soy.

far as the feed industry. Since not all growers have access to separate supply chains for responsible soy, RTRS runs a Certificate Trading Platform: producers are issued with a certificate for the amount of RTRS-certified soy they produce, which can be sold directly to manufacturers or retailers committed to responsible soy. RTRS also runs a separate module for non-GM soy (see box), as well as a module developed specifically to ensure that soy biodiesel meets the EU Renewable Energy Directive (www.responsiblesoy.org).

Round Table on Sustainable Biomaterials (RSB): The RSB, a multi-stakeholder forum of which WWF is a member, promotes the most credible and comprehensive global standards and certification scheme for biofuels and other biomass products. The RSB's principles and criteria include avoiding negative impacts on biodiversity and ecosystems, reducing greenhouse-gas emissions by at least 50 per cent, improving food and water security, and contributing to social and economic development. The first RSB certificates were issued in 2012. RSB is a meta-standard that recognizes multiple certification schemes for specific biofuel feedstocks such as RTRS. While there is to date no RSB-certified soy, RTRS-certified soy for biodiesel is recognized by the RSB (rsb.org).

ProTerra: WWF-Switzerland and the Swiss retail chain Coop developed a set of criteria for responsible, non-GM soy, known as the Basel Criteria. These evolved into the ProTerra standard by CERT ID, a private company, and influenced RTRS standards. Suppliers from Brazil meeting the ProTerra requirements have an annual capacity of around 4 million tonnes (2012-13). ProTerra's standard is comparable to

Brazil's Amazon Soy Moratorium

Advocacy from NGOs (e.g., Dros, 2004) and pressure from consumers led Brazil's soy industry to take voluntary action against Amazon deforestation. In 2006, two associations that represent around 80 per cent of soybean processors and exporters in Brazil – the Brazilian Association of Vegetable Oil Industries (ABIOVE) and the National Association of Cereal Exporters (ANEC) – pledged that their members would not buy soybeans produced on any Amazon farmland deforested after 24 June 2006. WWF is a member of the Soy Moratorium's Technical Working Group and plays a key role in ensuring the ongoing credibility of the initiative's monitoring system.

Initially the moratorium was set for 2 years, but it has been renewed every year since, and enforcement has improved. It is monitored annually by overlaying maps derived from satellite images of deforestation with registered farms known to be producing soy.

The success of the moratorium is monitored by remote sensing (Rudorff et al., 2011). Between the 2007-08 and 2012-13 crops, only 18,100 ha of the total 2.1 million ha of soy cultivated in the Amazon (less than 1 per cent) was in recently deforested areas (WWF-Brazil, Greenpeace, ABIOVE).

The moratorium was an important step toward reducing Amazon deforestation, and indeed many companies take their moratorium obligations seriously. There is, however, a danger that because of the success of the moratorium and the publicity it has attracted, the market now considers the problem of soy and deforestation to be solved. As this report shows, this is very far from being the case.

RTRS, but improvements need to be made in governance, transparency and level of assurance of the scheme (proterrafoundation.org).

Organic certification and fair trade: Several organic certification schemes can be applied to soy, though only a tiny fraction of soy production is organic. While some of these standards demand zero deforestation, others simply require that producers comply with laws on maintaining native vegetation. Similarly, other labels with high social and environmental standards, such as Fairtrade and the Brazilian EcoSocial label, do not necessarily deal with conversion of natural ecosystems to cropland.

2. Consumer country responses

Consumer countries have an important role to play in influencing the shift to more responsible soy production practices in producer countries. For example, consumer pressure helped to bring about the Amazon Soy Moratorium (see above), as well as to prompt the development of the RTRS and other certification schemes.

In consumer countries, particularly in Europe, WWF is lobbying businesses to commit to responsible soy and raising awareness among consumers. For example, WWF-UK's "Save the Cerrado" campaign in 2011 (WWF-UK, 2011) targeted the country's seven leading supermarkets; as a result, several joined RTRS or made time-bound commitments to sourcing responsible soy. The "Save the Cerrado" campaign's online video has been viewed more than 155,000 times.

WWF-Netherlands was a founding partner in the Dutch Soy Coalition, which brings together seven NGOs to reduce the negative environmental and social impacts of soy. The coalition works with organizations in soy producing and consuming countries, and was instrumental in bringing about the Netherlands' national commitment to certified responsible soy (see below).

Dutch national commitment: More than one-fifth of the soy that comes into the EU is imported through the Netherlands, making it the second largest importer in the world. In December 2011 the main food chain sectors, including the feed sector, dairy and meat industry, farmers, food businesses and retailers jointly committed to aim for 100 per cent of soy for the Dutch production of animal products to be certified to RTRS standards, or equivalent, by 2015. The Dutch government's Sustainable Trade Initiative (IDH) and NGOs including WWF support the commitment. To help achieve the initiative's goals, the involved companies have set up the Foundation for the Supply Chain Transition to Responsible Soy (Stichting Ketentransitie Verantwoorde Soja) that is helping producers in South America to achieve RTRS certification: the investment required to shift all Dutch soy requirements to RTRS is expected to be around €7 million, with participating companies and the IDH paying one-half each. By 2012, the proportion of responsible soy and soy products within the Netherlands had increased to 16 per cent. The Foundation has set the target to buy 1 million tonnes of certified responsible soy in 2013.

Other national initiatives: Similar initiatives are under way in other European countries. Soy Network Switzerland (sojanetz.ch) is an alliance of soy buyers, producer associations, manufacturers, retailers and WWF-Switzerland. Its aim is for at least 90 per cent of soy for the Swiss market to be responsibly produced by 2014. In 2012, the total stood at 70 per cent. In Belgium, the feed industry association Bemefa (bemefa.be) has committed to import 100 per cent responsible soy by 2015. Discussions are also taking place in Denmark and Sweden, among other countries.

Public–private partnerships: IDH runs pre-competitive market transformation programmes in 18 sectors. It has a €130 million co-funding grant from the Dutch, Swiss and Danish governments, and its investments are jointly funded by private companies. IDH's soy programme (idhsustainabletrade.com/soy), with a budget of €6.5 million, aims to make the soy sector responsible at an institutional level. It is currently funding projects to help soy producers in Brazil, Argentina and Paraguay to become RTRS-compliant. Along with the Dutch companies mentioned above, co-funders include Bemefa in Belgium, and Lantmannen in Sweden.

The Tropical Forest Alliance 2020 (TFA 2020) is a public–private partnership that aims to end tropical deforestation associated with key global commodities, including soy. Members include the Consumer Goods Forum and the governments of the United States, the Netherlands, Norway and the UK. They aim to work individually and in combination to tackle the drivers of tropical deforestation using a range of market, policy and communications approaches.

European Union Renewable Energy Directive: The EU has set a target that 10 per cent of energy in the transport sector should come from renewable sources by 2020. The European Union Renewable Energy Directive (EU-RED), as well as similar national legislation in member countries, has led to big increases in demand for biofuels, including biodiesel from soy. Meanwhile, responding to public and NGO pressure, the EU has introduced criteria to ensure biofuels don't destroy important ecosystems. Under these requirements, biofuels purchased to meet EU-RED targets must comply with one of the certification schemes that the EU deemed as compliant with its criteria. RTRS and RSB are among the strongest of these. WWF is concerned, however, that other schemes are too weak, particularly in looking at the indirect impacts of biofuels on greenhouse-gas emissions, biodiversity and food security, and is calling for more robust legislation.

Green public procurement policies: Public procurement policies that favour responsibly produced soy can be an important tool, especially in countries where government-related organizations such as schools and hospitals consume large amounts of food. So far, no public procurement policies have specifically addressed embedded soy in food. However, similar public procurement policies do exist, such as those in many European countries specifying timber and paper from well-managed forests, and those in the UK specifying responsible palm oil.

3. Producer country legislation

Producer countries have introduced temporary and permanent policies and legislation aimed at addressing loss of forests, and to a lesser extent other natural vegetation. These policies could, if effectively enforced, slow down the irresponsible expansion of soy farms (as well as other agricultural businesses). Many of these focus on particular regions, in response to fears about high levels of ecosystem loss. They have had varying success; in some cases, they have displaced the problems to other geographical areas.

Most governments have established protected areas to conserve a proportion of their country's native ecosystems. Under the Convention on Biological Diversity, countries are obliged to develop ecologically representative networks of protected areas, with a global target of 17 per cent land area under protection. Identifying and giving legal protection to these areas is only the first step. It's also critical that governments develop effective protected area management systems and strengthen governance to prevent degradation or illegal encroachment, both of which remain a problem in Latin America. Strong legislation is also needed to support conservation and protect biodiversity outside protected areas, including on farms and other privately owned land. Many governments are also experimenting with various carbon offset schemes, such as REDD+, as a way of bringing funding to help deter further forest clearance.

Brazil: Brazil has various laws protecting its forests. For public land, there is an extensive protected area network in the Amazon, and smaller protected area systems in the Cerrado and the Atlantic Forest. The most important set of laws relating to private farms is the Forest Code. Clearing of the Atlantic Forest has been banned for 20 years, and restoration projects are attempting to link remaining fragments together. In the Amazon, landowners are obliged to maintain 80 per cent forest cover – an increase from 50 per cent before 1996. Landowners in Cerrado regions within the area legally classified as the Amazon biome (Mato Grosso state and parts of Maranhão and Tocantins) are supposed to maintain 35 per cent of land, plus all permanent preservation areas, under natural vegetation – an average of 40-45 per cent of land when the law is enforced. In other Cerrado regions, the figure is 20 per cent, plus all permanent preservation areas – an average of 25-30 per cent of land, although again this depends on the law being enforced. Increased protection for the Amazon, the Soy Moratorium and international concern have resulted in most soy expansion in the last two decades taking place in the Cerrado. In 2012, Brazil's Forest Code was amended – the subject of bitter dispute between the agricultural sector and the environmental sector, including NGOs, researchers, politicians, the forest sector and society in general. In theory, the changes demand less conservation than the previous Forest Code did in most cases. Even so, WWF-Brazil considers that getting producers to comply with the Forest Code is a key conservation priority. Strict and consistent enforcement of the Code, even though it has been watered down, would be an improvement on the current reality of relatively uncontrolled expansion of soy and cattle ranching into forest ecosystems.

Argentina: In 2007, Argentina passed the Forest Act (Law 26,331), which required provinces to introduce comprehensive, participatory land-use planning processes. This was a major breakthrough in environmental protection and involving civil society in environmental planning. To date, 20 out of 23 provinces have policies in place for managing native forests. Since the Act was passed, the average annual deforestation rate in the country has fallen by almost 20 per cent – from around 280,000 to 230,000 ha a year. But this is still very high. And forests are still being cleared from areas defined as no-go zones under provincial forest management plans – 259,302 ha in Category II (yellow) and 16,148 ha in Category I (red). Clearly, the law is not yet being applied effectively, and its implementation remains underfunded (Greenpeace, FARN & FVSA, 2013). A Forest Compensation Fund was supposed to provide an incentive for forest conservation through a system of payments for ecosystem services, but this has not yet taken off, with funding allocation at just 10 per cent of the level required by the legislation.

Paraguay: In 2004, after some decades of very high deforestation rates, Paraguay brought in a temporary Zero Deforestation Law to protect the Upper Paraná Atlantic Forest. As a result, the deforestation rate has fallen by 90 per cent. WWF and other organizations have fought hard to keep the moratorium in place, and it was recently extended until 2018. However, strict protection in the Atlantic Forest has led to increased clearance of native vegetation in the Gran Chaco, mainly for cattle ranching, much of which has been displaced from the Atlantic Forest by soy production: the annual deforestation rate is now more than 900,000 ha. More land has also been opened up for soy production, especially in the Pantanal. Several attempts to implement a temporary moratorium in the Chaco have failed, due to strong opposition from cattle producers. WWF-Paraguay is attempting to introduce longer-term alternatives to keep forests standing. This includes promoting new laws and restoration programmes, and supporting the "Programme on Conformance with Forest Law", where landowners who have not reserved sufficient areas of forest (at least 25 per cent of land over 20 ha, and 100 metres on either side of water courses) have to restore forest cover. To complement this, a new law on PES will offer financial incentives to landowners who conserve more than the 25 per cent legal minimum (see page 82).

Bolivia: Conservation, development and production are the three pillars of Bolivia's new constitution, adopted in 2009, which puts sustainable development at the core of Bolivian law. The subsequent Law of Mother Earth (*Pachamama* in Bolivian indigenous culture) builds on this by seeking to ensure human society "lives in harmony with nature". This Law is based on three main components, namely well-living (*vivir bien*); Mother Earth and integral development. The Law establishes a forest management model called "The Joint Mitigation and Adaptation Mechanism for Integrated and Sustainable Management of Forests". This "mechanism" aims at reinforcing the environmental function of forests, recognizes the contribution of indigenous peoples to the conservation of forest ecosystems, supports indigenous peoples' rights, promotes forest governance systems, strengthens sustainable use and access to forest resources, contributes to tackling the underlying causes of deforestation and forest degradation and promotes the enhancement of sustainable livelihoods of local peoples. The Bolivian government enacted the "Food Safety and Forest Restoration Law" (No. 337), which sets out to foster agriculture in lands that were illegally deforested between 1996 and 2011, and has the objective of ensuring food safety and restoring affected forest areas. In order for the landholders to benefit from this Law, 10 per cent of the deforested area should be restored and the rest should be assigned to agricultural production. Failure to comply with this Law implies an immediate reversion of the entire previously deforested area to the state. In spite of the ongoing expansion of the agricultural frontier, there is widespread support for conservation and sustainable development. Fortunately, Bolivia is a sparsely populated country with vast areas of pristine natural habitat and the potential for conservation remains correspondingly large. WWF will continue to engage the productive sector, while working with national, regional and local government agencies to promote both conservation and responsible agricultural development.

United States: Relying on national and state regulations will not be enough to conserve priority areas in the United States. There are some conservation programmes within the Farm Bill, but participation is voluntary, and their future is uncertain– both the Senate and the House have called for cuts to voluntary conservation programmes of more than US$6 billion over 10 years. One key measure is the Conservation Reserve Program (CRP), established by the Food Security Act of 1985. Under the programme, agricultural producers and landowners retire highly erodible and environmentally sensitive cropland and pasture from production for 10-15 years. This land is planted to grasses, trees and other cover, reducing erosion and water pollution and providing other environmental benefits. However, there has been a drastic decline in the area of land enrolled in the CRP, from 14.9 million ha in 2007 to 10.9 million ha in 2013, a decline of 26.8 per cent (USDA-FSA, undated). With commodity prices rising while CRP payments remain steady, it is likely that more contracts will not be renewed when they expire: by 2018, another 7.6 million ha could be brought back into production, some of this within the prairies of the NGP.

4. Land-use planning

Legislation to protect natural ecosystems needs to happen within a broader context of integrated and inclusive land-use planning.

WWF wants to see all countries introduce transparent, participatory and democratic land-use planning processes to achieve an optimal distribution of natural forests, plantations, agricultural areas, urban areas and other land. Various tools exist to identify “go” and “no go” zones – areas suitable for production, such as degraded lands and low-productivity pasture, and areas of high conservation value that should be avoided. In Brazil, WWF and other civil society organizations have been working with the government and the private sector on Systematic Conservation Planning – a science-based approach that looks at land use within the context of the whole biome (Margules & Pressey, 2000). WWF believes that best available natural and social science should help to inform land-use decisions, whether these are determined through land-use plans and regulations, private sector investment and sourcing policies, or options agreed by rural communities and land owners.

WWF is also promoting a shift to “green economies” that recognize the value of natural environments and the benefits that flow from them, and build this into land-use decision-making. Governments, businesses, conservationists and civil society organizations all have a role to play in this process.

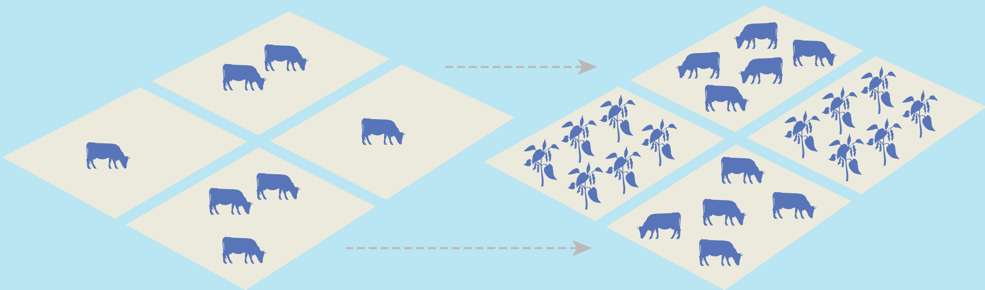
Soy cultivation on degraded pasture: part of the solution

Large areas of South America that have previously been converted to cultivated pasture are now degraded. By using these areas, it could be possible to significantly expand soy production without further conversion of natural ecosystems. Similarly, increasing livestock productivity in areas of very low-intensity grazing could free up land for soy cultivation. However, safeguards need to be in place to prevent this leading to more conversion for cattle ranching – the leading cause of deforestation in the Amazon and elsewhere.

Brazil has 200 million ha of pasture and 70 million ha of crops and tree plantations. Official estimates show that at least 30 per cent of these pastures are either degraded or well below reasonable productivity levels. By raising average pasture productivity by 30 per cent, Brazil could significantly increase its crop area with no conversion of native vegetation – while still having degraded land available for restoration of native vegetation. The cattle sector claims it could increase beef production even with 30-40 per cent less area.

Integrating crops such as soy with pastures is becoming more common. The Brazilian government is strongly supporting this with low-interest loans through its low carbon agriculture (ABC) programme. WWF is promoting joint ventures that link ranchers who have degraded or underproductive pastures with experienced soy farmers seeking to expand production in the Amazon and Cerrado regions of Brazil. Access to international climate finance would allow ranchers to invest in better range and animal management practices, enabling them to raise more cattle on the remaining land.

Figure 6
Intensifying pasture productivity. New soy production could be accommodated on a proportion of existing pasture land by increasing livestock productivity on the remaining pasture



5. Better Management Practices (BMPs)

BMPs can help farmers reduce the use of inputs such as agrochemicals and water, and mitigate negative environmental impacts. For example, integrated pest management techniques – such as controlling pests by hand or with traps, or using beneficial insects – reduce pesticide use. Similarly, measures such as adding compost, reducing tillage, and intercropping can improve soil health and productivity. More diversified systems of production, such as agroforestry and soy cultivated on smaller plots interspersed with strips of native vegetation, can reduce negative environmental impacts and benefit from ecological services such as natural biological pest control (Moreira, 2009).

In areas where yields are low, such as India and China, BMPs can help soy producers to increase yields without expanding the production area. Yield increase in India and China could in theory contribute to less expansion in South America.

Smaller producers, particularly in India and China, have the most scope for improving productivity through BMPs, as illustrated by the efforts of the Farmer

Support Programme run by the Dutch NGO Solidaridad in cooperation with RTRS. Designed to support smallholders to produce soy more efficiently and sustainably, the programme started in 2009 and is currently helping 80,000 soy farmers and farm workers in Argentina, Bolivia, Brazil, Paraguay and India to prepare for certification. In Madhya Pradesh, India, applying BMPs has increased productivity by 20-30 per cent; together with reduced inputs and an RTRS premium, this has led to improved incomes for 30,000 producers farming around 45,000 ha (RTRS, 2012). Another Solidaridad project launched in 2012 is training around 31,000 farmers in northeast China to improve farming practices, and hopes to achieve RTRS certification of 20,000 ha within 3 years. WWF's offices in producer countries also work with small-scale soy producers to improve management practices and help them achieve RTRS certification: for example, in Mato Grosso, Brazil, WWF is working with women producers to grow soy sustainably while supporting biodiversity protection. The lessons learned from the project will be used to educate other small producers.

For producers with already high productivity, such as in Argentina, Brazil and the United States, BMPs can help to produce the same (or even more) using fewer agrochemicals and less water, while increasing soil quality. In the United States, WWF and other NGOs are members of Field to Market: the Alliance for Sustainable Agriculture (fieldtomarket.org), which brings together grower groups, retailers and other supply chain businesses, and along with civil society promotes continuous improvement using an outcomes-based approach.

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Local people working on a mapping project in the Atlantic Forest, Paraguay

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Rotary irrigation systems like this one near Brasilia use less water than conventional irrigation

6. Payments for Ecosystem Services (PES)

Maintaining any more than the legal minimum area of forest cover is rarely in a landowner's financial interest, when much greater profits can be made from converting this to soy or other agricultural uses. PES mechanisms are one way of making forests worth more standing than cleared. PES schemes come in various forms, but essentially involve those who benefit from a service provided by a natural ecosystem making payments to those who maintain that ecosystem: for example, a hydropower operator might pay communities upstream for maintaining water flows and limiting silt levels by conserving forests.

Similarly, REDD+ – the international initiative for reducing emissions from deforestation and forest degradation – aims to provide developing countries with a financial incentive to maintain their forests, by paying for the carbon they sequester. Carbon markets also offer possible sources of funding for conserving and restoring natural ecosystems (WWF, 2013).

The potential of PES for reducing expansion of soy into natural ecosystems can be seen in the case of the Mapitoba region of the Brazilian Cerrado. The recent RTRS mapping process has identified many areas of high conservation value in the region; to maintain these areas, producers would have to preserve more natural vegetation than the law requires. However, the new Brazilian Forest Code allows producers who have less native vegetation on their land than the law demands to offset the shortfall by renting or buying an equivalent area within the same biome. With many producers in other parts of the Cerrado needing to do this, there is a great opportunity to protect large priority areas in Mapitoba.

In Paraguay, a new PES policy has been approved (Law 3.001/06), though not yet put into practice, which will support efforts to reduce deforestation. Landowners whose land is more than 25 per cent forested (the legal minimum) can obtain certificates of environmental services for their additional forests. These certificates can then be sold to landowners who are not in compliance, as a means of meeting their 25 per cent obligation. In addition, "environmental service providers" would benefit from tax reductions on their properties. Smallholders with fewer than 20 ha, indigenous lands and protected areas can also apply for the certificates.

7. Responsible investment

Financial markets have fuelled and benefited from the soy boom – and can help to shape the future of the soy industry by diverting capital away from projects that threaten natural ecosystems and toward sustainable production. Investors in agricultural commodities such as soy are waking up to the fact that environmental risks such as biodiversity loss and climate change can have a material impact on profitability.

In 2012, the IFC, the private-sector arm of the World Bank, updated its Performance Standards on Environmental and Social Sustainability. These require clients to "implement sustainable management practices to one or more relevant and credible standards as demonstrated by independent verification or certification", such as RTRS. The IFC's standards are a global benchmark, and have been adopted by the 73 leading lenders that make up the Equator Principles Financial Institutions (EPFI).

Meanwhile, members of the Banking and Environment Initiative (BEI), hosted by the Cambridge University Programme for Sustainability Leadership, have prepared a compact to rid their portfolios of deforestation by 2020. All clients that produce, process or trade in soy, along with other commodities linked to deforestation, will be required to commit to achieving credible certification within a 3-year timeframe. Banks that are participating in the dialogue include Barclays, Citi, Credit Suisse, Deutsche Bank, JP Morgan, Rabobank, Santander and UBS. At the time of writing, banks controlling around one-half of all global agricultural lending were preparing to publically sign the compact.

The world needs more capital in food and agricultural sectors, not less, and soy will be an essential part of the 21st century human diet. However, it needs to be smart money that manages environmental and social risks and opportunities. WWF recently produced a sustainable investment guide, *The 2050 Criteria* (WWF, 2012), outlining these risks and key performance indicators for assessing them. This can help financial institutions play a proactive role in creating a more responsible soy industry.

8. Reducing consumption and reducing waste

Humanity already uses more resources than the planet can sustain; with the population set to increase to over nine billion by 2050, reducing wasteful consumption is a critical global challenge. Projections of increased demand for soy over the coming decades are based on current trends. Reducing waste in the full supply chain and eating fewer animals products could keep soy demand in check, helping to take pressure off natural ecosystems while improving food security.

Reducing food waste: Every year, vast amounts of soy are wasted. It's estimated that 30-50 per cent of the total food we produce is never consumed, resulting in the waste of some 1.2-2 billion tonnes of food every year (IME, 2013). Wasting meat and animal products that have been raised on soymeal and other grains has a particularly significant environmental impact. In *Waste: Uncovering the Global Food Scandal,* Tristram Stuart (2009) writes: "It takes 8.3 million ha of agricultural land to produce just the meat and dairy products *wasted* in UK households and by consumers, retailers and food services in the US. That is seven times the amount of land deforested in Brazil in the past year." Opportunities exist to reduce waste at every step of the supply chain, from the farms where soy is grown to those where animals are raised, from supermarkets and restaurants to consumers. Most strikingly, millions of hectares of South American forests and grasslands could be spared if consumers, particularly in western countries, planned their shopping and meals more carefully (Stuart, 2009; Noleppa, 2012).

Reducing consumption of animal products: Growing crops to feed to animals is a highly inefficient way of feeding the world. Jonathan Foley writes in *Scientific American* (2011) that: "using highly productive croplands to produce animal feed, no matter how efficiently, represents a net drain on the world's potential food supply". Around one-third of global cropland is used to grow animal feed (FAO, 2006). The world's 1.6 billion cattle, buffalo and camels consume 4.6 billion tonnes of feed – more than four times what is needed to feed the global human population. (Flachowsky , 2008). A growing number of policy documents suggest that people in richer countries might eat less meat and dairy (e.g. FAO, 2006; Cabinet Office, 2008; Foley, 2011) – for health reasons as well as environmental and ethical ones. For example, the German Society of Nutrition recommends a maximum of 300-600g of meat per week, about half of what Germans currently consume. If all Germans adopted a healthy diet in line with scientific recommendations, meat consumption could drop by 3.2 million tonnes. This would reduce the amount of land needed for agricultural production by 1.8 million ha, including an estimated 826,000 ha of land used for the production of soy as animal feed, predominately in South America (Noleppa, 2012). Several WWF publications argue that world diets need to become more equitable: in other words, people in richer countries should eat less meat as consumption increases in the developing world. Modelling in the *Living Forests Report* suggests that meat consumption in Organisation for Economic Co-operation and Development (OECD) countries needs to halve by 2050 to maintain Zero Net Deforestation and Degradation (Taylor, 2011a); the scenario for 100 per cent renewable energy presented in *The Energy Report* (Singer, 2011) depends on a similar reduction in order to free up land to grow biofuels.

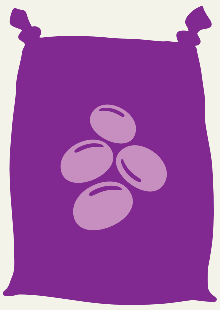
Alternatives to soy: Other products can be substituted for soy, particularly in animal feed. This could include feeding livestock on waste products or on other plants grown sustainably. Some countries in Europe are also keen to reduce its dependence on soy imports. This has led to growing interest in soy production within Europe, as well as alternative protein sources such as rapeseed meal, sunflower meal, and regionally adapted legumes crops such as lupins, peas and beans. Duckweed, insect proteins and algae may offer promising future alternatives. Studies and field projects are being initiated both by NGOs, and by the feed industry and farmers. However, soy is a high-protein, high-energy crop: as long as we depend on a system of intensive meat production, on a global level responsibly grown soy remains a very efficient animal feed.

7. WHAT YOU CAN DO

We all have a responsibility and a role to play in helping to reduce the negative environmental impacts of soy production. There is no single solution: everybody needs to act to contribute to the transition toward a more responsible soy industry.

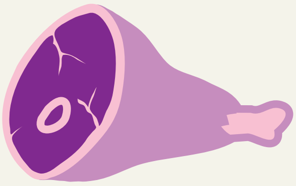
Soy producers

- Join the RTRS and agree to meet – and ideally exceed – RTRS standards, particularly with respect to choosing locations for growing soy.
- Set a time-bound plan for certifying all soy production.
- Use BMPs to improve productivity, minimize agrochemical use, improve or maintain soil quality, etc.
- Focus new production on degraded land or low-productivity pastures.
- Seek new ways to minimize off-site impacts of soy production.
- Take action to reverse loss of biodiversity and ecosystem services, for example by creating wildlife corridors and restoring natural vegetation around watercourses.
- For non-GM soy, choose and support development of RTRS non-GM or ProTerra-certified production and supply chains.



Soy traders

- Join RTRS and make a time-bound commitment to moving all trade to RTRS-certified soy.
- Start sourcing RTRS-certified soy.
- Inform your buyers about RTRS.
- Use your power: the volume of trade you control gives you the potential to shift the whole soy market toward greater responsibility.
- Support programmes to help producers implement BMPs and achieve certification.
- For non-GM soy, choose and support development of RTRS non-GM or ProTerra-certified production and supply chains. When buying ProTerra-certified soy, ask for improvement of governance and verification.



Buyers in feed, meat and dairy, food processing and retail sectors

- Join RTRS and commit to 100 per cent RTRS-certified soy under a time-bound plan.
- Begin purchasing RTRS soy, or animal products based on RTRS soy, as soon as possible.
- Buy RTRS certificates to increase responsible soy capacity in the short term, while supporting the development of mass balance and, ideally, fully segregated certified supply chains.
- Support programmes to help producers implement BMPs and achieve certification.
- For non-GM soy, choose and support development of RTRS non-GM production and supply chains. When buying ProTerra-certified soy, ask for improvement of governance and verification.
- Explore ways of reducing food waste and of reducing consumption of animal products.

Financial institutions

- Engage producers to achieve RTRS certification within a set timeframe.
- Provide preferential lending terms to RTRS-certified producers, processors and traders due to their lower risk factors and better overall governance and business performance.
- Lend to responsible and sustainable agriculture funds that capitalize production, new technology and systems and other value-chain functions.
- Engage food and consumer goods value-chain players to achieve RTRS certification within a set timeframe in their soy business.
- Put particular emphasis on traders, as they have a magnified impact on the supply chain.
- Evaluate the supply chain management/procurement policies of processors, traders and brands using RTRS or the key performance indicators of WWF's *The 2050 Criteria.*

Consumers

- Ask retailers and brands to commit to responsible soy throughout their supply chains.
- Choose soy products certified by RTRS, and choose animal products from animals that have been fed with responsible soy.
- If you're concerned about GM soy, ask about RTRS-certified non-GM soy or ProTerra.
- Consider reducing your consumption of meat, eggs and dairy products – for most people, this will result in a diet closer to health recommendations.
- Reduce food waste by planning your shopping and meals carefully – only buy and prepare as much as you need.

Governments in soy-producing countries

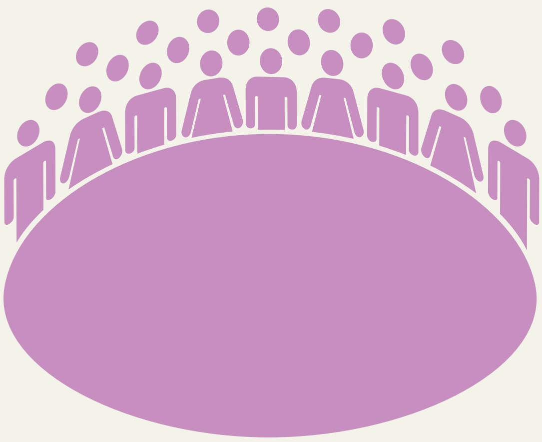
- Create decision-making processes for land use that are fair, informed by science and recognize the need to balance conflicting demands. Use RTRS maps or land-use maps produced by systematic conservation-planning methodology.
- Clarify and strengthen laws and policies to protect native forests, grasslands, savannahs and freshwater regions, and ensure these are applied.
- Tighten existing legislation where this is weak (for example in the Cerrado, Gran Chaco and some areas of the Amazon).
- Develop, maintain and enlarge a comprehensive, ecologically representative network of protected areas, and invest in managing these effectively. Include both strict protection (IUCN categories I-IV) and protection of culturally important landscapes or areas of sustainable development mixed with biodiversity conservation (IUCN categories V-VI).
- Address shortfalls in protection, particularly in the Cerrado and Gran Chaco regions and in the Pampas.
- Research the value of economic and other benefits derived from natural ecosystems, and investigate the option of restoring natural vegetation in areas that have become degraded, proved unsuitable for soy or should never have been converted.
- Pursue funding mechanisms such as REDD+ for maintaining and enhancing natural capital.
- Invest in improved storage and infrastructure to prevent food spoiling.

Governments in consumer countries

- Clarify and strengthen laws governing soy imports to ensure that products meet legal and ethical standards.
- Introduce regulations to ensure imported soy does not come from deforestation of native forests or other sensitive areas. Ideally this should support RTRS maps or similar land-use maps developed by the systematic conservation-planning methodology.
- Avoid perverse incentives within policy that might encourage detrimental direct or indirect land-use changes as a result of soy expansion.
- Strengthen policies related to the European Union Directive on Renewable Energy (EU-RED) to ensure soy biodiesel doesn't threaten natural ecosystems, by making sure recognized certification schemes meet RTRS standards.
- Specify RTRS soy in public procurement, for example in animal products in public sector catering.
- Promote reduced meat and dairy consumption as part of a healthy lifestyle, and programmes to reduce food waste among households and in the farming, retail and food services sectors.

NGOs

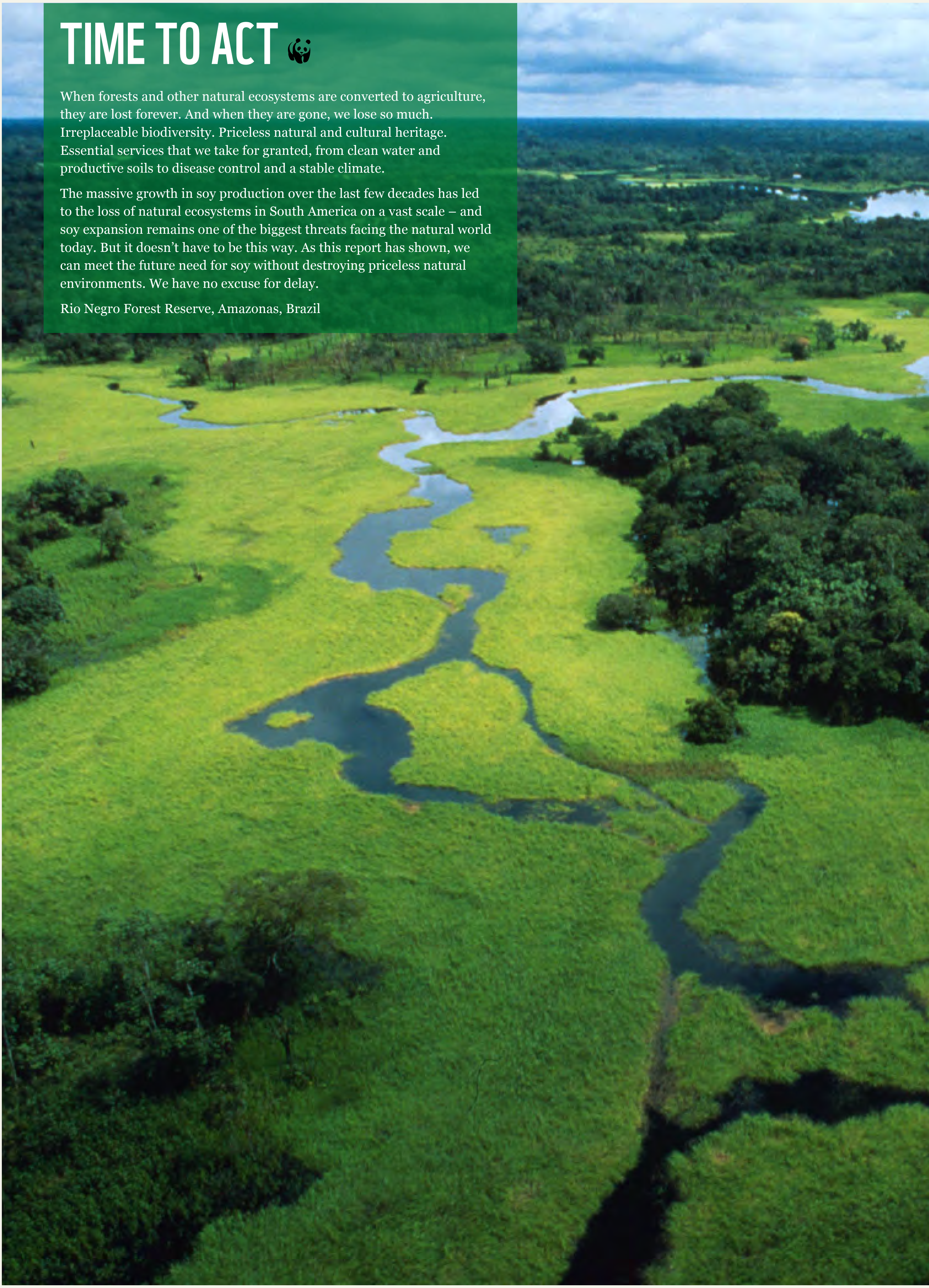
- Join RTRS and get involved in multi-stakeholder dialogues to improve soy production.
- Give input into consultations around standards and specific certification processes.
- Participate in developing tools for improving environmental and social standards and protecting natural ecosystems, for example around mapping areas of HCV or ecosystem services valuation.
- Raise awareness of issues surrounding soy and possible solutions.



TIME TO ACT

When forests and other natural ecosystems are converted to agriculture, they are lost forever. And when they are gone, we lose so much. Irreplaceable biodiversity. Priceless natural and cultural heritage. Essential services that we take for granted, from clean water and productive soils to disease control and a stable climate.

The massive growth in soy production over the last few decades has led to the loss of natural ecosystems in South America on a vast scale – and soy expansion remains one of the biggest threats facing the natural world today. But it doesn't have to be this way. As this report has shown, we can meet the future need for soy without destroying priceless natural environments. We have no excuse for delay.



Rio Negro Forest Reserve, Amazonas, Brazil

REFERENCES

Abril, A., Bartfield, P. and E.H. Bucher. 2005. The effect of fire and overgrazing disturbed on soil carbon balance in the Dry Chaco forest. *Forest Ecology and Management* 206: 399-405.

Agralytica. 2012. *Connections 2012 Soybean Market Scan*. Alexandria, VA, USA.

Aizen, M., Garibaldi, L.A. and M. Dondo. 2009. Expansión de la soja y diversidad de la agricultura argentina. *Ecología Austral* 19: 45-54.

Anon. 2012. *Soy Moratorium: Mapping and Monitoring Soybean in the Amazon biome – 5th year*. http://www.greenpeace.org/brasil/Global/brasil/documentos/2012/Monitoring%20report_Soya%20Moratorium%202012.pdf, accessed 13 October 2013.

Anon. 2013. Ley de Bosques: 5 años con pocos advances, Greenpeace, Fundación Ambiente y Recursos Naturales and Fundación Vida Silvestre, Buenos Aires, Argentina.

ANAPO (La Asociación de Productores de Oleaginosas y Trigo). 2012. http://www.anapobolivia.org.

Argentine Ministry of Agriculture (Argentina Líder Agroalimentario). 2011. Plan Estratégico Agroalimentario y Agroindustrial Participativo y Federal 2010-2020. 64.76.123.202/site/areas/PEA2/02=Publicaciones/index.php, accessed 17 July 2013.

Arima, E.Y., Richards, P., Walker R. and M.M. Caldas. 2011. Statistical confirmation of indirect land use change in the Brazilian Amazon. *Environmental Research Letters* 6: pp 7.

Arvor, D., Penello Meirelles, M.S., Vargas, R., Skorupa, L.A., Cardoso Fidalgo, E.C., Dubreuil, V., Herlin, I. and J.P. Berroir. 2010. Monitoring land use changes around the indigenous lands of the Xingu Basin in Mato Grosso, Brazil. Geoscience and Remote Sensing Symposium (IGARSS), IEEE International, Honolulu, Hawaii.

Asner, G.P., Knapp, D.E., Broadbent, E.N., Oliveira, P.J.C, Keller, M. and J.N. Silva. 2005. Selective logging in the Amazon. *Science* 310: 480-482.

Assuncao, J., Gandour, C.C. e and R. Rocha. 2012. *Deforestation Slowdown in the Legal Amazon: Prices or Policies?* Climate Policy Initiative, Rio de Janeiro, Brazil.

Autoridad de Fiscalización Social y Control de Bosques y Tierra (ABT) 2010. *Informe Anual 2010 y Balance de la Década*. ABT: Santa Cruz.

Baldi, G. and Paruelo, J.M. 2008. Land-use and land cover dynamics in South American temperate grasslands. *Ecology and Society* 13: 6: ecologyandsociety.org/vol13/iss2/art6, accessed 10 October 2013.

Banco Mundial. 2006. *Agricultura y Desarrollo Rural en Argentina: Temas Claves*. Informe No. 32763-AR, 12 Junio 2006, Buenos Aires, Argentina.

Barona, E., Ramankutty, N., Hyman, G. and O.T. Coomes. 2010. The role of pasture and soybean in deforestation of the Brazilian Amazon. *Environmental Research Letters* 5: pp 9.

Bäse, F., Elsenbeer, H., Neill, C. and A.V. Krusche. 2012. Differences in throughfall and net precipitation between soybean and transitional tropical forest in the southern Amazon, Brazil. *Agriculture, Ecosystems and Environment* 159: 19-28.

Bickel, U. and Dros, J.M. 2003. *The Impacts of Soybean Cultivation on Brazilian Ecosystems: Three case studies*. WWF, Frankfurt, Germany.

Biofuels Digest. 2011. Argentina to reach number 3 in biodiesel production, behind Germany, US. 28 December. biofuelsdigest.com/bdigest/2011/12/28/argentina-to-reach-3-in-biodiesel-production-behind-germany-us, accessed 2 March 2013.

Boucher, D., Elias, P., Lininger, K., May-Tobin, C., Roquemore, S. and E. Saxon. 2011. *What's Driving Tropical Deforestation Today?* Union of Concerned Scientists, Washington, DC, USA.

Brannstrom, C. 2009. South America's neoliberal agricultural frontiers: places of environmental sacrifice or conservation opportunity? *Ambio* 38: 141-149.

Brown, J.C., Koeppe, M., Coles, B. and K.P. Price. 2005. Soybean production and conversion of tropical forest in the Brazilian Amazon: The case of Vilhena, Rondonia. *Ambio* 34: 462-469.

Brown-Lima, C., Cooney, M. and D. Cleary. Undated. *An Overview of the Brazil-China Soybean Trade and its Strategic Implications for Conservation*. The Nature Conservancy, Latin America Region, Brasilia, Brazil.

Bruinsma, J. 2009. *The resource outlook to 2050: by how much do land, water and crop yields need to increase by 2050?* Paper presented at the FAO Expert Meeting, 24-26 June 2009, Rome on "How to Feed the World in 2050". Food and Agriculture Organization of the United Nations, Economic and Social Development Department, Rome, Italy.

Cabinet Office. 2008. *Food Matters: Towards a Strategy for the 21st Century*. Cabinet Office Strategy Unit, London, UK.

Castro, E.A. and Kauffman, J.B. 1998. Ecosystem structure in the Brazilian Cerrado: a vegetation gradient of aboveground biomass, root mass and consumption by fire. *Journal of Tropical Ecology* 14: 263-283.

Catacora, G. Undated. Soya in Bolivia: Dependency and the production of oleaginous crops. In: J. Rulli (Coordinator) *United Soy Republics. The Truth About Soy Production in South America*. GRR Grupo de Reflexión Rural, Buenos Aires, Argentina.

Céleres. 2012. *Biotechnology Reporting*. 14 December 2012. Brazil.

CNA. 1988. Censo Nacional Agropecuario 1988. 64.76.123.202/site/agricultura/analisis_economico/02-CNA_2002/_archivos/000001-Resultados%20Definitivos/000002_Parte%20II.pdf.

CNA. 2002. Censo Nacional Agropecuario 2002. 64.76.123.202/site/agricultura/analisis_economico/02-CNA_2002/_archivos/000001-Resultados%20Definitivos/000002_Parte%20II.pdf.

Conner, R., Seidl, A., Van Tassell, L. and N. Wilkins. 2001. *United States Grasslands and Related Resources: An Economic and Biological Trends Assessment*. Texas A&M Institute of Renewable Natural Resources. irnr.tamu.edu/publications/research-reports/2001/united-states-grasslands-and-related-resources-an-economic-and-biological-trends-assessment.

Conservation International. 2012. *Cerrado*.

conservation.org/where/priority_areas/hotspots/south_america/Cerrado/Pages/default.aspx, accessed 26 July 2012.

Dal Pont, S. and Longo, L. 2007. Transformaciones productivas en la Provincia de Chaco: avance de la frontera agrícola e implicancias sobre la estructura agraria local. *IADE Revista Realidad Económica*, 228: 113-133.

Di Bitetti, M.S., Placci, G. and L.A. Dietz. 2003. *A Biodiversity Vision for the Upper Paraná Atlantic Forest Ecoregion: Designing a Biodiversity Conservation Landscape and Setting Priorities for Conservation Action*. WWF and Fundacion Vida Silvestre, Buenos Aires.

Dirección de Bosques. 2008. *Pérdida de Bosque Nativo en el Norte de Argentina: Diciembre 2007 – Octubre 2008*. Unidad de Manejo del Sistema de Evaluación Forestal, Buenos Aires, Argentina.

Dros, J. 2004. *Managing the Soy Boom: Two Scenarios of Soy Production Expansion in South America*. AIDE Environment for WWF, Amsterdam, Netherlands.

Durigan, G. and Ratter, J.A. 2006. Successional changes in Cerrado and Cerrado/forest ecotonal vegetation in western São Paulo state, Brazil, 1962–2000. *Edinburgh Journal of Botany* 63: 119–130.

Durigan, G., Ferreira de Siqueira, S. and G.A.D. Franco. 2007. Threats to the Cerrado remnants of the State of São Paulo, Brazil. *Scienta Agricola* (Piracicaba, Brazil) 64: 355-363.

Dutch Soy Coalition. 2006. *Soy: Big Business, Big Responsibility* Amsterdam, Netherlands.

Dutch Soy Coalition. 2012. *Soy Barometer 2012*. Dutch Soy Coalition, Amsterdam, Netherlands.

EC. 2011. *Oilseeds and Protein Crops in the EU*. European Commission, Directorate-General for Agriculture and Rural Development, Unit C5, October 2011, Brussels, Belgium.

Endres, Joseph G. 2001. *Soy protein products : characteristics, nutritional aspects, and utilization,* pp 2-3. AOCS Press, Champagne, IL, USA.

Environmental Working Group, 2013. Going, Going, Gone. Millions of Acres of Wetlands and Fragile Lands Go Under the Plow. http://static.ewg.org/pdf/going_gone_cropland_hotspots_final.pdf

EU. 2012. *EU Oilseeds Trade 2011/12*. AGRI C 5 Management Committee for the Common Organisation of Agricultural Markets, 20 December 2012, Brussels, Belgium.

FAO. 2006. *Livestock's Long Shadow*. FAO, Rome, Italy.

FAO. 2007. *Future Expansion of Soybean 2005-2014*. FAO Regional Office for Latin America and the Caribbean, Rome, Italy.

FAOSTAT. 2013. *FAO Statistics Yearbook 2013*. FAO, Rome, Italy.

Fearnside, P.M. 2008. The roles and movements of actors in the deforestation of Brazilian Amazonia. *Ecology and Society* 13 (1): 23

Foley, J.A. 2011. Can we feed the world and save the planet? *Scientific American*, November 2011, 60-65.

Foley, J.A., Asner, G.P., M.H. Costa et al. 2007. Amazonia revealed: forest degradation and loss of ecosystem goods and services in the Amazon Basin. *Frontiers in Ecology* 5: 25-32.

Flachowsky, G., S. Dänicke, P. Lebzien and U. Meyer. 2008. Mehr Milch und Fleisch für die Welt … wie ist das zu schaffen? *Forschungs Report* 2/2008: 14-17.

Freitas, S.R., Hawbaker, T.J. and J.P. Metzger. 2010. Effects of roads, topography, and land-use on forest cover dynamics in the Brazilian Atlantic Forest. *Forest Ecology and Management* 259: 410-417.

Fundação SOS Mata Atlântica. 2012. Atlas dos Remanescentes Florestais da Mata Atlântica, Instituto Nacional de Pesquisas Espaciais, Fundação SOS Mata Atlântica, downloaded from http://mapas.sosma.org.br/)

Fundación Amigos de la Naturaleza. (FAN). 2013. Bolivia. Elaboración de un portafolio de herramientas cartográficas sobre la expansión de la frontera agropecuaria en las tierras bajas de Bolivia. Informe Final. Documento no publicado.

Fundação SOS Mata Atlântica. 2012. Atlas dos Remanescentes Florestais da Mata Atlântica. Instituto Nacional de Pesquisas Espaciais, Fundação SOS Mata Atlântica. http://mapas.sosma.org.br.

Fundación Amigos de la Naturaleza. (FAN). 2013. Bolivia. Elaboración de un portafolio de herramientas cartográficas sobre la expansión de la frontera agropecuaria en las tierras bajas de Bolivia. Informe Final. Documento no publicado.

Galindo-Leal, C. and de Gusmão Câmara, I. (eds) 2003. *The Atlantic Forest of South America: Biodiversity Status, Threats and Outlook*. Island Press, Washington, DC, USA.

García-López, G.A. and Arizpe, N. 2010. Participatory processes in the soy conflicts in Paraguay and Argentina. *Ecological Economics* 70: 196-206.

Gasparri, N.I., Grau, H.R. and Manghi, E. 2008. Carbon pools and emissions from deforestation in extra-tropical forests of Northern Argentina between 1900 and 2005. *Ecosystems* 11: 1247-1262

Gasparri, N.I. and Grau, H.R. 2009. Deforestation and fragmentation of Chaco dry forest in NW Argentina (1972-2007). *Forest Ecology and Management* 258: 913-921.

GMO Compass. 2010. GMO Crop Growing: Growing around the world. http://www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/342.genetically_modified_soybean_global_area_under_cultivation.html, accessed 12 October 2013.

Goldfarb, L. and A. Zoomers. 2013. The drivers behind the rapid expansion of genetically modified soya production in the Chaco region of Argentina. In: Zhen Fang (ed) *Biofuels, Economy, Environment and Sustainability*, INTECH Chapter 3.

GRAIN. 2012. Grain releases data set with over 400 global land grabs. grain.org/article/entries/4479-grain-releases-data-set-with-over-400-global-land-grabs, accessed 25 March 2012.

GRAIN. 2013. Leaked ProSAVANA Master Plan confirms worst fears. grain.org/article/entries/4703-leaked-prosavana-master-plan-confirms-worst-fears, accessed 10 August 2013.

Greenpeace. 2006. *Eating up the Amazon*. Greenpeace International, Amsterdam, Netherlands.

Greenpeace, FARN and FVSA. 2013. Ley de Bosques: 5 años con pocos avances, Buenos Aires, Argentina.

Grethe, H., Dembélé, A. and N. Duman. 2011. *How to Feed the World's Growing Billions: Understanding FAO World Food Projections and Their Implications*. WWF-Germany and Heinrich Böll Foundation, Berlin, Germany.

Guereña, A. 2013. *The Soy Mirage: The Limits of Corporate Responsibility: The Case of the Company Desarrolo Agrícola del Paraguay*. Oxfam Research Reports, Oxford, UK.

Guyra Paraguay, 2012. Monitoreo Ambiental del Chaco Sudamericano. www.guyra.org.pa

Hart Energy. 2013. Global biofuels outlook to 2025. globalbiofuelscenter.com/spotlight.aspx?ID=32#KeyFindings, accessed 27 February 2013.

Hecht, S.B. 2005. Soybeans, development and conservation on the Amazon frontier. *Development and Change* 36: 375-404.

Hecht, S.B. 2012. From eco-catastrophe to zero deforestation? Interdisciplinarities, politics, environmentalisms and reduced clearing in Amazonia. *Environmental Conservation* 39: 4-19.

Hobbs, J. 2012. Paraguay's destructive soy boom. *The New York Times* July 2 2012. http://www.nytimes.com/2012/07/03/opinion/paraguays-destructive-soy-boom.html?_r=0, accessed 12 October 2013.

Hoekstra, A.Y. and Chapagain, A.K. 2006. Water footprints of nations: Water use by people as a function of their consumption pattern. *Water Resources Management*, DOI 10.1007/s11269-006-9039-x.

Hoste, R. and Bolhuis, J. 2010. *Sojaverbruik in Nederland*. LEI-rapport 2010-059. LEI, Wageningen, Netherlands.

Huang, C., Kim, S., Altstatt, A. et al. 2007. Rapid loss of Paraguay's Atlantic forest and the status of protected areas – a Landsat assessment. *Remote Sensing of Environment* 106: 460-466.

Huang, C., Kim, S., Song, K. et al. 2009. Assessment of Paraguay's forest change using Landsat observations. *Global and Planetary Change* 67: 1-12.

Hutchison, S. and Aquino, L. 2011. *Making a Pact to Tackle Deforestation in Paraguay*. WWF-UK, Godalming, UK.

IBCE. 2011. Comercio Exterior in *Bolivia: Desarrollo del Sector Oleaginoso 1980-2010*, Newsletter Nº 193, IBCE.

IME (Institute of Mechanical Engineers). 2013. *Global Food: Waste Not Want Not*. IME, London, UK.

ISTA Mielke. 2012. *Oil World Annual 2011*. ISTA Mielke, Hamburg, Germany.

Izquierdo, A., de Angelo, C.D. and T.M. Aide. 2008. Thirty years of human demography and land-use change in the Atlantic Forest of Misiones, Argentina: an evaluation of the forest transition model. *Ecology and Society* 13 (2): 3

Izquierdo, A.E., Grau, H.R. and T.M. Aide. 2011. Implications of rural-urban migration for conservation of the Atlantic Forest and urban growth in Misiones, Argentina (1970-2030). *Ambio* 40: 298-309.

Jepson, W. 2005. A disappearing biome? Reconsidering land cover change in the Brazilian savanna. *The Geographical Journal* 171: 99-111.

Jepson, W., Brannstrom, C. and A. Filippi. 2010. Access regimes and regional land change in the Brazilian Cerrado, 1972–2002. *Annals of the Association of American Geographers* 100: 87-111.

Johnston, C. 2012. Cropland Expansion into Prairie Pothole Wetlands, 2001-2010. In: A Glaser (ed) *America's Grasslands Conference: Status, Threats, and Opportunities*. Proceedings of the 1st Biennial Conference on the Conservation of America's Grasslands. 15-17 August 2011, Sioux Falls, SD, USA. National Wildlife Federation and South Dakota State University, Washington, DC, USA and Brookings, SD, USA.

Joseph, K. 2012. *Argentina Biofuels Annual 2012*. Global Agricultural Information Network, USDA Foreign Agricultural Service, Washington, DC.

Kaimowitz, D. and Smith, J. 2001. Soybean technology and the loss of natural vegetation in Brazil and Bolivia. In: A Angelstam and D Kaimowitz (eds), *Agricultural Technologies and Tropical Deforestation*, CABI International, Wallingford, UK.

Killeen, T.J. 2007. *A Perfect Storm in the Amazon Wilderness: Development and Conservation in the Context of the Initiative for the Integration of the Regional Infrastructure of South America (IIRSA)*. Conservation International, Washington, DC, USA.

Killeen, Timothy J., Veronica Calderon, Liliana Soria, Belem Quezada, Marc K. Steininger, Grady Harper, Luis A. Solórzano, and Compton J. Tucker. (2007) Thirty years of land-cover change in Bolivia. AMBIO, 36: 600-606.

Killeen, T.J., Chavez, E., Peña-Claros, E., Toledo, M., Arroyo, L., Caballero, J., Correa, L., Guillén, R., Quevedo, R., Saldias, M., Soria, L., Uslar, Y., Vargas, I. and M. Steininger. 2007a. The Chiquitano Dry Forest, the transition between humid and dry forest in eastern lowland Bolivia. In: RT Pennington, GP Lewis and JA Ratter (eds), *Neotropical Savannas and Seasonally Dry Forests: Plant Diversity, Biogeography, and Conservation*, pp 213-233. Taylor & Francis CRC Press, The Systematics Association, London, UK.

Killeen, T.J., Guerra, A., Calzada, M., Correa, L., Calderon, V., Soria, L., Quezada, B. and M.K. Steininger. 2008. Total historical land-use change in eastern Bolivia: Who, where, when, and how much? *Ecology and Society* 13: 36; ecologyandsociety.org/vol13/iss1/art36.

Kirby, K.R., Laurance, W.F., Albernaz, A.K. et al. 2006. The future of deforestation in the Brazilian Amazon. *Futures* 38: 432-453.

Klein, H.S. 1982. *Historia General de Bolivia*. Libr. Ed. Juventud, La Paz, Bolivia.

Klink, C. and Machado, R.B. 2005. Conservation of the Brazilian Cerrado, *Conservation Biology* 19: 3.

KPMG, 2013. *Sustainable Insight. A roadmap to responsible soy. Approaches to increase certification and reduce risk.*

Kruglianskas, I. Undated. Soy production in South America: Key issues and challenges. ProForest, Oxford, UK.

Laborde, D. 2011. *Assessing the Land Use Change Consequences of European Biofuel Policies*. International Food Policy Institute for the ATLASS Consortium, Washington, DC.

Lahl, U. 2010. *An Analysis of Iluc and Biofuels Regional Quantification of Climate Relevant Land Use Change and Options for Combating It*. BZL, Oyten, Germany.

Lambin, E.F. and Meyfriodt, P. 2011. Global land use change, economic globalisation and the looming land scarcity. *Proceedings of the National Academy of Sciences* 108: 3465-3472.

Lapola, D., Schaldach, R., Alcamo, J., Bondeaud, A., Kocha, J., Koelkinga, C. and J.A. Priesse. 2010. Indirect land-use changes can overcome carbon savings from biofuels in Brazil. *PNAS*, 107: 8 pnas.org/cgi/doi/10.1073/pnas.0907318107.

Lee, B., Preston F., Kooroshy, J., Bailey, R. and G. Lahn. 2012. *Resources Future*. Chatham House, London, UK.

Mackey, L. 2011. Legitimating foreignization in Bolivia: Brazilian agriculture and the relations of conflict and consent in Santa Cruz, Bolivia. Paper presented at the International Conference on Global Land Grabbing, 6-8 April 2011, University of Sussex, UK.

Malhi, Y., Roberts, J.T., Betts, R.A., Killeen, T.J., Li, W. and C.A. Nobre. 2007. Climate change, deforestation, and the fate of the Amazon. *Science* 319: 169-172.

Margules, C.R. and Pressey, R.L. 2000. Systematic conservation planning. *Nature* 405: 243-253.

Martin, J. 2010. The billion gallon challenge. Union of Concerned Scientists, Cambridge, MA, USA.

Martins, H., Fonseca, A., Souza Jr., C., Sales, M., and A. Veríssimo. 2013. Boletim Transparência Florestal da Amazônia Legal (Julho de 2013) (p. 13). Belém: Imazon. http://www.imazon.org.br/publicacoes/transparencia-florestal/transparencia-florestal-amazonia-legal/boletim-do-desmatamento-sad-julho-de-2013.

Masuda, T. and Goldsmith, P.D. 2009. World Soybean production: area harvested, yield, and long-term projections. *International Food and Agribusiness Management Review* 12: 143-161.

Mattsson, B., Cederberg, C. and L. Blix. 2000. Agricultural land use in life cycle assessment (LCA): case studies of three vegetable oil crops. *Journal of Cleaner Production* 8: 283-292.

McLaughlin, D.W. 2012. Land, food and biodiversity. *Conservation Biology* 25:1117-1120.

MercoPress. 2012. Soybeans becomes Uruguay's main export item, estimated at 1.1bn in 2012. May 7th 2012. en.mercopress.com/2012/05/07/soybeans-becomes-uruguay-s-main-export-item-estimated-at-1.1bn-in-2012, accessed 24 March 2013.

Mittermeier, R.A., da Fonseca, G.A.B., Rylands, A.B. and C.G. Mittermeier. 1999. La Mata Atlántica. In: RA Mittermeier, N Myers, P Robles Gil and CG Mittermeier (eds) *Biodiversidad Amenazada: Las Ecoregiones Terrestres Prioritarias del Mundo*, pp 136-147. Conservation International – CEMEX, México.

MMA. 2010. *Plano de Ação para Prevenção e Controle do Desmatamento e das Queimadas no Cerrado*, Revised Version, September 2010.

Mondal, A. 2011. Soy production in India: key issues and challenges. Presentation at "Soy Sustainability and Challenges" Conference, 11 January 2011, London, UK.

Moreira, C.F. 2009. Sustainability of shaded organic and conventional coffee systems. Phd thesis on Agroecology. University of São Paulo, Piracicaba, Brazil, pp 145.

Morellato, L.P.C. and Haddad, C.F.B. 2000. Introduction: the Brazilian Atlantic Forest. *Biotropica* 32: 786–792.

Morton, D.C., DeFries, R.S., Shimabukuro, Y.E., Anderson, L.O., Arai, E., del Bon Espirito-Santo, F., Freitas, R. and J. Morisette. 2006. Cropland expansion changes deforestation dynamics in the southern Brazilian Amazon. *Proceedings of the National Academy of Sciences* 103: 14637-14641.

Narbondo, I.Y. and G. Oyhantçabal. 2011. *Ambiente y sojización en Uruguay: una aproximación a la valorización del impacto en el recurso suelo*, Montevideo, Uruguay.

Nelson, G.C., Rosegrant, M.W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M. and D. Lee. 2009. *Climate Change: Impact on Agriculture and Costs of Adaptation*. International Food Policy Research Institute, Washington, DC, USA.

Nepstad, D.C., Veríssimo, A., Alencar, A., et al. 1999. Large-scale impoverishment of Amazonian forests by logging and fire. *Nature* 398: 505-508.

Noleppa, S. 2012. *Climate Change on Your Plate*. WWF-Germany, Berlin, Germany.

OAS. 2009. Evaluación regional del impacto en la sostenibilidad de la cadena productiva de lasoja: Argentina - Paraguay - Uruguay. Organization of American States (OAS) Sustainable Development Department (official records OEA/Ser.D/XXIII.7). ISBN: 978-0-8270-5510-0. oas.org/dsd/environmentlaw/trade/Soja/Librosoja.pdf , accessed 17 July 2013.

Pacheco, P. 2012. *Soybean and Oil Palm Expansion in South America: A Review of Main Trends and Implications. Working Paper 90.* CIFOR, Bogor, Indonesia.

Palma, D.C. de Andrade. 2011. Agrotóxicos em leite humano de mães residentes em Lucas do Rio Verde – MT. University of Mato Grosso, Cuiabá, Brazil.

Paruelo, J.M., Guerschman, J.P., Piñeiro, G., Jobbágy, E.G., Verón, S.R., Baldi, G. and S. Baeza. 2006. Cambios en el uso de la tierra en Argentina y Uruguay: marcos conceptuales para su análisis. *Agrociencia* 47: 47-61.

Paruelo, J.M., Veróna, S.R., Volante, J.N., Seghezzo, L., Vallejo, M., Aguiar, S., Amdan, L., Baldassini, P., Ciuffolif, L., Huykman, N., Davanzo, B., González, E., Landesmann J. and D. Picardi. 2011. Elementos conceptuales y metodológicos para la Evaluación de Impactos Ambientales Acumulativos (EIAAc) en bosques subtropicales. El caso del este de Salta, Argentina. *Ecología Austral* 21: 163-178.

Pengue, W. 2005. Transgenic crops in Argentina: the ecological and social debt. *Bulletin of Science, Technology and Society* 25: 314-322.

Phillips, O.L., Aragão, E.O.C., Lewis, S.L. et al. 2009. Drought sensitivity of the Amazon Rainforest. *Science* 323: 1344-1347.

Popkin, B. 2009. *The World is Fat: The Fads, Trends, Policies, and Products That Are Fattening the Human Race, Avery-Penguin, New York, NY, USA*.

Rathman, R., Szklo, A. and R. Schaeffer. 2012. Targets and results of the Brazilian Biodiesel Incentive Program – Has it reached the Promised Land? *Applied Energy* 97: 91-100.

REDAF (Red Agroforestal Chaco Argentina). 2013. *Conflictos sobre tenencia de tierra y ambientales en la región del Chaco argentino*. REDAF, Reconquista, Argentina.

Redo, D., Millington, A.C. and D. Hindery. 2011. Deforestation dynamics and policy changes in Bolivia's post-neoliberal era. *Land Use Policy* 28: 227-241.

Reymondin, L, Jarvis,A, Perez-UribeA, , Touval, J, Argote, K, Rebetez, J, Guevara, E, Mulligan, M, (2012), A methodology for near real-time monitoring of habitat change at continental scales using MODIS-NDVI and TRMM. in press.

Ribeiro, S.C., Lutz Fehrmann, L., Soares, C.P.B. et al. 2011. Above- and below-ground biomass in a Brazilian Cerrado. *Forest Ecology and Management* 262: 491-499.

Reymondin, L., Jarvis, A., Perez-Uribe, A., Touval, J., Argote, K., Rebetez, J., Guevara, E. and M. Mulligan. 2012. A methodology for near real-time monitoring of habitat change at continental scales using MODIS-NDVI and TRMM. In press.

Ribero, M.C., Metzger, J.P., Martensen, A.C., Ponzoni, F.J. and M.M. Hirota. 2009. The Brazilian Atlantic Forest: how much is left, and how is the remaining forest distributed? Implications for conservation. *Biological Conservation* 142: 1141-1153.

Richards, P.D. 2011. Soy, cotton and the final Atlantic Forest frontier. *The Professional Geographer* 63: 343-363.

Rios, M., Zaldua, N. and S. Cupeiro. 2010. *Evaluación participativa de plaguicidas en el sitio RAMSAR, Parque Nacional Esteros de Farrapos e Islas del* Río Uruguay. Fundacion Vida Silvetre, EGP and UICN, Montevideo, Uruguay.

RIVM (Rijksinstituut voor Volksgezondheid en Milieu) 2011. *Nederlands Voedingstoffenbestand (NEVO-online). http://www.rivm.nl/dsresource?objectid=rivmp:216692&type=org&disposition=inline&ns_nc=1,* accessed 13 October 2013.

Rodrigues, R.R., Lima, R.A.F., Gandolfi, S. and A.G. Nave. 2009. On the restoration of high diversity forests: 30 years of experience in the Brazilian Atlantic Forest. *Biological Conservation* 142: 1242-1251.

Romero, S. 2012. Vast tracts of Paraguay forest being replaced by ranches. *The New York Times*, 24 March 2012.

RTRS. 2010. RTRS Standard for Responsible Soy Production Version 1.0. Roundtable on Sustainable Soy Association, Buenos Aires, Argentina.

RTRS. 2012. India Soy Forum case study. responsiblesoy.org/index.php?option=com_content&view=article&id=396&Itemid=198&lang=en, accessed 18 July 2013.

Rudorff, B.F.T., Adami, M., Alves Aguiar, D., Alves Moreira, M., Pupin Mello, M., Fabiani, L., Furlan Amaral, D. and B. Machado Pires. 2011. The Soy Moratorium in the Amazon Biome Monitored by Remote Sensing Images. *Remote Sensing* 3: 185-202.

Sawyer, D. 2008. Climate change, biofuels and eco-social impacts in the Brazilian Amazon and Cerrado. *Philosophical Transactions of the Royal Society* B 363: 1747–1752.

Schneider, M. 2011. Feeding China's Pigs: Implications for the Environment, China's Smallholder Farmers and Food Security. Institute for Agriculture and Trade Policy. http://www.iatp.org/documents/feeding-china%E2%80%99s-pigs-implications-for-the-environment-china%E2%80%99s-smallholder-farmers-and-food#sthash.Ol5FXr6J.dpuf, accessed 11 October 2013.

Schrag, A.M. and Olimb, S. 2012. *Threats assessment for the Northern Great Plains Ecoregion*. WWF-US, Bozeman, Montana, USA.

Secretaría de Ambiente y Desarrollo Sustentable, Ministerio de Salud y Ambiente de la Nacion. 2005. Primer Inventario Nacional de Bosques Nativos. Proyecto Bosques Nativos y Areas Protegidas BIRF 4085-AR, Informe Regional. Parque Chaqueño Dirección de Bosques. http://www.ambiente.gov.ar/archivos/web/UMSEF/File/PINBN/PCH/pch_informe_pinbn.pdf

Servicio Nacional de Áreas Protegidas – SENAP (2013). Deforestación y regeneración de bosques en Bolivia y en sus áreas protegidas nacionales para los periodos 1990-2000 y 2000-2010. Ed. Servicio Nacional de Áreas Protegidas, Museo de Historia Natural Noel Kempff Mercado y Conservación Internacional - Bolivia. La Paz, Bolivia.

Semino, S., Rulli, J. and L. Joensen. 2006. *Paraguay Sojero: Soy Expansion and its Violent Attack on Local and Indigenous Communities in Paraguay. Repression and Resistance*. Grupo de Reflexión Rural, Argentina.

Shurtleff, W. and Aoyagi, A. 2007. *History of World Soybean Production and Trade - Part 2*. soyinfocenter.com/HSS/production_and_trade2.php. Soyinfo Center, Lafayette, CA, USA.

Singer, S. (ed) 2011. *The Energy Report: 100% Renewable Energy by 2050*. WWF International, Gland, Switzerland.

Soares Domingues, M. and Bermann, C. 2012. The arc of deforestation in the Amazon: the livestock to soy. *Ecology and Society* 15:

Soares-Filho B.S., Nepstad, D.C., Curran, L. et al. 2006. Modelling conservation in the Amazon basin. *Nature* 440: 520-523.

Southworth, J., Marsik, M., Qiu, Y. et al. 2011. Roads as drivers of change: trajectories across the tri-national frontier in MAP, the southwestern Amazon. *Remote Sensing* 3: 1047-1066.

Steininger, M.K., Tucker, C.J., Ersts, P., Killeen, T.J., Villegas, Z. and S.B. Hechtl. 2002. Clearance and fragmentation of tropical deciduous forests in the Tierras Bajas, Santa Cruz, Bolivia. *Conservation Biology* 15: 856-866.

Stuart, T. 2009. *Waste: Uncovering the Global Food Scandal*. Penguin, London, UK.

Tabarelli, M., Paulo Pinto, L., Silva, J.M.C., Hirota, M. and L. Bedê. 2004. Challenges and opportunities for biodiversity conservation in the Brazilian Atlantic Forest. *Conservation Biology* 19, 695-700.

Taylor, R. (ed) 2011. *WWF Living Forests Report*. Chapter 1: Forests for a Living Planet. wwf.panda.org/livingforests, WWF, Gland, Switzerland.

Taylor, R. (ed) 2011a. *WWF Living Forests Report*. Chapter 3: Forests and Climate: Redd+ at a crossroads. wwf.panda.org/livingforests, WWF, Gland, Switzerland.

Teixeira, A.M.G., Soares-Filho, B.S., Fretas, S.R. and J.P. Metzger. 2008. Modelling landscape dynamics in an Atlantic Rainforest region: implications for conservation. *Forest Ecology and Management* 257: 1219-1230.

Tollefson, J. 2011. Changes to legislation could undermine authorities' power to halt deforestation. *Nature* 476, 259-260.

Townshend, J.R.G., Carroll, M., Dimiceli, C., Sohlberg, R., Hansen, M. and R. DeFries. 2011. Vegetation Continuous Fields MOD44B, 2010 Percent Tree Cover, Collection 5, University of Maryland, College Park, MD, USA.

UMSEF. 2007. Monitoreo de Bosque Nativo. Período 1998-2002. Periodo 2002-006 (Datos preliminares). Unidad de Manejo del Sistema de Evaluación Forestal (UMSEF), Dirección de Bosques, Secretaria de Ambiente y desarrollo Sustentable de la Nación. UMSEF, Buenos Aires, Argentina.

UMSEF. 2008. Pérdida de Bosque Nativo en el Norte de Argentina. Diciembre 2007-Octubre 2008. Unidad de Manejo del Sistema de Evaluación Forestal (UMSEF), Dirección de Bosques, Secretaria de Ambiente y desarrollo Sustentable de la Nación. UMSEF, Buenos Aires, Argentina.

UMSEF. 2012. Monitoreo de la superficie de bosque nativo de la República Argentina. Período 2006-2011. Unidad de Manejo del Sistema de Evaluación Forestal (UMSEF), Dirección de Bosques, Secretaria de Ambiente y desarrollo Sustentable de la Nación. UMSEF, Buenos Aires, Argentina.

United Soybean Board. 2008. *Food and Fuel: Meeting the Challenges of Feeding the World and Creating Renewable Fuels*. United Soybean Board, Chesterfield, MO, USA.

United Soybean Board Market View Database. 2012. Soybean Oil Consumption 2007/2008. usb.adayana.com:8080/usb/jsp/login.jsp, accessed 27 February 2013.

USDA. 2012. *USDA Agricultural Projections to 2021*. Office of the Chief Economist, World Agricultural Outlook Board, US Department of Agriculture. Prepared by the Interagency Agricultural Projections Committee. Long-term Projections Report OCE-2012-1. USDA, Washington, DC, USA.

USDA-FSA. Undated (US Department of Agriculture, Farm Service Agency). Conservation Programs. apfo.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp-st, accessed 18 July 2013.

USDA (United States Department of Agriculture). 2013. Foreign Agricultural Service, Circular Series. Oilseeds 13-01, January 2013 (http://www.fas.usda.gov/oilseeds/Current/).

USEA (United States Energy Administration). 2013. eia.gov/biofuels/issuestrends/#3, accessed 27 February 2012.

Van Gelder, J.W. and Kuepper, B. 2012. *Verdeling van de economische waarde van de mondiale sojateelt: Een onderzoeksrapport voor Milieudefensie*. Profundo, Amsterdam, Netherlands.

J.N. Volante, D. Alcaraz-Segura, M.J. Mosciaro, E.F. Viglizzo, J.M. Paruelo, 2012. Ecosystem functional changes associated with land clearing in NW Argentina. *Agriculture, Ecosystems and Environment* 154: 12-22.

Vides-Almonacid, R. and Justiniano, H. Ecological integrity and sustainable development in the Chiquitano Dry Forest, Bolivia. 2011. In: M Patry, R Horn and S Haraguchi (eds.) *Adapting to Change: The State of Conservation of World Heritage Forests in 2011*. World Heritage Paper number 30. UNESCO, Paris, France, pp 91-95.

von Witzke, H., Noleppa, S. and I. Zhirkova. 2011. *Fleisch frisst Land: Ernährung, Fleischkonsum, Flächenverbrauch*. WWF-Germany, Berlin, Germany.

Wassenaar, T., Gerber, P., Verburg, P.H. et al. 2007. Projecting land use changes in the Neotropics: the geography of pasture expansion into forest. *Global Environmental Change* 17: 86-104.

Weinhold, D., Killick, E. and E. Reis. 2011. Soybeans, poverty and inequality in the Brazilian Amazon. Working paper from the London School of Economics, London, UK.

Wright, C.K. and Wimberly, M.C. 2013. Recent land use change in the Western Corn Belt threatens grasslands and wetlands. *PNAS Early Edition*. pnas.org/cgi/doi/10.1073/pnas.1215404110.

WWF. 2012. *The 2050 Criteria: Guide to Responsible Investment in Agricultural, Forest and Seafood Commodities*. WWF, Washington, DC, USA.

WWF. 2013. *WWF Guide to Building REDD+ Strategies: A toolkit for REDD+ Practitioners Around the Globe*. WWF-FCII, Washington, DC, USA.

WWF-Bolivia, 2013. *Elaboración de una Herramienta Cartográfica sobre la Expansión de la Frontera Agropecuaria en las Tierras Bajas de Yungas de Bolivia*. WWF-Bolivia, Santa Cruz, Bolivia.

WWF-Brazil. 2012. *Production and Exportation of Brazilian Soy and the Cerrado 2001-2010*. WWF-Brazil, Brasilia, Brazil.

WWF-UK. 2011. *Soya and the Cerrado: Brazil's Forgotten Jewel*. WWF-UK, Godalming, UK.

Zak, M.R., Cabido, M. and J.G. Hodgson. 2004. Do subtropical seasonal forests in the Gran Chaco have a future? *Biological Conservation* 120: 589-598.

Zak, M.R., Cabido, M., Cáceres, D. and S. Díaz. 2008. What drives accelerated land cover change in central Argentina? Synergistic consequences of climatic, socioeconomic and technological factors. *Environmental Management* 42: 181-189.

Zullo, J. Jr, Silveira Pinto, H., Delgado Assad, E. and S.R. de Medeiros Evangelista. 2008. Potential economic impacts of global warming on two Brazilian commodities, according to IPCC prognostics. *Terræ* 3: 28-39.

Zurita, G.A., Rey, N., Varela, D.M., Villagra, M. and M.I. Belloq. 2006. Conversion of the Atlantic Forest into native and exotic tree plantations: Effects on bird communities from the local and regional perspectives. *Forest Ecology and Management* 235: 164-17.

The aim of this project has been to research and write a report about the global market for soy, its impact on forests and other valuable habitats and the possible solutions. The report is based on a thorough review of existing literature as well as the original research commissioned by WWF on the global soy market. A literature review was carried out initially (January 2013) using key word searches on the Web of Knowledge ('soy' and 'deforestation'; 'soy' and 'biodiversity'; 'soy' and 'social impact'; 'soy' and 'sustainability'; 'soy' and 'market'; 'soy' and 'environment'; 'soy' and 'trade'; 'soybean'; 'soybean' and 'commodity market'), which identified relevant peer-reviewed papers from 2010 to 2013. This was followed by additional literature research of peer-reviewed and grey literature, and material was substantially supplemented with information supplied by the project's Reference Group.

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