Towards sustainable soy

An assessment of opportunities and risks for soybean production based on a case study Brazil

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This study investigates opportunities for and implications of expanding soybean production in developing countries. Increasing soybean production is expected to take place mainly in Latin America. However the international community is increasingly concerned about managing the natural resources in this region. Within the Round Table of Responsible Soy (RTRS) an international dialogue has started to secure that current soybean production and its future expansion is carried out within a sustainable framework. Within the context of this RTRS the study evaluates the compliance of current soybean production in Latin American countries to the sustainability aspects based on the Brazilian case. The research shows that soybean cultivation is embedded in a complex land use system that hampers quick fixes to evolve towards more sustainable production, but also inherit interesting opportunities for the development of integrated soy-based production systems.

Deze studie analyseert de kansen voor en consequenties van uitbreiding van sojaproductie in ontwikkelingslanden. Een toename van de sojaproductie wordt met name verwacht in Latijns Amerika. De internationale gemeenschap maakt zich echter in toenemende mate zorgen over het beheer van de natuurlijke hulpbronnen in die regio. In de Rondetafel van Verantwoorde Soja (RTRS) is een internationaal overleg gestart dat zich inspant om teelt van soja en de uitbreiding ervan op duurzame wijze te laten plaatsvinden. Tegen de achtergrond van de RTRS geeft de studie inzicht in de mate waarin de huidige sojaproductie in Latijns Amerika voldoet aan duurzaamheidscriteria, aan de hand van de situatie in Brazilië. Het onderzoek laat zien dat sojateelt onderdeel is van een complex grondgebruiksysteem dat snelle ontwikkeling naar duurzame productie bemoeilijkt maar dat ook interessante mogelijkheden biedt voor de ontwikkeling van geïntegreerde op soja gebaseerde productiesystemen.

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Preface

Soy is an important agricultural commodity for the Dutch agrifood sector as a source of protein and oil soybeans with multitude uses in both human food and animal feeds and with numerous industrial applications. Soy is grown in many countries in temperate, sub-tropical and increasingly in tropical regions. Main producers include the USA, Brazil, Argentina, China and India. Over recent years soybean production has been increasing rapidly, a trend which is likely to continue. While the expansion of soybean production has many economic benefits, the international community is increasingly concerned about the potential negative environmental and social impacts in the developing countries such as loss of biodiversity and infringements of labour rights.

The Dutch government supports the Round Table on Responsible Soy in which an international dialogue has started to secure that future expansion of soybean production is carried out within a sustainable framework. As a result of the debate on a government letter reporting on the Dutch position with respect the issues discussed in the Round Table the Lower Chamber adopted several resolutions in early 2008. In one of them the Chamber requests the government for a survey of opportunities and risks of soybean production in developing countries. Agricultural Minister Verburg has promised the Lower Chamber to implement this resolution and requested Wageningen UR to provide the necessary objective information. The results have been laid down in this report.

Main authors of the study are Dr Siemen van Berkum (LEI) and Dr Prem Bindraban (PRI), who have been supported by LEI and PRI staff as well as by foreign experts from Brazil. The contributions of the latter are acknowledged in each of the respective chapters. The study at hand has benefitted from comments by the steering committee of LNV policy staff, chaired by Jan van Esch (LNV, DK). The substantive feedback of the committee is kindly acknowledged. Of course the authors remain responsible for the content of the report. Financial means for the study were provided from the DLO NAP budget 2008, administered under research programme BO Cluster International (BO-10).

Prof Dr R.B.M. Huirne
Director General LEI Wageningen UR

Summary

Introduction

The continuing expansion of global soybean production raises increasing international concern about the management of natural resources in countries where production increase takes place. This study describes and analyses the complex dynamics of land use involving soybean cultivation and explores current efforts by chain parties and governments to strengthen sustainable production. Due to this complexity, the assessment of the sustainability of soybean may not allow straightforward and firm statements. Moreover, sustainability is a comprehensive concept under continuous construction to be approved by the consent of multiple stakeholders. Therefore, this report has provided a worldwide overview of projected supply and demand, while an assessment of sustainable soybean production focuses on the specific case of Brazil only. This case shows most aspects of sustainable soy production related problems, as well as the actions taken to enhance sustainable soybean cultivation. Therefore, this case may be a good example to other countries dealing with the same issues. The assessment has been based on interviews with stakeholders to reflect their views and perceptions, mostly because hard scientific information on especially social and economic aspects appeared to be lacking.

Current situation and prospects in the production and trade of soya

The United States, Brazil and Argentina are by far the most important producing and exporting countries of soya beans, meal and oil. The area under cultivation, the production and export of the two latter countries have radically increased in recent decades. Projections indicate that the demand for soy products will further increase in China and other (South-East) Asian countries due to sustained economic growth in the coming 10 to 15 years. No expansion of soybean cultivation is expected in the United States, but increased production is expected in Brazil in particular and to a slightly lesser extent in Argentina. This will take place by increasing productivity on existing acreage and/or by expanding the acreage under cultivation. The latter will involve a shift in the arable crops and/or the exploitation of new land which has not yet been used for agricultural activities. Because demand is growing faster than the increase in supply via productivity growth, a further expansion of the acreage under cultivation is expected in the coming years. According to various studies, the soybean acreage in Brazil could increase by 7-8 million hectares to around 30 million hectares in

2020, while the acreage in Argentina could grow by 4-7 million hectares to around 19-22 million hectares. Production and exports will also increase substantially, but so will the pressure on ecologically vulnerable areas as new areas are converted into agricultural land. On the other hand, there are possibilities, particularly in Brazil, for using existing agricultural land more intensively by investing in productivity-increasing technology.

How sustainable is soya production?
Sustainability of soybean cultivation was assessed on the basis of field research in Brazil including interviews with those involved in the soya chain and on the basis of literature. The assessment follows the criteria currently being defined in the Round Table on Responsible Soy (RTRS). The RTRS acts as an international discussion platform aimed at creating support for sustainability criteria. In the RTRS, Latin American soya growers and processors, multinationals, umbrella organisations of mainly European business and industry and NGOs are represented. The aim is to reach agreement on principles and criteria in Spring 2009. The starting points are compliance with national and international laws, employment conditions, focus on the local population, responsible environmental conduct and guidelines for good agricultural practices. Criteria regarding genetic modification of soybeans have not been included in the list.

Land ownership rights
Unclear land ownership rights are a source of conflict. For example, there is a great deal of uncertainty about the usage rights of 'public land', i.e. land that has been used for decades by local people. Legislation is trying to establish rules, but effective enforcement of that legislation is proving to be difficult. The Brazilian government has been working for years on improving a land registration system, but that process is far from complete, meaning that millions of hectares in the Amazon area are still being illegally occupied and used.

Soybean cultivation and deforestation: a complex relationship
Soybeans are cultivated on land that used to be home to forests, but it is often not the first agricultural activity. The dynamics of land use is a very complex process with various players, some of whom are directly linked to deforestation while others are not. There is a clear, direct relationship between logging and deforestation. An open piece of land is then created, which is used as extensive grassland for cattle. This is later followed by arable farming, often dry rice cultivation followed by other crops including soybeans. This whole process takes around five years or more, so views are mixed regarding the direct involvement

of soya producers in deforestation. The monitoring report published by the soy moratorium, for example, states that no soybean cultivation was observed in the deforested areas, but that 'open areas' had been created with grassland, natural vegetation and sometimes rice or maize cultivation. Others point to the very strong correlation between deforestation and the expansion of soybean cultivation. It cannot therefore be concluded that soybean cultivation caused deforestation, but it does seem to be one of the main factors.

Labour

When assessing the employment conditions in the chain, the dynamics of land use are also considered. While soybean growers claim that the employment conditions comply with local legislation, others point to the indirect relationship with logging and other activities to adapt the land for arable farming which also involve soya producers when it is done on their behalf. Employment conditions can be particularly extreme when clearing land of tree stumps and other irregularities. Governments talk about 'exploitation', while NGOs describe the employment conditions as 'slavery'. On this point, too, Brazil has legislation to improve employment conditions, to which all those involved in the soy chain are committed.

Biodiversity

Loss of biodiversity is directly related to the degree of deforestation. The extent of deforestation is subject of much debate. In general, deforestation declined between 2004 and 2007, but there is a great deal of discussion about the developments in 2008 since the Brazilian research institute IMAZON started monthly measurements. Deforestation is the result of various interrelated factors, from the demand for wood to the future price of soy. Through the complex interactions between the driving forces which lead to deforestation, the loss of biodiversity cannot only be ascribed to the expansion of soybean cultivation, but it does play an important role. With the expected increase in the demand for soy, the effect of soybean cultivation on deforestation and loss of biodiversity will become more marked in the future, unless sufficient measures are taken to ensure that soybean cultivation does not encroach on ecologically vulnerable areas.

Integrated cultivation: opportunities for more sustainable production

The cultivation of soybeans as a monoculture can reduce the fertility of the soil in time because the soybeans are not fertilised with nitrogen. In addition, extensive livestock farming uses a lot of land. An ecologically promising approach to

this problem is the introduction of nitrogen fertilisation with artificial fertiliser from a non-soy crop in a crop rotation system (without ploughing). However, this cultivation technique is not applied very frequently due to the lack of economic incentives. This may change radically if the non-soy crop – for example maize – is used to feed beef cattle. This would create an integrated cultivation system including soybeans, feed grain, grass and meat. The result is an increase in the productivity of beef cattle farming, rendering it possible to achieve a closed nutrient cycle. If these possibilities are exploited with investments in increasing the productivity of grassland (by adding calcium and phosphorous), the pressure on forest and savannah areas will be reduced. The economic stimuli required for this system to fulfil its potential must come from a growing demand for meat on the domestic market and/or an improved market access to developed countries. Economic growth and abolition of trade-restrictive measures are thus the main conditions for using the potential of this production system. Naturally, strong management will be required to actually set up these integrated production systems.

A summary of the main opportunities and risks regarding economic, social and environmental aspects is presented in Table S1.

Table S.1	Opportunities and risks associated with expansion of soya production

	Opportunities	Risks
Economic	- Growing demand for soy for food and animal feed - Growing demand for soy as bio-fuel - Growing demand for meat	- Costs of more intensive use of grassland are higher than the costs of using ground with original vegetation - Reduced growth in demand resulting from declining economic growth in soy/meat importing countries - Limited opportunities for export of meat due to trade barriers or to failure to meet quality and/or sanitary requirements - High transport costs
Social	- Employment conditions correspond with international standards (incl. banning of child labour) - Better/fair remuneration - Land ownership rights are assured by introduction of land registration system	- In the case of large-scale production, labour is replaced by machines - Livelihood of native population disrupted by expansion of soya cultivation - Violation of labour laws due to poor enforcement
Environment	- Application of zero-tillage production methods - Application of a soy/grain/grassland rotation system - Application of Ecological Economic Zoning	- Loss of biodiversity resulting from expansion of soya cultivation as monoculture - Soil degradation, water pollution and loss of biodiversity as agricultural land is used more intensively - Local government is not able to manage control soya cultivation via spatial planning measures

The sustainability criteria (to be) are established through negotiations between industry and social organisations in the RTRS. The Dutch government can play an important guiding role in that process by supporting the parties involved with financial resources, knowledge and expertise. Support may also be offered to local governments in Brazil in the implementation of and compliance with labour legislation and measures related to spatial planning. More generally, the

Dutch government can play a role in helping to broaden the base towards all soybean producing and (major) importing countries aiming at solving the unsustainable elements of soy production at international level. Moreover, it is important to help create conditions under which local specific integrated production systems will become economically viable.

Samenvatting

Inleiding

Bij de voortdurende expansie van de sojaproductie neemt de internationale bezorgdheid toe over het beheer van natuurlijke bronnen in die landen waar de productie zich uitbreidt. Deze studie beschrijft en analyseert de complexe dynamiek van grondgebruik waar de sojateelt onderdeel van is en gaat in op de lopende acties van ketenpartijen en overheden om duurzame teelt te versterken. Tengevolge van deze complexiteit leidt een evaluatie van de duurzaamheid van sojaproductie niet tot eenduidige uitspraken. Daarbij is duurzaamheid een breed concept waarvan over de inhoud en reikwijdte nog geen consensus bestaat. Dit rapport biedt een overzicht van de wereldwijde productie en handel in soja, maar richt zich bij de evaluatie van duurzaamheid op de specifiek case van Brazilië. In deze case komen alle aspecten van de sojaproblematiek in relatie tot duurzaamheid aan de orde, met daarbij ook de acties gericht op verbetering van duurzame sojateelt. Hierdoor is het een goed voorbeeld voor andere landen waar dezelfde problematiek zich voordoet. De evaluatie is gebaseerd op interviews met direct betrokkenen, ook omdat 'hard bewijs' en informatie over bepaalde sociale, ecologische en economische aspecten niet voorhanden is.

Huidige situatie en vooruitzichten in de productie en handel van soja

De Verenigde Staten, Brazilië en Argentinië zijn veruit de belangrijkste producerende en exportlanden van sojabonen, schroot en olie. Teeltareaal, productie en export van de twee laatstgenoemde landen zijn de laatste decennia sterk toegenomen. Projecties geven aan dat de vraag naar sojaproducten verder zal toenemen in China en andere (Zuidoost-)Aziatische landen waar de komende 10 tot 15 jaar meer dan gemiddeld economische groei wordt verwacht. In de Verenigde Staten wordt geen uitbreiding van de sojateelt voorzien, maar wel en vooral in Brazilië en in iets mindere mate in Argentinië. Dat zal plaatsvinden via productiviteitsverhoging op bestaande arealen en door uitbreiding van het teeltareaal. Bij dat laatste gaat het dan om verschuiving binnen de akkerbouwgewassen en/of de ontginning van nieuwe gronden die eerder nog niet voor landbouwactiviteiten werden gebruikt. Omdat de vraag sneller groeit dan het aanbod via productiviteitsgroei kan toenemen, wordt een verdere uitbreiding van het teeltareaal in de komende jaren verwacht. Volgens verschillende studies zou het sojaareaal in Brazilië met wel 7-8 miljoen hectare kunnen toenemen tot circa 30 miljoen hectare in 2020, terwijl de het areaal in Argentinië met 4-7 miljoen hectare kan

groeien tot zo'n 19-22 miljoen hectare. Productie en exportopbrengsten nemen daarbij sterk toe maar ook de druk op ecologisch kwetsbare gebieden als nieuwe gebieden worden omgezet in landbouwgrond. Aan de andere kant zijn er vooral in Brazilië veel mogelijkheden om bestaande landbouwgronden intensiever te gebruiken door te investeren in productiviteitsverhogende technologie.

Hoe duurzaam is sojaproductie?
Duurzaamheid van de sojateelt is beoordeeld op basis van veldonderzoek in Brazilië inclusief interviews met betrokkenen in de sojaketen en op basis van literatuur. De beoordeling volgt de criteria zoals deze worden opgesteld in de Rondetafel voor Verantwoorde Soja (RTRS). De RTRS fungeert als internationaal discussieplatform om draagvlak te creëren voor de duurzaamheidscriteria. In de RTRS zijn Latijns Amerikaanse sojatelers en verwerkers, multinationale ondernemingen, koepelorganisaties van (voornamelijk het Europese) bedrijfsleven en NGO's vertegenwoordigd. Bedoeling is om in het voorjaar van 2009 te komen tot vaststelling van de principes en criteria. Uitgangspunten zijn naleving van (inter)ationale wetten, arbeidsvoorwaarden, aandacht voor lokale bevolking, verantwoord milieugedrag en richtlijnen voor goede landbouwpraktijken. Criteria ten aanzien van genetische modificatie van soja zijn (tot nu toe) niet opgenomen in de lijst.

Grondeigendomsrechten
Onduidelijke grondeigendomsrechten zijn een bron van conflicten. Zo is er veel onzekerheid rond de gebruiksrechten van 'publiek grond', ofwel grond dat tientallen jaren lang is gebruikt door lokale bewoners. Met wetgeving wordt getracht heldere regels op te stellen, maar een effectieve toepassing van die wetten blijkt moeilijk. De Braziliaanse overheid werkt al vele jaren aan de verbetering van een landregistratiesysteem, maar dat proces is nog verre van voltooid waardoor miljoenen hectaren in het Amazonegebied vooralsnog illegaal worden bezet en gebruikt.

Sojateelt en ontbossing: een complexe relatie
Sojateelt vindt plaats op grond waar eerder bos stond, maar is er vaak niet de eerste landbouwactiviteit. De dynamiek van het grondgebruik is een zeer complex proces met diverse spelers, waarvan sommigen wel en anderen niet direct verbonden met ontbossing. Bij het kappen van hout is een directe relatie met ontbossing duidelijk. Vervolgens ontstaat een open stuk grond dat wordt gebruikt als extensief grasland voor de rundveehouderij. Dat wordt op zijn beurt na verloop van tijd weer ingenomen door akkerbouwactiviteiten, vaak (droge) rijst-

teelt gevolgd door andere gewassen waaronder ook soja. Dit hele proces duurt zo'n vijf jaar of meer, wat ook leidt tot verschillende standpunten ten aanzien van de directe betrokkenheid van sojaproducenten bij ontbossing. Het monitoringrapport van het sojamoratorium stelt bijvoorbeeld dat er geen sojateelt is waargenomen in de ontboste gebieden maar dat er wel 'open gebieden' zijn ontstaan met daarop grasland, natuurlijke vegetatie en soms wat rijst of maïsteelt. Anderen wijzen juist weer op een hele sterke correlatie tussen ontbossing en de expansie van de sojateelt. Het kan dus niet worden geconcludeerd dat sojateelt de ontbossing veroorzaakt maar het lijkt wel een van de drijvende krachten.

Arbeid

In het beoordelen van de arbeidsvoorwaarden in de sojaketen wordt de dynamiek van het grondgebruik ook meegenomen. Waar sojatelers stellen dat arbeidsvoorwaarden voldoen aan lokale wetten, wijzen anderen op de indirecte relatie met de houtkap en andere activiteiten om de grond geschikt te maken voor akkerbouw waar ook sojaproducenten voor verantwoordelijk zouden zijn. Vooral bij het ontdoen van de grond van boomstronken en andere oneffenheden zijn de arbeidsomstandigheden soms extreem. Overheden spreken van 'uitbuiting' terwijl ngo's de arbeidsomstandigheden als 'slavernij' betitelen. Ook op dit punt is in Brazilië wetgeving van kracht om de arbeidsomstandigheden te verbeteren, waaraan ook alle betrokkenen in de sojaketen zich hebben gecommitteerd.

Biodiversiteit

Verlies van biodiversiteit is direct gerelateerd aan de mate van ontbossing. Hoe groot de mate van ontbossing is, is onderwerp van veel debat. In zijn algemeenheid is de mate van ontbossing afgenomen tussen 2004 en 2007, maar er is veel discussie over de ontwikkelingen in 2008 sinds het Braziliaanse onderzoeksinstituut IMAZON is begonnen met maandelijkse metingen. Ontbossing volgt uit diverse met elkaar samenhangende factoren, van de vraag naar hout tot de toekomstige prijs van soja. Door de complexe interacties tussen de drijvende krachten die leiden tot ontbossing, is het verlies aan biodiversiteit niet eenduidig toe te schrijven aan de expansie van de sojateelt, maar speelt ze wel een belangrijke rol. Met de verwachte toename van de vraag naar soja zal de invloed van sojateelt op ontbossing en verlies van biodiversiteit in de toekomst groter worden, tenzij maatregelen (zoals bv. het instellen van een moratorium of zgn. high conservation value areas) worden genomen die ertoe leiden dat de sojateelt niet verder uitbreidt in ecologisch kwetsbare gebieden.

Geïntegreerde teelt: kansen voor duurzame(re) productie

De teelt van soja als monocultuur kan na verloop van jaren de bodemvruchtbaarheid doen verminderen omdat sojabonen niet worden bemest met stikstof. Daarnaast zorgt extensieve veehouderij voor een groot grondbeslag. Een ecologisch veelbelovende manier om deze problemen op te lossen is de introductie van stikstofbemesting met kunstmest van een niet-sojagewas in een gewasrotatiesysteem (zonder te ploegen). Deze teelttechniek wordt echter nog niet veel toegepast omdat de economische prikkels daartoe ontbreken. Dit kan sterk veranderen als het niet-soja gewas - bijvoorbeeld maïs - als veevoer wordt gebruikt ten behoeve van de rundveehouderij voor vleesproductie. Daarmee kan een geïntegreerd teeltsysteem ontstaan met daarin soja, voergraan en vlees. Het resultaat is dat de productiviteit van de rundveehouderij toeneemt, waarbij de mogelijkheid ontstaat om een gesloten nutriëntenkringloop te realiseren. Als deze mogelijkheden worden uitgebouwd met investeringen in de verhoging van de productiviteit van de graslanden (door toevoegen van kalk en fosfor) zal de druk op bos- en savannegebieden afnemen. De economische prikkels, nodig om dit systeem kansrijk te maken, zullen moeten komen van een groeiende vraag naar vlees op de eigen binnenlandse markt en/of een verbeterde markttoegang tot ontwikkelde landen. Economische groei en afschaffing van handelsbelemmerende maatregelen zijn dus belangrijke voorwaarden om de mogelijkheden van dit productiesysteem te kunnen benutten. Uiteraard zal er een sterke sturing moeten komen om dit soort geïntegreerde productiesystemen daadwerkelijk tot stand te laten komen.

Een samenvattend overzicht van de belangrijkste kansen en risico's op economische, sociale en milieuaspecten wordt gepresenteerd in tabel S1.

Tabel S.1 **Kansen en risico's verbonden aan uitbreiding van sojaproductie**

	Kansen	**Risico's**
Economisch	- Groeiende vraag naar soja t.b.v. voedsel en veevoer - Groeiende vraag naar soja als biobrandstof - Groeiende vraag naar vlees	- Kosten van intensiever gebruik van grasland zijn hoger dan kosten van ingebruikneming van grond met oorspronkelijke vegetatie - Afnemende vraaggroei t.g.v. daling economische groei in soja/vleesimporterende landen - Beperkte mogelijkheden voor export van vlees i.v.m. handelsbarrières of vanwege het niet kunnen

Tabel S.1	Kansen en risico's verbonden aan uitbreiding van sojaproductie	
		nakomen van sanitaire afspraken - Hoge transportkosten
Sociaal	- Arbeidsvoorwaarden komen overeen met internationale standaarden (incl. uitbannen van kinderarbeid) - Betere/rechtvaardige beloning - Grondeigendomsrechten zijn verzekerd door invoering van landregistratiesysteem	- Bij grootschalige productie wordt arbeid vervangen door machines - Levensonderhoud van inheemse bevolking verstoord door uitbreiding van sojateelt - Schending van arbeidsrechten vanwege gebrekkige handhaving
Milieu	- Toepassen van zero-tillage productiemethoden - Toepassen van een soja/graan/grasland rotatiesysteem - Toepassen van Ecologische Economisch Zonering	- Verlies aan biodiversiteit bij uitbreiding van sojateelt als monocultuur - Bodemdegradatie, watervervuiling en verlies van biodiversiteit als landbouwgrond intensief wordt gebruikt - Locale overheid is niet in staat om expansie van sojateelt te sturen via ruimtelijke ordeningsmaatregelen

De duurzaamheidcriteria worden vastgesteld door onderhandelingen tussen het bedrijfsleven en maatschappelijke organisaties in de RTRS. De Nederlandse overheid kan een belangrijke begeleidende rol spelen in dat proces door de diverse betrokkenen te steunen met financiële middelen, kennis en expertise. Wat Brazilië betreft zou ondersteuning van locale overheden kunnen worden aangeboden bij de implementatie en naleving van arbeidswetten en maatregelen op het gebied van ruimtelijke ordening. Meer in het algemeen kan de Nederlandse overheid een rol spelen bij het helpen verbreden van draagvlak bij de aanpak van de onduurzame componenten van de sojaproductie op internationaal niveau door ook (naast Brazilië) andere sojaproducerende en importerende landen (zoals China) te wijzen op hun rol en verantwoordelijkheden. Daarbij is het van belang om de voorwaarden te helpen creëren waaronder locatie specifieke geïntegreerde productiesystemen economisch rendabel kunnen worden toegepast.

1 Introduction

Background

As result of a debate on a government letter about sustainability of the international soy supply chain, the Dutch Lower Chamber adopted several resolutions in early 2008. In one of them[1] the Chamber requests the government for a survey of opportunities and risks of soybean production in developing countries, as well as to search for European alternatives for soybeans. Agricultural Minister Verburg has promised the Lower Chamber to implement this resolution, for which objective information needs to be collected.

Objective and results of the study

The purpose of this research is to take stock of opportunities and risks of soy production in developing countries. In doing so this study executes the first part of the Minister's promise to implement the resolution. The study investigates opportunities for and implications of soybean production in developing countries and provides objective information on the possibilities and bottlenecks for sustainable soy production in these countries.

Approach and focus of the study

The study is based on a combination of statistical data, literature and interviews with experts and stakeholders such as producers, industry and civil society representatives. The broad scope on developing countries – defined as all countries except those in the high income country classification of the World Bank - as referred to in the resolution has been narrowed to a more in-depth analysis of the developments in Brazil. This country is an exponent of the expanding soybean cultivation in Latin America: major increase of the world's soybean area has taken place in Brazil and expectations are that increased production will mainly come from this country. International concerns with the sustainable management of natural resources are largely focused on the social and environmental effects of the expansion of soy production in the Cerrado and Amazon biome in Brazil. The first major observation from the country case of Brazil illustrates how the dynamics in land use associated with soybean production take place and how these dynamics affect the economic, social and environmental impact of increasing soybean cultivation now and in the future. As such the Bra-

[1] Resolution by Wiegman-van Meppelen Scheppink c.s. (nr. 174).

zilian case is an example to other developing countries that are looking for solutions for dealing with conflicting interests between increasing soybean production and responsible natural resource management. Two field trips to Brazil (in Mato Grosso and Pará – States where dynamics of soybean production and associate negative social and environmental effects show) have been part of the study. Local researchers in Brazil have contributed to the study as well. The other observation learned that little scientific information appears to be available about these issues, as much of the research so far has emphasized the agro-technical dimension as to how soybean can be cultivated best. The interviews conducted do show a rich source of information to assess the aspects of sustainability, yet it also indicates that there is much room for different interpretation often as a result of missing scientific facts. This report therefore also aims to present different views and 'sensitivity' of stakeholders in order to show the main issues of the discussion how to achieve increased sustainable soybean production.

Structure of the report

Section 2 presents an overview of recent developments in soy production and trade and pictures the present positions of major producing and trading countries. Section 3 provides insights into projections of developments in soy production and trade up to 2020. This section points out that major opportunities for soy bean production expansion are within Brazil and Argentina. Section 4 provides details on soy cultivation methods and looks into the compliance of current soybean production in Latin American countries to sustainability aspects, and introduces the complexity of systematically analysing land use dynamics related to the expansion of soybean area illustrated for the largest soybean producing state of Brazil, Mato Grosso. Initiatives (Dutch as well as international) to achieve the sustainable production, processing and trading of soy are described in section 5. Section 6 presents a synthesis of the soybean production in the context of land use and international trade for identifying opportunities and the conditions for exploiting these opportunities for more sustainable production systems. Section 7 summarises the main findings and proposes some recommendations.

2 Soy production and trade developments

Siemen van Berkum

2.1 Introduction

Soybean is an annual crop that yields an edible bean with a high protein and oil content. Soybeans are generally cultivated in (sub)tropical and humid climate zones: (the south of) the United States of America, Latin America (mainly Brazil and Argentina, yet also Paraguay and Bolivia) and Asia (largely India and China). In Europe the climate is less suitable for soybean production but the demand for soy is high especially as feed component in the intensive livestock (pig and poultry). Also in China and India demand is higher than national production levels. At present soy oil is used as alternative energy source (biodiesel), although its energy efficiency is pretty low compared to other crops. In general increased demand for cheap vegetable oil and vegetable protein has been the driver for the growth of the international trade in soy bean products.

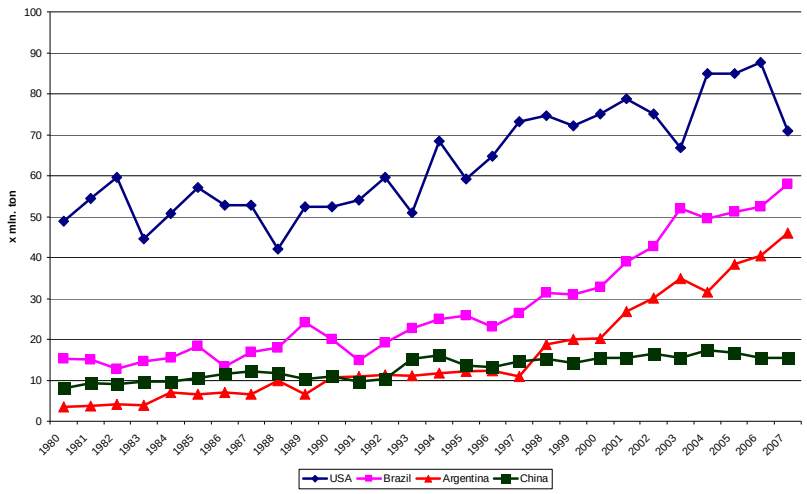
This chapter reviews recent developments in the soybean cultivation and trade in soybean, meal and oil. Next, current positions of most important exporters and importers are presented.

2.2 Soy production and area developments in the last 25 years

Total world production of soybeans accounted for 220m ton[1] in 2007 (FAO). The United States of America (71m ton), Brazil (58m ton) and Argentina (45m ton) are by far the largest producers. China (15.5m ton) is the leader of the group of followers which all produce more than 1m ton. This group includes also India, Paraguay, Canada, Bolivia and the EU. Figure 2.1 shows that production increased strongly in the USA as well as in Brazil and Argentina since the 1990, yet that the growth went up most quickly in both Latin American countries.

[1] M = million

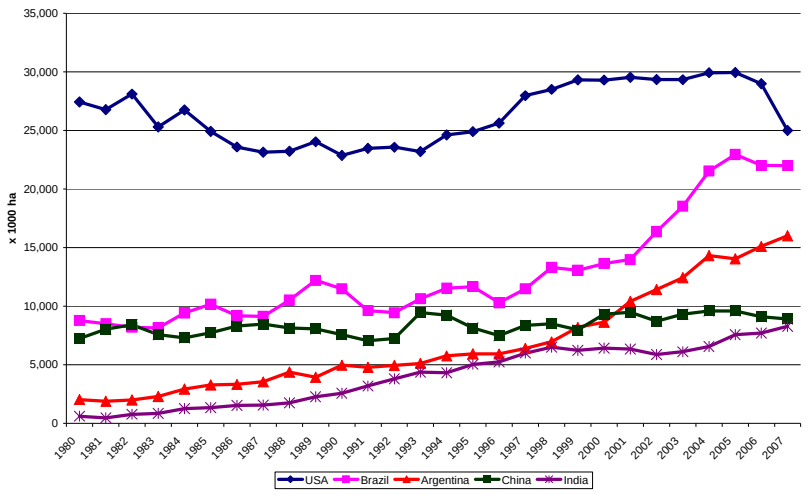
Figure 2.1 **Production of soybeans in the largest producer countries**



Source: FAO.

Figure 2.2 shows the development of the soybeans area in the five most important production countries (in 2007 accounting for 87% of total soybean area in the world). The rapid growth of the soybean production is largely due to a fast expansion of the area under soy. In the mid-1990s soybean areas in Brazil have been around 11m hectares. The 2004-2007 area was more than 20m hectares. In the same period the soybean area in Argentina increased almost threefold to reach 16m in 2007. Areas in the USA increased significantly in the 1990s and have been rather stable since then. In China the areas under soybean remain between 8 and 9m hectares, while in India and Paraguay – countries with also more than 1 million hectares of soybean – the soybean acreages have been steadily increasing over the last decades with a substantially growth in the last ten years: the soybean area in India counts 8.5m hectares in 2007 against 6.2m in 1995 and in Paraguay the area increased from 1.2m hectares to 2.3m hectares in the same period. Compared to that Bolivia's soybean area is much smaller (960,000 hectares in 2007) although it has also expanded over the last decade. Other countries in other parts of the world in which a noteworthy soybean area can be found are Ukraine (665,000 hectares in 2007), Nigeria (600,000 hectares – 50% of all soybean area in Africa), Uruguay (365,000 hectares) and South Africa (250,000 hectares). Except for Nigeria's case the soybean area in these countries are showing an increase over the last 10 to 15 years.

Figure 2.2 **Area development in the most important production countries**



Source: FAO.

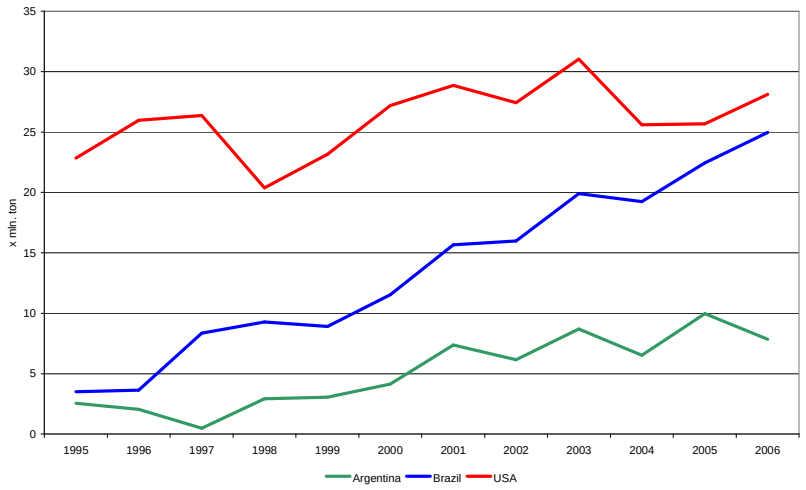
2.3 Trade positions in the past and at present

Trade positions differ depending on the markets of soybeans, meal and oil. Yet, on all these three markets the USA, Brazil and Argentina are the dominant exporters. The positions of most important importing countries are taken by a larger group of countries, although it is mainly the EU and China who play first fiddle.

Exports of soy beans

Since a long time the USA have the first position in the world as exporter of soybeans (Figure 2.3). Exports from Brazil are, however, increasing very rapidly and equals almost the export level of the USA in 2006. The export volume of beans from Argentina increases bit by bit.

Figure 2.3 **Exports of soybeans by Argentina, Brazil and the USA**

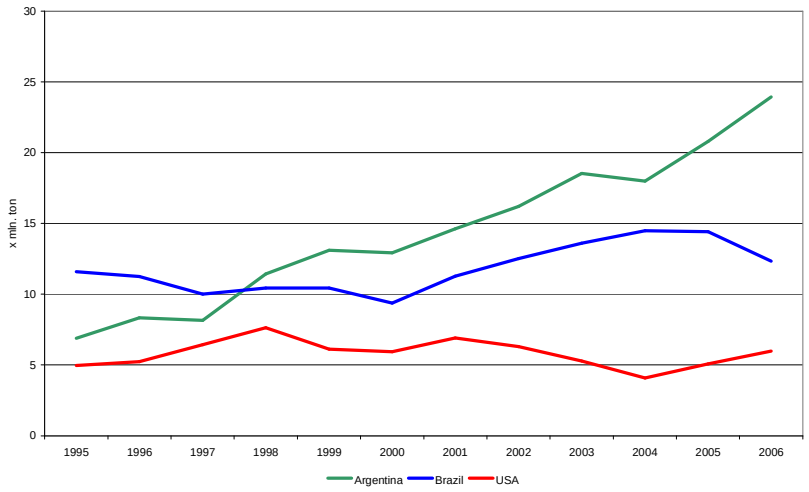


Source: UNSD, Comtrade.

Exports of soybean meal

Argentina is the largest exporter of soybean meal (Figure 2.4). The country is number one exporter already since 1997. The annual growth of Argentina's export of soybean meal is significant. Also exports from Brazil increased substantially after the year 2000 but this trend seems to have turned recently. The export volume of the USA is rather constant around 5m tons of meal over the period.

Figure 2.4 **Exports of soybean meal by Argentina, Brazil and the USA**

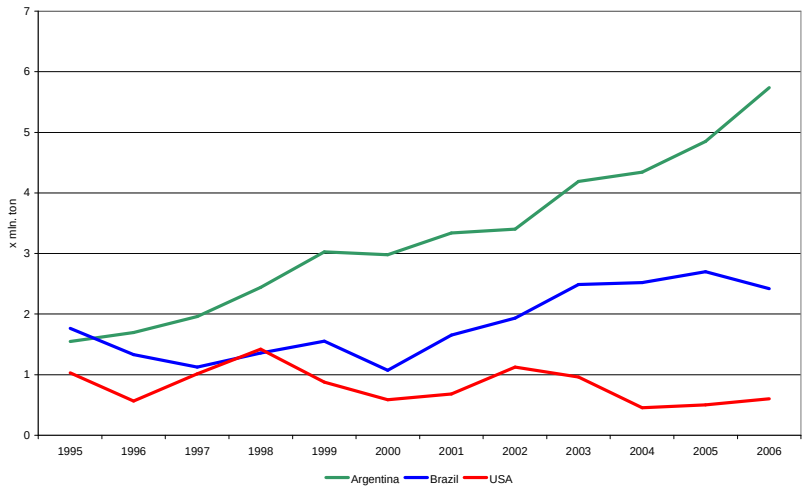


Source: UNSD Comtrade.

Exports of soybean oil

Also as an exporter of soybean oil Argentina is much bigger than Brazil and the USA (Figure 2.5). The positions of these three countries as exporter and the trends in the export volumes are comparable to those with respect to soybean meal.

Figure 2.5 **Exports of soy oil by Argentina, Brazil and the USA**

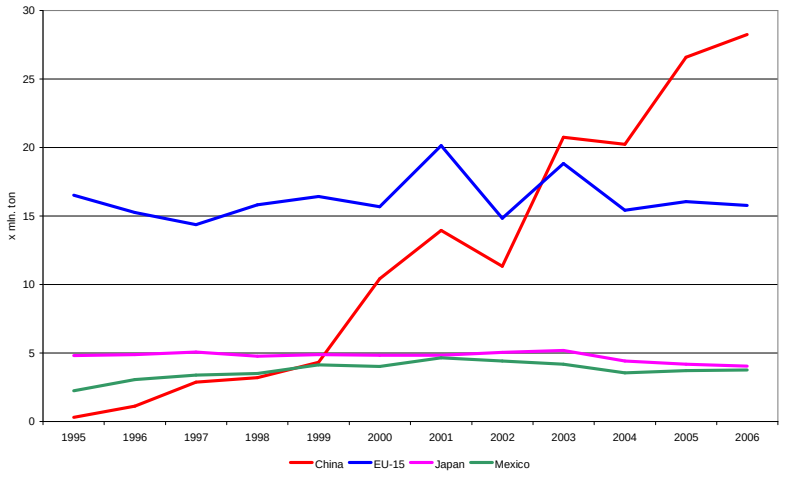


Source: UNSD Comtrade.

Taking a view of these developments in exports over the last 15 years, one clearly sees that the USA have lost much of their trade position, while Brazil - mainly in the export of soy beans - and Argentina - especially in the export of meal and oil - have strengthened their positions importantly.

Largest importers of soybeans are China and the EU (Figure 2.6). The increase of the imports in China is significant: within a period of only a half decade imports rose from less than 5m ton to almost 30m in 2006. Compared to that development, the imports in the EU are rather constant around 16m ton annually - although a single year showed a much higher import level.

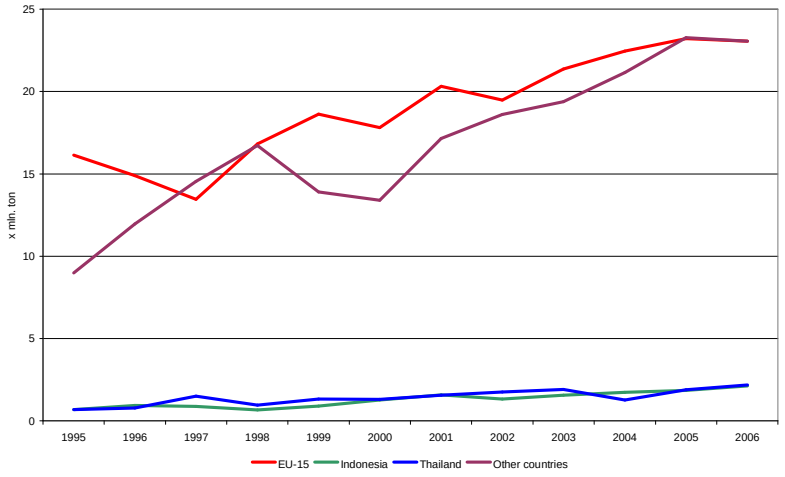
Figure 2.6 **Largest importers of soybeans in the world**



Source: UNSD Comtrade.

Yet, the EU is still by far the most important importer of soybean meal with imports ranging around 23m tons (Figure 2.7): of all meal imported (excluding EU's intra-trade) the EU has a share of over 50%.

Figure 2.7 **Largest importers of soybean meal in the world**

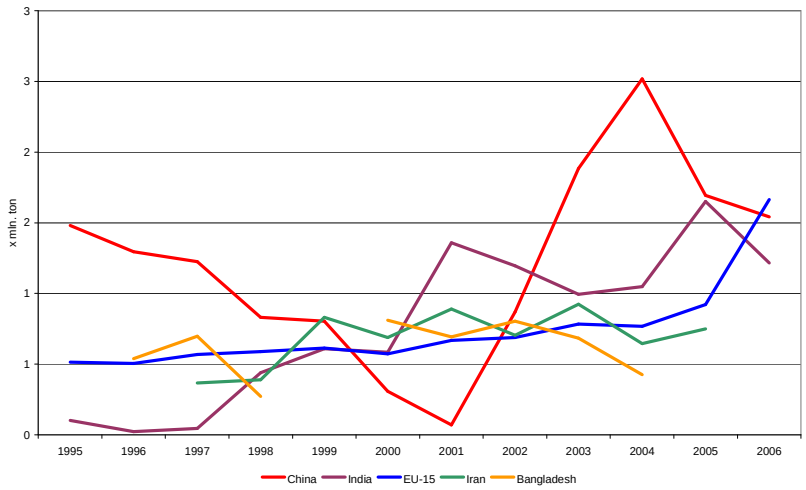


Source: UNSD Comtrade.

Five countries are dominating the imports of soybean oil (see Figure 2.8). Import levels however may vary a lot from year to year. For example, China's imports show a decreasing trend in the period 1995-2001. Yet, this period was followed by strongly increasing imports while imports declined again in most recent years.

India's import of oil from soybeans showed significant increases over the period, making the country the second most importer of the world. Imports in the EU show a rather steady annual growth in the period up to 2005, yet the volume increases in most recent years. Iran and Bangladesh complete the list of the most important importing countries of soybean oil in the world.

Figure 2.8 **Largest soybean oil importers in the world**



Source: UNSD Comtrade.

For its import of soybeans, meal and oil the EU is being sourced mainly from Latin America and for a minor part from the USA. Asian countries purchase their soybeans equally from the USA and the Latin American countries. Asian imports of meal and oil are again largely from Latin America.

Figures A1.1-3 in the Appendix indicate the major destinations of Brazil's exports of soybeans, meal and oil. Beans are largely exported to China (38%) and the Netherlands (19%), while Brazil's oil is mainly exported to Iran, followed by the Netherlands, India and China. Brazil's meal export finds its way to the EU in which the Netherlands and France are the country's two main export markets.

Looking at Argentina's major export markets (Appendix A1.4-6) Asia is more dominant than Europe. Soybean exports are mainly (around three quarter) focused on China. Half of Argentina's soybean oil is being exported to Asia, mainly to China (27%) and India (25%). Meal, on the other hand, is largely exported to Europe, in countries like Spain, the Netherlands and Italy.

3 Future developments: drivers and projections

Siemen van Berkum

This chapter presents an analysis of the main drivers of the supply and demand developments on the international market for soy and soy bean products. Furthermore, expectations in production and trade for the next 10 to 15 are depicted, based on the estimated international supply and demand developments. The projections show where (in which countries) and to what extent soybean production most probably will expand.

3.1 Supply and demand developments on international markets

Population and macroeconomic growth are the most important drivers of developments in the demand of agricultural products (see e.g. Nowicki et al., 2006). For the coming ten years the worldwide population growth is estimated to be no more than 1% annually, although population growth will be much higher in the lower and middle income countries than this average figure (OESO/FAO, 2008). Projections indicate a fierce economic growth for all regions in the World, yet the expected growth figures are significantly higher in transition and developing countries compared to those for the EU-15, the USA and Japan (economic growth in OECD-countries would be an annual 2% on average). The highest growth figures were projected for Brazil, China, India and the new member states of the EU.[1]

Economic growth per capita leads generally to more consumption of 'luxury' goods. This implies a shift in food consumption patterns towards more convenience and processed products, while consumers show greater attention to food safety, environmental and health issues. In volume terms it may not be expected that food consumption will increase much in high-income countries, yet increasing income in developing countries will result into more demand and a shift to products with higher added value. An important implication is the shift in the

[1] These projections were published in early 2008. Since the financial crisis became known shortly after the Summer economic growth projections have been modified and show generally much less optimistic expectations for the years to come.

consumption pattern from cereals to meat products. An increasing meat consumption implies again an increasing demand of coarse grains and protein rich products such as soybeans for feed.

According to OECD/FAO projections (2008) supply response to these demand developments will largely be the results of productivity increases while expansion of areas and/or livestock numbers will only contribute little. The outcome of the dynamics in supply and demand is that in the years to come the (nominal) prices of agricultural commodities will be on average on a significant higher level than they were in the previous decade. For many important commodities demand and supply in developing countries will increase more than in developed countries. The consequence is that trade flows will shift to the advantage of developing countries, indicated by the more than average increase in imports in developing countries while (other) emerging and developing countries will provide an increasing share of the demands by increasing export volumes.

3.2 Soy production and trade projections

Soybean supply and demand projections by OECD/FAO (2008) and FAPRI (2008) indicate that market developments are strongly influenced by the increasing demand for soy in the feed and energy sector. The price increase of soybeans, meal and oil since 2006 has stimulated production to growth especially in the Latin American countries but as demand increased and will increase as well (mainly in China, also in the EU) both organisations expect that prices will on average be at higher levels than what has been the case in the last decade.

Growing demand in China and some other South-east Asian countries is largely due to rapid economic growth resulting in higher food consumption levels and a consumption pattern including more meat. To supply the increasing demand for vegetable oil and animal feed China has to import around 60% of its total consumption (USDA, 2008). China has very limited possibilities to expand soybean production as there are many competing claims on suitable agricultural land and other crops turn out to be economically more attractive. Therefore it is plausible to expect an increasing import dependency. This picture also comes from FAPRI projections (2008), indicating a stable soybean area harvested of around 8.5m hectares over the projected period and estimating the growth of Chinese imports of soybeans from 33m ton in 2007/08 to more than 52m ton in 2017/18 (see Table 3.1). The latter implies that China accounts for 55% of world imports of soybeans in that year. The EU is traditionally a deficit region resulting in large import flows of soybeans and meal. FAPRI does not expect

that imports will increase significantly, as economic growth is modest, population growth is stagnant, and livestock numbers rather constant over the period of the projection. Yet, there may be more demand for vegetable oil for bio-fuel purposes. This increasing demand stimulates next to domestic (EU) supply of rapeseed, the import of sunflower and palm oil, while in economic terms soy oil is less suitable for bio-fuels. FAPRI's projections indicate rather stable EU imports of soybeans and a modest increase (10-15%) in the imports of meal over the period up to 2017/18.

Table 3.1 Projections of soy exports and imports (million ton)

	Soybeans		Soybean meal		Soybean oil	
	2007/08	**2017/18**	**2007/08**	**2017/18**	**2007/08**	**2017/18**
Net-exporters						
Argentina	9.1	6.0	29.5	39.9	6.4	8.3
Brazil	29.6	54.2	11.8	9.8	2.3	1.7
USA	26.9	22.6	7.4	10.3	0.7	0.7
Paraguay	4.5	6.9	1.7	3.0	0.4	0.7
Net-importers						
China	33.7	52.0	0	3.0	2.7	3.5
EU	15.4	14.7	22.9	27.7	0.7	0.9
Trade [1)]	71.4	91.7	54.6	72.2	9.8	11.4

Source: FAPRI World Agricultural Outlook, 2008: 224-241.

Note 1: excludes intraregional trade

The USA, Brazil and Argentina are the main suppliers of soybeans, meal and oil and dominate on the export side of international trade. A quick expansion of production in the USA in response to increasing demand for soybeans is not plausible: expansion has to come from increasing yields or from crowding out other crops as there is no land in the USA presently unused that may be easily used for agricultural purposes. Other crops such as maize are more attractive than soybeans from an economic point of view; the position of maize has been enhanced in recent years due to the increasing demand for the crop as bio-fuel. The increasing demand for soybean products in China and other Southeast Asian countries will not lead to much expansion of the area as other crops are either more economically attractive (in combination with agronomic circumstances). FAPRI therefore concludes that the supply response to continuously increasing demand for soy products has to come from Latin American countries

like Brazil, Argentina and Paraguay, by applying new land for agricultural purposes, shifts between crops and/or more intensive use of agricultural land.

3.3 Impact of soy production expansion on land use, production value and export revenues

Using outcomes of own (LEI) simulations provide some more details on land use changes, production and trade effects of a future scenario which takes into account major trends in economic drivers as described above.[1] These outcomes show a significant increase of the soy production value in Brazil (+75%), Argentina (+40%) and in Bolivia (+37%) in the period up to 2020, while Paraguay's soybean production value decreases (see Table 3.2). Also in North America soybean production value increases considerably, by around 30%. This will induce a substantial increase of the land used for soybean cultivation, especially in Brazil and Argentina.[2] Starting from the countries' 2004 levels of 15m hectares and 21m hectares respectively, the projection results into a soybean area of 22m hectares in Argentina and 40m hectares in Brazil in 2020. Soybean areas in Bolivia and Paraguay would account for 1.5m to 2m hectares respectively.

Table 3.2 Changes in oilseeds production value and land use (% change from 2004 to 2020)

	Argentina	Bolivia	Brazil	Paraguay	North America	EU_27	China	Asia	RoW
Oilseeds production	41.5	36.6	74.0	-7.1	31.3	-7.1	6.9	18.5	37.0
Agricultural land	37.9	22.7	77.1	13.8	21.8	-2.5	11.1	25.7	26.6
Of which under:									

[1] Using the LEITAP model we construct a projection of the global economy from 2004 to 2010 and from 2010 to 2020. This projection is based on a business-as-usual assumption, in other words we keep all policies as they are in 2004 through the projection period. The only exception is the bio-fuel directive in the EU. In accordance with this directive we impose a mandatory blending of petrol of 4% until 2010 and of 10 % from 2010 to 2020. Further details can be read in a background note, available upon request.

[2] Note that the model outcomes refer to oilseeds and not specifically to soy beans. More detailed FAO data show that all oilseed area in Latin America is used for soybean production, while in North America this is 75%. The oilseeds area in the EU is largely rapeseed while in China and Asia oilseeds can be estimated 50% and 20% soy respectively.

Oil seeds	44.2	38.0	92.6	5.1	20.7	-1.5	-10.1	37.9	65.1
Grains	28.5	13.8	59.5	19.2	23.0	-1.7	20.3	18.7	25.3
Sugar beet & cane	42.2	25.2	54.8	35.0	24.4	-4.7	43.2	31.9	47.6
Other crops	35.3	25.5	65.1	13.6	20.8	-6.2	11.8	24.0	31.6
Livestock	38.0	22.4	78.7	14.1	21.8	-1.1	10.1	30.8	25.5

Source: LEI, own calculations.

Gains from trade (exports) are presented in Table 3.3. Due to higher production and exports, Argentina records a 120% increase of export value in its bilateral trade with China - its most important trading partner in 2004. Brazil which is much more focused on the EU for soybean (meal and oil) exports faces a decline in its export value to the Union (-15%) but on the other hand gains much in its bilateral trade with important costumers in China (+316%). Also North America benefits from an increase in exports to China, making the latter by far the most important destination of oilseed exports from major producing countries. Imports by the EU are declining compared to 2004 levels: 15% less from Brazil and while imports from North America will decline by more than a quarter.

Table 3.3 Initial levels and change in bilateral trade in oilseeds

	Importing regions								
	Argentina	**Bolivia**	**Brazil**	**Paraguay**	**North America**	**EU_27**	**China**	**Asia**	**RoW**
	Bilateral trade in 2004 (mill. US $)								
Argentina		1.2	1.8	1.9	23.1	246.5	1,373.0	319.7	286.4
Bolivia	11.0		0.2	2.2	0.1	1.1	0.0	5.2	23.5
Brazil	4.3	33.4		7.3	203.4	2,756.7	1,837.3	620.6	457.0
Paraguay	17.0	0.0	73.4		30.3	275.7	0.2	18.3	583.8
North America	1.6	0.0	0.8	0.2		1,606.5	3,078.5	2,890.0	530.9
EU_27	0.7	0.0	1.0	0.0	51.4		2.8	65.2	185.8
China	0.0	0.0	0.1	0.0	49.3	164.7		258.7	134.1
Asia	0.4	0.0	1.0	0.0	64.8	113.7	47.4		78.0
RoW	16.7	0.1	1.6	0.5	106.6	654.8	56.2	614.4	
	Change in bilateral trade (% from 2004 to 2020)								
Argentina		-23.7	-23.2	-57.1	-46.9	-54.0	120.3	-29.8	-38.1
Bolivia	24.2		13.4	-28.5	-11.8	-27.5	324.4	-17.7	13.6
Brazil	71.9	30.1		-15.8	-0.6	-15.4	316.8	7.9	6.7

Table 3.3	Initial levels and change in bilateral trade in oilseeds								
Paraguay	29.4	-0.1	0.7		-25.1	-36.5	308.9	-13.3	8.1
North America	70.7	32.2	29.4	-13.9		-26.7	256.8	-12.9	5.1
EU_27	44.6	23.7	25.0	-14.1	-12.7		320.5	22.8	-10.2
China	-87.0	-90.2	-88.3	-91.3	-90.8	-91.8		-90.5	-89.5
Asia	-31.1	-0.3	-57.8	-30.5	-62.5	-64.1	208.2		-35.8
RoW	74.8	90.0	181.3	-33.1	69.2	26.6	1,073.7	66.2	
Source: LEI, own calculations.									

Table 3.3 clearly shows the large export gains that can be derived by the two major soy exporting Latin American countries. For instance, Argentina's soy export value to China will amount an extra US$ 1.6 billion in 2020, while Brazil is expected to increase its export earnings in its bilateral trade with China with US$6 billion (compared to 2004 levels).

Other studies projecting soybean production in the next decade confirm that indeed Brazil will be the main country to respond to the increasing demand in the world for soy. Abiove (2005) calculates world production will grow from 220m ton in 2005 to 280m in 2015 and estimates that production will be over 300m ton in 2020. Brazil will double its production and produce 105m ton. With that production level Brazil will be the number one producer of soybeans in the world, surpassing the USA. By assuming a productivity growth of 1.5% per hectare over the whole period, Abiove accounts for an increase of 8m hectares of soybean area in Brazil up to 30m hectares in 2020. FAPRI (2008) forecasts of soy area expansion in Brazil are up to 28.5m hectares in 2018 which is quite close to Abiove's estimates, while for Argentina FAPRI comes up with an soybean area slightly higher than 19m hectares. FAPRI expects Paraguay's soybean area to expand by about 1m hectare to about 4m hectares in ten years time. Compared to FAPRI LEI's projections are significant lower for Paraguay, yet expects stronger increase in the two major producing countries in Latin America, especially for Brazil.

Expansion of soybean cultivation in Latin America does however not have to lead to deforestation per se. The soybean acreage can also be expanded by using agricultural land more intensively. For that, there seem to be many opportunities, especially in Brazil. USDA/FAS (2003), for instance, claims to make a 'conservative' estimation when stating that Brazil's cropping area can expand by 170m hectares with investments in new production and productivity increasing technology (among which genetically modified crops) and in infrastructure. According to USDA/FAS half of this area (circa 80m hectares) can be realised by

turning grassland into arable land. Next to that, USDA/FAS' estimates of the possible soybean acreage expansion are based on information from Brazil's agricultural research organisation EMBRAPA that indicate that about 65m hectares in the Cerrado can be made suitable for arable cropping against relative low costs.[1] In addition to that EMBRAPA indicates that investments in soil fertility improvements can make 10m hectares of 'degenerated' land available for soubean cultivation. An other possibility is to invest in an integrated system of livestock and arable farming. In such a system grassland will be used for soybean production for a number of years after which it returns into grassland. Rotation of land has economic gains (land is being used more productive) and environmental benefits (soybeans fixes nitrogen, an important nutrient for grass). Abiove (2005) claims that 30m hectares of extensively used grassland would be suitable for this kind of integrated farming system.

With the further increase of demand for soy products in the years to come, the soybean production is expected to expand mainly in Brazil and Argentina, and to a lesser extent in Paraguay too. The result will be that the soybean area in these countries will continue to increase. This may lead to the use of land for agricultural purposes where no agricultural activities have been before. This may have negative consequences for ecologically vulnerable areas. It is however also clear that there are many options for using agricultural land more intensively. By applying these options pressure to exploit new areas for agricultural purposes will diminish and ecologically vulnerable areas may be saved.

[1] The Cerrado, a savannah type of biome, is estimated to be around 200m hectares. About 70m hectares is being used for agriculture: 60m hectares of grassland and 10m arable crops (Klink, 2006). In 1975 total agricultural land in the Cerrado was only 25m hectare, of which 17m hectares of grassland. The grassland area increased rapidly to reach 50m hectares in the mid-1990s.

4 The sustainability and resource use of soybean cultivation

Prem S. Bindraban and Felipe Greco

4.1 Introduction

Soybean is a versatile crop that is used for very many purposes. The prime driver of soybean production has been the demand for feed for the production of chicken and pork, primarily in Europe and China. Soya beans are used for food consumption and its health aspects are increasingly recognised and being accepted. Soybean oil is an important ingredient in much of processed food items. Soybean is a major source for the chemical industry for the production of an array of bio-based products. Recently also, soybean oil has become the main feedstock for the production of bio-diesel in Latin America.

It is due to these increasing demands worldwide that production volumes of soybean has dramatically increased and will continue to do so in future. Bindraban and Zuurbier (2007) show that such a volumetric increase cannot be obtained by increasing yield only, necessitating the expansion of the cultivation area. As have been elaborated in chapter 3, most of the expansion is expected to occur in Latin American countries like Brazil, Argentina and Paraguay. Because of the relative abundance of productive land and fresh water, virtually all nations in the world have found their way to these countries to satisfy their growing demands for food, feed and fuel. The analyses that project future demand and supply have indicated that soybean cultivation might be increasing in other regions of the world, such as Europe, Africa and Asia is particularly unlikely. Technical production is feasible in these regions as will be briefly dealt with in section 7.3.

This expansion of the acreage raises much concern of national and international actors in the chain and more importantly, the consumers of soybean or soybean related products, such as pig and chicken meat, and recently biodiesel. The global importance of Brazil in providing food, feed and fuel to the world is so vast that it even becomes a concern for the international community as to how Latin American countries manage their natural resources. In addition, overexploitation of the enormous biodiversity on Brazils territory that hosts

world largest rainforest area for instance, would not only affect the economy and ecology of Brazil, but of the world as a whole (e.g. Santilli et al., 2005).

It is for these reasons that some nations, in particular within Europe, are concerned with the sustainable exploitation of the natural resources, in and outside Europe. In Europe, sustainability principles such as presented in agreements on Good Agricultural Practices (e.g. EurepGAP, 2007) and stringent conditions for agricultural production are imposed on farmers, but also to other actors and activities along the production chain.

Sustainability is commonly accepted to inherit social, economic and ecological dimensions that should be well balanced. The complexity to assess the sustainability of soybean is high because of the international dimension where soybean producing and consuming countries are even thousands of kilometres apart. The desires and objectives of societies differs greatly between countries due to different development stages, resource base, education and the like, leading to different perceptions on sustainability. Despite different views, the necessity to sustainably manage world's natural resources is key to provide the ever growing population with sufficient, safe and healthy food, while maintaining and even improving socio-economic prosperity.

In 1972, the club of Rome gave a politically strong signal that humankind should use its natural resource base in a conscious matter, even calling for austerity to ensure fulfilment of the needs of future generations (Meadows and Meadows, 1972). Many debates have taken place over the past decades on 'sustainability'. The concern for the environment has culminated in the World Summit in 1992 in Rio de Janeiro, Brazil. The Rio Declaration on Environment and Development and Agenda 21 emphasises the need to simultaneously meet development and environment needs for present and future generations.

Since the 1990's, numerous efforts have been made to stimulate sustainable agriculture and rural development. The principal characteristics of sustainable development (in the agricultural, fisheries and forestry sectors) concerned the conservation of land, water, plant and animal genetic resources, the development of agricultural practices that were environmentally non-degrading, technically appropriate, economically viable and socially acceptable. Despite these global concerns and international calls for sustainable development, progress has been slow or even negative. Current discouraging developments in food security (FAO, 1996, 2008), climate change (IPCC, 2007), over-fishing, degradation of land quality (Oldeman, 1999), pollution and overuse of water (Cosgrove and Rijsberman, 2000), and poorly managed animal production (Steinfeld et al., 2006) indicate that the effectiveness of the exploitation of the natural resource base has been excessive and not sustainable.

Over the past decades, a different approach is under construction to progress more effectively towards sustainable practices. The agri-food supply chains increasingly operate on a global level so that actors are linked within the chain. Changing requirements on food quality in the EU, for instance, have consequences for requirements with regard to food production thousands of kilometres away and the use of raw materials in the EU imported from developing countries have far reaching impacts on the environment in those countries (ecological footprint). As a result, the magnitude of the current demands urges for complete transformations of production systems in their local context to comply with sustainability demand from the market and to respond to concerns for global issues.

The awareness of this strong interdependence implies that the global platforms are needed to negotiate their desires. These desires should be transformed into sets of criteria that can be monitored through indicators which can be implemented in reality by the actors involved in the production chain. These dialogue about these concerns for soybean have lead to the installation of the Round Table on Responsible Soy (RTRS) to secure that future expansion of soybean production is carried out within a sustainable framework. The RTRS describes the current issues in the production of soybean in Latin American countries as follows:

> 'Soy for Latin American countries is one of the largest sources of income and foreign currency, boosting both employment and development. Extensive cultivation and the expansion of agricultural frontiers, also entail, however, considerable social and environmental costs, such as water pollution, deforestation, and soil erosion. Soy expansion may also generate social conflicts and tension between producers and local communities. The rapid growth of soy farming in Latin America also represents a threat to the rich biodiversity of the region, caused by the expansion of agriculture and the ensuing conversion of forests and other valuable ecosystems to arable land. Soy production and yields in Brazil could be increased due to technologies that allowed the cultivation of virgin areas with relatively poor soils of the 'Cerrado' and parts of the Amazon. Also, agricultural expansion brings in its wake tensions between large and small farmers, as well as major agribusiness and local communities.'

It is within this context of the RTRS that this chapter looks into the compliance of current soybean production in Brazil, as the most important country where expansion of soybean production will take place, to most of the sustain-

ability aspects as formulated by the RTRS. Literature, official data from governmental bodies, reports from producers and industry associations and civil society along with two field trips in Mato Grosso and Pará to visits and interviews actors in the production areas have been the basis for the findings presented here.

4.2. Sustainability perceptions and facts

Whereas several components of sustainability can be technically quantified, there is much room for different interpretations depending on personal views, desires, objectives, interest, educational level etc. It is essential therefore to present a balanced view of the actors in the chain, certainly so if the reliability on factual information is limited. To illustrate the complexity of the sustainability dimensions and to understand the fierce discussion between actors, a field study was carried out in Brazil. The findings of this research are presented for the relevant principles as defined in the RTRS. Other, more technically based principles have been evaluated on the basis of literature reviews. Options for improving use efficiencies of resources are integrated in these descriptions.

4.2.1. Sustainability criteria

In order to achieve the sustainable production, processing and trading of soy, it is fundamental that a global definition on sustainable soy is developed that is acceptable to all stakeholders involved. The RTRS therefore is set up to be a multi-stakeholder and participatory process that promotes economically viable, socially equitable and environmentally sustainable production, processing and trading of soy.

By March 2008 a set of eleven basic principles had been set up that are currently being elaborated by a RTRS Principles, Criteria and Verification Development Group. The group will develop a set of normative baseline requirement of standards, expressed as verifiable principles, criteria and indicators that define responsible production and early processing (crushing and trade) of soybeans. In addition, a verification system for soy production and processing will be developed.

Table 4.1	The principles of the RTRS encompassing Economic (1&11), Social (2-5) and Environmental (6-10) dimensions in line with the People, Planet, Profit concept, as presented for discussion in March 2008
1	Responsible business practices
2	Responsible labour conditions
3	Respect for land rights
4	Small scale and traditional land use
5	Responsible community relations
6	Environmental responsibility
7	Responsible Water Management
8	Responsible Soil Management
9	Protection of biodiversity
10	Crop protection and responsible use of chemicals
11	Responsible establishment of infrastructure and new areas of cultivation

The Development Group is currently involved in an interactive participatory process[1] to advance the set of sustainability criteria, which takes much time and effort. When actors will not be willing to live up with the criteria, any effort to develop the set would be wasted. It is important to continuously support this effort, also with scientific insight, for the creation of a firm set of criteria.

Much of the discussion and the sentiments in European countries, and in particular in the Netherlands, about soybean relate to environmental aspects of deforestation and to social aspects, the phenomenon of slavery. The findings of the literature review, interviews and field visits have been presented following the principles of the RTRS, but an integral understanding of the soybean chain and the land use dynamics is of eminent importance to unravel cause-effect relations and in the end to be able to identify effective measure for improvement.

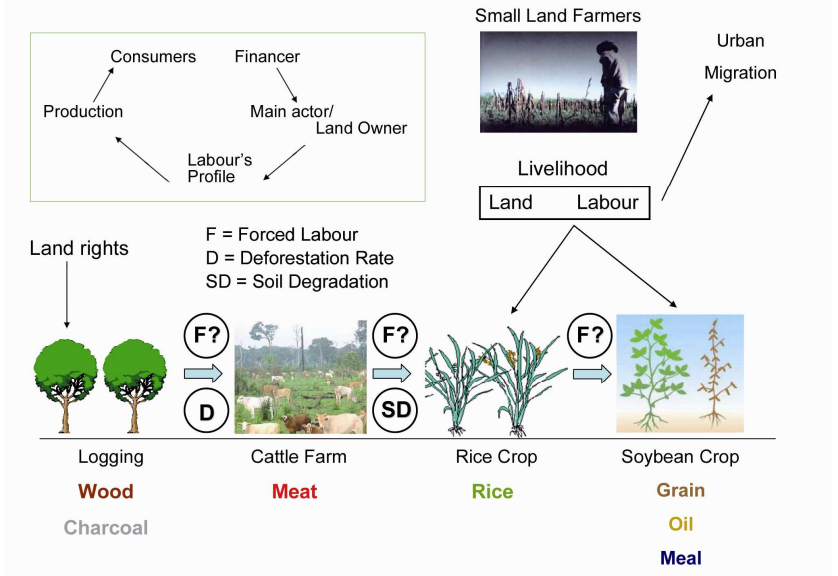
4.2.2 Land use dynamics

Likely the most important component of the sustainability debate relates to the expansion of the soybean area. Stakeholders differ greatly in their views with

[1] A latest document on the principles and criteria has been released for a third public consultation on 23 October 2008. In this document the previously eleven principles have been summarized into five, basically covering all sub-elements of the March document. The October Draft of the principles is presented in Appendix 2, with an elaboration of the criteria. As the start of this research was in Summer 2008 the assessment has been linked to the March document of the RTRS.

regard to the actor that is responsible for deforestation. In this section we schematically outline the land use dynamics as has been derived for the situation in Brazil. It provides an overview of some relevant issues like a most common land use dynamic, who owns the land, who are the potential financers, labour profile, etc.

Figure 4.1 **Schematic presentation of the land use dynamics in Brazil and relevant issues and actors**



At first, forest or savannah land is cleared mainly for wood and charcoal production by national and international loggers. Concessions are given by the government and are regulated by the law n°11.284 from 2006 (www.planalto.gov.br/ccivil_03/_Ato2004-2006/2006/Lei/L11284.htm), but in several cases illegal logging has been reported. In the state of Mato Grosso for example in June 2008 the report "Forestry Transparency" elaborated by the institutes IMAZON and ICV (Instituto Centro de Vida) affirmed that 84% of the deforestation in that month was illegal since the great majority of the deforestation occurred in rural properties outside of the SIMLAM (Monitoring and Environmental Licensing Integrated System of the State of Mato Grosso) (Transparência florestal, June of 2008). Much public land, especially in the State of Pará, has no land title and loggers may simply claim land. Logging for timber generally does not lead to a complete clearing of the land as useable trees are ex-

tracted only. The demand for wood and related products is expected to grow at a rate of 1% globally, with Asia increasing its imported share, while Brazil will take a more important role in export (FAO, 2007; Pepke, 2002). Deforestation however may be more related to charcoal production, cattle ranging and agriculture, as a close correlation between the price of meat and soybean was found with the rate of deforestation (P. Barreto, IMAZON – personal communication).

Traditionally, the National Institute for Space Research (INPE) analyzes the rate of deforestation in Brazil on an annual basis using LANSAT data (see Figure 4.2). Data is accessible through internet and shows a declining trend in deforestation after 2004. The most recent data about deforestation of the past months have, however, been subject to severe debate. The research institute IMAZON developed a new methodology using daily data from the MODIS satellite to generate monthly information on deforestation. These data showed an accelerated rate of deforestation during the last few months of 2007. The INPE also released monthly monitoring information but added both deforested and degraded forest areas. According to the IMAZON, degraded forest areas are the areas that suffered logging exploration and/or were affected by natural fires in different intensities, but are not considered deforested areas yet, which caused the confusion.

Based on the data provided by IMAZON the government of Brazil took immediate action by putting strict criteria on credit facilities for both public and private funds. As a result, the rate of deforestation decreased during the first half year of 2008, even with 70% compared to the rate during the similar period in 2007. This measure seems more effective than fines given by the government to illegal deforestation, because of her inability to implement the penalty. To what extent the impact on deforestation will remain is unclear. National interest call for releasing such stringent measures. Obviously, monthly monitoring of deforestation has a large impact on government policies.

Figure 4.2 Rate of deforestation in the legal Amazon (data from INPE)

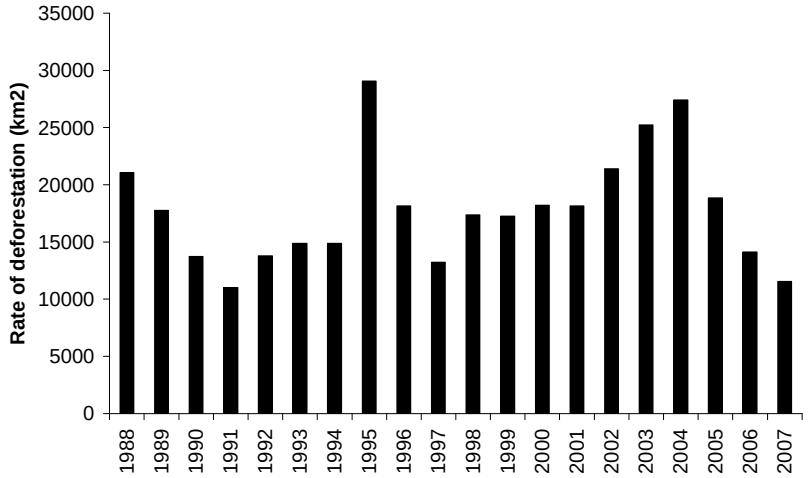


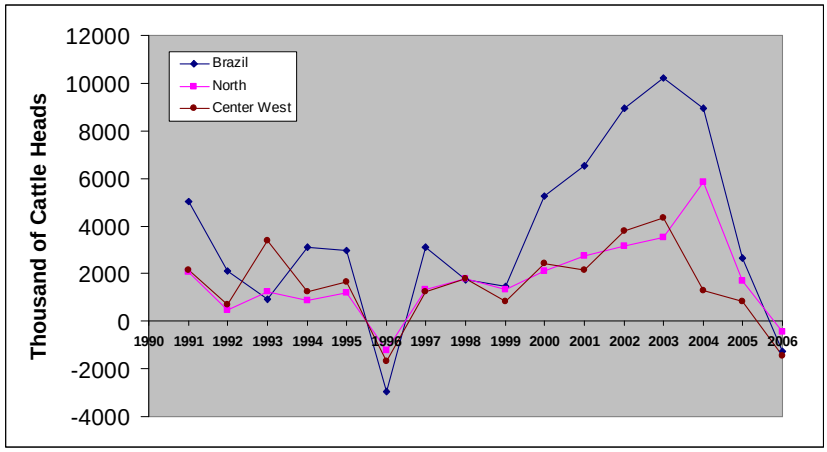
Table 4.2 Rate of deforestation in the Legal Amazon per state (km^2)

	Acre	Amazonas	Amapá	Maranhão	Mato Grosso	Pará	Rondônia	Roraima	Tocantins
1988a	620	1,510	60	2,450	5,140	6,990	2,340	290	1,650
1989	540	1,180	130	1,420	5,960	5,750	1,430	630	730
1990	550	520	250	1,100	4,020	4,890	1,670	150	580
1991	380	980	410	670	2,840	3,780	1,110	420	440
1992	400	799	36	1,135	4,674	3,787	2,265	281	409
1993b	482	370	9	372	6,220	4,284	2,595	240	333
1994b	482	370	18	372	6,220	4,284	2,595	240	333
1995	1,208	2,114	30	1,745	10,391	7,845	4,730	220	797
1996	433	1,023	7	1,061	6,543	6,135	2,432	214	320
1997	358	589	0	409	5,271	4,139	1,986	184	273
1998	536	670	25	1,012	6,466	5,829	2,041	223	576
1999	441	720	46	1,230	6,963	5,111	2,358	220	216

Table 4.2	Rate of deforestation in the Legal Amazon per state (km²)								
	Acre	Amazonas	Amapá	Maranhão	Mato Grosso	Pará	Rondônia	Roraima	Tocantins
2000	547	612	33	1,065	6,369	6,671	2,465	253	244
2001	419	634	30	958	7,703	5,237	2,673	345	189
2002	883	885	39	1,014	7,892	7,324	3,099	84	212
2003	1,078	1,558		993	10,405	6,996	3,597	439	156
2004	728	1,232		755	11814	8,521	3,858	311	158
2005c	592	775		922	7145	5,731	3,244	133	271
2006c	398	788		651	4333	5,505	2,049	231	124
2007c	184	610		613	2678	5,425	1,611	309	63
a Average from 1977 to 1988; b Average from 1993 and 1994; c Consolidated annual rates.									

After logging, the land is then cleared generally by cattle farmers who have purchased the land from the loggers or any other land owner. It is sown with African grass species (Brachiaria) that performed well under the prevailing soil conditions for cattle raising. Generally investments to maintain soil quality are not made. Productivity increase in cattle raising is obtained from supplementary feeding which increases the meat production per head. The stocking density however remains low and the productivity of the grassland itself is subject to degradation. Improvement of productivity per hectare would be obtained with high investments to increase the pH (i.e. reduce the acidity) of the soils by liming and improve the P-status by fertilisation, but appears economically unfeasible. It remains attractive therefore to expand into new lands as profit margins are higher, also because public land is cheaply acquired (Anualpec 2008). The importance of the Northern and Central Western regions in Brazil for expansion of cattle raising is presented in Figure 4.3.

Figure 4.3 **The change in number of cattle over time in Brazil, with most of the expansion in the Northern and Central Western regions**



After 3 to 5 years, these grazing lands may be converted into cultivation land. Land preparation requires burning of the trunks and uprooting of the roots left in fields after logging and clearing and did not jeopardising cattle raising. The elapsed time starts a process of decomposition of these roots and trunks to ease the process. It is for this harsh work that cheap labour is used in some location, though machines are increasingly being introduced for this activity.

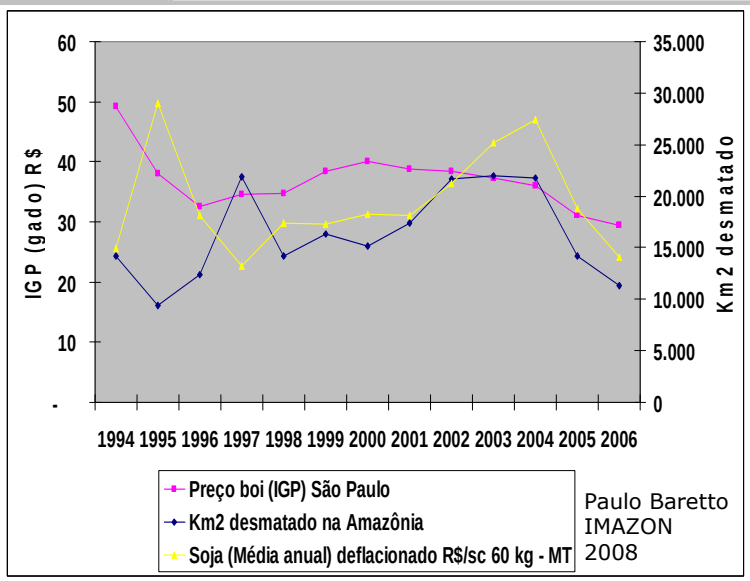
The first arable crop to be grown is dryland rice. After 2-3 years, other crops including soybean generally occupy the land. For these crops the lands should be well cleared to allow mechanical operations.

Another pathway to increase the acreage of soybean is through the purchase of land from family agriculturalists by large investors. This dynamic will be dealt with in another section.

These dynamics in land use reveal the large number of strongly interacting factors and actors that together create the driving force for land clearing and ultimate use for soybean production. There is a general assumption in Brazil that no additional land needs to be cleared for the expansion of arable crops like soybean and sugarcane. By increasing the productivity of the 220m hectares of grasslands by 10-15%, the required 25-30m hectares for the expansion of these crops can be absorbed. Given the high investments to increase the productivity of grasslands, and the demand for wood, it seems not likely that the process of land use dynamics will stop in the very near future. Moreover, a

close relation between the price of meat and soybean with deforestation suggests an indirect, but clear link. It remains important therefore to monitor these dynamics and to identify a package of measures that impact on all the activities, rather than on one commodity only.

Figure 4.4 **Relation between the price of meat and soybean and the rate of deforestation**



Source: Paulo Baretto – IMAZON.

4.2.3. Labour conditions

Brazil has installed a national plan to eradicate forced labour in 1995 and establishes the Executive Group for Repression Against Forced Labour (GETRAF) with the purpose of coordinating and implementing the necessary provisions for the repression to forced labour. The RTRS states that labour conditions for soybean should comply with the international agreements (see box).

International Labour Organization (ILO)

According to the ILO (2005), forced labour can be defined as the coercion of one person to perform certain types of work and the imposition of a penalty in case this work is not done. It may arise from abusive practices of recruitment, which lead to debt bondage. In Brazilian

rural areas, this is the typical scenario that characterised slave labour, where workers are subject to degrading conditions of work added to the impossibility of displacement due to geographical isolation, the fraudulent debts and/or the presence of armed guards.

Some working conditions in Brazil has been coined as 'slavery', mostly by NGOs, while the ministries classifies these as exploitation and over-exploitation. Currently, professional associations, such as ABIOVE (Brazilian Association of Vegetable Oils Industries) and domestic and foreign companies related to the processing industry and trade of soybeans are part of the National Pact for the Eradication of Slave Labour, launched in 2005, in Brasilia, the International Organization for Labour (ILO), the Ethos Institute and the NGO Reporter Brasil. All participants of the pact have undertaken not to acquire more products from soybean producers that, demonstrably, use forced labour. The pact follows the so-called 'dirty list' of slave or forced labour in Brazil, a public registry that informs the irregular farms, updated regularly by the Ministry of Labour and Employment. Based on that list, public and private banks, as well as local and federal governments, could block financing these farms. Major retailers refuse to distribute soybeans produced at these farms. Although the pact is not responsible for the arrests or investigations on these cases (but the prosecutor is), blocking of credits to those producers has already led to the reduction in the number of forced labour in general (Reporter Brasil, 2008).

Interview and ABIOVE [2]

With the productivity increasing, there is a tendency to replace labour by machinery in the soybeans fields. Nowadays the soybeans agricultural production demands intense use of machinery and labour in the soybean production must therefore be better qualified than traditionally.

Withdrawals of the ILO from the soybean sector indicate that the number of farms reported on the work of soybeans analogous to slavery is very small. Still however ABIOVE signed the national pact to eradicate slavery in soybean, because any event would undermine the image of the farmers and of the country as a whole.

Reporter Brasil [3]

At its report from 2008, Reporter Brasil presents data from the Ministry of Work affirming that from 1995 to April of 2007 about 29 thousand people were found in inhuman conditions of labour in the whole of Brazil. During the same period the NGO 'Comissão Pastoral da Terra' aiming to combat rural violence and forced work registered around 50 thousand workers' complaints related to this type of inhuman exploration.

About the incidence of this problem in the soybean fields, the report presents a list (www.reporterbrasil.org.br/listasuja) of 163 rural properties with register of presence of forced labour. The soy properties occupy the third position in the rank with a total of 10 cases registered.

There are two cases of soybean property presented in the report: one in the State of Piauí, Northeast of Brazil when agents from the Ministry of Work found 17 people working without individual protection equipment, precarious condition of housing, working hours above the amount that Brazilian legislation admits and unpaid salaries. The second cases reported was in the State of Maranhão (also Northeast Region) where twenty workers were released by the Ministry and Federal Police Agents. The rural workers housing did not have sanitary facilities and drinking water.

Repórter Brasil [3]

According to data from the Brazilian Government (ministry of social affairs), in 1999 it registered 99 cases of accident or sickness involving workers from soybean field, in 2006 this number jumped to 304 cases. This data is related to sickness, typical accident during precarious transportation to the working place.

The problems regarding poor labour conditions on soy farms were historically associated with irregular workers, bad working conditions, child labour or forced work. While these problems were registered at some point in time, the cultivation of soybean has fundamentally changed since. Soybean production does not demand many employers because of the technological inputs and intense mechanization that in turn have induced the need for high quality labourers (Roessing, 2004; ABIOVE, 2007). Workers at the soy farms are therefore better qualified than the average rural workers. This argument contrasts the observations of the Ministry of Work and NGOs who relate worker exploration and forced work mainly to workers with low qualification who are taken to remote areas to work under inhuman and exhausting conditions.

Fernandes and Marin (2007) scanned the causes and activities on forced work and found that all cases were registered in the central west and north regions of Brazil during the period of 1995 to 2002, with the only exception the State of Maranhão located in the northeast region. The state of Pará was responsible for 70% of all cases registered in Brazil, with 96% occurring in the southeast of Pará.

Table 4.3	The number of freed workers in various states of Brazil									
Freed workers	**1996/ 98**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total**
Acre										
Ceará							2	12	8	22
Rio Grande do Norte									88	88
Rio Grande do Sul							29			29
Mato Grosso do Sul								35		35
Paraná						29		26	29	84
Alagoas								82	26	108
Piauí				49						49
Minas Gerais	83						38	18	54	193
São Paulo	12				24		19		39	94
Espírito Santo					76		142		430	648
Goiás							244	80		324
Rondônia			79				245	404	3	731
Rio de Janeiro					42	355	18	42		457
Tocantis						446	183		68	697
Bahia		32		27		482	541	318	455	1,855
Maranhão						1,089	150	312	684	2,235
Mato Grosso		27	157	457	184	276	347	484	285	2,217
Pará	436	283	280	245	567	683	326	1,412	397	4,629
Total	254	383		527	1,392	1,888	928	1,345	1,149	7,866

Source: Comissão Pastoral da Terra, 2007.

The lack of solid scientific information about labour conditions, be it forced labour or other less dramatic direct effects like exposure to agro-chemicals, hampers firm conclusions. As a result, actors tend to portray their own findings and perceptions as most relevant leading to blurred discussions, loaded with

sentiments. Given the various efforts made by the government, the increasing mechanisation of the cultivation practices of soybean, it could be stated that the incidence rate might indeed have been declining in Brazil, though not yet eradicated along the various steps of the land use change processes.

4.2.4. Respect for land rights

Land rights is a very complex subject that for many is the 'root' to most problems related to agricultural development, environmental conservation and social conflicts. Current initiatives in Brazil do reveal the efforts being undertaken by government to resolve problems related to land rights.

Barreto et al. (2008) present an extensive review of problems related to land rights for the Brazilian Amazon, stating that land rights are better controlled with properly developed institutions that are responsible for the control and legalisation of the rural properties in other regions in Brazil. Their review also present an analysis about the land re-registering that is under development for the rural properties in the Brazilian Amazon. Although this publication is not direct related to the soybean production, it is important for analyzing the actual situation.

According to the authors, the missing answer of the question 'Who are the Amazon land owners?' is the cause of many problems in this region. Land that was suspected to be illegally possessed, stimulated land conflicts that was responsible for about 46 death cases in the Brazilian Legal Amazon between the years of 1985 and 2005. Also because of the missing regulation for land registering many people that occupies public lands can not access the financial programmes for environmental licenses to produce or manage the forest. The irregular status and lack of information about land ownership, create great difficulties to governmental agencies responsible to prevent illegal deforestation as they cannot trace the responsible person to impose legal charges. Maps of the properties to identify land owners are missing.

An example relates to the registration of rural properties and governmental conservancy units and indigenous territories in the Brazilian Amazon. In 2007, 43% of the Brazilian Amazon territory was occupied by conservancy units and indigenous territory, corresponding to about 209m hectares. Some of those areas were, however, also registered by private owners. According to Bóris Cesar from the Brazilian Institute of Environment and Natural Resources (IBAMA) that is responsible for the management of the conservancy units, there were misunderstandings about at least 10m hectares, only on their responsible area (Barreto et al., 2008).

The uncertainty about the land rights and owners in the Brazilian Amazon can be demonstrated by the large number of rural properties that have fake documents and informal land ownership in places with unknown localisation. In the last ten years the Federal Government developed three programmes of rural properties re-registering in 1999, 2004 and 2008. In the beginning of this decade the Ministry of Agrarian Development published a study revealing the results of the 1999 program, as a basis for the programmes in 2008, presenting a large number of rural areas that were suspected of being illegally possessed. Still there remains a lack of scientific publications and studies regarding the results of those programmes about the recovery of public lands being exploited illegally (Barreto et al., 2008).

The land re-register aims to prevent suspicious land ownership in rural registration by requesting all owners of the rural properties to present themselves with all land documents and georeference maps to the agency responsible (INCRA). By blocking all current registrations, the programme aimed to stimulate the re-registering because land owner cannot not access public financial programmes or sell the property without their land certificate. The re-registering in 1999 blocked, for instance, 3,579 rural properties with area equal or superior to 10,000 ha, totalling 120m hectares being 14% of the Brazilian territory, of which 67% was located in the Brazilian Legal Amazon. The 2004 re-registering blocked 743 rural properties with area between 5 thousand hectares and 9,999 ha, reaching close to 5m hectares which 77% was inside the Brazilian Legal Amazon.

The main achievements related to this governmental initiative were among others the:

- cancellation of rural register of 20m hectares that to a great majority become conservancy units;
- validation of documents for 20m hectares regarding 663 rural properties;
- 'possession declaration' by INCRA being a precarious document that created expectation towards land regularisation and was used by medium and small producers with areas smaller than 450ha to obtain public funding and for commercialisation of the land;
- blocking of the Certificates of Rural Properties Register of proximally 66 thousand rural properties that impeded the formal sale of the area;
- the creation of the National Register for Rural Properties by the Federal Government (CNIR) to increase the security in the process of the rural registering.

Despite all this advances during the ten years of the first programmes of re-registering, some important lacks about the regulation, occupation and use of public areas in the Brazilian Amazon, including that:

- by the end of 2006, 56m hectares were still under process or with no information and some million hectares where archived with clear verification of the State's documents presented by the land owners;
- more than 40m hectares remained illegal;
- the Federal Government developed only a single attempt (experimental plan) for the CNIR implementation, including only the State of Maranhão of the nine States of the Brazilian Legal Amazon.

Soy Expansion at the Region of Xingu-Araguaia

The Low 'Araguaia' region is located at the Northeast of the Mato Grosso State, between the rivers Araguaia e Xingu. This region has almost 100 thousand square kilometres, with a population of 90,000 habitants. Originally this is an Indians territory that was successively occupied by farmers coming from the South of Brazil. Since the 1970's, large agricultural projects were installed in the region using governmental incentives. Those projects occupied the lands of the native population especially for pasture for cattle raising. This region is traditionally characterised by small-farmers, with small properties occupied many times by possession. In the last year INCRA (Governmental Institution responsible for the land regularisation) worked on the regularisation of many of these possessions for the land reform. Although in the last years the soybean producers are expanding in this region, with the perspective of creating large properties and projects that will lead to some probable social and environmental effects once this process will be under development.

The most cultivated crops in this region are soybean, corn, rice, bean, sugarcane and cassava. The production system is characterised as small properties with intense use of human labour and low yields. The advance of he mechanised agriculture over this region can be observed when analyzing the soybean production in 2003.

The soybean area in this region of the State of Mato Grosso correspond to 1,63% of the State soybean area and 1,68% of the states production. This study elaborated by Dr Barrozo affirmed that the irrational advance of the soybean production in the Northeast of Mato Grosso will be at the areas occupied by small producers and areas destined to land reform. The dislocation of those producers will cause the dislocation of those producers to urban areas or outside this region, as the capital and technology intensive soybean production creates low amount of human labour.

Source: Interview Dr João Carlos Barrozo Univ Federal de Mato Grosso.

4.2.5 Small scale and traditional land use

Here, information about the small scale and traditional land use has been presented for Brazil mainly based on census data from 1996. While a new census has been carried out in Brazil recently, the information has not yet been processed and not readily available for this report.

Embrapa Soja (2006b)

It can be derived by trend revisions of the Brazilian agribusiness, that the production of soybean increasingly focuses on large properties in the central region of the country. The owners of small and medium-sized properties of the southern region, for lack of competitiveness in the production of soybean, tend to alter their practices to more profitable agricultural activities, including production of milk, pigs and poultry, cultivation of fruit and vegetables and ecotourism. Because these activities require a more intensive use of labour they appeal to small family properties with abundant labour but scarce in land resources.

Traditionally the South of Brazil is the main region that concentrates close to 200,000 small farmers producing soybean in a small-scale system of production. Since the last census in 1996 by the Brazilian Institute of Geography and Statistics (IBGE) there was a clear division between the soybean production in the South of Brazil and the Brazilian Central West (Roessing et al., 2004).

As Table 4.4 shows, the small and medium size properties are mainly concentrated in the southern states Rio Grande do Sul and Paraná of Brazil, while the states Mato Grosso, Mato Grosso do Sul and Goiás in the central west concentrates mainly medium and large size properties. In Mato Grosso, for example, 78% of the soybean farms had areas larger than 1,000ha in 1996 while Rio Grande do Sul had 66% of the soybean farms with less than 1,000ha and only 10% with more than 1,000. The production data reveals the same conclusion and also reveals other important aspect related to the differences in productivity between the small and large soybean properties.

The efficiency of the soybean production is very dependent of the level of technology adopted by each property. Overall the productivity of farms has increased over time with larger farms achieving higher yields. It is important to distinguish between technology adoption by smallest farms and farms exceeding 1,000ha that all apply similar large scale technologies. The data further suggests that soybean production in the Central West, especially in the State of Mato Grosso, developed in large areas enjoying the benefits of economy of scale. The production in the South however was developed at small and medium

size properties but in recent years they are turning into larger properties because the dependency on small properties is feasible only when they are linked to an integrated chain (Roessing, 2004).

Table 4.4 Area cultivated with soybean in the main producer States - 1995/96

Area (ha)	Brazil	RS	PR	MT	MS	GO	Other
Thousand hectares							
less than 10	195	112	71	1	3	-	7
10 to -100	2,168	1,070	1,002	4	47	26	19
100 to 1,000	3,759	977	1,007	383	332	392	668
1,000 to 10,000	2,810	244	182	1,122	315	429	518
more than 10,000	383	-	5	230	50	16	83
total	9,316	2,403	2,268	1,740	747	863	1,295
Percentage							
less than 10	2.1	4.7	3.2	0.06	0.40	-	0.54
10 to -100	23.3	44.5	44.2	0.23	6.3	3.0	1.5
100 t0 -1,000	40.04	40.7	44.4	22.0	44.4	45.4	51.6
1,000 to -10,000	30.2	10.1	8.0	64.5	42.2	49.7	40.0
more than 10,000	4.1	-	0.23	13.2	6.7	1.9	6.4

Source: IBGE cited in Roessing et. al. (2004).
States: RS=Rio grande do Sul; PR=Paraná; MT=Mato Grosso; MS=Mato Grosso do Sul; GO=Goiás.

There is a large difference in the number of employers between the small farms compared with the large properties. As the small farmers are not able to adopt capital intensive large scale technologies, they are more dependent of labour creating more jobs per area.

These developments of the increasing farm size of soybean cultivation and the expansion of soybean towards the North-eastern and North-western regions continues as of today, and is likely to continue as the total production volume of soybean cultivation will continue to increase

Table 4.5	Evolution of number of producers, production and soybean area in Brazil			
Area (ha)	**Producers**	**Production (t)**	**Area (ha)**	**Yield (t/ha)**
1985 Census				
less than 10	125,175	521,844	370,324	1.40
10 to -100	263,150	5,664,254	3,293,734	1.72
100 to -1,000	28,225	6,971,811	3,824,098	1.82
1,000 to - 10,000	3,388	3,111,418	1,694,021	1.84
more than 10,000	149	476,614	249,289	1.91
not informed	117	4,144	3,218	-
1996 Census				
less than 10	57,203	356,726	195,068	1.83
10 to -100	157,147	5,059,819	2,337,097	2.16
100 to -1,000	24,713	8,602,393	3,759,820	2.29
1,00 to 10,000	3,774	6,656,601	2,809,816	2.37
more than 10,000	153	912,441	386,171	2.37
not informed	8	213	96	-
Source: FIBGE (1985) and Censo Agropecuário (1996). Cited in Embrapa (2004).				

Where increase in farm size is not easily feasible, farmers, especially in the South of Brazil are looking for niche markets such as organically produced soybean or, more recently, non-GM-soy because of the demand by Europe. An increasing number of initiatives are being developed to this aim.

4.2.6 Responsible community relations

A way to understand how the soybean sector affects community development is by measuring the number of direct jobs created by this activity. Other important issues related to rural production and characteristics and the soybean industry should however also be taken into consideration (Roessing, 2004).

The first aspect of the creation of jobs by the soy chain that needs to be considered is the different type of jobs that an economic activity can generate. The governmental funding institution responsible for the promotion and support of economic activity (BNDES), developed a methodology to measure the number of employments created by a sector. Najberg and Pereira (2004) explained that this methodology distinguishing three types of employment. Firstly, direct employment that corresponds to the employment required by the sector in increas-

ing production. Secondly, indirect employment that relates to working places created in sectors that support the productive chain, since the production of a final product stimulates the production of all inputs necessary for its production. And thirdly, wealth-effect employment that is obtained from the transformation of the workers and businessman wealth into consumption. Part of the company's income is transferred through the payment of salaries or dividends share, into wealth to its employers and businessman.

According to an Embrapa study, soybean production does not employ the same amount of jobs as other rural activities because of the intense demand of machinery and technology (Sachs, 2004). Table 4.6 shows the number of direct jobs required for different rural activities in 2004. Soybean production requires two direct employers in a rural property with 100 hectares, compared to crops like rice and potato with 16 and 29 employers, respectively.

Table 4.6 **Direct jobs (man/year) demanded for some of the main rural activities for 100ha in 2000**

Activity	Number of jobs	Activity	Number of jobs
Tomato	245	Cashew	23
Grape	113	Orange	16
Tobacco	70	Rice	16
Pineapple	61	Coconut	14
Onion	52	Bean	11
Coffee	49	Sugarcane	10
Cassava	38	Maize	8
Cocoa	37	**Soybean**	**2**
Potato	29	Cattle	0.24
Herbarium Cotton	24	Grains (12)	7
Castor Plant	24	Average of 36 crops	12

Source: Fundação Seade / Sensor Rural. Mentioned by Sachs (2004).
States: RS=Rio grande do Sul; PR=Paraná; MT=Mato Grosso; MS=Mato Grosso do Sul; GO=Goiás.

This would imply that on the current Brazilian acreage of 20.6m hectares in 2007 cultivated with soybean, would create close to 415 thousand direct jobs. When considering the last official data from 1996 (IBGE), however, this amount could be underestimated even when correcting for the high dependence of technology and mechanisation. It is estimated that that about 891 thousand people are involved at soybean farms (Embrapa, 2004).

Where Sachs (2004) estimated that an increased production through agricultural or animal farm by 10m Brazilian Reals would result in 393 direct jobs, 131 indirect jobs and 303 wealth effect jobs. Roessing and colleagues (2004) reasoned the soybean production increase would then create about 60% of these jobs. They find however that the soybean chain is more efficient in creating new indirect jobs and wealth effects than direct jobs. The total number of jobs related to the soybean chain was calculated for 2003 at some 3.8m, but considering the influence of the soybean sector on the Brazilian agriculture and its impacts on other important sectors including the animal production and agrochemicals, the whole soybean sector might be responsible for 4.5-5m jobs, taking into account the direct, indirect and wealth effects.

Scientific reports on other aspects related to a responsible relation with local communities, such as associated with the expansion of productions systems, have not been found during this study period and would have to be looked at in more detail. It might not be expected that much scientifically verifiable information will be available, implying that one would still have to rely on case descriptions.

4.2.7. Environmental responsibility

The biggest issue regarding the environmental responsibility on the soybean production relates to the illegal deforestation in the Brazilian Amazon. The most famous case is the report published by the NGO Greenpeace (2006) called Comendo a Amazônia ('Eating the Amazon'). Greenpeace warns for the fact that the Amazon Biome is under the pressure because new investments and logistic infrastructure are being made for this crop, though the current soybean area in the Amazon biome itself represent only 5% of the cultivated land in Brazil. The report motivates its claim by stating that it is easier to deforested primary forest areas than to buy already deforested areas in the Amazon.

The Brazilian Association of Vegetable Oil Industries (ABIOVE, 2008) however claims that soybean does not represent any threat to the Amazon biome since its area corresponds to less than 0.5% of the Amazon Biome. ABIOVE further states that, following the Brazilian Environmental Legislation, all rural property in the Brazilian Cerrado and Amazon, should maintain 35%, respectively 80% of their areas as protected area. Including all conservation units and indigenous territories this would result in 63% of all Brazilian Legal Amazon territory to be protected (Table 4.7).

Table 4.7	Policy of Environmental Protection in the Brazilian Amazon
	Million ha
Protected areas (conservation units and indigenous areas	178
Legal Reserve (Amazon Biome 80% / Cerrado 35%)	143
Total Protected (63% of the Brazilian Legal Amazon)	321
Source: ICONE, mentioned by ABIOVE (2007).	

Hence, ABIOVE argues that if the Brazilian Government uses its institutions and agencies to prevent illegal deforestation and to assure that the rural properties will follow the established Forestry Code, the soy production should not be considered a threat to the Amazon conservation.

The complexity related to the land use dynamics associated with this issue was elaborated in section 4.2.2.

The different views reflect the lack of scientific evidence about these issues. Moreover, much confusion about the impact on the Amazon relates to the delineation of the Amazon and the legal Amazon. While the Amazon refers to the biome itself, the legal Amazon is an extended area that includes some of the Cerrado biome. Some groups will refer to the entire legal Amazon as the Amazon, while others will refer to the biome only.

4.2.8 Responsible water management

Little irrigation is used for soybean cultivation. In Brazil, the number of pivot centres is however increasing. Soybean yields are heavily affected by rainfall, which necessitates adequate management to limit yield loss. The efficiency of water uptake depends highly on the management of the soil structure and other inputs. Plants that have the same amounts of water available will grow more efficiently with adequate amounts of nutrients than without. The quality of the water leaching from soils will depend on the nutrient management and application of other agro-chemicals. These strong interactions should be considered in any sensible assessment of water quality and quantity.

Additional information about the hydrological characteristics and water related issues of the Cerrado have been presented in Elbersen et al (2008).

Repórter Brasil

Reports from the Secretary of Environment from the State of Mato Grosso presented high phosphate concentration at some sub-basins in the State. At its report one of the possible causes are from the utilisation of higher amounts of fertiliser in the agricultural activity in the

Repórter Brasil
State. Reporter Brasil admits that the correlation of intense rural activity and impacts over the water resources are an issue that demand more studies in order to establish better conclusion.

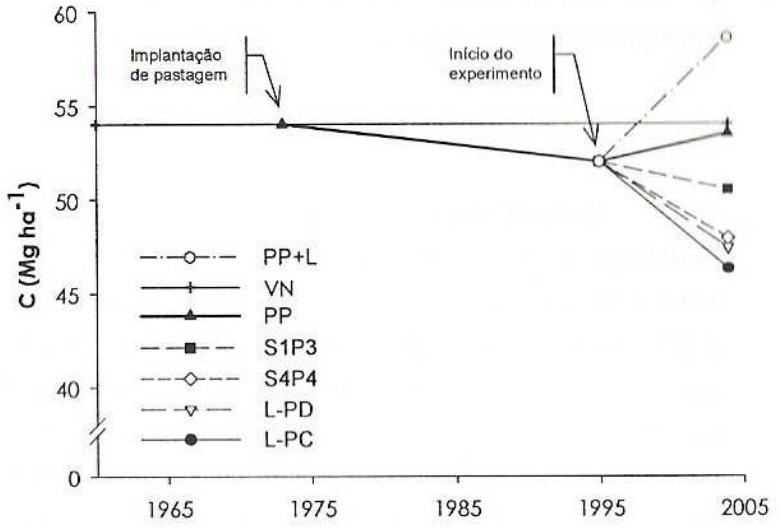
4.2.9 Responsible Soil Management

Responsible soil management implies that the production quality of the soil is maintained or improved and does not decrease over time. Soil structure is of importance to facilitate nutrient and water uptake by plants. A high pore density for instance facilitates water flow and might be an indication for high levels of soil biota. The surface characteristics of the soil is important to facilitate infiltration of water into the soil rather than water running off the field, potentially causing soil erosion. High levels of compactness for instance due to tractor movements can limit infiltration of water. These characteristics depend highly on the texture of the soil, i.e. the composition of sand, silt and clay, indicating that these issues have to be evaluated location specific.

Maintaining the fertility of a soil depends highly on the way and amount of nutrients applied during cultivation and the amount of Soil Organic Matter (SOM). Nutrient application should be optimised to the need of the crops as the rate of nutrient uptake depends on the growth rate of the crop that varies during the season. It should be optimised such that nutrients are not leached for instance due to rain showers and/or because application rate and timing does not meet crop demand. Also, nutrients can be placed in the soil such that it can be taken up best by the roots. Quantity, timing and placing are important elements in evaluating soil fertility.

Soybean as a legume has the ability to fix nitrogen from the air. Therefore generally no nitrogen fertilisers are being applied in countries like Brazil. The extent to which the nitrogen fixation entirely provides the nitrogen that is removed from the field remains unclear. Findings vary greatly suggestion both net depletions and net improvement of soil fertility. This is illustrated by Figure 4.5.

Figure 4.5 **The carbon content in soils as an indication of soil fertility shows that the fertility of soils under soybean-based cultivation practices will depend greatly on agronomic practices and cropping systems. Lines represent different management and cropping practices**



Source: Salton, 2005.

Literature review suggest that the sole and continuous cultivation of soybean may lead to declining soil fertility over time, while application of N-fertilisers to non-soybean crops in the crop rotation in combination with zero tillage practices ultimately lead to the build up of soil organic matter (Batlle Bayer, in prep). Bustamante and colleagues (2006) found similar patterns by simulating the dynamics of C and N in soils after conversion of native Cerrado vegetation over a period of 30 years.

The use of other nutrients depend very much on the local soil conditions. In the Cerrado biome soils are for instance slightly acid in the range of pH 4 to 6. A pH above 5.3 prevents toxicity of microelements like aluminium, to which aim lime is applied at rates ranging from 700 to over 3200 kg ha^{-1}. Soil phosphorus should be adequately available to stimulate this symbiotic process of soybeans with rhizobium to fix nitrogen, and the soil pH should not be too low. Soluble soil phosphorus content are far below recommended levels for plant growth in almost 90% of the soils (Yamada, 1983), and potassium availability in most of the soils is low as well. Actual application rates for correcting soil P and K ranging

from 60-240 for P_2O_5 and 50-100 for K_2O. Phosphorus application rates in the Cerrado may roughly double application rates in the southern states of Brazil like Paraná (Embrapa Soja, 2006a b; Embrapa Informação Technológia, 2004).

Zero tillage is a cultivation practice with a number of ecological and economic benefit. Less energy is needed as soils are not tilled, residues left on the soil serve as input for carbon build up in the soil and erosion is generally reduced. Findings are diverse however, though with positive overall results.

Findings about SOM dynamics reveal substantial opportunities to implement management practices that would maintain the production capacity of the soil, but these practices should be location specific. The large demand for phosphorus is however a major concern, because it has to be imported in large quantities, it is not a renewable source and much is fixed in the soils. Therefore more emphasis should be placed in future to unravel the fate of phosphorus and ways to reduce requirement, such as by placing close to root systems.

Abiove

About 50% of the area planted with grain in country is based on the zero-tillage system. Brazil is the world leader in zero-tillage, a practice which has a number of benefits such as reduction of degradation and impoverishment caused by soil erosion, and significant reduction in consumption of diesel oil. The tillage allows more stability in production because of the increased storage of water provided by the large infiltration into the soil and reduction of its evaporative loss, due to protective mulch. While generating an increased use of herbicides, the practice also brings environmental gains because it reduces the silting and contamination of springs, rivers and lakes, biodiversity and increases soil organic matter content.

4.2.8. Protection of biodiversity

The Brazilian law (number 4771/65) has established the Brazilian Forestry Code and introduced the concepts of Permanent Preservation Areas (APP) and Legal Reserves (LR) (Brazilian Civil Code, 2008). The APPs are defined as areas covered or not covered by native vegetation, with the environmental function of preserving water resources, landscape, geological stability, biodiversity, the gene flow of fauna and flora, protect the soil and ensure the welfare of the people. These are considered permanent preservation forests and other forms of natural vegetation located. Along the rivers or any water course a natural boundary with minimum width are imposed of 30, 50, 100, 200 and 500 meter for rivers with a water courses of less than 10 meters, 10 to 50, 50 to 200, 200 to 600, and more than 600 meters, respectively.

Legal reserves are area located within a rural property or possession, except the APPs, necessary for sustainable use of natural resources, conservation and restoration of ecological processes, conservation of biodiversity and or shelter and protection of native flora and fauna. The Legal Reserves (LR) extension depends on the location of the agricultural property; i.e. 80% in rural area in the Legal Amazon; 35% in areas located in the Cerrado, of which 20% on the property and 15% in the form of compensation in another area when it is located on the same micro basin; and 20% in rural area in other regions of the country.

Repórter Brasil

The conservation areas inside the Cerrado biome protect only 2.2% of the biome territory in 2002. According to the data from the NGO Conservation International, if the deforestation rates in the Cerrrado remains the same from the average rates between 1985 to 2002 (1,1% loss of Cerrado covered annually) the biome will disappears by 2030. Nowadays only 34% of this biome remains with its natural vegetation.

The Brazilian Ministry of Environment, developed a list with 14 areas of high biodiversity value. Reporter Brasil demonstrate that all this areas are suffering pressure from the soybean expansion in State like Maranhão, Piauí, Tocantins and Bahia.

4.2.9. Crop protection and responsible use of chemicals

Little science evidence seems to be available on this particular issue. Therefore here only some views of stakeholders have been presented. The case descriptions do suggest the need for closer research into the matter.

Brasil Sinotox

From 1985 to 2003 the number of cases of human intoxication by the use of agrochemicals registered by hospitals and clinics increase from 1749 to 5945. The number of obituary related with the use of agrochemicals in rural activities, was 73 in 1989 and by 2003 reach 164 cases. The data also shows the registered cases by state. The information about the State of Mato Grosso, Brazilian number one soybean producer, indicates a reduction in the number of accidents and obits. The number of cases in 1988 was 104 cases and in 2003 this number has drop to 16 cases.

It is important to note that this data only registered the accidents that reached treatments in hospitals and clinics. The accidents are not registered when the intoxicated person does not go to a hospital. Also, epidemiological effects leading to diseases such as cancer related to the intense or continuum exposing to agrochemicals may not be identified.

Rural Workers Association from Lucas do Rio Verde
Many things have changed within the Project Lucas do Rio Verde Legal related to use of agrochemicals, because of a very serious accident in 2006. Because of the irresponsible air application and intense use of agrochemicals in the rural properties in the city, there was a massive contamination of other rural properties and the agrochemicals reach the city. The technicians responsible for the official report about the incident just arrive in Lucas do Rio Verde 9 days after the event, and concluded that there was no air application above the city, but a dislocation of agrochemicals during application to the soybean fields because the wind was superior than normal. Many small producers of vegetables and fruits, a medicine plants farm and other producers around the city registered the effects of this over their plants. Videos, pictures, reports and several interviews about this case can be found on the website http://www.radiobras.gov.br/materia_i_2004.php?materia=263252&editoria.
Source: Mato Grosso.

4.2.10. Responsible establishment of infrastructure and new areas of cultivation

With the consolidation of the productive areas in the South and Central West of Brazil, all major discussion are now focused on the possibility of the advance of the soybean production over the Amazon Region. According to the ABIOVE in 2005 the soybean represented only 1.4% of the territory if the Brazilian Legal Amazon and only 0.3% of the Amazon Biome area (ABIOVE, 2008).

Regardless of this small participation in the Amazon Region, two infrastructural investments will promote soy to advance into the Amazon Region according to NGOs and environmental organisations. One is the harbour for soybean export located in the city of Santarém, State of Pará, that is operation since 2006 and was built by Cargill, one of the biggest grain multinational operating Brazil. The second infrastructure investments that triggers many discussions is the road BR-163 that will connect the city of Cuiabá in the State of Mato Grosso to the city of Santarém where the harbour is located.

The Santarém Harbor lead to discussion about the soybean advance into the Amazon Biome. In 1999 Cargill won the public concession to built its terminal in the margin of the Tapajós River, with a strategic position because the river characteristics allow ocean carriers from the Atlantic Ocean to reach the harbour. The river has two different depth measures depending on the time of the year; 12 and 18 meter during the dry and rainy season, respectively. At the harbour, the current capacity of storing 60,000 tones of soy is planned to be expanded with another storing room of 30,000 tones capacity (Table 4.8; Cargill, 2008 - Personal Information).

Table 4.8	General Information and Operational Data of Santarém Harbor
General Info	
Product Exported	Soybean (Grain)
Quantity Exported	600,000 tonnes / year
	(Perspective for 1,000,000 tonnes / year)
Main destinies	Amsterdam and Liverpool
Origin of the Soybean	95% Mato Grosso and 5% Pará
Operational Data	
Number and Type of Ship attended	13 Ship / year
	Panamax and Hand max
Stocking Capacity	60,000 tones
	(Perspective for 90,000)
Receiving Capacity	750 tones / h from the boats
	250 tones / h from trucks
Ship Loading Capacity	1,500 tones / h

Source: Cargill, 2008.

The Greenpeace report states that 85% of all deforestation in the Amazon Biome occurs within 50 kilometres along both besides of the road BR-163 (Greenpeace, 2006). The distance between Cuiabá and Santarém is 1,780 km much of which still has to be paved, between the cities of Nova Mutum in the State of Mato Grosso and Santarém. Greenpeace (2006) reveals that the soybean production over the BR-163 increased from 2.4 thousand hectares to 44 thousand hectares between 2002 and 2005.

Concern about the BR-163 is because it will connect the biggest soybean producing state Mato Grosso directly to an exporting harbour in the Amazon region. The two major harbours of Santarém in the State of Pará and Itacoatiara in the State of Amazonas that export the soybean are reached by boats from the old harbour in the city of Porto Velho in Rondônia that is supplied by trucks from Mato Grosso. Therefore, the largest proportion of soy from Mato Grosso is still transported by trucks to the harbours of Paranaguá in the State of Paraná and Santos in São Paulo in the South of Brazil. Because transport costs for the producers in Mato Grosso are very big compared to producers in Paraná or Mato Grosso do Sul, improved logistic through Santarém will stimulate the development and expansion of soybean in the Central West and Central East of

Brazil as it will bring positive results for producers and industries in these regions.

4.3. Case analysis land use change in Mato Grosso[1]

Important ecological components of the sustainability of soybean cultivation relates to the loss of biodiversity and the effects on greenhouse gasses (GHG) and soil fertility due to land expansion. While GHG are not an integral part of the RTRS this information is becoming relevant as soybean oil is by far the largest source for production of biodiesel in Brazil to meet the targets set by the Brazilian government (Brazilian Ministry of Agriculture, 2006), and because of the increasing export of biodiesel. Disentangling commodities for food, feed or biofuel becomes difficult and improving the sustainability for food and feed, while neglecting the impact of bio-fuel would be detrimental for the sustainability of soybean at large.

Therefore a preliminary search has been initiated to look into the land use dynamics of the largest soybean producing state of Brazil, Mato Grosso. This analysis only initiated the development of a methodology to establish science based information about the impacts of deforestation on biodiversity, GHG emissions and changes in soil fertility. Because of the complexity, it is a long lasting and ongoing scientific endeavour of which some general remarks have been presented here.

It appears that much data is available to carry out such analyses but they should be systematically structured, complete sets should be generated through the coupling of various data sources, and data should be aggregated and disaggregated to allow desired analyses. Because of the complexity, new and advanced methodologies to analyze the data have to be developed. Verification and validation of data prior to estimating consequences for soil and biodiversity, and the methodologies to be developed should be carefully performed and need further developed.

For soil information, the Soil Terrain Database SOTER (FAO, 2006) contains detailed data of the distinguished soil types and appears useful for further analysis of changes in soil characteristics due to land use change. As the resolution is low, a more detailed map is being composed on the basis of Brazilian data (RADAM Brazilian project 1970 - 1990), to increase the resolution for more appropriate analyses.

[1] By Prem S. Bindraban and Joao Cannavale Pacheco.

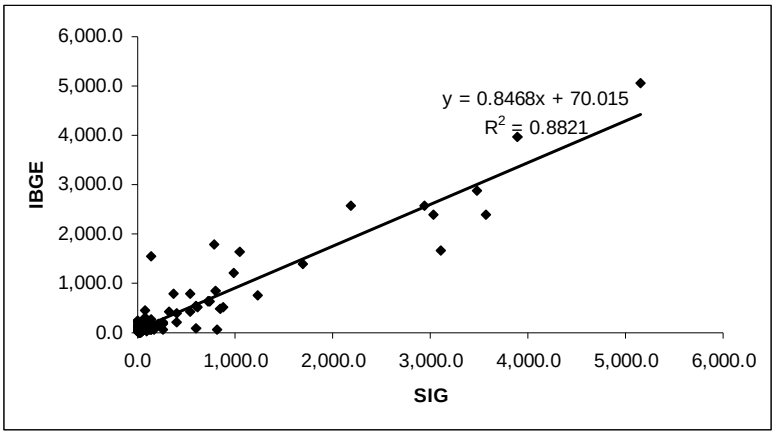
For estimating GHG emissions due to land use change, information on both soil and vegetation characteristics, as well as agricultural activities, are required. By using land use change over a certain period of time, e.g. from 1996/96 to 2006/2007, GHG losses and decline in biodiversity can be estimated. Identifying carbon stocks is the most important component in estimating these GHG emissions. Because of different carbon contents in the vegetation, the type of vegetation where expansion is taking place should be identified in order to make reliable estimates of carbon loss and biodiversity. A map with vegetation types in Mato Grosso is being composed from three different vegetation maps, based on data for the Amazon Bioma from IBGE (Geography and Statistical Brazilian Institute), for the Cerrado and the Pantanal from EMBRAPA (Agricultural Research Institute Brazil).

Changes in carbon stocks when converting natural systems depends on the agricultural activities that is implemented for which their location should be identified. Therefore areas affected by human activity for 2000 has been obtained from IBGE, though with some errors. Another map provided by INPE (Space Research National Institute) allowed a comparison between the two data sets, to correct the errors for creating a new map.

Areas estimated to have been deforested over the research period should ultimately coincide with the changes in land use for human activities, that could be verified using data on deforestation between 1997 and 2007 that was generated during the Prodes Digital program by INPE (Space Research National Institute).

The complexity to accurately mimic the dynamics in land use for estimating changes is illustrated by Figure 4.6. A close correlation between the estimated land areas using GIS information and statistical census data could be expected. This is confirmed in the figure, though with a large error margin and a systematic difference in cropping area between these methods. The accuracy of any estimates therefore depends heavily on the error margins in estimates derived from mapped data and available statistical data and should be carefully looked into.

Figure 4.6 **Correlation between IBGE 2000 crops area and crops area estimated using the GIS map (SIG) (km²)**



The indirect relations between the various human activities (see Figure 4.1) do not allow straightforward analysis of land use dynamics and correlations as has been demonstrated by Figures 4.7 and 4.8. While no correlation of found between the area deforested and the areal change in soybean, a weak relations might be observed with grassland expansion.

Figure 4.7 **Direct correlation between the change in the deforested area and the change in the soybean area for 21 micro regions in Mato Grosso (ha)**

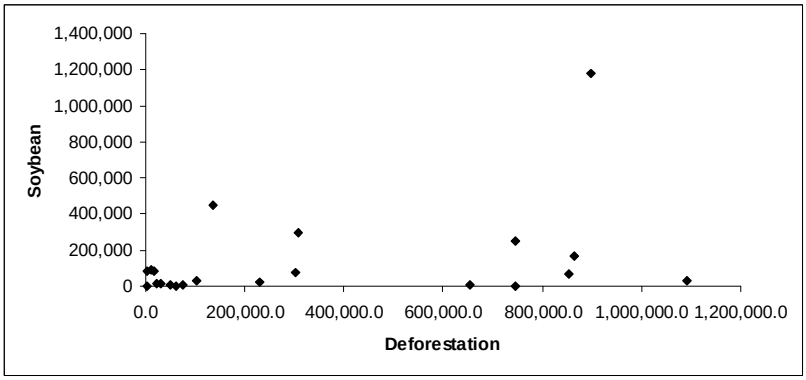
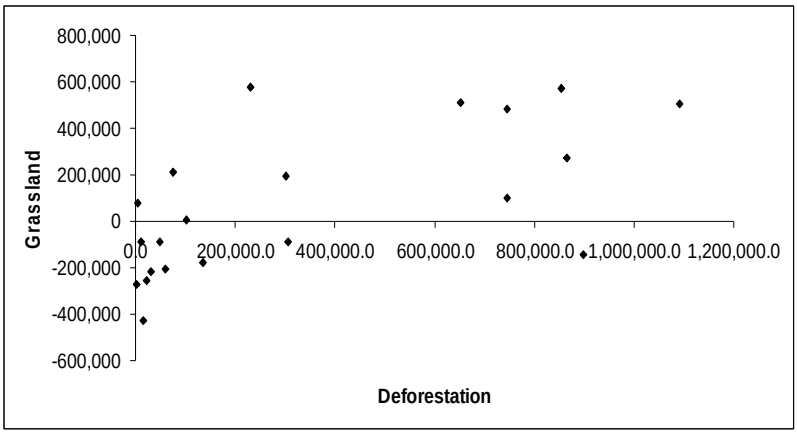


Figure 4.8 **Direct correlation between the change in the deforested area and the change in the grassland area for 21 micro regions in Mato Grosso (106 ha)**



These methodology being developed allow estimating carbon and biodiversity changes due to deforestation and expansion of agricultural activities. However the complex nature of the land use change does not allow straightforward conclusions. The analysis has been presented here to reveal the complexity of the issue what requires much and intensive research to arrive at conclusive statements about cause-effect relations in the complex soy-based production system in Mato Grosso. Similar complexities can be expected in other regions to occur as the direct use of deforested areas by soybean may not be likely. No firm conclusions can therefore be drawn with regard to the precise allocation of the losses in biodiversity and carbon to soybean based on the presented information, though an association cannot be excluded.

As a result of this complexity, various views can be presented by different actors. The State of Pará since 2005 is leading the annual deforestation in the Brazilian territory. Considering the years 2005, 2006 and 2007, the State of Pará had approximately 1.7 million hectares land deforested. In 2006, the State reached 72,335 hectares only cultivated with soybeans, which represent 4% of the deforested area accumulated during 2005, 2006 and 2007 (INPE and IBGE, 2008).

4.4. Closing remarks

The assessment of the sustainability of soybean for Brazil reveals the complexity of the soybean chain and the lack of factual information that gives room for different interpretations. Most scientific research on soybean production has looked into the agro-technical aspects of soybean cultivation. Some research has been focused on ecological aspects, such the loss of biodiversity or soil organic matter due to land use change. However, little scientific effort has been put on socio-economic aspects of soybean production. It is this lack of verifiable information that creates many different views, as actors rely on their own, often one-sided, sources of information.

Overall, the increased production of soybean will go with the rapid expansion of the acreage and as such add to the pressure on grassland and natural ecosystems, directly or indirectly. Both the speed of expansion as well as the need for the production systems to be economically competitive at the global scale might lead to undesired social, economic and ecological developments. While many laws are in place to address these developments, their enforcements appear difficult because of insufficient institutional capacity and a time consuming endeavour to deal properly with the many sensitive issues, like land ownership. This case study clearly shows the need for verifiable and scientific information to support stakeholders in their efforts to arrive at measures to stimulate the sustainable cultivation and expansion of soybean according to their desires. It also implies that it will not be easy to unambiguously assign responsibilities for undesired developments to actors involved in the chain, despite indirect evidence. Obviously this might be different for specific events.

Some of the lessons from the Brazilian case are generally applicable for other countries and regions, while others depend so heavily on national and location specific conditions that generalization is not possible. In general, the increased production volume of soybean will lead to expansion into grasslands or natural lands, such as in the case of the Chaco in Argentina also (e.g. Nijhof et al., 2008). However, the presence of laws and the ability of national governments and local governing bodies to enforce these laws are country and location specific. An assessment of the social and economic components of sustainability, i.e. whether national and international laws and agreements are complied with, will have to be carried out nationally.

To some extent, this applies to ecological components also, as local biophysical conditions should be taken into consideration in relation to the production systems being practiced. Grua and colleagues (2005) for instance report an increased rate of deforestation of the Chaco biome, driven by favourable

soybean prices and the introduction of transgenic soybean and demand from China and Europe. They (Grua et al., 2008), however, also observed an intensification of soybean production and a decline of low-density extensive cattle production to reduce the overall pressure on natural resources. For assessing the overall impact on sustainability, these findings should be reflected upon in a broader framework, for instance along the sustainability criteria of the RTRS.

5 Initiatives for sustainable soy

Siemen van Berkum

5.1 Societal organisations' activities

The connection of soybean production with losses of biodiversity, deforestation and social injustice is for many development, nature conservation and environmental protection organisations the reason for fixing on the consequences of increasing soybean production in Latin America. In the Netherlands ten non-governmental organisations (NGOs) joined forces on the theme of soybeans in the Dutch Soybean Coalition. The organisations at hand are: Both ENDS, Cordaid, FairFood, Wereld Natuur Fonds, ICCO, IUCN Nederland, Stichting Natuur en Milieu, Kerkinactie, Milieudefensie and Solidaridad. The Dutch Soybean Coalition urges relevant players such as businesses, government and consumers to help reduce the negative social and environmental consequences of production, transport, processing and consumption of soya. This is done by encouraging the agri-food sector to purchase only sustainable produced soybeans and products. Also the coalition aims at increasing sustainable production methods by stimulating the debate on the relation of intensive livestock production and meat consumption with expanding soybean areas and associated negative social and environmental consequences.

International organisations such as Greenpeace and Oxfam are also very much focused on the consequences of expanding soybean production and push for interventions and measures to encourage sustainable soya production chains too. These organisations conduct research into the effects of cultivation methods and use the results of their inquiries in public campaigns and debates with stakeholders directly involved. Campaigning is one of their strategies: in June 2008 for example Greenpeace blocked the landing of cargo ships full with soya from Brazil in the Amsterdam harbour at Cargill's. With this blockade Greenpeace pointed at the ongoing deforestation in the Amazon and the role of soybean production in that process.

Organisations mentioned and their activities have importantly contributed to the fact that governments and consumers are increasingly sharing the concerns about the negative social and environmental consequences of soybean production. These concerns have also penetrated into the board rooms of the companies that are involved in production, trade and/or soybean processing. This has

led to a number of concrete initiatives all aimed at making soybean production more sustainable. Some of the most important of them are mentioned below.

5.2 Basel criteria

On the initiative of the Swiss retail chain Coop Swiss the so-called Basel criteria[1] were drafted in 2004. This initiative came from the strong need felt that for acting responsible on both sides - companies that purchase soy and soy products and soy producers one need to develop and use an internationally accepted set of criteria that define responsible soy production. This provides clarity to producers about what they need to do, and allows purchasers to source soy and soy products from producers who meet the criteria and are therefore not associated with negative environmental and social impacts such as soil erosion or infringements of labour rights. The purpose of the Basel Criteria for Responsible Soy Production is to provide a working definition of acceptable soy production that can be used by individual retailers or producers.

The author expects that companies meeting the requirements of the Basel Criteria will be well positioned to comply with any international criteria that are developed as Basel Criteria are drawn on widely accepted existing criteria and standards such as Eurepgap and the ILO convention. This should ensure that they are compatible with the requirements of other users and schemes. Aspects covered by the Basel criteria include compliance with applicable legislations, technical (production), environmental and social management, and traceability. Most of the criteria might not be controversial, except for one included in the technical management criteria where it is stated that the use of genetically modified plant material is not allowed. Generally there is not much consensus among stakeholders in the soy chain about the impact of genetically modified soybean on sustainability.

The criteria are generic whereby the implementation (with indicators and their cut-off rates) has to take place on the local level. This also provides some flexibility in the interpretation of the rules. Stakeholders within the chain agree on transition periods in applying the criteria (in an action plan), as well as on monitoring (by an independent third actor) of the implementation of the rules.

[1] Proforest, The Basel Criteria for responsible Soy Production, August 2004, ProForest Oxford.

5.3 Round Table of Responsible Soy

While the Basel criteria have been set up by a unilateral initiative, the Round Table of Responsible Soy (RTRS) is a multilateral international platform in which soy producers, traders, processors, banks and societal organisations cooperate to develop sustainability criteria for the global soybean cultivations and to implement measures in practice. Societal pressures from Europe have been key to start the first RTRS in 2005. The May 2007 General Assembly of the RTRS agreed on 11 principles for which criteria are designed to measure the sustainability of the soy production (see also 4.2). The Principle and Criteria document of October 2008 send out for consultation has summarised the principles into 5 (see Appendix 2 for more details).

Partners in the RTRS also agreed that in the course of 2009 criteria for sustainable soy have to be developed. Also it must be clear how these criteria are applied in practice and how their implementation will be managed and monitored. An international working Group of representatives from the soy production chain and societal organisations are still working on it. Also there is a build-in process of public consultations that has to result eventually in sustainability criteria that can count on broad international support. Stakeholders participating in the process show optimistic to reach conclusions on the criteria text by early 2009 (oral information and www.mvo.nl).

When in 2009 principles and criteria for sustainable soy are drafted and laid down in an agreement, surely an important step has been made. However, after signing the agreement the implementation and the enforcement of the agreement shall follow. The RTRS concentrates on the production methods. This implies that farmers and processors should be committed to complying with the criteria. Both have to be informed about the requirements of sustainable production methods, have to be trained to comply with the requirements and have to adopt and build-in the requirements into their day-to-day business operations. Those who comply with the obligations will be certified. The whole course of implementation, and control (among which is also the establishment of a certification system including a certifying organisation and their accreditation) may be a time consuming and costly task.

5.4 Amazon moratorium

An important initiative to enhance sustainable soy is the Amazon Moratorium. Soybean traders and processors from Brazil have agreed in June 2006, in con-

sultation with the European industry and societal organisations like Greenpeace, to avoid selling soy that is cultivated at land in the Amazon Biome that is deforested after July 24 2006. In June 2008 Abiove, the Association of the Brazilian Vegetable Oil Industry and ANEC, the Association of Brazilian Cereal and Oilseeds Exporters, took the initiative to extend the Amazon Moratorium with one year up to 23 July 2009. Abiove claims that the measures aiming at preventing lodging in the tropical forest areas are successful. Based on field observations the Association states that 251,000ha of forest disappeared between August 2006 and July 2007, which was 59% less compared to the previous year. The extension of the Moratorium allows the Brazilian Ministry of Environment together with societal organisations and the soy industry to spend time to map protected areas precisely, to establish an adequate monitoring system and elaborate rules on land use rights in the Amazon. The latter would provide the Ministry of Environment also elaborate on the implementation of 'Ecologic Economic Zoning'. Within that concept it is the government that governs land use changes in soy producing states by effective spatial planning. The local governments could use their spatial planning authority also to direct private investments to areas where production is permitted only under the conditions of the principles of sustainability.

5.5 Dutch links to the Round Table of Responsible Soy

Various Dutch companies and organisations in the industry of animal feed, dairy, meat, fats and oils, acknowledge the need to come to more sustainable soybean production. For this purpose the Task Force Sustainable Soy has been established. This Task Force frequently meets and consults societal organisations (for example the Soy Coalition), producer organisations, the Dutch government (Ministry representatives), NGOs and banks in a so-called soy-consultation. Because the members of the Task Force consider the international approach focused on the main stream the most effective to achieve the objective to enhance sustainable soybean production and because one considers the international Round Table on Responsible Soy (RTRS) the most suitable platform, the Task Force takes a position in which it supports the RTRS with respect to content and finance.

As on August 1 2008 the Task Force Sustainable Soy counted 19 members: ADM, Ahold, Bunge, Campina, Cargill, Cefetra, Cehave landbouwbelang, Friesland Foods, LTO Nederland, Productschap MVO (Margarine, Vetten en Olien), Nevedi (Nederlandse Vereniging van Diervoederindustrie), Nutreco, Plu-

kon Royale, Storteboom, Unilever, Vion Food Group, Fediol (Europese Olie en Eiwitmeel Industrie), en Fefac (Europese Diervoerindustrie).

As a consequence of the Schokland Akkoord (2007) the Platform Initiatief Duurzame Handel (IDH) has been established in Summer 2008.This platform - that is broader than soy only - aims to bundle knowledge of the participants (companies, unions, and NGOs) of sustainable chains. With human resources and financial means the IDH supports sectoral improvement programmes that focus on the bottlenecks in a sector to achieve a more sustainable production method. The focus of these programmes is mainly at the small-scale farmer's level in the developing countries. In July 2008 the government and 37 companies and associations, next to 24 NGOs and the Labour unions FNV and CNV committed themselves to the IDH.

5.6 Changes in operational management by Dutch actors

A few Dutch agribusiness companies have developed initiatives that show how they implement the objective to use sustainable produced soy products.

In July 2006 Campina launched the programme to stimulate the cooperative's members to use only sustainable produced soy in animal feed. Starting from January 2007 about 600 dairy farmers purchase compound feed in which only sustainable produced soybean meal is being used. This soybean meal is from soybean produced according to the Basel criteria, implying that soybeans have been produced without illegal lodging, without violation of labour conditions and without harmful effects on flora and fauna.1 Campina purchased 10,000 ton sustainable produced soybean meal for members. The company's goal is to have 150,000 ton sustainable soybean meal imported from 2011 onwards.

Friesland Foods links to the initiative of Campina by announcing that from 2009 onwards the company wants dairy farmers delivering milk to use soy that has been produced at non-deforested land. Friesland Foods collaborates in this campaign with Nevedi (De Nederlandse Vereniging Diervoederindustrie) and some other chain partners (Vion, Kwetters, en Gebr. Van Beek) to establish a certification program. This programme has to ensure that the animal feed sector does not purchase soy produced at recently deforested land in the Amazon biome. The companies at hand still work on the details of a joint action plan. De

[1] According to the Basel criteria genetically modified soy is not sustainable soy (see www.proforest.net). It is unclear whether the soybean meal purchased by Campina was gmo-free soy (AgriHolland, 28/04/08). The RTRS does not discriminate between gmo-soybeans and gmo-free soy.

guarantee measures will be applied from the first harvest of soybeans in Latin America in 2009 (AgriHolland, 29/04/2008). The companies involved support the RTRS in determining and elaborating criteria for sustainable soy. Yet, as long as the Roundtable has not come up with working criteria they have decided to conduct their own program.

5.7 Impact of the initiatives

The initiatives are only shortly implemented (Campina) or are only in the starting up phase (Friesland Foods, Nevedi and others). Therefore one cannot say much about about the impact of these programmes. However, it is clear that the awareness of the issue of sustainable soybean production has increased very much in the Netherlands, which is now also illustrated by real actions undertaken by the agrifood sector. At the same time it is obvious that success of the initiatives of the Dutch companies depends on the collaboration of the international business community and especially of the chain partners in Brazil and Argentina. Such collaboration should be realised within the framework of the agreements made in the RTRS.

6 An integrated soy-based production system

Prem S. Bindraban and Siemen van Berkum

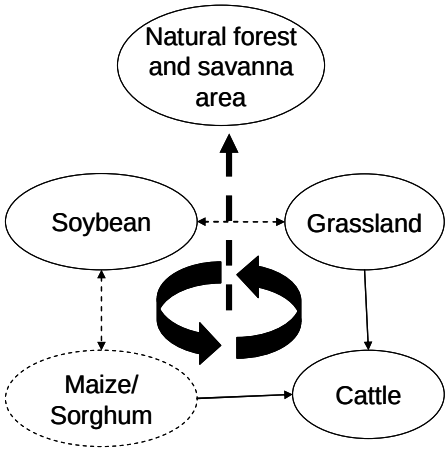
Soybean cultivation is embedded in a complex land use system that hampers quick fixes to evolve towards more sustainable production, but also inherit interesting opportunities for the development of integrated soy-based production systems.

At the field scale still a number of agronomic practices can be improved related to phosphorus and water use for instance. Zero tillage tends to contribute to more stable soil conditions, though not resolving all issues. The soil organic matter content under soy cultivations remains however a critical aspect of soybean cultivation. As discussed in chapter 4, the sole and continuous cultivation of soybean may lead to declining soil fertility over time, as soybean is not fertilised with nitrogen.

An ecologically promising option to resolve this problem is by introducing the application of N-fertilisers to non-soybean crops in the crop rotation in combination with zero tillage practices that ultimately leads to the build up of soil organic matter. The cultivation of such a second crop like maize or sorghum appears promising.

Still, the cultivation of such as second crops is not yet widely applied because of a lack of sufficient economic incentives, i.e. a market. This could be changes drastically by using this crops as feed to increase the meat production. As such an integrated soy-based production system could be developed where the production or soybean, feed and meat could be related, with the result of an overall increase in productivity and the increased possibility to close nutrient cycles. When such increased opportunities will be associated with increased investments to enhance the productivity of current grassland, e.g. through the application of lime and phosphorus fertilisers, then the pressure on forest and savannah resources might decrease (Figure 6.1).

Figure 6.1	**The introduction of a second non-soybean crop and intensified grassland cultivation to increase meat production could enhance the sustainability of this integrated soy-based production system and alleviate the pressure on vulnerable ecosystems**



The bovine meat market therefore could play a catalyzing role in implementing such integrated systems. Currently, export of meat from Latin American countries to developed countries are constrained because of import taxes and quality requirements.1 Prices of meat for Brazil are for instance competitive when not subjected to import taxes by Europe (ABIOVE, 2008). Reducing these import tariffs for instance within the framework of the WTO Doha round would strongly improve market access to developed countries for bovine meat from Latin America. Moreover, increased welfare in the region would also encourage demand for bovine meat.

There are a few conditions that should be complied with however to benefit from the above sketched opportunities. The increased demand of bovine meat might not necessarily lead to the intensification of the grassland productivity, as the high associated costs may still favour lower cost expansion of extensive grasslands into natural lands. Promising outlook in bovine meat markets would

[1] For example, EU imports of meat from Brazil and Argentina are subject to a 12.8% ad valorem tariff plus a specific rate (between 141 and 303 euro per 100 kg, depending on the tariff code). At the same time exports are hampered because the state of affairs with respect to animal diseases are not in compliance with the international rules on trade as laid down by the OIE, WTO and WHO.

therefore stimulate long term improvements in productivity as is needed with grassland either.

In any case, ex-ante analyses about the most optimal ecological allocation of agricultural activities and their proper management to minimise land use change are essential to guide the sustainable expansion of the agricultural activities to boost economic development in Latin American countries. Potential threats and caveats in the systems should however be carefully analyzed before heavily promoting such options. Ecological aspects should be further analyzed, such as related to P-requirement, water use and animal production related diseases. Economic drivers and policy measures to govern a smooth transition should be known prior to firm implementation is undertaken, while social benefits to society at large should always be taken into consideration.

Table 6.1 **Opportunities and threats related to integrated soy-based production systems**

	Opportunities	**Threats**
Agro-technical	- Zero-tillage - Rotation system - Increase productivity of grasslands - Feeding lots for meat production	- Variability in production due to rainfall - Availability of phosphorus
Economic	- Increasing demand for soybean food and feed - Increasing demand for soybean fuel - Increasing demand for meat	- Costs of intensification of grassland production higher than cost of expansion of grasslands - Decreasing demand due to reduced economic growth in importing countries - Limited or decreasing demand of meat due to failure to meet quality and/or sanitary requirements

The necessity to stimulate the sustainable exploitation of the natural resources in developing countries and developed countries therefore can and should be governed through both national and international forces. Whereas national policy and institutions should ensure sustainable implementation to benefit from integrated soy-based production systems, international agreements such as in World Trade (WTO), the Convention on Biological Diversity (CBD) and the like be attuned to create basic and stable conditions.

7 Conclusions and some recommendations

Siemen van Berkum and Prem Bindraban

This study has looked into opportunities for and implications of expanding soybean production in countries in transition. The study aims at relating societal demands in European countries[1] concerning sustainable food production to ongoing developments in soybean cultivation and to activities and mechanisms that support initiatives towards a more sustainable soybean chain. For that the study has described the complex dynamics in land use associated with soybean production and the current actions and activities in the soybean chain undertaken to enhance sustainable production. The case study on Brazil is conducted to illustrate the social and environmental consequences of expanding soybean production and is considered to be representative for countries that seek for solutions to deal with conflicting interests between increasing soybean production and responsible natural resource management.

7.1 Present positions and future outlook in soy production and trade

The USA, Brazil and Argentina are by far the major countries producing and exporting soybeans, oil and meal. Production and exports from the latter two countries have increased strongly, in particular since the second half of the 1990s but growth spurred between 2000 and 2004/05. Market forecasts indicate that demand for soy products will grow strongly in net soy importing countries like China and other (south-east) Asian countries that are expected to realise more than average economic growth in the coming 10 to 15 years. Expansion of production is not foreseen for the USA. Largely Brazil, Argentina and to a lesser extent neighbouring countries like Paraguay, Bolivia and Uruguay will respond to these higher demands by expanding the acreage under soybeans, either by shifting between crops, intensive use of existing areas and/or exploring new land, previously non-agricultural land. Because the demand increases

[1] Societal concerns are most pronounced in countries like the Netherlands, UK, Germany and Switzerland. It is also that business and societal organisations from these countries take part in the RTRS.

faster that can be absorbed by the increase in yield, expansion of the cultivation is expected to continue mainly in Latin America during the coming decade. Forecasts differ among the sources used, but indicate that the soybean area in Brazil may increase by 7-8m hectares to reach around 30m hectares in 2020, while the area under soybean cultivation in Argentina may add up from 15m to 19 to 22m hectares at that date. As a result these countries will derive significant economic gains as production and export values increase but the pressure on ecologically vulnerable areas to be converted into agricultural land increases too. On the other hand, especially in Brazil there appear to be opportunities to expand the soybean acreage by using existing agricultural land more intensively through making investments in productivity increasing technology.

7.2 How sustainable is soy production?

A large number of sustainability components as defined by the RTRS been assessed based on field study comprising interviews with actors in the soybean chain in Brazil and on literature review. The situation in Brazil is considered to be representative for all other countries dealing with conflicting interests between increasing soybean production and responsible natural resource management. The assessment follows the criteria of the RTRS.

Stakeholders differ in their views with regards to the achievements of the sustainability criteria. Overall however there is great willingness to join forces in advancing the soybean chain to increasingly comply with the criteria, with the RTRS providing the discussion platform for consensus building. Various national initiatives have been installed by various actor groups to advance the sustainability of soybean cultivation. An increasing numbers of certifiers of soybean are becoming active in Latin American countries, while Latin American soybean growers are represented at the RTRS.

At the same time, it appears highly complex and sensitive to incorporate most pressing social and environmental issues, such as land rights and GM soybean. Other issues like labour conditions and land use change are highly complex because of indirect relations to soybean cultivation. Then again some more agro-technical criteria are more easily agreed upon, such as the efficient use of water and soil, but might turn out to be difficult to monitor during implementation.

Complying with land right appears highly relevant with regard to the final destiny of lands. The availability of 'public land', or land cultivated for decades by local people and the like create unclear rights. While specific laws are in

place to govern some of these issues, effective implementation appears difficult.

The dynamics of land use is a highly complex process with many actors involved, with drivers that are directly and indirectly related to deforestation. While extraction of wood is a direct deforestation activity, this releases land to be used as extensively cultivated grasslands for the expansion of cattle raising, that in turn is being taken over in time by arable crops often initiating with rice cultivation followed by crops like soybean. This entire process may last five years or more which leads to different claims, views and positions. The monitoring report of the soybean moratorium states for instance that no soy is observed in deforested areas, but observes 'open areas' with signs of slash-and burn, with pasture, natural regeneration and few only with rice or maize (ABIOVE, 2008). On the other hand, other point to a strong correlation of deforestation with the expansion of the soybean area (Baretto, pers. comm.). It can henceforth not be directly concluded that soybean expansion causes deforestation but does appear to be one of the drivers.

In understanding the labour condition in the soybean chain, the entire land use dynamics is generally taken into consideration by various parties. Where soybean producers argue that labour conditions comply with local laws, other point to the indirect relations to land clearing activities. Along the various activities in the land use process indeed different labour conditions and capabilities are required. The most fierce conditions coined as 'overexploitation' by government and as 'slavery' by NGOs occur during land clearing, again indirectly related to soybean as discussed above. Still actors in the soybean chain have agreed to eradicate these labour conditions by signing national agreements, as any undesired event would be at the detriment of the sector.

Loss of biodiversity is directly related to the rate of deforestation. Measurement of deforestation is subject to much uncertainty leading to heavy debates. In general the rate of deforestation has been decreasing from 2004 to 2007, but there is much debate about the rates in 2008 because of the introduction of monthly measurements by a research IMAZON in Brazil, in addition to the annual estimates of another national institute INPE. As discussed above the rate of deforestation is likely being driven by many interacting factors, from demand for wood to the future prices of soybean commodities etc. While much research is being done on quantifying land use change, little is known about the complex interactions of the driving forces leading to deforestation.

From a more agro-technical perspective at the field scale, the impact of the cultivation of soybean on soil fertility is not unambiguous. Research finding still differ with regard to the ability of soybean to maintain soil fertility, while im-

provements have also been recorded. In general though, a total decline in soil organic matter is observed relative to the native vegetation. Some practices, such as zero tillage, tends to inherit important components to prevent degradation of soil quality, though not resolving all issues. There is large body of evidence that the introduction of a rotational soybean-based cropping pattern with the application of nitrogen fertilisers for the non-soybean crops increases soil organic matter. Of great concern is the large demand for Phosphorus on the P-fixing soils in the Cerrado. As these countries, and especially Brazil, is a large net importer of the finite rock phosphate, approaches to increase the use efficiency of this element will be inevitable. Yield loss due to water limitation in the mostly rain fed soybean production can be substantial, though little quantified information is available which hampers the search for opportunities to reduce losses.

The above depicted complexity related to the soybean chain reveals the reasons for the fierce debates between various actors. Attempts to govern the soybean cultivation to become more sustainable are bound to be a long term process due to the high complexity of the matter.

7.3 Opportunities and risk of soy production summarised

Soybean originates from the China and grows at approximately 30° latitude. It has been imported in the USA and later to Argentina to be grown at more or less the same latitude on the Southern Hemisphere. Soybean flowering is induced by the reducing day length at these latitudes. This so called vernalisation requirement has been reduced through breeding allowing soybean to yield also nearer to the equator, though a slight decline in yield ability is likely. Currently soybean is even grown almost at the equator, for instance in Santarem in Brazil. Together with its demand for high temperatures, soybean can now be grown in large areas in the world ranging from the sub-tropics to the tropics. It could agro-technically be grown in the south eastern part of Africa, on the Southeast of Europe and also in India and Indonesia, though yield potentials may be lower (e.g. Stehfest et al., 2007) . Current cultivation however also depends on the socio-economic conditions. For instance, soybean production appears less economically viable in Europe, unless subsidised. The overall shortage of land and water resources in China and India does not allow large scale expansion other than at the expanse of other crops. As in many other countries where soybeans are part of the cropping pattern, soybean production in China and India did not show much dynamics over the last decade due to fact that the eco-

nomic attractiveness of soybeans did not improve compared to other crops. In countries with relative abundance of productive land and fresh water, soybean production can respond to increasing demand in the world for the crop. Latin American countries like Brazil, Argentina, Paraguay, Bolivia and Uruguay are then in the best position.

It is clear from the previous analysis that among developing countries Argentina and Brazil are the most competitive suppliers of soybean in the world. Next to suitable natural conditions these two countries have the advantage of abundant land for large-scale production of this crop. Moreover, there is a strong R&D infrastructure around the cultivation of this crop that continuously seeks for adopting technology aimed at improving productivity and applying requirements to enhance sustainable production methods.

There are major economic opportunities for soybean production expansion in the above mentioned Latin American countries. These opportunities are from the increasing demand for soybeans and products, which is largely from net-importing developing countries with a significant economic growth (China, India, other south-east Asia). The demand for soybeans is fuelled by increasing demand for livestock products (meat, dairy) whereby soy meal is a valuable feed ingredient. Yet an increased demand for bio-fuels also generates more demand for soybeans (oil for biodiesel) - although this strongly depends on fossil fuel prices and government policies.

Argentina and Brazil especially – at present the most competitive soybean producers among developing countries - will have the chance to exploit these opportunities by increasing their production and export of soybeans based on strong points such as the large-scale production technology (exploiting economies of scale), a plenteous land base and a technology base that enables increasing land productivity of crop and grasslands. Due to the relatively abundant land, especially Brazil has many possibilities to acquire cattle grazing lands that can be turned into crop land. These grazing lands can be made more productive by appropriate management and use of agro-inputs stimulated by favourable economic conditions, including higher meat prices and increased export opportunities. This will increase the economic viability for the introduction of rotational cropping system.

Yet, the economic strength of the soy supply chain may be mitigated by the relatively high transport costs due to large distance between production areas and export harbours in Latin America in combination with inadequate roads, rail and water ways infrastructure. Furthermore, some inherent features of the soy production chain may have negative environmental effects. Large scale production methods induce monocultures with - if not carefully managed - negative

consequences for soil quality and biodiversity. Furthermore, current cost structures in the chain and the rapid increase in demand tends to favour expansion of soybean acreage following or inducing land clearing in ecologically vulnerable areas. Next, the demand pull for soy production expansion in Argentina and Brazil may have negative consequences when existing agricultural land is being used much more intensively that detrimental environmental effects occur (soil degradation, water pollution, loss of biodiversity).

However, these economic and environmental *threats or risks* of increasing soy cultivation in these countries may be reduced importantly by applying an integrated soy-based production system. The introduction of a second non-soybean crop and intensified grassland cultivation to increase meat production could enhance the sustainability of such a production system and alleviate the pressure on vulnerable ecosystems.

Based on the foregoing analysis, and including the assessment on the present state of social sustainability of soy production in chapter 4, the opportunities and risks of expanding soy production are summarised as follows in Table 7.1.

Table 7.1 Opportunities and threats related to expansion of soy production

	Opportunities	**Threats**
Economic	- Increasing demand for soybean food and feed - Increasing demand for soybean fuel - Increasing demand for meat	- Costs of intensification of grassland production higher than cost of expansion of grasslands - Decreasing demand due to reduced economic growth in importing countries - Limited outlet for meat products due to trade barriers - High transportation costs
Social	- Labour conditions complying with international standards (incl. erase of child labour) - Fair remuneration of labour - Securing land rights by land re-registration pro-	- With increased scale of production labour is replaced by machinery - Livelihoods of indigenous population disturbed by moving up of soy production - Infringements on labour rights due to lack of en-

	grammes	forcement
Environmental	- Zero-tillage production method - Soy-based rotation system - Ecological Economic Zoning	- Loss of biodiversity if cultivation expands as monoculture - Soil degradation, water pollution and loss of biodiversity as existing land is used more intensive - Local government is incapable to enforce spatial planning measures aimed at controlling soy area expansion

7.4 Some recommendations

Increasing the sustainability of soy cultivation in ecologically vulnerable areas is primarily in the realm of the local government, farmers and the locally active agribusiness companies. However, downstream chain partners can encourage or maybe even enforce the soybean producers to adopt more sustainable production methods if they make their purchase decisions conditional to compliance with sustainability criteria that reflect the societal concerns on the negative environmental and social impact associated with expanding soy production. Within the context of the RTRS stakeholders meet to define a workable set of criteria for sustainable production of soy. NGO's have played an important role to raise public awareness of negative social and environmental consequences of expanding soybean production and are a major player in the RTRS process to draft workable sustainability criteria. Foreign governments like the Dutch government do not have a major role in this process but can help to further encourage and facilitate the process as much as possible. Therefore, Dutch government activities may focus on supportive actions mainly in the field of offering expertise to help farmers, chain partners, (local) governments, societal organisations, international platforms and the Dutch agribusiness sector in initiatives to counter negative environmental, social and economic consequences of an increasing soybean production, and to stimulate stakeholder to benefit from possible opportunities. Such support should not be limited to the larger soybean producing countries but be open to all countries where tensions between soybean production and natural resource management would appear. Yet it re-

mains to be emphasised that the main responsibility to balance increasing soybean production on the one hand and social and environmental consequences of expansion on the other hand is with local governments in the producing countries at hand and the soybean supply chain partners. NGO's as well as foreign governments may put pressures on these actors by showing their concerns about a proper natural resource management in the developing countries. At the same time foreign governments should be open for consultation and requests for support in order to contribute to enhanced sustainable soybean production in developing countries.

To make steps towards sustainable soybean production most likely and successful the following call to all stakeholders can be made:

- Participants should continue their discussions and collaboration in the Round Table of Sustainable Soy also after an agreement on the principles and criteria indicators has been made in 2009 in order to have a forum for evaluation of the impact of the agreement and for discussion on implementation of measures (like certification).
- In order to more effectively address sustainability, insight of RTRS stakeholders ought to be further increased about the complexity of the soybean chain and land use dynamics, and about the need for the development of an integrated soy-based production system that links various economic activities, rather than soybean only. Implementation of such system however calls for concerted actions in designing feasible systems through research into the agro-technical possibilities and market opportunities.
- Local) governments and organisations should continue to improve their efforts to implement and enforce laws on legal issues as spelled out in the RTRS criteria, such as land and property rights, labour issues, environmental protection and preservation of natural lands. Upon request, the international community (NGO's, foreign governments) could provide support in this area.
- Stakeholders in the RTRS should set up an effective program to reach soybean farmers in Brazil and other Latin American countries with (potentially) increasing soybean production in order to encourage them to adopt sound production methods.
- Broaden the international base of the RTRS initiative towards all soybean producing and (major) importing countries, to have the sustainability criteria agreed upon applied to the mainstream market of soy products.

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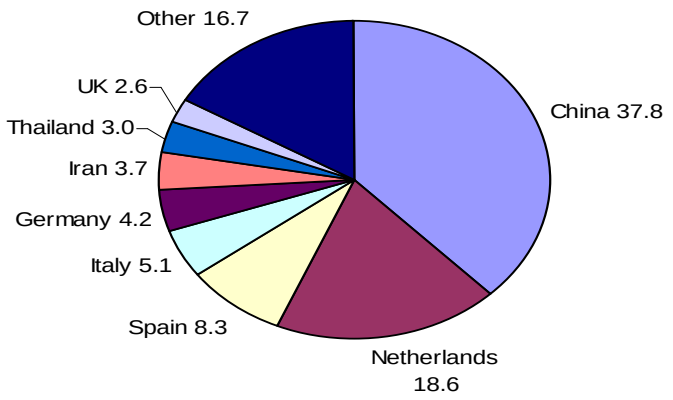
Appendix 1

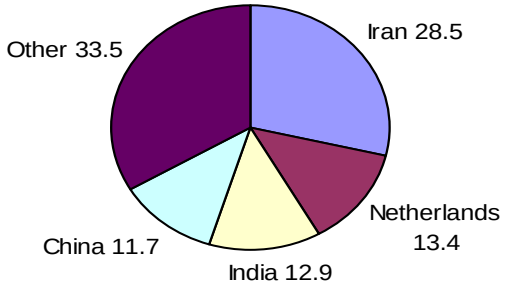
Major destinations of soy exports from Brazil and Argentina

A1.1	Share in % of Brazil's soybean exports, av. '05/'06, 23.7 mln. Tonnes



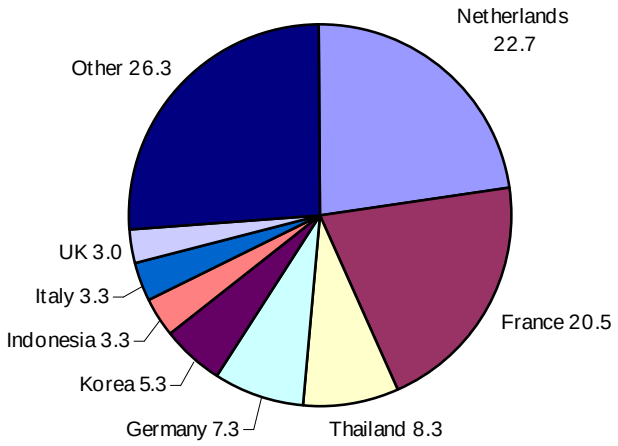
Source: UNSD Comtrade.

A1.2	Share in % of Brazil's soy oil export, av. '05/'06, 2.6 mln. tonnes



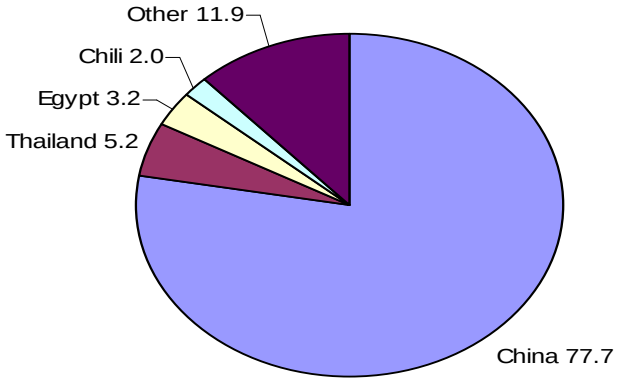
Source: UNSD Comtrade.

A1.3	Share in % of Brazil's soy meal exports, av. '05/'06, 13.4 mln. tonnes



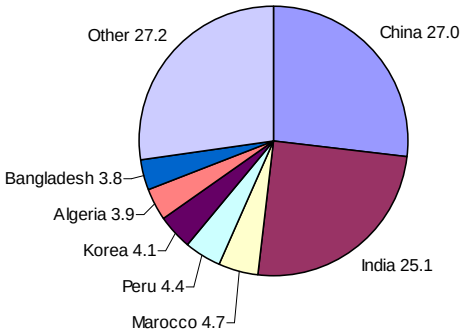
Source: UNSD Comtrade.

A1.4	Share in % of Argentina's soy bean exports, av. '05/'06, 8.9 mln. tonnes



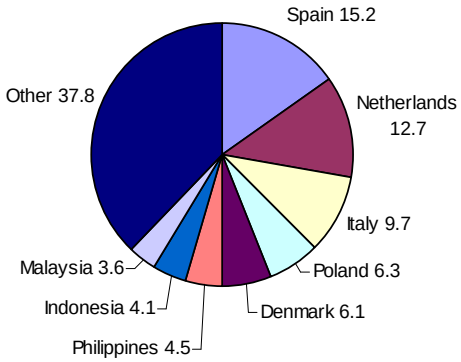
Source: UNSD Comtrade.

A1.5	Share in % of Argentina's soy oil exports, av. '05/'06, 5.3 mln. tonnes



Source: UNSD Comtrade.

A1.6	Share in % of Argentina's soy meal exports, av. '05/'06, 22.4 mln. tonnes



Source: UNSD Comtrade.

Appendix 2

Summary of the principles and criteria of the Round Table of Responsible Soy, as formulated by the Development Groups

Source: Draft RTRS Principles and Criteria. Third Public Consultation Document (DG4-OUT-02-ENG Draft RTRS Principles and Criteria for Consultation), 23 October 2008, produced by the RTRS Principles, Criteria and Verification Working Group (DG) as an output of their fourth meeting, (Atibaia, Brazil) 10-13 October 2008

Principle 1. Legal Compliance and Good Business Practice

1.1. There is awareness of, and compliance with, all applicable local and national laws
1.2. Legal use rights to the land are clearly defined and demonstrable
1.3. Option a: [There is open and transparent engagement with interested parties.] Option b: [remove this criterion]

Principle 2. Responsible Labour Conditions

2.1. Do not engage in or support child labour or forced labour, or engage in or support discrimination or harassment
2.2. All workers, sharecroppers, contractors and subcontractors are adequately informed and trained for their tasks and are aware of their rights and duties
2.3. A safe and healthy workplace is provided for all workers
2.4. Workers have freedom of association and rights of collective bargaining.
2.5. All workers, employed directly or by major service providers, receive remuneration that is sufficient to meet basic needs

Principle 3. Responsible Community Relations

3.1. Traditional communities affected by expansion of soy bean areas are compensated for any relinquishment of rights (including traditional land use rights), subject to their free, prior, informed and documented consent

3.2. A dialogue is established with local communities and a procedure is in place to address complaints and grievances
3.3. Preference is given to the employment and training of the local population, and to the contracting of services and purchasing inputs in the local market, as a means to promote community development

Principle 4. Environmental responsibility

4.1. On and off site impacts (both positive and negative, both social and environmental) of new infrastructure have been assessed and appropriate measures taken to minimise and mitigate any negative impacts
4.2. Pollution is minimised and production waste is managed responsibly
4.3. Efforts to reduce emissions of Greenhouse gases are made
4.4. Habitats for rare, threatened or endangered native or endemic species are maintained and safeguarded
4.5. Expansion for soy cultivation takes place on land cleared of native vegetation before Option a: [date of publication of the standard]. Option b: [2008]. After this cut-off date clearance takes place only on land that has been designated as an agricultural expansion area by an official and participatory process (land use planning) and outside areas identified as HCVAs
4.6. Impacts (both positive and negative, both social and environmental) of expansion for soy cultivation have been assessed and appropriate measures taken to minimise and mitigate any negative impacts

Principle 5. Good Agricultural Practice

5.1. The quality of surface and ground water is maintained or improved
5.2. The efficiency of water use for irrigated soy production is optimised
5.3. Natural vegetation areas around springs and along natural watercourses are maintained or re-established
5.4. Soil quality is maintained or improved and erosion is avoided by good management practices
5.5. Systematic, recognised Integrated Pest Management (IPM) techniques, including biological control, to monitor, prevent and control pests, crop diseases and weeds are adopted
5.6. All application of chemicals is documented and all handling, storage, collection and appropriate disposal of chemical waste and empty containers, is monitored to ensure compliance with good practice

5.7. Chemicals listed in the Stockholm and Rotterdam Conventions or in the Pesticide Action Network (PAN)Dirty Dozen will not be used
5.8. Document, monitor and control the use of biological control agents in accordance with national laws and internationally accepted scientific protocols
5.9. Systematic measures are planned and implemented to monitor, control and minimise the spread of invasive introduced species and new pests
5.10. Appropriate measures are implemented to prevent the drift of agrochemicals and genetic material to neighbouring areas
5.11. Control of the origin of seeds as a measure for the prevention of introduction of new diseases