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Future expansion of soybean 2005-2014

Implications for food security, sustainable rural development and agricultural policies in the countries of Mercosur and Bolivia

Synthesis document

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Foreword

The extraordinary expansion of soybean production in the last 10 years has changed global agriculture and impacted strongly on international agricultural commodity markets. Soybean production has grown more than twice faster than all the other major crops. Exports of soybean seed and soybean products now account for more than 10 percent of world agricultural trade.

This development has been particularly intense in the Mercosur region[1] and Bolivia. While world soybean production grew 58 percent between 1996 and 2004, from 130 million tonnes to 206 million tonnes[2], it surged 123 percent in the countries of Mercosur and Bolivia, from 39 million to 87 million tonnes. These five countries are today the world's principal soybean production area. Their total sown area reached 39 million hectares in 2004 and their aggregate production exceeded the 85 million tonnes of the United States, the world's leading producer. The global boom in soybean production therefore has a strikingly South American hallmark.

The expansion of soybean production has had an important impact on the economies of those countries, at macroeconomic level as well as on the export sector and on the evolution of their agriculture and agroindustry. It also gave rise to extensive technological, economic, financial, social and institutional changes. Although to varying degrees and with country-specific impacts, the "soybean phenomenon" has consolidated a production model that is highly technological and mechanized, favourable to medium and large-scale commercial production and intimately linked to the international market, whose demand and attractive prices have been determining factors.

While soybean expansion has helped improve the general financial and economic situation of the countries, it has also encouraged farm land concentration and enlargement. Besides the collateral problems of the new technologies employed, it has also displaced livestock production and other activities and has highlighted the hazards of monoculture, raising concerns about its sustainability and its long-term impact on natural resources, especially forest areas.

Given the prospect of continued soybean expansion in coming years and thus new policy challenges, FAO, with the collaboration of the authorities of Argentina, Brazil and Paraguay conducted an in-depth analysis - with case studies and projections for these three countries - of future soybean expansion and its implications for food security, sustainable rural development and agricultural policies. The regional analysis was completed with information from Bolivia and Uruguay.

The purpose of the investigation was to study the soybean phenomenon in these five countries in order to: identify the causes of its expansion and the various transformations that it has brought along; estimate the expected growth of soybean and soybean products until 2014; assess the associated implications of this growth; warn about dangers and inadequacies; and suggest measures to optimize the positive effects and contain or minimize the negative ones.

The preliminary results of this work were examined in national seminars held in Argentina, Brazil and Paraguay with the participation of representatives of public and private sector, as well as producer associations. The observations made at these meetings were included in the final version of the study. The general findings were also pre-released to the Ministries of

[1] This refers only to Argentina, Brazil, Paraguay and Uruguay. Venezuela, which joined Mercosur in 2006, is not included in this study.
[2] These volumes include production recorded in MERCOSUR and Bolivia.

Agriculture of the five countries at the meeting of the Southern Agricultural Council held in Santa Cruz de la Sierra, Bolivia, in July 2006.

In carrying out this activity, FAO benefited from the collaboration of government counterparts: in Argentina, the Secretariat of Agriculture, Livestock, Fisheries and Food, and the National Institute of Agricultural Technology (INTA); in Brazil, the Ministry of Agriculture, Livestock and Food Supply, and the Brazilian Agricultural Research Corporation (EMBRAPA); and in Paraguay, the General Directorate of Planning of the Ministry of Agriculture and Livestock. Exchanges and consultations were also held with the departments of agricultural policy in Bolivia and Uruguay. The FAO Representations in Argentina, Brazil and Paraguay provided invaluable support in organizing the national workshops that were held in the three countries. Our heartfelt thanks go to all institutions involved in this exercise and their staff.

We also convey our special gratitude to the experts who carried out the national studies: in Argentina, Gustavo López and Pedro Lavignolle; in Brazil, Antônio Salazar Pessoa Brandão, Antonio Carlos Roessing, Gervásio Castro de Rezende, Mauro Virgino de Sena e Silva and Joelsio José Lazzarotto; and in Paraguay, Ricardo R. Pedretti, Juan Cresta and Mariana Oeyen.

The investigation was jointly carried out by the Policy Coordination Service of the Policy Assistance and Resources Mobilization Division (TCA) at FAO headquarters in Rome, and the Policy Assistance Branch of the Regional Office for Latin America and the Caribbean (RLC), in Santiago, Chile. It also benefited from the invaluable support of analysts from the Trade and Markets Division (EST) in applying the projections model. The technical team in Rome comprised Carlos Santana and Oscar Cismondi (TCA), and Holger Matthey, Merritt Cluff and Peter Thoenes (EST); and in Santiago, Luis Gómez Oliver, Marcela Bocchetto and Fernando Soto (RLCP), together with consultants Melina Panduro and Claudia Ferrando.

This synthesis document, prepared by Carlos Santana and Oscar Cismondi on the basis of the national studies, summarizes the more striking aspects and findings of those studies and presents the main conclusions. We hope that the results of this investigative effort will help guide the agricultural policy decisions of the main soybean producer countries of Latin America and the Caribbean, and will provide greater insight into this sphere of world agriculture which has such a forceful impact on the region's agriculture. It goes without saying that comments and suggestions will be very welcome.

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Abbreviations and acronyms

CAS	Southern Agricultural Council
CET	Common External Tariff
CIF	Common Investment Fund
CIS	Community of Independent States
CNA	National Confederation of Agriculture and Livestock of Brazil
CNT	National Confederation of Transport
CNTBio	National Technical Commission on Biosecurity
EMPRAPA	Brazilian Agricultural Research Corporation
GMO	Genetically Modified Organism
ICMS	Tax on the Transfer of Goods and Services
INTA	National Institute of Agricultural Technology
MERCOSUR	Southern Common Market
MFE	Mercantile and Futures Exchange
MODERFROTA	Programme for the Modernization of the Fleet of Agricultural Tractors and Associated Implements and Harvesters
OCDE	Organization for Economic Co-operation and Development
PNLT	National Plan for Transport Logistics
PRODECER	Nippon-Brazilian Programme for the Development of the Savannahs
RR	Roundup Ready ®
SAGYPA	Secretariat of Agriculture, Livestock and Fisheries
USDA	United States Department of Agriculture

Executive Summary

The purpose of this document, which summarizes a study carried out by FAO in collaboration with institutions of the countries of Mercosur[3] and Bolivia, is to provide greater insight into the possible implications of soybean expansion for food security, rural development and agricultural policies in these countries for the period 2005-2014. Based on country studies carried out for the investigation, this document summarizes the causes of soybean expansion in the last ten years and presents the main changes that have accompanied the process. It also quantifies in approximate terms, the growth of soybean and its products (meal and oil) between 2005 and 2014, explores the main implications of this expansion and offers a number of analytical conclusions.

Expansion of soybean production

In the period 1996-2004, soybean production in the countries concerned recorded a spectacular growth of 123 percent increasing from 39 million tonnes in 1996 to approximately 87 million in 2004. This expansion was 1.7 times higher than the increase in global production and easily outstripped growth in the United States, indicating that the world boom in soybean production is essentially a South American phenomenon.

Principal causes of expansion

A number of external and internal factors favoured to varying degrees the extraordinary growth of soybean production in the countries studied. External factors include the vibrancy of the international market for soybean and soybean products, and technological innovations from outside the region. Key internal factors include the adoption of zero-tillage; the use of genetically modified seeds; the employment of new cultivation techniques; advances in agricultural research which made cropping possible in hitherto inconceivable areas; the reduction in production costs resulting in improved margins compared to other crops; the availability of extensive new areas for soybean cropping; changes in production organization; development of a dynamic processing industry; and a partially favourable public policy framework.

The combination of these factors boosted profitability, the major factor behind soybean expansion.

Changes associated with the expansion of soybean production

The expansion of soybean production contributed to sweeping changes in the agricultural sector and the economy of the countries studied. These changes, which result from growth in soybean production or other processes, embrace structural, institutional, agroindustrial, environmental and social aspects.

Primary structural aspects or changes include: an accentuation of the process of agriculturization and change in cropping patterns in Argentina; an intensification of the historical process of change in the agrarian and production structure of the countries studied; and an expansion of the agricultural frontier, in particular in Argentina, Brazil and Paraguay.

[3] That is, the four countries that form the original nucleus of Mercosur: Argentina, Brazil, Paraguay and Uruguay. The study does not refer to Venezuela which joined Mercosur in 2006.

The expansion of soybean production in these countries has also been accompanied by significant institutional changes, including an escalation of land leasing for production, greater recourse to credit contracts between private agents, and broader technical assistance available from the private sector.

At the same time, Argentina and Brazil – and to a lesser extent Paraguay – have experienced significant agroindustrial change characterized by the development of a vigorous soybean processing industry and a promising national by-products industry for the food industry, human consumption, the chemical sector, and energy production (biodiesel).

The expansion of soybean production has also contributed to environmental change, with the clearing of native forest and forest areas, which has further compromised the sustainability of agricultural production.

In this respect zero tillage, which has been promoted as sustainable, has in some cases, increased the incidence of pests, alarming many producers. This has led to an increase in agrochemical treatment, raising production costs and posing a threat to the environment and to the sustainability of soybean production in the region. In some areas, sustainability has also been affected by inadequate crop rotation and fertilizer use.

Soybean expansion in these countries has also accentuated social phenomena such as concentration along the commodity chain and intensification of land leasing contracts. Changes in the real estate market have been partly fuelled by small producers who have seen no alternative to selling their land, which has intensified rural migration, especially in Paraguay.

Growth perspectives of the soybean sector

Projections of future growth of soybean production were made on the basis of estimates using the Aglink-Cosimo partial equilibrium model. In addition to the baseline, three sets of scenarios were drawn up for Argentina, Brazil and Paraguay based on judgements of national experts. These scenarios assumed maximum and minimum trajectories for the following variables: yield and production costs of soybean, and soybean and product demand from China. Under the most favourable assumptions these scenarios suggest that in 2014 Argentina could produce 56 million tonnes of soybean, Brazil 86 million tonnes and Paraguay 7 million tonnes.

Outlook implications in individual countries

a) Argentina

Food security. Projections for 2005-2014 indicate that food production in Argentina will be sufficient to cover the country's needs and to contribute significantly to the generation of foreign exchange from exports. In spite of the expected expansion of soybean production, the country's food security will therefore continue to be ensured.

Rural development. With regard to impacts on land use, soybean will mainly expand over pasture land, and to a lesser degree by expanding the agricultural frontier.

Environment and sustainability of the soybean production system. The process of agriculturalization is expected to continue: soybean cultivation will encroach upon rangeland and forests will be cleared for the relocation of stock farming. The design and application of the legal framework for deforestation will therefore need to be fine-tuned, with a review of ·rent regulations, the introduction of new measures, and stricter enforcement.

In addition, the sustainability of production systems requires better agricultural practices, for example, more crop rotation adjusted to soil and climate, as well as balanced fertilization.

Agricultural policies. Macroeconomic policy for the coming years should ensure the maintenance of economic and currency stability and a gradual review of the regime of taxation on the agricultural sector.

In order to combat rural poverty, sectoral policies and programmes should be further integrated and coordinated with those of other spheres of governmental action.

Crop rotation could be encouraged by reviewing the legal framework for leasing and share tenancy contracts in order to introduce incentives for crop rotations that foster sustainability of land and water use and do not endanger biodiversity.

b) Bolivia

Rural development. Soybean cultivated area in Bolivia is projected to reach 1.3 million hectares in 2014. Santa Cruz has 4 million hectares suitable for soybean cultivation of which only 850 000 hectares are under use. Expansion could therefore take place without affecting other more sensitive ecosystems.

Transport, storage and port logistics. Soybean production in Bolivia is estimated to almost double the 2004 level reaching 3 million tonnes in 2014. This expansion requires heavy investment in infrastructure in order to improve Bolivia's marketing chain.

Trade policy. Bolivia's current advantage over other countries exporting soybeans into the Andean market is the guaranteed preferential tariff that it enjoys under the Andean Community agreement. Bolivia's concern is that its exports to other Andean countries, especially Colombia, will lose competitiveness upon the entry of soybean from the United States made possible by US free trade agreements with the countries of the Andean Community.

Given the current context of international trade negotiations, Bolivia should seek to improve its international competitiveness by lowering its production and transport costs for soybeans and improving yield.

Infrastructure policy. A study on Bolivia's transport costs is needed to better assess its infrastructural investment requirements. Efforts should also be made to establish alternative routes for the export of goods through the Peruvian and Chilean ports on the Pacific.

c) Brazil

Food security. Food availability is not expected to be threatened by an expansion of soybean production in 2005-2014.

Rural development. Regarding land use, the area seeded to soybean will continue to increase in 2005-2014, but at a lower annual rate than in the previous ten years. Degraded pasture will probably continue to serve as the main source of land for soybean expansion.

The expansion of the soybean area between 2005 and 2014 should create between 575 000 to 1.4 million additional jobs depending on the scenario assumptions about yield, cost of soybean production and market development.

Environment and sustainability of the soybean production system. According to the projections, Brazil's soybean seeded area could top 30 million hectares in 2014, which would represent a total increase of about 8 million hectares in 2005-2014. Brazil is estimated to

have 9 million hectares of non-forest land suitable for soybean cultivation, which is more than the maximum expansion projection for 2014. As much of this additional land is degraded pasture, soybean cultivation could expand sustainably without significant loss of forest.

Agricultural policies. Macroeconomic policy should be directed towards creating a stable macroeconomic environment and should include measures that result in interest rates similar to those of competitor countries. The country should also establish financial instruments which protect against instability of the domestic currency.

The expansion of soybean in Brazil is closely dependent on maintaining high levels of productivity and competitiveness. This will require a package of measures on agricultural research, technology transfer and agricultural insurance. Also, the Kandir Law should be amended to lower marketing costs and correct distortions that disadvantage processing industries located outside soybean producer states.

There should also be policies, rules and regulations aimed at ensuring that soybean expansion is compatible with the efficient use of natural resources and the conservation of the environment.

d) Paraguay

Food security. The expansion of soybean production should not have a negative impact on food security. However, in traditional soybean areas, the growing dependence of employment on a single sector that is sensitive to fluctuations in climate and international markets causes uncertainty and increases vulnerability.

Rural development. The projections imply that soybean cultivation will cover, at most, 2.4 million hectares in 2014. This expansion will be accompanied by a reduction in the number of holdings of under 50 hectares resulting in greater land concentration and in migration of agricultural workforce to urban centres, which will aggravate urban poverty.

Environment and sustainability of the soybean production system. According to the projections, the expansion of soybean area poses only a marginal threat to the native forest during the period 2005-2014.

Agricultural policies. An important aspect to be considered by Paraguay is to promote the soybean processing industry which is still in its infancy in the country.

It would also be advisable to establish specific policies and social programmes targeting small farmers and the rural poor in areas affected by the expansion of soybean production.

e) Uruguay

Given that the expansion of soybean production in Uruguay is more recent and the area cultivated with this crop is relatively small by South American standards, the future growth of soybean cultivation will have less visible consequences than in the other countries.

The expansion in area will be approximately 100 000 hectares by 2014, which current land availability should be able to absorb without the need to inflict significant pressure on other production activities. The main consequences of any future expansion concern the possible development of the local soybean oil industry, which is in its infancy. The country has the necessary transport, storage and port infrastructure to increase industrial production and exports.

Conclusions

Analysis of the extraordinary growth of soybean cultivation, its possible evolution and its implications for food security, rural development and agricultural policy in the countries of Mercosur and Bolivia point to several key conclusions.

The main force behind the expansion of soybean production has been the significant change in profitability. Other factors, including strong, growing and sustained international demand and the adoption of zero tillage and transgenic varieties, have all contributed to the process that has also seen a parallel but insufficient increase in capacity and efficiency of storage, transport, processing and port facilities.

New technology has pushed the agricultural frontier over traditional rangeland, pushing in turn livestock activities to convert forest or ecologically fragile land into pasture.

The expansion of soybean production has been fostered by many policies, including research and development policy. Other measures have also played a role: in Argentina, market liberalization and the abandonment of fixed parity with the dollar followed by a significant currency devaluation; in Brazil, the Kandir Law, the PRODECER and MODERFROTA programmes; in Bolivia, the National Seed Policy and the tariff preference laws; in Paraguay, credit policies.

An expanding soybean sector has facilitated the intensification (and in some cases the development) of important structural transformations. The production process and the involved agribusinesses have changed profoundly: production units have increased in size and fallen in number; a burgeoning agricultural real estate market has encouraged new agents and capital to enter the sector; there has been an increasing separation in firm ownership and management with more leasing and greater use of outsourced farming activities; new financial modalities have evolved and proliferated, such as sowing, production and marketing pools, common investment funds and non-agricultural financial investors; labour productivity has increased with a consequent reduction in employment per hectare; and there has been a broader globalization of agricultural production.

The analyses indicate that the intensification and expansion of agriculture in the soybean producing countries of South America will continue between now and 2014. However, this study possibly underestimates the future expansion of soybean as it does not account for prospective future policies that encourage the use of biodiesel, thus providing an additional market for soybean oil.

Land availability will not be a major constraint on expected soybean expansion in any of the countries studied. What is important is the impact of increased seeded area on the dynamics of land use, in particular on deforestation and unsustainable use of ecologically fragile land.

High returns from soybean have led to the dominance of a single crop resulting in insufficient rotation for the conservation of soil fertility and quality. It is essential to assess the condition of agricultural land and, ideally, to monitor sustainability indicators and actively promote the application of sustainable rotations over time.
There is also a need to review the legal framework for leasing, share tenancy and investment in the soybean sector in order to introduce incentives for rotations that will sustain land use, water resources and biodiversity.

The projections indicate that food production in the countries studied will not be affected by the expansion in soybean cultivation. However, small farmers who have been directly affected and have sold or leased their land will find themselves in a new situation of greater

vulnerability, lacking the safety net of their own production (whether for market or home consumption).

Also important is the inadequacy of storage and transport infrastructure which is a serious impediment to soybean expansion. This could be exacerbated in the future unless appropriate investment policy and programme measures are taken to address the maintenance, replacement and increase of transport and storage capacity.

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This study has shown that soybean production in the countries of Mercosur and Bolivia has come to stay. The consequences of future development on food security, rural development, land use, the environment and other aspects of agricultural production will depend not only on the general trend towards greater cultivation, but also on the capacity of governments to adopt policies and measures that capitalize on the positive effects and counter the negative ones, monitoring constantly the evolution and the environmental, agronomic, social and economic sustainability of this complex phenomenon.

1. Introduction

During the period 1996-2004, the agricultural sectors of the Mercosur countries (Argentina, Brazil, Paraguay, and Uruguay)[4] and Bolivia recorded a spectacular phenomenon: the accelerated expansion of soybean and soybean products. Production of this oilseed in those countries increased 123 percent expanding from 39 million tonnes in 1996 to approximately 87 million tonnes in 2004. This increase was 1.7 times greater than the increase in global production[5] and more than matched that of the United States, confirming the South American hallmark of the global soybean boom (see Table I.1 of Annex I).

In terms of volume, the boom was led by Brazil, followed by Argentina and Paraguay. Brazil's production increased by some 27 million tonnes from 1996 to 2004, while that of Argentina and Paraguay increased 19 million and 1 million tonnes respectively[6]. The expansion of production in the five countries was due to an increase in cultivated area and, with the exception of Paraguay, to higher yield (see Tables I.2 and I.3 of Annex I). Between 1996 and 2004, the cultivated area more than doubled in Argentina, Brazil and Paraguay, almost doubled in Bolivia, and multiplied by 32 in Uruguay[7].

The increase in soybean production in the five countries not only converted them into the leading producer region in the world but also modified the geographic distribution of international trade in soybean and soybean products. Until 1996, the United States had been the world's main exporter of soybean and soybean products, but this status gradually eroded and, by 2004, exports from Mercosur and Bolivia accounted for 60 percent of the world total, with exports from the United States amounting to 25 percent. Brazil became the main exporter of the aggregate soybean sector, with 32 percent of the total value of exports, followed by the United States (25 percent) and Argentina (24 percent).

The expansion of soybean production provided substantial input to the economies of Mercosur and Bolivia in terms of higher national gross product, tax revenue and investment in infrastructure. The expansion was accompanied by a series of structural, institutional, agroindustrial, environmental and social transformations, that have had a profound impact on the rural sectors of those countries.

Projections of several institutions[8] suggest that soybean production should continue to trend upwards in South America in the medium term. This expansion will come from increased seeded area and productivity, and will be determined by factors that include increased domestic demand for vegetable oils for human consumption and biodiesel, and oilseed meal requirements by the domestic livestock sector. Growing exports of soybeans to China and other countries; the adoption of technological innovations and the use of modified transgenic seeds are additional contributing factors.

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[4] Reference to the countries of Mercosur does not include Venezuela, which joined in 2006 and is not involved in the phenomenon studied in this work. Bolivia is an associate member of Mercosur but is mentioned separately so as not to include Chile, which is also an associate member of the expanded Mercosur but is not affected by the soybean phenomenon.

[5] This calculation does not include the production of Mercosur and Bolivia in the world total.

[6] The expansion in Bolivia and Uruguay was less than 1 million tonnes.

[7] In absolute terms, these data correspond to an expansion of about 11 million hectares in Brazil, 8 million in Argentina, 1 million in Paraguay, 427 000 in Bolivia and 239 000 in Uruguay.

[8] Including the United States Department of Agriculture (USDA), the Australian Bureau of Agricultural and Resource Economics (ABARE) and the Food and Agricultural Policy Research Institute of IOWA State University in the United States.

This document intends to provide a synthesis of an investigation recently promoted by FAO to gain more insight into the possible implications of an expansion of soybean production on food security, sustainable rural development and agricultural policies in the countries of Mercosur and Bolivia in the decade 2005-2014[9].

The following section lists the factors that have determined the expansion of soybean production in the last 15 years. The third section presents the main transformations that have accompanied this process, while the fourth provides an approximate quantification, based on a series of hypotheses, of possible soybean expansion in the period 2005-2014. The fifth section explores the main implications that the future expansion of soybean production might have on food security, sustainable rural development and agricultural policies in the countries studied, while the last offers a number of analytical conclusions.

2. Factors determining the soybean boom

Various external and internal factors have helped determine the extraordinary expansion of soybean production in Mercosur and Bolivia. Key external factors have been the dynamism of the international market and technological innovations generated outside the region[10], while internal factors include technological change, research and development, production cost and returns, commercial strategy and public policies.

The aggregate result has been a strong increase in soybean profitability which has been the main factor driving the expansion.

2.1 External factors

2.1.1 Dynamism of the global market for soybean and soybean products

One of the external factors that has strongly influenced the recent expansion of soybean production in South America and the rest of the world has been the sustained demand for protein meal to supplement feed, especially in the more developed countries with highly intensive livestock sectors.

At the same time, the need to bridge the shortfalls in vegetable oil consumption in the developing countries that were beginning to change their dietary habits and patterns also buoyed up the global market for soybean oil and thus the soybean production sector. The Asian countries, especially those with rapid economic growth such as China and India, have played a key role in this dynamic.

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[9] This investigation involved specific studies on Argentina, Brazil and Paraguay by national experts of each country. However, because of time constraints, similar studies could not be carried out on Bolivia and Uruguay before the meeting of the Southern Agricultural Council in November 2006.

[10] In various years of 1996-2004, the historical average price ratio between soybean and maize (f.o.b. in the United States and Argentine ports) favoured the soybean. During the same period, the international price of soybean oil followed a more favourable path than the price of other vegetable oils, with the exception of palm oil. These findings indicate that the international price of soybean and soybean products contributed positively to the expansion of the soybean chain. However, the impact of this external factor is not presented as a specific item in this synthesis given that it was not examined in depth in the country studies.

2.1.2 *Technological innovations from outside the subregion*

The expansion of soybean production in Mercosur and Bolivia during the period 1996-2004 was also facilitated by the adoption of technological innovations from outside the subregion, notably genetically modified seeds, especially seeds of varieties resistant to glyphosate[11] which became increasingly popular in Argentina and Paraguay.

Towards the end of the 1990s, Roundup Ready (RR)[12] soybean accounted for approximately 75 percent of the seeded area in Argentina, 57 percent in the United States and only 10 percent in Brazil. Informal reports point to current proportions of 95 percent, 75 percent and 35 percent respectively[13].

In Paraguay, the introduction and dissemination of transgenic soybean was done directly by farmers who acquired the seeds in Argentina to carry out spontaneous and uncontrolled tests in the country, probably since 1998. The lower cost of production and easier control of weeds with glyphosate stimulated a rapid dissemination of the transgenic variety in Paraguay, to the point of accounting for 60 percent of cultivated area in the 2004/2005 cropping season and about 80 percent in the next one[14]. Uruguay has also seen a rapid expansion of RR soybean since the beginning of this century, with a current estimated share of 99 percent of total soybean area.

2.2 Internal factors

2.2.1 *Technological changes*[15]

Zero tillage. In the late 1980s, agriculture in the South American region began to encounter serious problems of soil erosion and degradation due to intensified cropping, aggressive tillage, cultivation on slope land and scarce replenishment of nutrients. This led to experimentation of new seeding techniques initially known as "minimum tillage", and then as "zero tillage or direct seeding". This practice spread quickly, fuelling the expansion of soybean production in Mercosur and Bolivia.

This technique is currently employed on 73 percent of soybean seeded area in Argentina and more than 85 percent in Uruguay. In Brazil, the area under zero tillage increased from 2 million hectares in 1990 to approximately 22 million in 2005[16], while in Paraguay it rose from 20 000 to 800 000 hectares between 1992 and 1999.

Introduction of transgenic seeds (GMOs). Zero tillage and the introduction of RR soybean in the mid-1990s were well received by farmers, especially in Argentina, Bolivia and

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[11] Glyphosate is an herbicide that permits wide-spectrum weed control.

[12] RR soybean is a transgenic variety that tolerates glyphosate.

[13] **López, G.** 2006. *Caracterización y análisis de la expansión de la soja en Argentina: transformaciones observadas en la agricultura en los últimos 15 años*. Country study prepared for FAO.

[14] **Pedretti, R.** 2006. *Expansión futura de la soja en Paraguay: implicaciones para la seguridad alimentaria, desarrollo rural y politicas agricolas*. Country study prepared for FAO.

[15] The process of technological change observed in Mercosur and Bolivia includes the intensified use of capital goods, fertilizers, agrochemicals (herbicides and pesticides) and machinery. However, in general, the introduction of zero tillage and transgenic crops had particular importance.

[16] This figure includes the area sown to soybean and other annual crops such as maize, cotton, wheat, barley, rice and bean, but it mostly corresponds to soybean. There is a clear trend in Brazil towards a comprehensive use of zero tillage in soybean production.

Paraguay. Two applications of glyphosate a year were now enough to replace the previous five or six applications of herbicides, with the added benefit that the seed companies offered comprehensive technology packages at very attractive prices.

RR soybean has been distributed commercially in Argentina and the United States since 1996. While the sale and use of RR technology in the United States have been protected by patent and sales contract, there were fewer restrictions to its dissemination in the South American countries where the prices were lower than in the United States.

The new technology was taken up very rapidly. In Argentina, hybrid maize took 27 years to dominate the market, wheat cultivars with Mexican germplasm took 16 years[17], but RR soybean took only six years, from 1996 to 2002. It is estimated that in 2002 some 95 percent of soybean area was with RR seeds. A similar situation occurred in Uruguay where the present proportion is estimated to be 99 percent. There are currently more than 60 soybean varieties on the Uruguayan seed market, all of foreign origin (mainly from Argentina and the United States).

In Bolivia and Brazil, on the other hand, the use of soybean transgenic varieties is still growing. In Bolivia, approximately 70 percent of the soybean area is under conventional varieties and the rest under transgenic varieties[18].

In Bolivia, the use of genetically modified soybean was only recently authorized in 2005[19], by Supreme Decree N° 28225 of 01/07/2005. In Brazil, its use has only been authorized since the 2005/2006 cropping season; although in the state of Rio Grande do Sul there were already 4 million hectares planted with transgenic seed from Argentina.

2.2.2 Research and development

National research and development (R&D) systems have also played a fundamental role in soybean expansion, especially in Argentina and Brazil. In Argentina, the National Institute of Agricultural Technology (INTA) and other institutions have concentrated heavily on R&D, with a focus on glyphosate-resistant varieties better adapted to each production zone and its specific soil and environmental conditions.

In Brazil, the Brazilian Agricultural Research Corporation (EMBRAPA-Soja in particular) and other national research institutions have introduced some 195 new soybean cultivars in the last 15 years. Similarly, the introduction of long juvenile soybean that adapts perfectly to low latitude regions extended the soybean frontier to hitherto inconceivable areas. It is now even possible to grow soybean in areas situated to the north of the Equator whose sowing period coincides with the United States.

As will be seen later, public and private technical assistance also played an important role in the expansion of soybean in the subregion.

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[17] From 1973 to 1989.

[18] **Pardo, Martín and Eduardo Gudyma**. 2005. Soja en Bolivia, la encrucijada entre mercados, tecnologías e impactos. *El Observatorio del Desarrollo*, December.

[19] **Zabala Moreno, Rolando**. 2006. *Evolución de la superficie de soya en Bolivia: Oportunidades y limitantes – Enfoque técnico, legal y sanitario*. Paper presented at MERCOSOJA 2006, Third Soybean Congress of Mercosur, July 2006, Rosario, Argentina.

2.2.3 *Production costs and soybean returns*

Soybean cultivation in South America is characterized by relatively low production costs and higher returns than other countries, which makes the region extremely competitive on the world market. As Table 2.1 shows, the average production cost per hectare in Argentina and Brazil in 2004 was much lower than in the United States, which favoured the expansion of soybean production in these two countries.

In Argentina and Paraguay, the new technology of zero tillage and GMO seeds led to an appreciable reduction in production costs[20]. This saving, combined with higher productivity per hectare and rising prices, had a considerable cumulative impact on returns and made soybean one of the most attractive crops for farmers in both countries.

In Brazil, although net soybean returns in the period 1998-2004 were similar to maize and lower than cotton, many farmers opted to grow soybean because it carried fewer technical risks and offered higher liquidity than maize. In addition, much higher investment is required for the high-tech cultivation of cotton than for soybean, not to mention the fact that growing cotton is technically more complex, requiring greater technical and management skills.

Table 2.1
Soybean production costs, 2004[a]
(US dollars per hectare)

Item	US	Brazil	Argentina
	US dollars/hectare		
Direct cost[b]	202.8	353.8	140.0
Land cost	250.0	84.7	200.0
Other costs[c]	169.7	94.4	136.9
Total cost	622,5	532,8	476,9

[a] Brazil data refer to the district of Cascavel; Argentina data to the south of Santa Fe province (region of high productivity); US data also to a region of high productivity.

[b] Inputs, operating costs and wages.

[c] Depreciation, interest, tax, insurance, structural costs and other indirect costs.

Source: FAO/RLC.

2.2.4 *Commercial strategy*

The increase in world demand for soybean and soybean products encouraged South American producers to adopt commercial strategies that would enable them to respond with a significant production expansion. Of the five producer countries of South America, Argentina and Brazil have positioned themselves best on the extra-regional markets. Both share the Chinese market while only Brazil trades with the European market.

[20] Agrochemical costs were more than halved and labour costs fell because of reduced agricultural labour per hectare.

The significant presence of Brazil on the European market is basically due to the fact that from 1998 the European Union placed a barrier on the importation, production and industrialization of new transgenic crops and imposed a system of labeling and traceability of product from transgenic origin. In contrast to Argentina, Uruguay and Paraguay, Brazilian soybean is mostly of conventional and not transgenic origin.

Paraguay acts as a supplier of soybean to the major producer countries of Mercosur, especially Brazil which receives 44 percent of Paraguay's soybean exports. The only European market for Paraguayan soybean since 2002 has been Switzerland which took 15 percent of its exports in 2002 and 22 percent in 2003. Until 2000, the Netherlands had accounted for a large proportion of Paraguayan exports.

Bolivia's exports have focused on the Andean Community because, although its production costs are higher than Argentina and Brazil, it benefits from Andean tariff preferences. However, Colombia's free trade agreement with the United States and subsequent agreements with other Andean countries, together with the inclusion of Venezuela in Mercosur, have reduced the significance of those tariff advantages for the Bolivian soybean.

There are therefore, three distinct trade flows in the region: one external, from the Mercosur countries to Asia and Europe; and two internal, the first from Mercosur to the Andean Community, and the second between the Mercosur countries themselves, in particular towards Brazil and Argentina, the major processors of soybean.

The commercial strategies of producer countries centre on opportunities available in distinct markets. Argentina clearly focuses on the Chinese market and, although there are no signs of significant slowdown of growth in China, any change in its supply policy would affect its imports of soybean products, which account for a large share of Argentina's exports.

Bolivia's soybean exports, which depend on short-term preferences, are also vulnerable to changes in commercial policy of importing countries. Under the current process of trade liberalization and economic integration, it will be difficult to maintain an international market share based on tariff preferences, so it is imperative to enhance competitiveness.

2.2.5 Public policies[21]

Some public policies adopted by the countries of Mercosur and Bolivia have favoured the expansion of soybean and soybean products. During the period 1990-1998, Argentina's soybean sector benefited greatly from trade liberalization measures[22], the elimination of fuel taxes and the reduction of inefficiencies and monopolistic earnings of market networks (elevators, transport and ports)[23]. Also, after a period of significant macroeconomic disequilibrium, financial crisis and deepening recession, the soybean sector was bolstered in 2002 by the abandonment of fixed parity with the dollar and resulting monetary devaluation. Brazil's soybean sector was motivated by Complementary Law N° 87 of 13 September 1996, the monetary devaluation of 1998, and implementation of the Nippon-Brazilian Programme of

[21] Some public policies have favoured the soybean sector while others, such as taxation, have had the opposite effect. The country studies for this synthesis document do not include a comparative analysis of these two contrasting policies. This item therefore only refers to policies that have had a significant positive impact on the sector. The expansion of the soybean sector in the countries studied is however considered to reflect a net positive impact of public policies.

[22] The elimination of export taxes and quantitative restrictions on imports, together with reduced duty on the import of fertilizers, herbicides, pesticides, machinery and irrigation equipment.

[23] **World Bank**. 2006. *Agricultura y desarrollo rural en Argentina: temas claves.*

Development of the Savannahs[24] (PRODECER), and the MODERFROTA programme by the National Bank for Economic and Social Development (BNDES) in 2000. The first of these measures, known as the Kandir Law, exempted exports of primary and semi-finished goods from the tax on the circulation of goods and services (ICMS), which gave a significant boost to external sales, especially of the soybean sector.

PRODECER promoted the expansion of soybean production by providing investment credit, while MODERFROTA facilitated the purchase of tractors and harvesters through medium-term credit at favourable interest rates. Brazilian and Argentinean soybean producers have also benefited from public policies on agricultural research, although resource allocations to this area have fallen in respective government budgets.

In Paraguay, credit policy was crucial in the early stages of soybean expansion. The financial liberalization of the early 1990s produced major changes, including a reduction on the legal bank reserve (from 42 percent to 18 percent), liberalization of lending and deposit rates, and authorization for public institutions to deposit funds with private banks rather than the Central Bank. This boosted the availability of funds for internal financing. From 2000, there has also been a notable increase in competitiveness and profitability of the soybean sector and a sustained depreciation of the national currency.

In Uruguay, the absence of export taxes and low customs duties on imported agricultural machinery and inputs are significant competitive advantages in regional terms. This, coupled with lower land prices, has encouraged many Argentine producers to invest in the Uruguayan soybean sector.

In Bolivia, about 98 percent of soybean production is concentrated in the department of Santa Cruz where soybean cultivation has expanded, partly because of the availability of cheap fertile land. The Eastern Lowlands Development Project[25], financed by the World Bank, provided funds for a new agricultural frontier to the east of Rio Grande on the eastern plains of the department of Santa Cruz. Implementation of its components built the technological and rural infrastructure platform for the emergence of a new agricultural export model in eastern Bolivia[26].

Soybean cultivation in Bolivia has also received important institutional support from the National Seed Programme which was launched in 1982 under the Ministry of Agriculture. Each department of the country has a Seed Committee under joint public-private management. The executive arm is the Regional Seed Office. Official data indicate that 80 percent of soybean is sown with certified seed controlled and inspected by the Regional Seed Office. This office introduced a measure to relax certification standards to permit the production, importation and marketing of glyphosate-resistant seeds.

Bolivia's soybean sector has also been favoured by the above mentioned tariff preferences of the Andean Community.

[24] This programme operated in a number of states including Pará, where it provided investment credit amounting to US$70 million until the year 2000.
[25] Also known as the Lowlands Project.
[26] **Montenegro, Diego**. 2006. *Características y análisis de competitividad de las oleaginosas en Bolivia*. Paper presented at MERCOSOJA 2006, Third Soybean Congress of Mercosur, July 2006, Rosario, Argentina.

3. Changes associated with soybean expansion

The expansion of soybean production has been accompanied by sweeping changes in the agricultural sector and the economy of the countries of Mercosur and Bolivia. These changes resulting from soybean expansion or other processes embrace notable structural, institutional, agroindustrial, environmental and social aspects.

3.1 Structural changes

Agriculturization. The expansion of the soybean sector in South America contributed significantly to a series of structural changes, including the acceleration of agriculturization in Argentina. Under this still ongoing process, crop-livestock[27] rotations are replaced by a model essentially based on cropping. During the period 1995-2004, the agricultural area expanded 40 percent, from 20 million to 28 million hectares, largely due to soybean whose cultivated area increased from 6 million hectares in 1995 to 14 million in 2004. At the same time, the cattle population dropped from 52.6 million head in 1993 to 48.8 million 2001[28]. Most of the reduction occurred in the zones with the greatest increase in soybean production, the provinces of Buenos Aires and Cordoba.

Expansion of the agricultural frontier. The spread of soybean cultivation contributed also to intensify another structural transformation: the expansion of the agricultural frontier, particularly in Argentina, Brazil and Paraguay. In Argentina, this expansion occurred by increasing the soybean seeded area in the core soybean zone[29] and by rapidly developing new zones – the regions of the Northwest and Northeast and the rest of the Pampas, especially the provinces of Entre Ríos and La Pampa.

Prominent among the core soybean provinces is Córdoba which has overtaken Santa Fe, the pioneer of soybean development, to become Argentina's main soybean region in terms of cultivated area. Significant new soybean zones include the province of Entre Ríos, where the cropped area increased eight-fold, from 155 000 hectares in 1995 to 1.2 million in 2004. Also important are the regions of the Northwest and Northeast whose joint share of total soybean area increased from 8 percent in 1995 to 15 percent in 2004[30].

In Brazil, soybean's contribution to the expanded agricultural frontier was an increase of 13 million hectares of soybean area between 1995 and 2004[31], with 4 million in the traditional soybean producing states[32] and 9 million in agricultural expanding regions. The average rate of growth of cultivated area in the states of the new expansion zones was at least one percentage point higher than in the traditional soybean zone (6.5 percent in Paraná).

Three important aspects need to be highlighted: i) since the 2003/2004 harvest, Mato Grosso has been the largest soybean producer state in the world; ii) the states of the North and Northeast recorded average annual rates of growth far high than those of the states of the Centre-West; and iii) the increase in soybean area did not cause an expansion of the agricultural frontier comparable to Argentina, as it occurred far more by substituting crops

[27] This was the predominant production system in the country until the mid-1970s.
[28] Although there is no comprehensive reliable information on the evolution of cattle numbers in Argentina, partial data such as these confirm this observation.
[29] This zone covers the Littoral region (Corrientes y Misiones), the north of Buenos Aires province, the centre-east and south of Córdoba province and the south and centre-north of Santa Fe.
[30] The region of the Northeast was more dynamic than the Northwest as it virtually increased its sown area ten-fold, with sustained growth in the provinces of Santiago del Estero and Chaco.
[31] Brazil's soybean area increased from 12 million hectares in 1995 to 21 million in 2004.
[32] This region is made up of the states of São Paulo, Paraná, Santa Catarina and Rio Grande do Sul.

and pasture than by incorporating new areas. As will be seen later, although the current soybean area in the Brazilian Amazon[33] covers only 2 percent of that territory, there is mounting concern from the ecological perspective.

In Paraguay, the extraordinary growth of soybean production has also played a crucial role in the expansion of the agricultural frontier in the last 10 years. The soybean area increased 124 percent between 1990 and 2002 in the traditional soybean zones[34] and extended into new areas (San Pedro, lower Canindeyú, Caaguazú and Caazapá), where the seeded area increased 239 percent in the same period.

Intensive expansion in the new zone has resulted from the conversion of extensive planted pasture and the advance of the agricultural frontier into forest land, with forest clearance and mechanization. The increase in soybean area in the traditional zone has also led to a reduction in pasture area. However, in contrast to Argentina, the conversion has not reduced the cattle population in any of these zones; on the contrary, the highest rates of growth of the cattle herd have been recorded precisely in the traditional soybean departments (Itapúa, Alto Paraná and Canindeyú) through higher stock load per hectare.

Changes in agrarian and production structure. The expansion of soybean cultivation has also accentuated the historical process of change in agrarian and production structure experienced by the countries of Mercosur and Bolivia. In Argentina, for example, the total number of farm holdings fell from 421 221 in 1988 to 333 533 in 2002[35]. The number of holdings in the main soybean regions (Pampas, Northeast and Northwest) fell from 287 678 to 212 372 during the same period. At the same time, the area under annual crops increased from 14 million to 20 million hectares, resulting in a higher concentration of production in larger holdings.

Something similar occurred in Brazil and Paraguay. Brazil's agricultural censuses of 1985 and 1996 indicate that the number of soybean farms with under 100 hectares fell by about 14 percent during this period, the number of farms with between 100 and 1000 hectares remained more or less the same, while farms with more than 1000 hectares increased from 18 percent to 30 percent. As a result, 65 percent of Brazil's soybean production in the 1990s was concentrated in properties of more than 200 hectares.

Brazil's soybean production is becoming increasingly concentrated in properties of more than 500 hectares. In the Centre-West region, the expansion reflects an attempt to achieve larger economies of scale. Similarly, in the south of the country, grain and oilseed cultivation is no longer based on small holdings.

In Paraguay, the expansion of soybean production has also resulted in a larger size of holding and a concentration of soybean cropping in larger units. The number of holdings of under 50 hectares is estimated to have fallen by 2 681 units in the period 1991-2002 giving rise to a gradual concentration of production in medium and large holdings of more than 50 hectares. Smallholder agriculture, especially in areas adjacent to large and medium holdings, has had to adjust its coping strategy: sell, lease or convert to soybean.

Change in sowing patterns. In Argentina, the above changes have been accompanied by changes in sowing patterns. The initial stage of soybean development was to sow on land previously growing wheat, in other words the pattern known as second–crop soybean. But

[33] This region is a biome which occupies about 59 percent of the national territory and includes the states of the North region (Acre, Amapá, Amazonas, Pará, Rondônia, Roraima and Tocantins), the state of Mato Grosso, part of the state of Maranhão and a small part of the state of Goiás.
[34] This zone includes the departments of Alto Paraná, Itapuá and the upper part of Canindeyú.
[35] Information based on the national agricultural censuses of 1988 and 2002.

the introduction of soybean varieties better adapted to individual regions and greater returns from soybean because of its good prices changed the sowing patterns, especially in the Pampas region, which is why second-crop soybean now only accounts for one-fifth of the total soybean area.

3.2 Institutional changes

Intensification of institutional land access arrangements. The expansion of soybean cultivation in South America has been accompanied by important institutional changes, such as greater recourse to leasing mechanisms and production contracts. These changes have been particularly important in Argentina, where the role of the contractor has rapidly gained prominence, now accounting for 60 percent of the soybean area. There are three types of contractor (generally working on leased land): machinery[36], "tanteros"[37] and contractor farmers[38].

The boom in soybean production has also given rise to modalities of cultivation without land ownership, especially in Argentina. Such innovative institutional arrangements based on producer and investor associations include:

- Producer associations – judicially de facto societies, "collaborative groups" or "transitional unions of enterprises" – established to purchase inputs at a discount (purchase pool), to better negotiate sales (sale pool) or to cover the whole production cycle (cropping pool).
- Financial trust funds: common investment funds (CIFs) through which investors supply funds to an association for their administration, receiving certificates of membership or collective ownership (assessed shares)[39].

Such modalities of cropping without land ownership are very common in soybean cultivation in Argentina and have created an active and varied leasing market. The main form of leasing by contractors is to pay the owner a proportion of expected production in kilograms of soybean per hectare. This form of payment has become very common in leasing contracts.

Multiplication of credit contracts between private agents. Agricultural financing, especially financing for soybean, has undergone significant institutional change with greater employment of credit contracts signed by producers and the processing industry, trading houses, input manufacturers and/or retailers and market operators. In Brazil, an estimated 40 percent of financial requirements for soybean cultivation are now provided through credit contracts signed with the processing industry and trading houses, and about 15 percent with the input industry. The remaining funds come from government credit (30 percent), farmers'

[36] Machinery contractors provide seeding, sanitary and phyto-sanitary plant protection and harvesting services to third parties in exchange for money or produce. These contractors assume no production risks (except from own-account error or technical problems when providing the service).
[37] "Tanteros" contract plots from third parties for one or more harvests and pay part of the lease in predetermined amounts of produce or cash. These contractors incur production risks.
[38] These contractors supplement their own production by sowing on leased land.
[39] CIFs run greater risks although these are limited by the fact that members cultivate in different areas. They employ scale as in pools to secure opportunities and advantages for marketing, direct sales, lower costs (brokerage etc.). The involvement of non-agricultural investors solely interested in the financial aspect of the soybean business has been an important feature in Argentina in recent years, attracted by higher returns than from other financial options. However, there are no precise, sufficiently broad data on the volumes involved to determine the exact magnitude of this phenomenon.

own resources (10 percent) and other sources (5 percent), such as manufacturers of agricultural machinery[40].

The main forms of soybean financing by the agricultural input industry are:

- Sale of soybean at a fixed price with payment at sight and future delivery of production to pay for inputs received[41].
- Sale of soybean with a price and terms to be defined later, but with part payment (forward pricing) to cover inputs.
- Sale of soybean at a fixed price with future payment through delivery of output and future payment of inputs received.

The country studies undertaken for this investigation do not include specific information on the role of the industrial sector or the trading houses in financing soybean cultivation in Argentina, Bolivia, Paraguay and Uruguay, but there is a definite impression that all these countries have experienced institutional change similar to Brazil.

Expansion of private technical assistance. The development of soybean cultivation in Mercosur and Bolivia has also contributed to an expansion of private technical assistance services. Producer cooperatives, representatives of input manufacturers and consultancy and agricultural planning companies have increased their technical assistance to meet growing demand from soybean producers for services relating to soil analysis, incidence of diseases such as soybean rust (*Phakopsora meibomia*e) and recommendations on the use of seeds, fertilizers and agrochemicals.

In Paraguay, the role of the private sector in technological innovation and development increased rapidly, while that of the public institutions declined because of a reduction in their human and financial resources.

3.3 Changes in agroindustry

Development of a vibrant processing industry. A dynamic processing industry has developed in conjunction with the expansion of soybean cultivation, especially in Argentina and Brazil, and to a lesser extent in Paraguay. In Argentina, where there was already a significant oilseed milling industry, mainly for sunflower, linseed and groundnut, the expansion of soybean production raised soybean processing to the point where it now accounts for 65 to 75 percent of total milling output.

The development of this industry in Argentina has largely been due to the high international prices that sustained farmer income and stimulated soybean production, to the point where supply regularly outstripped installed processing capacity. The industry also benefited from differential export tariffs which gave it a competitive edge over traditional exports of raw soybeans.

The installed capacity of Argentina's processing industry tripled in ten years, rising from 15 million tonnes in the first half of the 1990s to its current 45 million tonnes. A key feature of this expansion has been a high concentration of crushing capacity and greater involvement of multinationals[42].

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[40] **Roessing, A. C. y Lazzarotto, J. J.** 2006. *A cultura da soja no Brasil: evolução recente*. Country document sponsored by FAO.

[41] This financing modality is also known as the "green soybean" trade.

[42] Of the 47 plants in operation, 33 operate with domestic capital and the remaining 14 with multinational capital. However, the average daily milling capacity of the former is 1315 tonnes, while

Argentina's vegetable oil industry is the most dynamic industrial sector of the country and the sector with the highest growth in the last two decades. Argentina began to import soybean since the 1996/1997 season, mainly from Paraguay and to a lesser degree from Bolivia and Brazil in order to feed its increase in milling capacity[43].

Brazil has also developed a sizeable processing industry, but with the application of the Kandir Law in 1996, it changed its commercial strategy and modified the proportion of soybeans devoted for industrial processing. Until that year, Brazil had processed between 75 and 80 percent of its soybean production and exported less than 20 percent. After 1996, however, the proportion of soybean crushed dropped rapidly while the exports of soybean seed increased reaching its present level of 41 percent of the soybean harvest. In spite of this change, the size and buoyancy of the domestic market for soybean products has favoured the expansion of Brazil's processing industry.

Paraguay's processing capacity is very small in comparison to Argentina and Brazil[44]. However, the vegetable oil industry is one of the country's main industries and has always had a clear export orientation, given its limited domestic market. The local industry absorbs 30 percent of domestic production, the remaining 70 percent being exported in bulk. In the period 1994-2003, domestic consumption of the processing industry increased 51 percent.

Emergence of a promising industry of alternative soybean uses. The expansion of soybean production has also created a promising national industry in by-products for the food industry, human consumption, the chemical industry and energy (biodiesel). In Brazil, the use of soymeal to produce isolated protein and other protein products is still in its infancy, but many industries are acquiring soybean grain for various forms of processing. Although there are no precise data, it is estimated that Brazil allocates 1.5 million tonnes of soybean each year to meet the demand of these industries, equivalent to 3 percent of total production for the 2004-2005 season.

An estimated 40 percent of lecithin produced in Brazil is for the food industry, 20 percent for the chemical industry and 40 percent for the external market[45]. Although sectoral entrepreneurs consider that the lecithin market still has to be developed, there are already major companies in Brazil with strong competitive positions, including Santista, Incopa and Braswey which together cover 90 percent of the market.

Brazil's chemical industry has also benefited from the production of different soybean products because these are considered to be of biological origin and therefore biodegradable and/or derived from renewable natural resources. This is the case with various plastics, adhesives, solvents, lubricants and other products.

The substantial increase in the price of petroleum and the desire to reduce fossil fuel emissions have led to the development of biofuels, including biodiesel, especially in Argentina and Brazil. In May 2006, Argentina issued National Law 26 093 on the Regulation and Promotion of Production and Sustainable Use of Biofuels, which stipulates that from 2010 diesel or petrol fuel sold in Argentina should be mixed with 5 percent biodiesel or bioethanol (B5), thus opening the way for commercial production[46].

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that of the latter is 4650 tonnes, in other words 60 percent of installed capacity corresponds to companies with international capital.

[43] Soybean imports in that period exceeded one million tonnes while in the following cycle they fell to 500 000 tonnes and then stabilized at an average of 300 000 to 400 000 tonnes.

[44] Equivalent to 7 percent of Brazil's installed capacity. Plants are also much smaller. The average size of a vegetable oil processing plant in Argentina is six times larger than in Paraguay.

[45] According to information provided by Masuo Okada, consultant in food technology.

[46] The commercial production of biodiesel has not yet started; a number of pilot plants have been in ɔration since 2003.

In contrast, the production of biodiesel in Brazil is slightly more advanced. As of October 2005, the National Agency for Petroleum, Natural Gas and Biofuels (ANP) has authorized the operation of six industrial production plants – two based on soybean and sunflower – in the states of Minas Gerais and Paraná[47]. The remaining plants process castor and palm oil. In addition to these authorized plants, there are six others in the pipeline. The expectation is that the number of plants will increase appreciably in the next years[48] with the implementation of Law 11097 of January 2005 on the introduction of biodiesel into Brazil's energy matrix.

3.4 Environmental changes

Clearance of native forest and forest areas. In Argentina, the expansion of soybean production has resulted from a partial substitution of area under annual crops[49], clearance of native forest and, mainly, displacement of beef and dairy farming. Forest clearance and the displacement of cattle farming have had a strong environmental impact which has raised strong criticism. The clearance of vast areas of native vegetation has affected Chaco-Santiagueño and Salteño forest land and, to a lesser degree, the Paraná forest in the province of Misiones, while in the Pampas region, soybean has replaced cattle farming, which has driven it to more marginal areas, reduced the number of dairy farms and displaced the cultivation of other grains.

In Brazil, soybean production expanded by replacing other crops and pasture and, to a lesser degree, by absorbing "virgin" areas[50]. Although the soybean-deforestation correlation is a controversial issue in Brazil, most studies agree that soybean cultivation has mainly expanded on pasture, some of which itself came into existence from the conversion of forest to pasture for extensive ranching[51]. There is therefore a strong impression that cattle farming[52] has contributed most to deforestation[53] but that soybean has had an indirect impact on the clearance of forest and savannah.

According to the study on Brazil sponsored by FAO, this perception is based on the following: i) it is very difficult to clear virgin savannah, especially in the Amazon jungle, and convert it to soybean in the same year or even a longer period; on the contrary, it takes years

[47] These two industries will have an annual production capacity of 21 million litres.
[48] This law stipulates a minimum mandatory percentage of added biodiesel to diesel fuel retailed to the consumer of 5 percent volume, referred to as B5. The timeframe for implementation of this provision is 8 years but during the first 3 years there is a mandatory minimum of 2 percent volume, referred to as B2. B2 will be mandatory from 2008, B5 from 2013.
[49] In the Northeast and Northwest regions for example, the area sown with industrial crops fell 30 and 17 percent respectively during the intercensus period 1998-2001. The crops most affected were sugar cane and cotton, although there were also reductions in bean, tea and tobacco.
[50] According to the Institute of Environmental Research of the Amazon Region (IPAM), there have been cases of conversion of forest land to soybean in the state of Mato Grosso; however these cases have been limited.
[51] According to the last agricultural census in Brazil, the planted pasture area increased from 7 million to 50 million hectares between 1970 and 1995. During this same period, natural pasture fell from 46 million to 23 million hectares.
[52] Especially medium and large-scale ranching
[53] As reported by Alencar *et al.* 2004 (*Desmatamento na Amazônia: indo alem da emergencia crônica*. Belem. Institute of Environmental Research of the Amazon Region) now, as in the last 20 years, 70 percent of the deforested Amazon Region is used as cattle pasture. According to Margulis, Sergio. 2004 (*Causas do Desmatamento da Amazônia Brasileira*,. Brasilia, World Bank), the reasons for this include technological and management changes in cattle farming and adjustment to the geo-ecological conditions of the Eastern Amazon.

for such new areas to be suitable for soybean production[54]; ii) the virgin areas of savannah or Amazon jungle that are available do not generally have the minimum infrastructure needed to gain effective returns from an agricultural activity such as soybean cultivation that requires intensive capital input[55]; and iii) it is estimated that during 2001-2003 the conversion of pasture to cropland amounted to 5 million hectares, and to more than 3 million in 2004[56]. The sum of these figures is very close to the 7 million hectare increase in Brazil's total soybean area in the period 2001-2003.

In spite of the general recognition that cattle raising played a lead role in deforestation in Brazil, especially the Brazilian Amazon, it is possible that by replacing pasture and therefore displacing livestock production to other areas, soybean has contributed indirectly but significantly to the escalation of forest clearance. Regrettably, there are no data to verify this hypothesis, but the large expansion in soybean area noted in the period 1995-2004, together with the fact that most of this area has come from the conversion of pasture and the sustained growth of extensive ranching tend to confirm that the expansion of soybean production has had an indirect but not insignificant impact on deforestation.

In Paraguay, deforestation for agricultural purposes has long existed. The main historically documented impact of the expansion of mechanized agriculture on land use was the massive deforestation of the Atlantic subtropical forest, although this was not so much a consequence of soybean expansion itself, but rather of land settlement in general.

More recently, with the expansion of soybean and especially in the new soybean regions and the advance of the agricultural frontier, the process of forest clearance has gained pace, but not to the same extent as in the past. As a result, the Atlantic forest region of Alto Paraná is now seriously threatened by the pressures that increased demand and agricultural expansion are exerting on this rich ecosystem. On the other hand, the loss of forest land in the Eastern Region has been mainly due to the incorporation of extensive areas into livestock production, the agrarian reform and land settlement programmes and the expansion of mechanized agriculture.

In Bolivia, although the phenomenon is more recent than in Argentina and Brazil, the expansion of soybean is exerting similar pressures on forest and pasture ecosystems, such as the Bosque Chiquitano and other areas neighbouring the Pantanal.

Sustainability of the agricultural production system. As stated earlier, zero tillage contributed significantly to the expansion of soybean in South America. Although promoted as a sustainable practice, this technique has nevertheless contributed to an incidence of pests[57] of an intensity that has alarmed many producers in the region. These drawbacks of the new cropping technique have led to an increase in agrochemical treatments, which have not only increased production costs but also represent a serious threat to the environment and to the sustainability of the soybean production system. The sustainability of this oilseed in South America has also been affected by inadequate crop rotation and fertilizer use. In Argentina, for example, the soybean seeded area now accounts for 50 percent of total grain

[54] However, according to a recent study by Morton *et al.* (*Cropland expansion changes deforestation dynamics in the southern Brazilian Amazon*. In Proceedings from the National Academy of Sciences of the USA – PNAS), a new dynamic of direct conversion of forest into cropland began to emerge between 2002 and 2003, when forest cleared for pasture dropped from 78 to 66 percent, while cleared forest directly converted to cropland rose from 13 to 23 percent.

[55] This does not generally occur in regions already occupied by cattle ranching which tend to be well endowed logistically.

[56] **Torres Jr., A. de M; Rosa, F. R. T.; Nogueira, M. P.** 2004. Mais boi em menos pasto. *Agroanalysis*, August.

[57] Including the cyst nematode, slugs, snails, sowbugs and soybean Asian rust.

cropland, raising doubts as to the effective implementation of the rotations needed for rational land use.

In addition, a number of small-farmer households in Paraguay in direct contact with modern agriculture have experienced serious health problems and had their food production contaminated by the large-scale use of agrochemicals on nearby medium and large-scale soybean farms.

At the same time, the massive use of agrochemicals has harmed the development of other agricultural activities in Paraguay such as beekeeping which, because of the biological limitation of reduced flower availability, is one more activity that has been marginalized by massive soybean production. Apart from impacting negatively on the sustainability of crops for on-farm consumption (cassava, bean, maize, groundnut, horticulture) and commercial crops (cotton and sesame), this has also led to the sale of land by the farmers affected, a trend that is expected to continue.

3.5 Social changes

Concentration along the commodity chain. The expansion of soybean has also contributed to intensifying some social changes, such as concentration of large size land holding. Data from the last two censuses in Argentina indicate that the number of holdings fell 21 percent between 1988 and 2002, to 334 000 units. At the same time, the average size of Argentine farm holding increased 28 percent from 1988, averaging 538 hectares, which is larger than in the United States, Europe and other parts of the world.

Meanwhile the proportion of economically active population (EAP) working in agriculture fell from 15 percent in 1970 to 8 percent in 2001. Full-time agricultural workers numbered 1.78 million in 1969, 1.05 million in 1988, but only 775 000 in 2001, of whom 44 percent were farmers, 30 percent wage labourers and the rest family workers.

The process of concentration noted in Argentina and in other countries of Mercosur and Bolivia is not exclusive to the initial stage of the soybean and soybean products commodity chain (i.e. the production of soybeans) but also applies to the downstream parts of the chain such as transportation of output, storage and treatment, processing of raw material, port logistics and exportation.

Change in the socio-economic conditions of small-scale agriculture. Soybean expansion has also contributed to boosting the sale and lease of agricultural land in the countries of Mercosur and Bolivia. This active real estate market alluded to earlier has had a significant impact on small-scale agriculture[58]. The sale of land by small farmers and reduced opportunities for employment in a technology-based production structure have accelerated rural migration, especially in Paraguay.

The reduction in family farms has also contributed to a loss of rural jobs and lower household income. The introduction of intense soybean monoculture and its increasing dynamism have led directly or indirectly to the development of various associated economic activities, especially in neighbouring urban areas. However, the general inability of towns to absorb the new migrants, because the demand is mainly for skilled labour, has not helped to reduce

[58] For example, in the state of Mato Grosso the area under small farmer soybean cultivation amounts to 2 million hectares. Because of problems of profitability and debt, particularly in the last two years, those small farmers have had to sell their land. They generally have more difficulty renegotiating their debts and/or have less access to loans, which means that, in contrast to large producers, they have to sell their properties.

poverty. Therefore, although there have been positive aspects to soybean development, many families continue to live in poverty.

4. Prospects of growth of the soybean sector

Given the extraordinary expansion of soybean and soybean products presented above, the objectives of this section are twofold: first, to provide an approximate estimation of the future growth of this sector in the five main producer countries of Latin America for the period 2005–2014; and second, to explore the main implications of the expected growth for food security, rural development, the environment, the sustainability of the soybean production system and for agricultural public policies.

4.1 Quantitative model

The forward-looking part of the study was carried out using the Aglink-Cosimo partial equilibrium model, a joint project of FAO and the Organization for Economic Co-operation and Development (OECD). The model provides a comprehensive dynamic economic and policy specific representation of major world producing and trading countries for the main temperate-zone commodities as well as rice and vegetable oils[59].

The modules are all developed by OECD and FAO together with country experts and, in some cases, with assistance from other national counterparts. The information generated is used to prepare market assessments for cereals, oilseeds, meats, dairy products and sugar over the course of the outlook period. The Outlook process implies that the baseline projections presented in this document are conditioned by those developed by OECD countries and other participating economies. It also reconciles inconsistencies between individual country projections through the use of a formal modeling framework. The review process ensures that judgment of country experts is brought to bear on the projections and related analyses. However, the final responsibility for the projections and their interpretation rests with the OECD and FAO[60]. In addition to quantities produced, consumed and traded, the baseline also includes projections for nominal prices (in local currency units) for the commodities concerned.

The model's assumptions are that the climate will remain stable around its long-term historical average during the projection period; agricultural market policies will not change unduly; the macroeconomic environment will remain stable; and economic growth will be strong and sustained throughout most of the world. Commodity markets, including soybean and soybean products, will develop in a stable environment without major disruption, including in external demand from major importers, such as China and the OECD countries.

The model also employs a series of hypotheses on macroeconomic variables, such as the evolution of real GDP and exchange rate, rate of inflation and population growth. These hypotheses are based on the following medium-term macroeconomic projections of OECD's Economic Department and the World Bank: the OECD zone will grow by about 2.6 percent per year during the period 2006-2014, with growth in the Euro zone and Japan lower than in the United States; economic growth in many developing and transition economies will be

[59] The model covers 48 countries and regions and 18 agricultural items.

[60] More details of the list of countries and commodities and a description of the model and its main assumptions can be found in OECD-FAO Agricultural Outlook 2005-2014 published by these bodies in 2005. The data used in the estimates are sourced from the OECD and FAO databases, which are in turn based on national statistics. Other sources of information include the World Bank and International Monetary Fund (IMF).

higher than in the OECD zone and will drive the global rate of growth during the following period; economic activity in the countries of the Commonwealth of Independent States (CIS) will fall sharply in relation to the high pace of recent years, with average annual growth in Russia slightly above 2 percent from 2007; the dynamic economies of Asia will continue to grow rapidly until 2014, especially China, at an annual average of more than 7 percent.

The projections are also based on the assumption that inflation rates will remain low in most countries until 2014, and that 2004 exchange rates in relation to the US dollar will remain unchanged during the projection period[61]. World population growth will fall to slightly above 1 percent per year, compared to 1.3 percent during the last decade. Although down slightly, population growth in the developing countries will continue to outpace that of the OECD zone, mainly because of higher fertility rates. The following section presents the estimates resulting from the quantitative model.

[61] The euro/US dollar exchange rate is assumed to remain constant at the early 2005 level, while the yuan will devalue slightly in relation to the US dollar during the period 2005-2014.

Box 1 – Development of the exchange rates

In the Aglink-Cosimo partial balance model, used in the construction of the projections of this study, there is the assumption that the US Dollar exchange rate of 2004 would remain the same in most countries during the entire projection period. The USD/Euro exchange rate is also thought to remain stable until the beginning of 2005. This will make the USA farming exports more competitive, while other exports would remain the same in comparison to some OECD countries whose currency has become stronger, such as the countries in the Euro zone, Canada, Australia and New Zealand.

However, according to projections used for the exchange rate in the model, an inverse situation could take place in some of the developing countries exports, such as Argentina and Brazil, whose currency will continue to weaken in comparison to the USD until 2014 (Farming Perspectives, EOCD-FAO 2005-2014).

Hypothetic exchange rates can be decisive for commercial projections, especially for the relative competitiveness of countries in the global market. Therefore it is necessary to closely monitor the evolution of exchange rates and its contradictory effect in the competitiveness of farming exports. In Brazil, during the 2005-2007 period, the *real* grew 8.55 per cent against the USD. In Paraguay, in 2006, the *guaraní* registered a 9.25 per cent gain against the dollar. In Bolivia and Uruguay, during the same period, there was a similar – yet more restricted – tendency. Only the Argentinean currency has lost value in this time frame. Some governments have developed active exchange policies to prevent or contain the surge of their currency and its related loss of competitiveness in exports, not only agricultural but industrial and service related. In this context of great influence of exchange rates in competitiveness of exports and imported goods, it is of the utmost importance to observe the evolution and impact of these variables in the soy production chain.

Nominal exchange rate (national currency vs. USD)

Country	2005	2006	2007	Annual variation percentage
Argentina	3.01	3.04	3.08	1.04
Bolivia	8.04	7.98	7.92	-0.73
Brazil	2.34	2.14	1.96	-8.55
Paraguay	6120	5190	5040	-9.25
Uruguay	24.10	24.40	23.90	-0.43

Source: 2005 y 2006 FMI, International Financial Statistics Database, 2007. 2006, Central Bank of each country. Exchange rate, FAO/RLC.

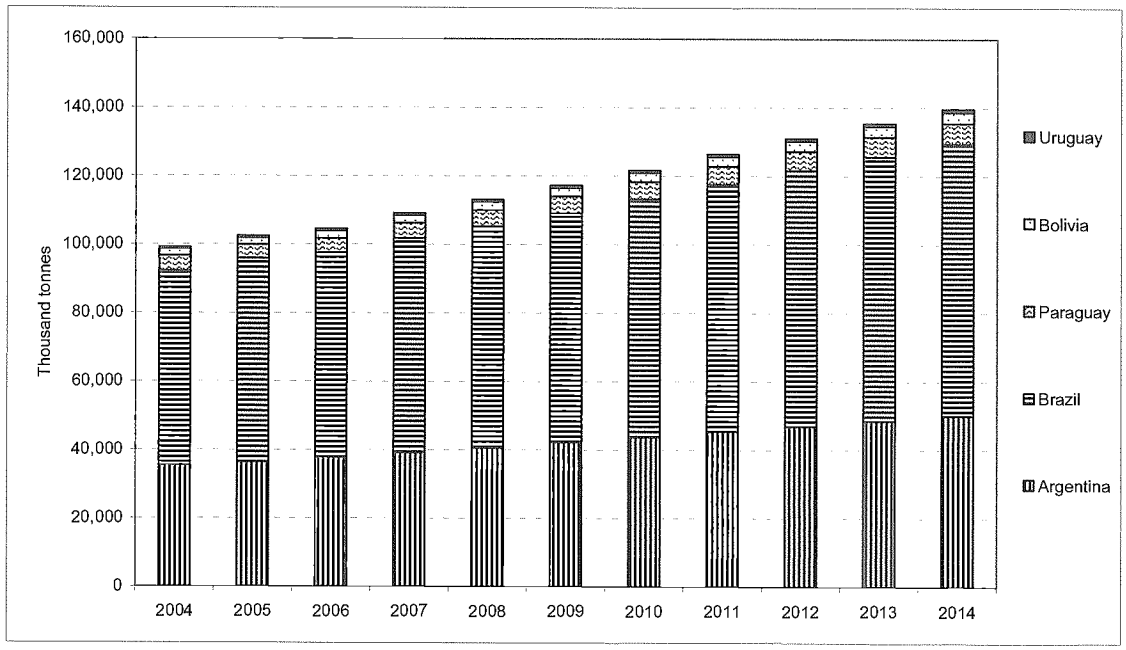
4.2 Outlook towards 2014

Based on the specifics and assumptions of the quantitative model, the estimates suggest that Latin America will continue to drive world growth of soybean and soybean products, with soybean production also increasing in the four countries of Mercosur and Bolivia until 2014. However, this expansion will be at a lower rate than in the late 1990s and early twenty-first century, because international prices are expected to increase only moderately during the outlook period[62]. However, soybean production in Mercosur and Bolivia is expected to rise

[62] Soybean production during the period 2005-2014 will basically increase on account of higher productivity, changes in cropped area and increased demand resulting from higher income and population. On balance, these factors suggest that the nominal prices of soybean seed and meal will

from 104 million tonnes in 2005[63] to 142 million in 2014. Comparison with the projection of world soybean projection of the Food and Agriculture Policy Research Institute (FAPRI) confirms that these countries will continue to contribute more to global volume, their share gradually rising from 47 percent in 2005 to 52 percent in 2014 (see Graph 4.1).

Graph 4.1
Countries of Mercosur and Bolivia: Soybean production, 2005-2014
(Thousand tonnes)



Source: FAO, Trade and Market Division (EST).

Of the five South American countries, Brazil will maintain its quantitative leadership throughout this period, followed by Argentina. Bolivia, Paraguay and Uruguay will produce smaller volumes but with a higher average annual rate of growth[64]. In these three countries the expansion of the soybean sector is relatively recent and begins from low levels, therefore growth rates are expected to be higher.

Growth of soybean production in the five countries will be based on a larger cultivated area and higher yield, particularly the former; with cropped area increasing from 38 million hectares in 2005 to 46 million in 2014, an increase of 21 percent. Slightly more than half of this will occur in Brazil, approximately one-third in Argentina and the rest in Paraguay, Bolivia and Uruguay[65] (see Graph 4.2).

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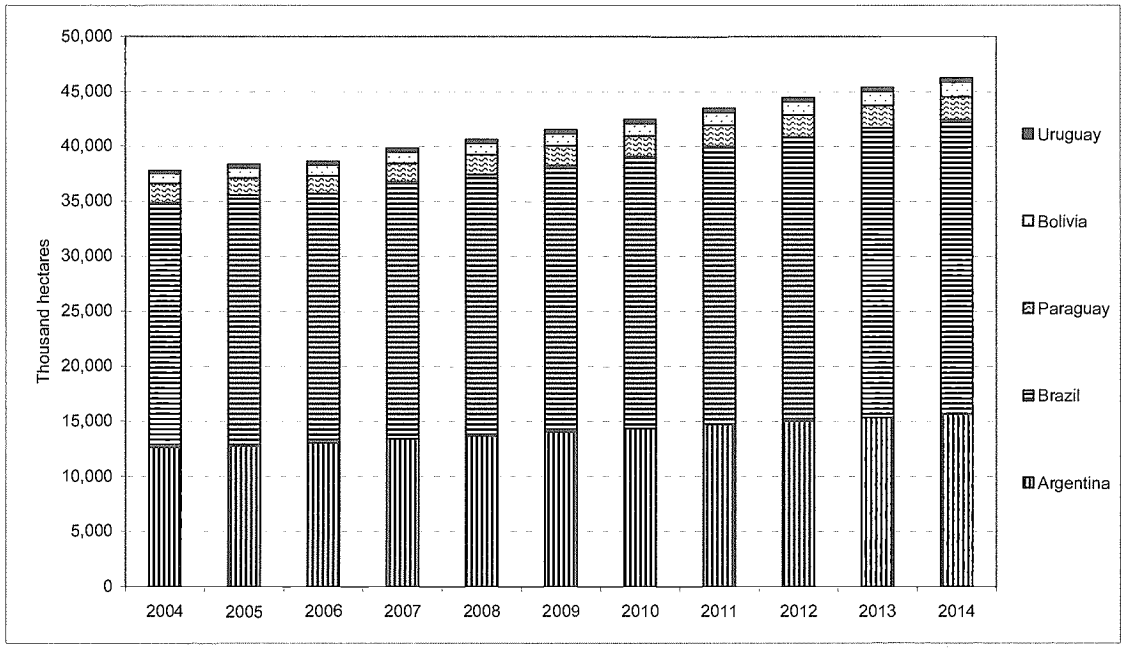
increase above the 2004 levels throughout the projection period, but that the real prices will remain stable or fall. Soybean oil prices have risen since the late 1990s because of firm and sustained demand, and are expected to continue rising during the period 2005-2014, albeit at a slower rate.

[63] This figure and subsequent figures referring to 2005 form part of the estimates obtained using the model. There is therefore a slight discrepancy between these figures and statistical information on the values actually observed.

[64] Soybean production in the period 2005-2014 is expected to grow at an average annual rate of about 5 percent in Bolivia, Paraguay and Uruguay and about 3.5 percent in Argentina and Brazil.

[65] The expected share will be approximately 5, 3 and 1 percent respectively

Graph 4.2
Countries of Mercosur and Bolivia: Soybean area, 2005-2014
(*Thousand hectares*)



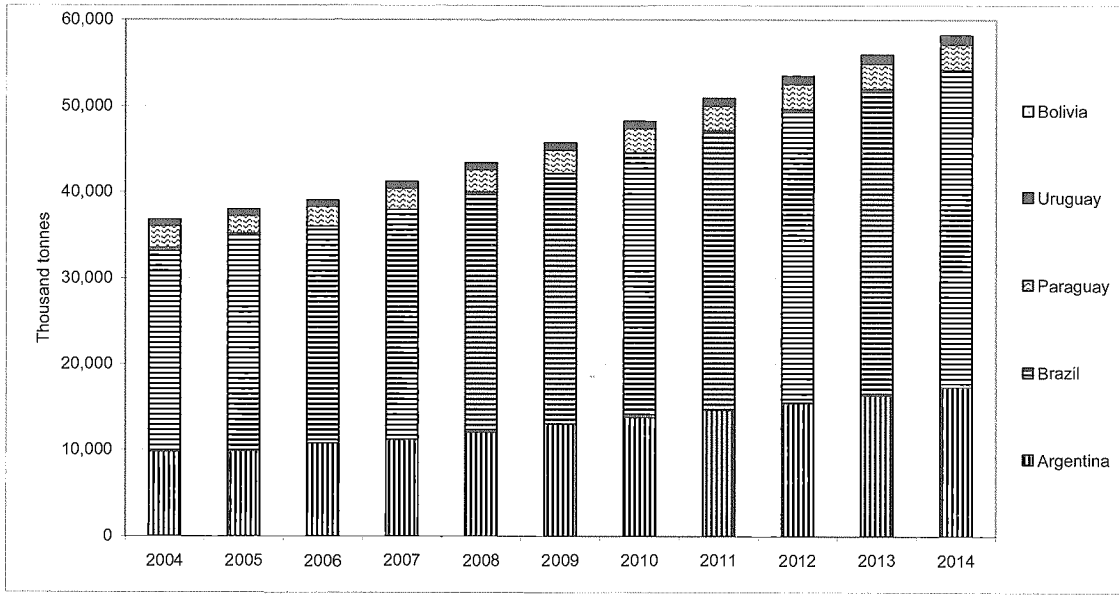
Source: FAO, Trade and Markets Division (EST).

With regard to changes in yield, greater use of genetically modified varieties will result in a higher average annual growth of soybean productivity in Brazil than in Argentina and Paraguay, but the highest rates of growth of this variable will occur in Bolivia and Uruguay[66].

Sustained demand from the traditional importing countries or regions, including China, Japan, the Republic of Korea and the European Union, will greatly boost the global soybean market in 2005-2014, with the result that soybean seed exports from Mercosur and Bolivia will increase by about 53 percent, from 38 million to 58 million tonnes. In absolute terms, this trend will continue to be dominated by Brazil and Argentina, which will export 37 million and 17 million tonnes of soybean seed respectively in 2014[67]. However, Argentina's exports are expected to increase by a higher average annual rate than the other four countries, so its share of the aggregate export total will gradually rise[68]. Brazil and Paraguay's share of exports will decline slightly, while that of Bolivia and Uruguay will remain practically the same (see Graph 4.3).

[66] According to projections, yield will increase in the period 2005-2014 by an average annual rate of 1.5 percent in Brazil, 1.3 percent in Argentina and Paraguay, 1.6 percent in Bolivia, and 1.8 percent in Uruguay.
[67] This is partly explained by the development of the milling industry in Argentina and Brazil which is lagging behind domestic soybean production.
[68] Between 2004 and 2014, Argentina's share of total soybean exports of the five countries will increase from 26 percent to 30 percent; that of Brazil will fall from 66 percent to 63 percent; while that of Paraguay will fall from 5.6 percent to 5.2 percent.

Graph 4.3
Countries of Mercosur and Bolivia: Soybean exports, 2005-2014
(Thousand tonnes)



Source: FAO, Trade and Markets Division (EST).

The projections also indicate that higher income and population should lead to higher world demand for livestock products and vegetable oils, so exports of soybean products from the five countries should continue to rise, particularly in Argentina, Brazil and Paraguay. Argentina will continue to lead exports from this bloc, with 25 million tonnes of soymeal and 6 million tonnes of soybean oil in 2014. Brazil will export 20 million tonnes of soymeal and 4 million tonnes of soybean oil, while Paraguay will export 4 million tonnes of soymeal and 285 000 tonnes of soybean oil. Detailed information on the growth prospects of the soybean sector in each of the countries is given in Annex II.

4.3 Alternative scenarios

The above baseline estimates provide a reasonable approximation of the future performance of the soybean sector in the five countries, as they are generally in line with other projections[69]. However, as it is inherent to projection exercises, there are uncertainties with respect to the evolution of key variables such as production cost, cropping productivity and world demand for soybean and soybean products. Therefore, in order to gain greater insight into the consequences of future growth of soybeans three sets of scenarios were constructed for Argentina, Brazil and Paraguay based on judgements of national experts: one with variations in production costs; another with changes in yield; and a third with changes in import demand from China[70].

As indicated in Table 4.1, the first set of the above-mentioned scenarios tracks maximum and minimum production cost trajectories defined on the basis of forecasts that include elements such as initiatives to prevent the occurrence of soybean Asian rust, the payment of royalties on transgenic seeds and a possible increase in fuel prices in Argentina. The second

[69] For example, the difference between projections from the Aglink-Cosimo model and FAPRI projections on soybean production in 2014 is 8 percent in the case of Argentina and 13 percent in the case of Brazil.

[70] Because of limited time available to include specific details concerning Bolivia and Uruguay in the Aglink-Cosimo model, scenarios were not constructed for these two countries.

set, which plots maximum and minimum soybean yield projections in each of the three countries and in the United States, considers possible improvements in cropping practices[71], the occurrence of disease and the adoption of technological innovations, such as more productive conventional varieties and genetically modified seeds.

The third set of scenarios explores the possibility of China, the world's largest soybean importer, introducing changes into its agricultural policy that affect its external purchases for processing domestically instead of importing vegetable oils. This possibility is simulated with two alternative scenarios: one with a gradual increase and the other with a gradual decrease in Chinese imports of soybean seed and soybean products. Both simulations correspond to a total variation in China's demand of 20 percent, uniformly distributed throughout the projection period.

Taken as a whole, the results (see Annex III for more details) indicate that for Brazil and Paraguay all scenarios with favourable characteristics[72] project higher production levels than the baseline projections. However, for Argentina the lower cost scenario resulted in a relatively lower level of production in 2014 than the baseline, due to the lower perceived cost savings potential of this country vis-à-vis Brazil.

Regarding the impact of the scenarios on domestic soybean production, the results also show that the future development of the sector in Argentina, Paraguay and Brazil will largely depend on domestic factors. Argentina and Paraguay will achieve the highest level of soybean production in the scenario of greater yield since in these two countries national experts rank yield growth potential higher than cost cutting. In addition, the production response induced by increased Chinese demand is lower compared to the yield scenario. On the other hand, experts see significant cost cutting opportunities in Brazil compared to small yield improvements over the baseline level. Therefore, the highest level of soybean production in this country would be achieved under the reduced cost scenario.

The scenario of higher Chinese demand for soybean and soybean products projects larger production response in Brazil in 2014 (5 percent above the baseline) vis-à-vis Argentina (3 percent) and Paraguay (2 percent). Therefore, Brazil is able to expand its soybean market share increasing its exports by 11 percent above the baseline in comparison with 8 percent in Argentina and 6 percent in Paraguay in 2014.

Looking at the situation from an unfavourable perspective, in other words, lower yield, higher production costs and less demand from China, Argentinean experts see a greater threat for higher production cost vis-à-vis lower yields with respect to the baseline. This view is based on the perspective of formal payment of royalties on transgenic seeds and a possible increase in domestic fuel prices. Therefore, as Table 4.1 indicates the first of these scenarios places Argentina's soybean production at its lowest level below the baseline in 2014. This highlights the need for adopting measures to mitigate the impact of this potential cost on soybean production.

In the case of Paraguay, the unfavourable scenario differing most from the baseline in terms of impact on soybean production is that of lower productivity. Should the hypothesis of lower yields in the three scenario countries and in the USA materialize, soybean production in Paraguay would be 5 million tonnes in 2014, which is 15 percent below the baseline. This is the lowest projection for Paraguay in 2014. It suggests that Paraguay needs to adopt measures to increase soybean yield.

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[71] For example, appropriate crop rotation, adequate fertilization of the area and suitable pest management.

[72] Specifically, those with increased yield, reduced production cost and higher demand from China for soybean and soybean product.

According to scenarios assumptions, soybean production in Brazil would be the most negatively impacted by the reduction of the Chinese demand. In this scenario, Brazil would produce 76 million tonnes of soybean in 2014, the lowest level projected for this country for that year. As indicated in Table 4.1, the realization of the lower Chinese demand scenario would also result in the lowest level of Brazilian soybean seed exports in 2014.

Table 4.1
Projections for baseline and scenarios of lower production cost, higher yield and greater demand from China, 2005 and 2014

	Baseline		Increased import demand of China		Higher yield		Reduced soybean production cost	
Countries and products	2005	2014	2005	2014	2005	2014	2005	2014
International price								
US dollar/tonne	228	264	231	277	216	221	228	246
Domestic price								
Argentina (peso/tonne)	632	694	641	740	580	539	629	627
Brazil (R$/tonne)	517	753	519	791	506	619	516	699
Paraguay (guarany/tonne)	609,133	726,025	615,439	765,128	571,991	596,588	607,120	670,207
Production - soybean								
Argentina	36,406	50,079	36,457	51,683	36,663	56,299	36,559	48,181
Brazil	59,478	79,362	59,509	83,145	59,585	86,273	59,569	91,093
Paraguay	3,883	6,043	3,887	6,186	3,954	7,046	3,903	6,727
Crop area								
Argentina	12,793	15,661	12,793	16,039	12,792	14,978	12,838	15,228
Brazil	22,761	26,733	22,760	27,554	22,766	25,303	22,786	30,133
Paraguay	1,531	2,119	1,531	2,158	1,531	2,116	1,538	2,356
Export - grain								
Argentina	9,957	17,349	10,036	18,816	9,920	23,464	10,092	15,420
Brazil	25,205	36,812	25,248	40,732	25,214	42,916	25,285	48,160
Paraguay	2,137	3,029	2,143	3,221	2,194	3,776	2,156	3,626
Export - meal								
Argentina	19,733	25,278	19,743	25,465	19,709	24,828	19,734	25,120
Brazil	16,334	20,101	16,324	19,959	16,399	20,744	16,338	20,342
Paraguay	810	1,605	809	1,573	813	1,768	810	1,659
Export - oil								
Argentina	4,375	5,596	4,375	5,646	4,403	5,568	4,377	5,584
Brazil	3,350	4,335	3,352	4,394	3,353	4,370	3,350	4,346
Paraguay	161	285	161	278	163	332	161	301

Table 4.1 (continued) Projections for baseline and scenarios of higher production cost, lower yield and reduced demand from China, 2005 and 2014

	Baseline		Reduction in import demand from China		Reduction in yield		Increase in soybean production cost	
Countries and products	2005	2014	2005	2014	2005	2014	2005	2014
International price								
US dollar/tonne	228	264	226	252	260	290	231	287
Domestic price								
Argentina (peso/tonne)	632	694	623	648	760	785	643	775
Brazil (R$/tonne)	517	753	515	716	544	832	519	829
Paraguay (guarany/tonne)	609,133	726,025	602,905	687,863	701,554	803,670	617,245	795,070
Production - soybean								
Argentina	36,406	50,079	36,355	48,328	34,546	46,562	35,251	38,979
Brazil	59,478	79,362	59,448	75,616	59,541	84,204	59,617	78,927
Paraguay	3,883	6,043	3,879	5,897	3,824	5,143	3,875	5,753
Crop area								
Argentina	12,793	15,661	12,792	15,238	12,795	15,964	12,632	12,501
Brazil	22,761	26,733	22,761	25,906	22,749	28,464	22,785	26,247
Paraguay	1,531	2,119	1,531	2,079	1,531	2,074	1,528	2,049
Export - grain								
Argentina	9,957	17,349	9,878	15,771	8,741	13,869	8,886	6,188
Brazil	25,205	36,812	25,163	32,920	25,473	41,972	25,354	36,688
Paraguay	2,137	3,029	2,131	2,833	2,107	2,283	2,132	2,889
Export - meal								
Argentina	19,733	25,278	19,723	25,054	19,706	25,468	19,725	25,504
Brazil	16,334	20,101	16,344	20,248	16,184	19,802	16,320	19,815
Paraguay	810	1,605	810	1,637	801	1,501	809	1,507
Export - oil								
Argentina	4,375	5,596	4,374	5,535	4,312	5,612	4,367	5,625
Brazil	3,350	4,335	3,348	4,267	3,343	4,324	3,349	4,326
Paraguay	161	285	161	293	157	257	161	257

Source: FAO, Trade and Markets Division (EST).

5. Implications of future development

The baseline and scenarios indicate that production of soybean and soybean products will grow steadily during the period 2005-2014 in the five countries. This section examines the implications of such development on food security, rural development, the environment and sustainability of soybean production in these countries, together with the repercussions on national agricultural policies. The analysis is broader for Argentina, Brazil and Paraguay because of the greater availability of disaggregated data and results in Aglink-Cosimo and because specific country case studies for Bolivia and Uruguay were not carried out as part of this exercise.

5.1 Argentina

5.1.1 Food security[73]

Projections for 2005-2014 indicate that Argentina's food production will be sufficient to cover its needs and to contribute significantly to the generation of foreign exchange through

[73] Food security essentially means that all people have access at all times to safe and nutritious food to live a healthy and active life. This definition has three dimensions: availability, access and stability; and four levels: world, national, household and individual.

exports. Food security will therefore continue to be ensured despite the expected increase in soybean cultivation.

The baseline projection for 2005-2014 indicates that maize, wheat and rice production will grow at an average annual rate of 4 percent, 3 percent and 8 percent respectively[74]. Meat production will also increase at higher rates than in the ten years preceding the projection period. Beef will increase by 1 percent, pigmeat by 5 percent and poultry meat by 4 percent, but the proportion of beef in the total of all three will gradually drop from 74 percent in 2004 to 68 percent in 2014. This trend is largely determined by a loss of cattle grazing area and a consequent reduction in stock as grassland could fall 49 percent in this period, from 8.7 million hectares to about 4.5 million.

5.1.2 Rural development

Impact on land use – main annual crops and pastures[75]**.** According to the baseline, the total harvested area with soybean and other main annual crops[76] should increase by 5.6 million hectares during the period 2005-2014, reaching about 30 million hectares in the last year. Besides soybean, harvested area will also increase for all the other crops in the analysis, especially wheat, sunflower and maize. The expansion of these three crops will account for 39 percent of the expected increase in total harvested area, while soybean will respond to 53 percent and the remaining percentage would correspond to the area expansion of sorghum, cotton, rice and sugar cane.

The baseline projection also indicates that pasture land will lose 4.2 million hectares in 2005-2014, dropping from 8.7 million to 4.5 million. Thus, in contrast to what occurred during the period 1995-2004[77] when the expansion of soybean cultivation resulted from a combination of displaced pasture and substitution of other annual crops, mainly in the Pampas region, the situation expected in 2005-2014 is for soybean and other key crops to expand mainly by replacing pasture and, to a lesser extent[78], by expansion of the agricultural frontier. Different sources agree that the provinces of Northwest and Northeast Argentina offer possibilities for further soybean expansion, depending on resource conservation policies (forest clearing) and the water regime[79].

Demand for agricultural machinery. The future expansion of soybean also implies higher demand for agricultural machinery. On the basis of a ratio of 0.74 HP/ha and the projected cultivation area for the five main crops[80], it is estimated that 29 280 tractors of 100 HP and 8

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[74] The average annual rates for the ten years before this period are lower by 0.5 percent in the case of maize, 1 percent in the case of wheat and 10 percent in the case of rice.

[75] In the case of crops, the impacts are estimated on the basis of harvested area, as the quantitative model uses this variable and not the cropped area.

[76] These crops are: wheat, maize, sunflower, sorghum, cotton, rice and sugar cane.

[77] During that period, the harvested area of soybean grew by an annual average rate of 10 percent while that of sunflower, maize, sorghum and rice decreased between 4 and 5.5 percent a year and that of cotton fell by an annual average rate of 18.5 percent.

[78] Approximately 25 percent of the additional required area, responding to 1.4 million hectares.

[79] **López, G.** 2006. *Caracterización y análisis de la expansión de la soja en Argentina: transformaciones observadas en la agricultura en los últimos 15 años*. Country study prepared for FAO.

[80] Because of the difficulty in obtaining information on the number of tractors and harvesters used exclusively for soybean cultivation, the analytical procedure used in the study "Future expansion of soybean in Argentina: its main effects" (Lavignolle, 2006) consisted in using data on the national fleet of each type of machinery. The results that are given in this section therefore, correspond to demand for agricultural machinery relating to the area to be cultivated not only with soybean but also with sunflower, wheat, maize and sorghum. The results expressed in this section contain a slight overestimate, as the estimation used in the study on the area cultivated with these crops in 2014 is 10

963 of 140 HP will be needed in 2014. However, this estimate refers only to the number of tractors needed to increase total power and maintain current availability per seeded hectare. Considering the existing tractor fleet in 2004 and assuming that it was half-way through its working life, it was estimated[81] that an additional 37 579 tractors will be needed in 2005-2014 to replace those that become obsolete. This estimation, together with the previous one results in a total of 75 822 units, which implies an average of almost 7 600 new tractors each year. This estimate is close to the 1996-1997 peak in tractor sales and substantially higher than the average 4 638 new tractors per year observed in 1990-2001.

On the basis of a similar approach, it is expected that an additional 4 624 harvesters will be needed in 2014 to harvest the five main crops and maintain the same proportion of harvesters per hectare as in 2002. Adding the harvesters needed to replace those that become obsolete results in a total of 9 459 additional units in 2014, or 950 per year.

Seed and agrochemical requirements. According to the projections made, in 2014 it will be required 1.26 million tonnes of soybean seeds to grow this crop in the baseline projected area and 1.04 million tonnes if the higher yield scenario[82] materializes. Herbicide needs under these two alternative scenarios will be between 58 million and 60 million litres; the demand for insecticides will vary between 21.8 million and 22.8 million litres, while fungicide requirements (single application) will be between 4.5 million and 4.7 million litres, according to the scenario.

Regarding fertilizers, the baseline result indicates additional requirements of nitrogen, phosphorous and potassium in 2014 of 3.4 million, 1.4 million and 1.9 million tonnes, respectively. These estimates peak at 4 million, 1.6 million and 2.1 million tonnes respectively under the higher yield scenario. It is, however, important to note that not only should greater quantities of fertilizer be applied, but there should also be crop rotations for more input of organic matter to conserve or increase the physical and chemical fertility of the soil.

Requirements for storage, transport and port logistics. In Argentina, as in other countries of Mercosur, storage capacity is one of the main bottlenecks of the marketing system. In 2005, the proportion between national storage capacity and average total production of the five main crops, as a static efficiency indicator, was about 80 percent, increasing to 100 percent if the 18 to 20 million tonne capacity of the so-called silo bags is considered[83]. Given this situation and a baseline prospect of soybean production totaling 50 million tonnes in 2014, storage capacity will need to increase by 14 million tonnes – 20 million if the scenario with the highest production takes place.

Regarding transport requirements between collection centres and ports or processing plants, it is estimated that in 2014 approximately 7 500 or 16 800 additional units should be added to the 2005 fleet of trucks to transport the soybean production obtained under the base line or the most favourable scenario, respectively. This implies an investment between US$680 million and US$1 500 million.

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percent higher than the baseline projection resulting from the Aglink-Cosimo model (33 million hectares compared to 30 million).

[81] **Lavignolle, P.** 2006. Expansión futura de la soja en Argentina: sus efectos principales. Country study prepared for FAO.

[82] That is, among all favourable scenarios, the one envisaging the smallest area cropped with soybean in 2014.

[83] **López, G.** 2006. *Caracterización y análisis de la expansión de la soja en Argentina: transformaciones observadas en la agricultura en los últimos 15 años*. Country study prepared for FAO.

Various studies agree that the privatization of Argentina's main railways has significantly improved bulk transportation, although a ceiling is now being reached because of insufficient investment in maintenance and renewal of track. It is therefore difficult to envisage the railways accounting for more than 15 to 20 percent of soybean freightage in the next years.

With regard to port logistics, the Argentina country study indicates that five companies have announced their intention to build ports to cover the additional infrastructure needed for the shipping of soybean and soybean products. If those investments materialize, Argentina's port facility requirements will be met until the middle of the next decade.

Impact on fiscal revenue – export taxes. Argentina's exports of soybeans and soybean products are subject to differential taxes[84]. Besides constituting a transfer from the primary sector to the processing industry, this is designed to offset the tax scaling of industrialized goods.

According to the baseline projection, the application of this policy in 2005-2014 would increase annual revenue, starting at US$1 500 million and reaching US$2 200 million in the last year[85]. In aggregate terms, the revenue would amount to about US$20 000 million for the whole period, while total transfer to the processing industry would be about US$2 400 million. The best-case scenario would produce a top revenue of US$21 000 million for the period 2005-2014, while total transfer to the processing industry would remain practically the same as the baseline.

5.1.3 Environment and sustainability of the soybean production system[86]

The process of agriculturization[87] that has occurred in Argentina's countryside has shifted the agricultural frontier towards traditional cattle farming areas and forest clearing for pasture land. Moreover, there is evidence of growing soil erosion and degradation in certain zones, together with other phenomena that are seriously undermining the environment and human health, such as excessive use of agrochemicals against pests.

This situation, which is already causing concern about the sustainability of agricultural development, is further aggravated by the fact that the projections indicate substantial future expansion of soybean cultivation at the expense of pasture and native forest. It is therefore essential to fine-tune the design and application of the legal framework for deforestation by revising regulations, introducing new measures and strengthening enforcement. Although there is ample area for agricultural expansion, it is necessary to apply regional land-use planning criteria so that expansion is compatible with conservation of the environment and with equilibrium among stakeholders.

In addition to such measures, the sustainability of production systems requires better agricultural practices, including greater use of crop rotation adapted to soil and climatic conditions and more intensive application of balanced fertilization.

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[84] 23.5 percent on soybean seeds and 20 percent on soybean products.

[85] These figures correspond to the total tax revenue from exports of soybean and soybean products.

[86] Sustainable systems are those that permit the integrated protection of natural resources, that are profitable to the farmer and that are socially acceptable as mechanisms that contribute to economic growth and to the welfare of society .

[87] This process involves the substitution of the crop-livestock rotation model, which was the prominent production strategy in the country until the mid-1970s, by a model based entirely on agricultural crops.

5.1.4 Agricultural policies

The country's macroeconomic policies for the next years should include the maintenance of currency stability and possibly a revision of the agricultural fiscal regime, particularly the export duties. In the recent past, inflation pushed production costs upwards. This trend is likely to continue in the medium term as the lag in the adjustment of relative prices of certain non-tradable services will tend towards higher values, implying consequently a rise of production costs. This could lead to a revision of export duties to safeguard farm profitability. Such a revision however, should consider the impact of this policy instrument on the domestic price of staple food and the incentive that it represents for investment in soybean processing plants.

With respect to agricultural policies, it is important to note that reducing rural poverty is an undertaking that goes beyond the agricultural sector. Policies and programmes directed towards agriculture need to be better integrated and coordinated with those of other public spheres of action, such as health, education, housing and infrastructure. Given that soybean cultivation does not have a large positive social impact at local level, the regional distribution of income should be analysed, as local population do not seem to be benefiting from modern agriculture. Among other elements, the analysis should look into the extent to which the absence of basic services, such as education and health, is limiting the access to those benefits.

The possibility of adding value to primary production at its point of origin also needs to be studied, for example promoting the conversion of vegetable protein into animal protein through poultry or pig production.

The sustainability of the soybean production system requires additional measures. Sustainable rotations over time could be promoted by developing and diffusing sustainable management systems, accompanied by financial and economic instruments[88] that render those systems competitive in terms of returns, including the Clean Development Mechanisms (CDMs) of the Kyoto Protocol. In addition, current legislation on leasing and share tenancy contracts should be revised to introduce incentives for the implementation of rotations that foster sustainable soil use and safeguard water resources and biodiversity.

Finally, a biodiversity conservation strategy should be applied in areas where the agricultural frontier is expanding at the expense of natural vegetation. The following measures could be adopted: consolidation and reinforcement of protected areas; creation of new protected areas representative of ecologically important environments where conservation units do not exist; and establish in highly fragmented areas clusters of small reserves which, together with the forest belts envisaged in provincial legislations, could form corridors of protected areas.

5.2 Bolivia

5.2.1. Rural development

According to the projections made, Bolivia is expected to have 1.3 million hectares cultivated with soybeans in 2014. Only 850 000 hectares of the 4 million hectares with agricultural potential in Santa Cruz are used for soybean production, therefore there is sufficient land to

[88] Among others, lower interest rates and tax reductions.

expand the cultivation of this crop without the need to affect other more sensitive ecosystems.
However, it is important to heed the dynamics of natural resource use within this framework of broad potential. Current production systems are not considered sustainable and are causing soil losses with consequences that could be very serious.

As part of the amended law on the National Institute for Agrarian Reform, the Bolivian Government has considered the possibility of redistributing idle land to peasant and indigenous communities for production purposes. The allocation of land to small farmers will not necessarily mean that they will grow soybean, which requires high capital input and training in modern agriculture, although such a result could be attained in the future through farmer associations.

5.2.2 Transport infrastructure, storage and port logistics

Transport is mainly by river, accounting for 61 percent of exports. The Paraná-Paraguay Waterway continues to be the route most used for the export of soybean and soybean products, although it entails a very long journey to transport goods to the Andean markets. However, there are still significant problems of reduced navigability at certain times of the year.

According to FAO projections, Bolivia's soybean production will amount to 3 million tonnes in 2014, almost twice the production of 2004. The country will need to invest heavily in infrastructure if it is to improve its marketing chain.

5.2.3 Agricultural policies

Trade policy. Bolivia's only advantage in the Andean market over other soybean exporting countries is the preferential tariff guaranteed by the Andean Community agreement. Bolivia's concern is that the entry of soybean from the United States will undermine its share of soybean exports to the Andean Community countries, mainly Colombia. Bolivian soymeal enters Colombia and Peru duty free, while that of other countries pays a tariff of 4 to 15 percent. By virtue of the agreement between the United States and the Andean countries, soybean products will immediately enter at zero duty.

Bolivia signed a free trade agreement with Cuba and Venezuela, according to which Venezuela is entitled to import soybean products free of duty. Given this agreement, Venezuela has promised to purchase all of Bolivia's soybean production; however this has caused concern among producers who see a danger in depending on a single market.

The free trade agreement between the Andean countries and Mercosur is another source of concern for the Bolivian soybean sector. Paraguay has already conquered part of the Peruvian and Colombian market, and Bolivia is expected to lose its advantages when this agreement comes into effect.

The increasing trend towards bilateral free trade agreements obliges Bolivia to seek alternatives to improve its market position. Given the current context of international trade negotiations Bolivia should seek to improve its international competitiveness by lowering its production and transport costs of soybeans and improving yield.

Infrastructure policy. Bolivia needs to conduct a specific study on the comparative costs of its transport in order to better estimate the attendant infrastructural investment requirements.

The navigability of the Paraguay River could be improved through joint investment by the governments of Argentina, Bolivia and Paraguay. There should also be renewed public investment in Bolivia's road network with the construction of highways and rural access roads.

Bolivia should consolidate alternative routes for the export of finished products towards the Pacific ports, through the La Paz-Ilo-Matarani (Peru) and the La Paz-Arica (Chile) highways.

5.3 Brazil

5.3.1 Food security

Brazil's food security at national level should not be threatened by the expansion of soybean production in the period 2005-2014. According to the baseline projection, food production (such as beef, poultry and pigmeat) will increase at lower rates than those observed between 1999 and 2004. However, it will enable the country to cover its domestic needs and continue exporting increasing volumes. Similarly, the production of wheat, rice and maize in 2005-2014 will grow at a lower rate than in 1999-2004. Part of the national requirements will continue to be met through imports, especially wheat which have historically been imported in relatively larger volumes vis-à-vis other grains.

Brazilian imports of agricultural commodities have steadily declined in absolute terms (volume and value) as well as a proportion of the domestic consumption. In 2004, imports of maize and rice were less than 1 percent and 5 percent, respectively of the domestic consumption of each of these grains. Only wheat imports have been high, although their share of domestic consumption fell considerably between 2000 (82 percent) and 2004 (50 percent). In view of this situation and given the prospect of imports of agricultural commodities continuing to fall in 2005-2014, there will be no need to spend large amounts of foreign exchange to guarantee food security[89].

It should also be noted that during the period 1995-2004, soybean's share of total production of the four main grains (wheat, rice, maize and soybean) increased from 36 percent to 48 percent, while that of the other three grains fell significantly, particularly maize and rice[90]. The share of each of these major grains in their total production is expected to remain more or less unchanged in the period 2005-2014 with a slight increase (from 50 percent to 53 percent) for soybean[91]. Therefore, soybean expansion should have less impact on domestic food production than in the previous period. This conclusion is corroborated by the simulations made. For example, according to the lower production cost scenario, soybean production in 2014 would be 15 percent higher than the baseline projection and livestock and dairy production remains at about the baseline level. With respect to food crops, wheat production will fall 1 percent, rice 2 percent and maize will remain unchanged vis-à-vis the baseline. Thus, the future expansion of soybean production will not threaten Brazil's food security, as it will have little impact on the production of other foodstuffs.

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[89] According to the baseline results, Brazil's wheat imports will tend to grow during the period 2005-2014, rising from 4.7 million to 7.7 million tonnes. In contrast, rice imports will fall from 900 000 tonnes to 700 000 tonnes in 2014.

[90] The share of maize in the total production of the four grains fell from 51 percent to 42 percent in the period 1995-2004, while that of rice fell from 11 percent to 5 percent.

[91] The share of wheat and rice will fall from 5 percent to 4 percent, and that of maize from 40 percent 39 percent.

5.3.2 *Rural development*

Impact on land use – main annual crops and pasture areas. In Brazil, soybean competes with maize and rice in terms of cropped area and is cultivated under a double crop rotation system with wheat, particularly winter wheat in the southern part of the country. During the period 1995–2004, the harvested area for these four grains expanded by about 30 percent increasing from 33 million to 42 million hectares[92]. In disaggregated terms, this expansion was due to an increase in the harvested area with soybean and wheat, while the harvested area with rice and maize remained virtually unchanged[93].

According to baseline projections, the soybean harvested area will continue to grow in 2005-2014, but at an average annual rate of 2 percent, which is lower than the one observed in previous 10 years. In contrast, the harvested area will remain unchanged at approximately 3 million hectares in the case of rice and wheat and at 14 million hectares for maize.

However, the simulations indicate that if soybean production costs were to rise less than the baseline projection, soybean and wheat harvested areas in 2014 would be 13 and 8 percent higher than the baseline estimates implying an utilization of 30 million and 3 million hectares respectively. In addition, in 2014 the harvested area with maize would amount to 13.5 million hectares and that with rice 2.7 million hectares. These estimates are respectively 3 and 2 percent below the baseline level.

Soybean also competes for land with sugar cane and planted grassland. The model used to estimate future expansion of soybeans does not include sufficient data to determine possible changes in cultivated area with these crops, but the historical trend of agricultural expansion in Brazil indicates that livestock production is the first production activity usually carried out in new lands, given that it does not require large infrastructural investment. Soybean then steps in once the infrastructure has been improved. Only at a later stage does sugar cane replace soybean, given that sugar production requires higher infrastructure investment.

Considering that the temporary conversion of degraded pasture into soybean cropland is beneficial for livestock production, it can be expected that this practice will no doubt continue, at least in the medium term. Degraded pasture will therefore possibly continue to be one of the major sources of land for soybean expansion in the coming years. At the same time, it is reasonable to expect that the increased investment in sugar and ethanol plants and in transport infrastructure will lead to an expansion in the cultivated land with sugar cane. However, the projections suggest that such an increase will not be sufficiently large to have a marked impact on soybean cultivated area.

Impact on agricultural and rural employment. Soybean cultivation employs relatively little labour per hectare. However, a substantial increase in cultivated area such as that projected under the lower production cost scenario could have a significant impact on labour demand. Using coefficients obtained by other authors on soybean area cultivated per person[94], the country study on Brazil estimates that the workforce directly employed in soybean production in 2014 under the lower production cost scenario would be between 861 000 and 1.04 million workers. Considering that in 2004 there were 766 000 workers directly employed in soybean production agricultural employment would increase by 36 percent during the period as a result of the expansion of this crop.

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[92] In the period 1995-2005, these four grains accounted for 65 to 70 percent of the total harvested area of permanent and seasonal crops.

[93] During this period, the harvested area with soybean and wheat grew by average annual rates of 7 percent and 9 percent respectively, while rice and maize registered negative rates of -0.8 percent and -0.2 percent.

[94] These coefficients vary between 29 and 35 hectares of soybean cultivated area per worker.

Regarding the impact on employment throughout the soybean and soybean product chain, the above study estimates that the total number of jobs created by the expansion of this oilseed under the most favourable conditions would be between 1.3 and 1.6 million in 2005-2014. These estimates suggest that the expansion of soybean production could have an appreciable impact on rural employment in Brazil.

Requirements for storage, transport and port logistics. One of the main challenges facing Brazilian agriculture today is the need to overcome the major limitations that exist in infrastructure for storage of agricultural products, transport and port logistics[95]. Government estimates based on current storage capacity indicate that producers (and the country in general) will incur significant economic losses if soybean production exceeds 60 million tonnes. Since current production of this oil crop is close to that level, storage capacity would need to be raised by some 30 million tonnes during the next years to store the highest volume of soybean projected for 2014 (91 million tonnes).

This investment effort should prioritize the expansion of storage at farm level and the construction of warehouses in expansion zones of the agricultural frontier. Special attention should also be paid to the growing need to segregate products with different characteristics, for example, conventional grains from genetically modified grains.

Regarding the road network, the survey carried out in 2005 by the National Confederation of Transport (CNT) qualified as deficient, poor or very poor 72 percent of the 18 000 kilometres examined and estimated that an investment of some R$118 billion (about US$56 billion) was needed for repair work. The CNT's assessment prompted government action to remedy the situation, but not enough was done and the roads are again deteriorating with the start of the rainy season. The required level of investment in road repair and maintenance therefore, continues to be high, but no further estimates have been made. The National Plan of Transport Logistics (PNLT) which the government is currently formulating will determine the level of investment needed until 2023 and will also consider capitalizing on past experience in the joint public and private construction of transport infrastructure.

5.3.3 Environment and sustainability of the soybean production system

According to the projections made, Brazil's soybean area could top 30 million hectares in 2014, which would mean a total increase of 8 million hectares in the period 2005-2014. The margin for increasing soybean area in Mato Grosso in the short term amounts to 5 million hectares[96]. An additional 1.5 million hectares are available in the other states of the Centre West region, while the Northern and Northeast regions have 2.5 million hectares. These three regions therefore have a total of 9 million hectares of non-forest land suitable for soybean cultivation, which is more than the area required for the maximum projected expansion. Since much of this additional land is degraded pasture, soybean cultivation can expand sustainably without the need to clear vast areas of forest.

The prospect that the soybean area could increase more rapidly in the Centre West, North and Northeast regions than in the regions of the South and the Southeast does however imply a threat to sustainability from an ecological and economic point of view. Soybean cultivation in the former regions tends to be monocropping, therefore the utilization of crop rotation which is generally recommended for improving ecological conditions and minimizing

[95] According to the Brazilian Confederation of Agriculture and Livestock (CNA), in 2004 soybean agribusiness incurred an economic loss of some US$1 billion because of inefficiencies in transport and port logistics.

[96] **Roessing, A. y Lazzarotto, J.J.** 2006. *El cultivo de soja en Brasil: Evolución reciente*. Londrina, Brazil. Country study sponsored by FAO in collaboration with EMBRAPA-Soja.

the economic risks of cultivating a single crop in general is not applied with the frequency required.

The study *Soybean cultivation in Brazil: recent trends* also indicates that some national institutions have been developing production systems that combine agriculture and livestock activities in the same area using a rotation practice. Although these systems cover a relatively small area at the moment, they offer an important alternative for several objectives, such as minimizing problems of limited crop diversification and incidence of pests and diseases, recovering pasture productive capacity and improving soil fertility. Greater use of such systems could strengthen soybean sustainability in the coming years.

5.3.4 Agricultural policies

The policy framework needed for the sustainable development of the soybean sector should include measures aimed at creating a stable macroeconomic environment, with interest rates comparable to those of competitor countries. Such a framework needs also to consider that the instability of the domestic currency has had significant impacts on the economic returns of Brazil's soybean production. Given this situation and the inadvisability of formulating an exchange rate policy on the basis of a single economic sector, adjustments should be made in the macroeconomic policy, particularly on its fiscal component. Consideration should also be given to financial instruments that protect farmers against exchange rate instability, such as futures contracts negotiated on the Brazilian Mercantile and Futures Exchange (BM&F).

In this regard, more information would need to be provided on the benefits and requirements of those instruments. In addition, credit lines should be created to facilitate its adoption by rural enterprises. However, such lines of credit should also be made available to stakeholders by private financial agents, not only by the public sector.

Brazil should not only ensure an appropriate macroeconomic framework but also continue to pay systematic attention to the trade and domestic support policies of competitor countries and major importers. Special attention should be paid to China, Japan, Argentina and the European Union as well as to the domestic support policies of the United States, as they could lead to significant trade distortions if they were to reduce international prices.

As corroborated by the yield and production cost scenarios, the expansion of soybean production in Brazil is closely linked to maintaining high levels of productivity and competitiveness. The future growth of the sector therefore, requires adopting measures for further strengthening agricultural research, technology transfer and agricultural insurance including: i) streamlining and/or simplifying the process carried out by the National Technical Commission on Biosecurity (CNTBio) to evaluate and approve research and studies on biotechnology and GMOs; ii) upscaling technical assistance activities, especially those of the public sector, in order to foster more efficient use of technology and avoid the hitherto excessive use of inputs; iii) establishing a statistical information system that enables private companies to assess the risks of growing soybean in different parts of the country; and iv) introducing income guarantee mechanisms (such as agricultural insurance) for farmers.

With respect to domestic marketing policy, the Kandir Law should be modified to rectify the distortions that its application is producing for processing industries that are not located in soybean producing. Payment of the tax on the movement of goods and services (ICMS) of 12 percent on soybean bought in another state is a heavy additional cost. Under current situation, it is more convenient for industrial processors to establish their processing plants in neighbouring countries and import soybean seed than it is to locate the industry in San Paolo, for example, and purchase soybean from a producer state such as Mato Grosso.

As it occurs with most agricultural activities, soybean cultivation has an environmental impact. It is therefore important to ensure that soybean expansion will take place drawing upon national production potential and capacity in a way that is compatible with a sustainable use of natural resources and environmental conservation. One inherent challenge is the rational conversion of forest to cropland. Brazilian legislation has many regulations, but these should be complemented with further policies and measures, such as regularization of land tenure, especially in the Amazon region, in order to reduce pressure on forest land.

There should also be policies which remunerate farmers for safeguarding the environmental services that forest reserves provide. The experiences of the Programme of Sustainable Development of Rural Family Production in the Amazon Region (Pro-Ambiente), which pays participant families for the environmental services they provide, can shed useful light in this regard. Also needed are measures to relax the legislation concerning the minimum size of forest reserve area on rural properties, so that farmers with a larger reserve than the statutory minimum can trade the environmental services from their surplus area with farmers who lack the forest area needed to meet this legal requirement.

A third area of action would be to adjust legislation to avoid discrepancies between laws on productive land use (divestiture of land considered unproductive) and rules requiring property to retain a forest reserve.

The above actions should also include measures aimed at: strengthening the market of certified wood; government promotion of frequent technical dialogue between stakeholders on issues relating to agricultural production and socio-environmental impact; and promotion of agricultural practices that will facilitate sustainable production. The latter should include action to promote the use of integrated crop and livestock production systems.

5.4 Paraguay

5.4.1 Food security

The expansion of soybean cultivation in Paraguay should not have a negative impact on national food security. Even in the scenario that results in the largest expansion of soybean area (low production cost scenario[97]), the growth rate of maize and poultry production exceeds that of soybeans (55 percent over the projection period). In addition, wheat, rice, beef and pig meat production grow at a lower rate, but none of them fall significantly below population growth. Other subsistence foodstuffs of small-scale agriculture not included in the model (cassava, bean, groundnut and horticultural produce) show the same independence to the expansion of soybean area. Therefore, from the perspective of impact on food supply, the expansion of soybean should not affect the overall food security of the country.

It is also important to note that in zones and sectors participating directly in the soybean production chain, the higher income of the population involved in the chain will improve their access to foodstuffs and thus translate into greater food security. However, in traditional soybean areas, the increasing dependence on a single crop that is highly sensitive to fluctuations in international markets and climate causes concern and renders the population more vulnerable.

[97] This scenario projects that 2.4 million hectares of soybeans would be cultivated in Paraguay in 2014.

5.4.2 Rural development

Impacts on land tenure. According to the lower production cost scenario, soybean will occupy a maximum of 2.4 million hectares in Paraguay in 2014. On the basis of this figure and given that the number of soybean farms with less than 50 hectares followed a downward path in 1991-2002, the country study indicates that this trend will sharpen, with farms in this category falling from 19 165 in 2002 to 18 400 in 2014.

In the traditional soybean cultivation region, the reduction shall occur through small farmers selling their properties to domestic and foreign farmers, mainly Brazilians. Some small farmers could therefore end up precariously occupying land without production potential along river banks or on steep slopeland unsuited to agriculture. Urban poverty belts could also expand around rural towns and larger urban centres.

At present, soybean cultivation in new production areas is expanding mainly on pasture land (located on large ranching estates) leased on a medium-term basis, with little impact on small farmer settlements. However, future soybean growth could displace more family farms located next to medium or large soybean farms, mainly through sale of their land. This should not occur in areas with peasant holdings situated on slopes unsuited to large-scale mechanized farming.

Impact on agricultural and rural employment. Given the scarce amount of labour required by the technology used in soybean production, the future expansion of this crop should intensify the process of "agriculture without people" through land concentration. This process is expected to continue, especially in new soybean producing regions, driving small-farmer households to the outskirts of large and small urban centres, where they generally face precarious subsistence conditions.

The sources of employment for this population (whose economic and social condition is determined by the kind of work they do) have been changing by virtue of the fact that some occupations have lost status or disappeared, while others have flourished. The former include activities relating to forest and timber activity, agricultural wage labour, retailing of inputs and products of small-scale farming, and the small trading that depends on this clientele.

In contrast, although on a much lower scale, there has been an increase in secondary and tertiary activities centred around a clientele that is smaller but with far greater purchasing power. Emerging job categories include tractor drivers, mechanics and others related to the sale of machinery, equipment and inputs for mechanized agriculture.

There has also been an increase in small rural towns of private sector banks and financial services, supermarkets and other service activities, including technical assistance, bookkeeping and administration, which generate employment, but generally require a higher level of education that is not observed among most of the displaced rural population. Therefore, employment opportunities for the marginalized rural population are limited. These people have little access to urban wage labour and generally pressure municipalities for occasional work related to the implementation and maintenance of public works. They require educational and training programmes to enhance their integration into emerging industries and the service sector.

Requirements for storage, transport and port logistics. According to projections, Paraguay's soybean production could top 7 million tonnes in 2014. This increase, if compared to the 3.6 million tonnes observed in 2004, should exert considerable additional pressure on the storage, transport and export infrastructure, especially for soybean seed.

With respect to storage, the higher soybean yield scenario implies the need to increase storage capacity by 7 percent per year in 2009-2014. Regarding the transport of soybeans, it is expected an increase in river and road transport, while railway use (conditioned by the limited length of track and its poor state) should remain constant. The study on Paraguay did not estimate the investment needed to meet these requirements. However, the public and private sectors are both aware of the importance of continuing to develop the export corridors, of strengthening the transportation of grains by barge and truck, and of improving the use of port facilities.

Given that investment in grain storage capacity is exclusively made by private exporting companies and production cooperatives, the expansion of storage capacity could be promoted by introducing credit lines with more competitive interest rates and longer repayment period than those currently available under Paraguay's financial system.

5.4.3 Environment and sustainability of the soybean production system

Paraguay experienced large deforestation in the past. However the projections suggest a relatively favourable outlook, as the additional area required for soybean cultivation in 2005-2014 will only marginally affect native forest. Soybean expansion is expected to mainly take place by diverting natural pasture in Misiones and planted pasture in the departments of Caaguazú, San Pedro, Canindeyú (lower zone) and possibly Concepción and Amambay. These latter five departments account for the bulk of the two million hectares of planted pasture that exist in the country, while total availability of highland suitable for mechanized agriculture in Misiones does not exceed 150 000 hectares.

The pace of soybean expansion will depend on the competitive edge of soybean over beef production. There is considerable demand for meat exports in the countries of Mercosur, which implies competition over land use. However, sporadic outbreaks of foot-and-mouth disease and resulting falls in exports have stimulated the short-term leasing of rangeland for soybean production. Despite all the efforts made to eradicate foot-and-mouth disease, it is not possible to discard a possible repetition of contagious outbreaks in cattle ranching areas in the next decade, which would broaden the availability of land for temporary conversion to crops.

5.4.4 Agricultural policies

Paraguay like other countries with small domestic markets, needs to ensure a stable macroeconomic environment, in which macroeconomic prices are not misaligned and foster export-driven growth.

Such a favourable macroeconomic environment could be created by fiscal discipline and a monetary policy with clear objectives, thus avoiding negative impact on private operator expectations and contributing to consolidate the local financial market. It is also important to develop forward currency markets introducing instruments that will help economic agents to deal with exchange rate instability. Consideration should also be given to the possibility of establishing a soybean compensation fund (similar to Chile's copper compensation fund), which would provide the government with resources to be allocated as a countercyclical measure when there are negative shocks in the Paraguayan economy.

With regard to the agricultural sector, the analyses indicate that Paraguay does not produce or export any significant quantity of soybean meal and oil. Such activities should be promoted. The soybean producing and exporting sector is initiating to make some progress in adding value to its exports, but these efforts need to be supported by trade policies which

encourage exports, for example credit support. At the same time, it is important to advance with the negotiations aimed at reducing trade barriers and the use of other instruments by importing countries to restrict trade in these goods. Such negotiations should take place under the umbrella of Mercosur's negotiation agenda.

The future expansion of soybean will generate pressure for increased investment in roads and ports in Paraguay. A number of studies on this country have indicated that the full entry into effect of the Mercosur common external tariff (CET) will have some negative impacts, mainly on the flow of goods to Paraguay which include inputs and capital goods imported by the soybean sector[98]. These could produce significant price hikes. Investment in transport infrastructure reduces costs of imported and exported goods. This is particularly relevant to Paraguay as it would help offset the increased cost of imported inputs for its soybean sector. From this point of view, an important step in minimizing the negative impact of full implementation of the CET would be to increase investment in transport and port infrastructure.

In relation to social policies, the main challenges lie in addressing the problems of displacement, exclusion, migration, loss of employment, marginalization and worsening food and social insecurity of small-farmer households located in the soybean expansion regions. One solution to the unemployment of displaced peasant farmer households living in rural towns would be to facilitate "their occupational reintegration or to enhance the employment of those already working, through programmes of direct employment, incentives for new recruitment, job bureaux and training programmes"[99]. It would also be important to strengthen literacy and education centres in rural areas.

The above measures could be accompanied by actions to promote the establishment of partnership between small, medium and large producers in conducting joint marketing activities[100], and in establishing discussion forums in which large and small producers, environmental organizations and government authorities could draw up criteria for good agricultural practices.

Environmental policies in Paraguay require measures and strategies to avoid major deforestation and mitigate its impact, for example reforestation, regeneration of native forests and protection of ecological reserves. Land-use planning and stricter enforcement of forest legislation could reinforce such actions. With respect to traditional cattle ranching regions, it is important to promote medium and long-term investment in order to improve the use of natural pastures and to modernize the management of cattle herds along sustainable lines.

There is also a need to strengthen the capacity of municipalities to establish norms and supervise the application of regulations associated with a safe and non-contaminating use of agrochemicals. In addition, in order to minimize and avoid risks of agrochemical contamination in rural areas investments in water supply infrastructure should be made for the benefit of agricultural producers.

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[98] The common external tariff (CET) is in effect but there are still lists of exceptions for goods considered to be of vital importance to each country. The goods that feature on the lists receive differential treatment in the form of lower tariffs. As the process of integration advances and the dates for the full entry into effect of the CET approach, each country will have to eliminate its list of exceptions until there is convergence in uniform CET rates.

[99] **Carosini, L.** 2003. *Las políticas de empleo en los países del Mercosur, 1990-2003. Estudio Nacional: Paraguay*. ILO-WTO (Observatorio del Mercado de Trabajo del Mercosur). See www.eclac.org.

[100] There are local experiences of social responsibility, especially between cooperatives of large-scale producers and their surrounding environment of small farming families, in which these families receive assistance for their economic development with the support of such organizations.

Finally, attention should also be given to strengthening the public institutional framework. In this regard the actions should include: improving public sector's capacity for the formulation and monitoring of policies; increasing legal security of land tenure by completing the entitlement of land settled in 1998; and conducting an agricultural census as a key mechanism for sectoral assessment and policy design[101].

5.5 Uruguay

Since in Uruguay the expansion of soybeans is a more recent phenomenon and the area cultivated with this crop is relatively small by South American standards, the future growth of this sector will have less visible consequences in this country than in the rest of Mercosur region and Bolivia

Soybean area is expected to expand by an additional 100 000 hectares between 2004 and 2014. Given the current availability of land, this will not place strong pressure on other agricultural activities.

The main consequences of future expansion refer to the potential development of the local vegetable oil industry, currently in its infancy.

The country has sufficient transport, storage and port infrastructure to increase its industrial production and its exports.

[101] The last census was in 1991.

Box 2 – Soy expansion: effects over land availability and the production system sustainability

An intensification and expansion process is expected to continue in the five countries until 2014, based on the agricultural projections. The surface devoted to soy will increase from 38 million acres in 2005 to 46 millions in 2014. This represents a 21 per cent increase. Over half of this increase will happen in Brazil, whereas 33 per cent will take place in Argentina. The rest will be distributed in Paraguay, Bolivia and Uruguay.

In general, none of these countries will suffer restrictions in land availability in a decisive way due to the expansion of soy farming at the foreseen rate. The issue lies in the influence that the increase of farmed land has in the general dynamic of land use and, in particular, the impact it may have over deforestation and ecologically sensitive areas.

Thus, the **close observation of sustainability indicators** is recommended (including the undermining of natural resources, the protection of primary forests, ground fertility, regional development, farming zoning). This, once established, could help in the analysis on the development of soil, water and biodiversity conditions, in order to promote the necessary adjustments.

It would also be convenient to **actively promote the incorporation of production systems that reduce problems that are collateral to the lack of farming diversification, to problems with infestation and disease, and that help recuperate the productivity and soil fertility**. **The use of sustainable rotation is recommended as well**, through the development and promotion of sustainable policies. This requires the support of financial and economical tools to prevent negative effects on the competitiveness of the production systems.

It is of the utmost importance to make sure that the legal **frame regarding the land rental and use are properly construed**, so that the incentives to use crop rotation for soil, water and biodiversity sustainability are in place.

The multiplying effect of the soy phenomenon in the general economy and in the subsectors linked to the agrarian producers is undeniable. However, the benefits are not equally distributed among the different economic agents involved. In this sense, it is important to observe that one of the strongest effects of the speedy growth of soy production in South America is **the tendency to a greater land concentration**. Therefore, **it would be significant to accompany the productivity and competitiveness increase that is brought by the soy production development with social policies** that promote the positive aspects and reduce the negative impact over human groups with limited options.

6. Conclusions

This analysis of the extraordinary expansion of soybeans, of its future growth and of related implications for food security, rural development and agricultural policies in the countries of Mercosur and Bolivia points to a number of important conclusions.

The expansion of soybeans in these five countries has been a real boom. The cultivated area increased from 17 million hectares in 1996 to 39 million in 2004, making soybean the most important crop in terms of land utilization. Production rose from 39 million tonnes in 1996 to

87 million in 2004 registering an average annual growth of approximately 12 percent. A crop which was introduced relatively latter in the region, soon surpassed other long-established high-yield crops, such as maize, wheat, sunflower and cotton, and took over some of the best livestock farming land. In ten years, the Mercosur countries and Bolivia became the main engine of growth of the world's soybean and soybean products sector.

Soybean established itself in the traditional agricultural areas of the South American countries and has continued its expansion towards other regions (Northwest and Northeast of Argentina, Centre West, North and Northeast of Brazil, regions of San Pedro, Canindeyú, Caaguzú and Caazapá in Paraguay). Mercosur countries and Bolivia now account for 44 percent of the global soybean area and 45 percent of global soybean production, collectively surpassing the United States, the world's leading producer.

The impact of the soybean sector on the economies of the countries studied increased extraordinarily in the last decade. The soybean complex is very important to the macroeconomy: it is a very dynamic sector that stimulates the economy as a whole and the growth of trade, agroindustry and exports. It is also a significant source of foreign exchange and rural income, and contributes extensively to the production of inputs for poultry and pig production, and to the domestic supply of edible oils.
The analyses indicate that soybean will continue to expand in the five countries in the next years, although at a slightly reduced rate. However, the present study did not explicitly analyze the impact that the use of soybean for producing biodiesel could have on the future development of the crop. Therefore the above conclusion possibly underestimates the actual expansion that will take place in the coming years.

The public and private sectors will therefore possibly have to consider future soybean growth and implications that are on an even larger scale than those suggested in the projections and analyses of this paper.

Attention should also be given to the future evolution of the domestic currency and its impact on the competitiveness of the soybean sector. The projections used for the exchange rate in the quantitative analysis assume that the domestic currencies will continue to devalue against the US dollar until 2014. However, during the 2005-2007 period, some currencies particularly those of Brazil and Paraguay have appreciated significantly vis-à-vis the US dollar.

A number of factors have contributed to the extraordinary expansion of soybean production in Mercosur countries and Bolivia, among them the strong, growing and sustained international demand for soybean. Added to this is the ease with which the agroindustrial sectors of these countries have been able to adapt and respond to market opportunities, in terms of use of natural resources, strong entrepreneurial and managerial capacity and available technologies.

In addition to the favourable conditions of the international market, other important factors behind the expansion of soybean have been the adoption of zero tillage and of genetically modified varieties (GMOs). These technologies have produced moderate increases in yield but above all have simplified the production process in the field and reduced labour and agrochemical costs. The process has been accompanied by a parallel – but still insufficient – increase in capacity and efficiency of storage, transport, processing and port facilities.

The introduction of zero tillage coupled with the growing use of transgenic seeds, which were rapidly taken up in Argentina and Paraguay, helped raise soybean returns, which expanded the cultivated area and incorporated new areas that had hitherto been unsuited to soybean cultivation. The new technology pushed the agricultural frontier towards traditional cattle raising areas, which in turn displaced pasture to forest and ecologically fragile zones.

The expansion of soybeans was also facilitated by a number of policies, including R&D and; in Argentina, trade liberalization, the subsequent abandonment of fixed parity with the US dollar and resulting devaluation; in Brazil, the Kandir Law and the PRODECER and MODERFROTA programmes; in Bolivia, the National Seed Programme and the tariff preference laws; in Paraguay, credit policies.

The most decisive factor for the expansion of soybean production however has been the surge in economic returns.

The expansion of the soybean sector has favoured the intensification (in some cases the development) of major structural changes in the five countries. The production process and agribusiness have changed deeply: an increase in size and reduction in number of production units; further development of a real estate market that has brought new actors and capital into agriculture; increased leasing of land and outsourcing of production, which has accentuated the de-linkage of ownership and management of farm holdings; the expansion of new financial modalities such as cultivation, production and marketing pools, common investment funds and a proliferation of non-agricultural financial investors; an increase in labour productivity and therefore a reduction in labour per unit of area; and broader globalization of agricultural production.

The projections suggest that the process of intensification and expansion of agriculture will continue in the five countries until 2014; the soybean area will grow from 38 million hectares in 2005 to 46 million in 2014, an increase of 21 percent. Slightly more than 50 percent of this increase will be in Brazil, about 33 percent in Argentina and the rest in Paraguay, Bolivia and Uruguay.

Land availability will not restrict the expected expansion of soybean cultivation in none of the five countries covered in the study. The important aspect is the influence that the increase in soybean area will have on the general dynamic of land use and, in particular, the impact that it could have on deforestation and unsustainable uses of ecologically fragile land.

High economic returns from soybean have led in some cases, to excessive simplification of production systems, several of which characterized by insufficient rotation to conserve soil fertility and quality due to the prevalence of a single crop.

The expansion of soybean cultivation thus has its negative side, as the combination of zero tillage and monoculture of glyphosate-tolerant soybean can undermine the sustainability of agro-ecosystems, unless complementary measures are taken. There is already mounting concern over the loss of the natural resource base and the use of the current production systems.

With this in mind, it is essential to carry out an updated assessment of agricultural soil conditions in these countries, given the gradual displacement of planted pasture and the virtual monocropping of soybean. In this regard, sustainability indicators should be established and monitored since they could contribute to examining the evolution of soil, water, biodiversity and other conditions and facilitate the formulation of appropriate corrective measures.

There is also a need to actively promote the implementation of sustainable rotations over time through the development and dissemination of sustainable management practices which should be accompanied by financial and economic instruments that do not reduce the competitiveness of production systems in terms of profitability. Moreover, soybean research and development policies should be reviewed and strengthened in Mercosur countries and

Bolivia, taking into account the opportunity cost and potential input of increased cooperation between public and private sectors at regional and international level.

There is also a need to review the legal framework for leasing and share tenancy contracts and for investments in the soybean sector by actors who are not tied to the agricultural sector or land, so as to introduce incentives for the utilization of rotation practices that will sustain land use, water and biodiversity.

Despite some doubts regarding environmental sustainability, the extraordinary growth of soybean has been an important source of wealth in the countryside (although with notable imbalances in land holding concentration and income) and has stimulated agroindustry and trade.

The soybean phenomenon has also had a major multiplier effect on the economy in general and on the agricultural services subsector (inputs, transport, trade, insurance), on the promotion and expansion of the associated agroindustrial sector (soybean meal, vegetable oils and other products) and on rural employment (not necessarily agricultural), despite lower demand for labour per hectare.

Buoyant soybean production, processing and trade have attracted investment, which has in turn created new income and employment opportunities in the rural sector. Other indirect positive impacts on rural development have come from improvements in fiscal accounts, which helped to finance social and development programmes.

However, the benefits have not been equally spread among all economic players. One of the major features of the accelerated growth of soybean production in the South American countries has been the strong trend towards land holding concentration. In many cases, the sale or lease of farms has displaced rural families and thus perhaps further aggravated an already difficult living condition.

The projections for 2005-2014 indicate that soybean expansion will not impact on food production in these five countries. However, small farmers directly affected who have sold or leased their land will face a new situation which may increase their vulnerability, as they will no longer have the safety net of their own production (either for market or home consumption).

Under the current economic model where market forces determine the allocation of resources, it is likely that the small-farmer sale or lease of land will continue towards 2014. Therefore, it will be important to complement the increase in the productivity and competitiveness of soybean production with social policies that optimize the positive impacts and mitigate the negative ones on the population that has little room for manoeuvre.

Rural development policy cannot focus on a single crop despite its relevance. It is important to place such policy within a global strategy that considers all production possibilities, including activities outside the agricultural sector.

Training and education programmes, broader access to services and assets, the development of institutions that facilitate the economic and social integration of the rural poor and all the other widely recognized thrusts of rural development strategy should project rural development policy beyond the primacy of soybean activity.

But it is also important to consider the opportunities for rural development and for enhanced living conditions of the rural poor that a highly dynamic soybean sector can provide. It is essential to maximize the effective participation of small farmers in soybean production. This will mean overcoming their disadvantages in terms of reduced scale of production by means

of institutional arrangements that combine organizations of small producers with contract mechanisms which enhance their possibilities to participate in the soybean sector. Such efforts should be complemented with differentiated policies tailored to the conditions of small producers.

Another important aspect is the inadequacy of storage and transport infrastructure that constitutes an important challenge for the expansion of soybean production. The rapid growth of soybean cultivation and sales to national and international markets took place in a context of limited infrastructure for the marketing of agricultural products. However, unless corrective measures are taken rapidly, the poor road network, the shortage of trucks to transport grains and grain products, the limited capacity and unsatisfactory management of port facilities and the low utilization and inefficiency of the railway network will affect significantly the soybean sector, especially in the harvesting period. Although the five countries have similar transport problems, they face in this case greater differences than in agricultural production processes. High transport costs impact negatively on the prices received by farmers, especially those located furthest from the ports and processing areas.

Another problem related to the internal distribution of soybean production is the concentration of transport during the time of harvest, due to insufficient and/or precarious storage infrastructure. There are innumerable facilities with actual capacity limited in terms of space, movement (bucket elevators, conveyors) and treatment (drying, sieving, airing).

Unless appropriate investment programmes and policy measures are adopted for the maintenance, replacement and increase of transport and storage capacity, the future expansion of the soybean sector could be seriously undermined.

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The conclusion from the foregoing chapters is that soybean production in the countries of Mercosur and Bolivia has come to stay. The possible consequences of its future development on food security, rural development, land use, the environment and other aspects will depend not only on the general expansionary trend of soybean cropping, but also on the ability of governments to adopt policies and measures that will capitalize on the positive effects and counter the negative ones, keeping a constant eye on the evolution and the environmental, agronomic, social and economic sustainability of this complex phenomenon.

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ANNEX I – Statistical information

Table I.1 – Production of soybean seed in selected years

Country	Tonnes			Percentage share (%)			Average annual rate of change Percentage (%)		
	1990	1996	2004	1990	1996	2004	1990-1996	1996-2004	1990-2004
World	108 453 156	130 212 831	206 461 698	100	100	100	4.14	5.21	4.89
Brazil	19 897 804	23 155 274	49 793 000	18.3	17.8	24.1	6.64	10.43	8.02
Argentina	10 700 000	12 448 200	31 500 000	9.9	9.6	15.3	2.57	15.06	9.75
Paraguay	1 794 618	2 394 794	3 583 680	1.7	1.8	1.7	6.95	5.84	7.41
Bolivia	232 743	861 636	1 670 000	0.2	0.7	0.8	25.46	7.04	12.59
Uruguay	37 000	13 600	377 000	0.0	0.0	0.2	-10.74	49.45	14.14
Subtotal South America	*32 662 165*	*38 873 504*	*86 923 680*	*30.1*	*29.9*	*42.1*	*5.49*	*11.68*	*8.64*
United States	52 416 000	64 782 000	85 012 800	48.3	49.8	41.2	3.47	1.53	3.03
China	11 008 140	13 233 693	17 600 000	10.2	10.2	8.5	6.07	2.57	3.11
India	2 601 500	5 400 000	7 500 000	2.4	4.1	3.6	14.41	1.42	6.85
Others	9 765 351	7 923 634	9 425 218	9	6.1	4.6	-3.02	-0.32	-0.68

Source: FAO/RLCP based on FAOSTAT figures.

Table I.2 – Soybean cultivated area

Country	Hectares			Percentage share (%)			Average annual rate of change Percentage (%)		
	1990	1996	2004	1990	1996	2004	1990-1996	1996-2004	1990-2004
World	57 184 013	61 093 134	91 189 599	100	100	100	2.03	4.32	3.43
Brazil	11 487 300	10 291 500	21 538 990	18.8	16.8	23.6	0.92	8.43	4.80
Argentina	4 961 600	5 913 415	14 320 000	8.1	9.7	15.7	4.06	11.93	8.26
Paraguay	899 900	833 005	1 870 000	1.5	1.4	2.1	1.59	9.24	7.78
Bolivia	143 372	463 243	890 000	0.2	0.8	1.0	21.79	5.78	12.28
Uruguay	28 500	7 600	247 000	0.0	0.0	0.3	-12.87	48.21	13.10
Subtotal South America	*17 520 672*	*17 508 763*	*38 865 990*	*28.7*	*28.7*	*42.6*	*2.21*	*9.69*	*6.23*
United States	22 869 008	25 636 000	29 930 060	37.4	42.0	32.8	1.82	1.39	2.25
China	7 563 788	7 475 774	9 700 000	12.4	12.2	10.6	1.79	2.70	1.62
India	2 564 200	5 233 000	6 900 000	4.2	8.6	7.6	12.05	1.96	6.15
Others	6 666 345	5 239 597	5 793 549	17	8.6	6.4	-3.26	0.24	-1.38

Source: FAO/RLCP based on FAOSTAT figures.

Table I.3 – Soybean yield in specific years

Country	Tonnes/Hectares			Index			Average annual rate of change Percentage (%)		
	1990	1996	2004	1990	1996	2004	1990-1996	1996-2004	1990-2004
World	1.9	2.1	2.3	1.0	1.0	1.0	2.07	0.85	1.41
Brazil	1.7	2.2	2.3	0.9	1.1	1.0	5.66	1.84	3.07
Argentina	2.2	2.1	2.2	1.1	1.0	1.0	-1.43	2.80	1.38
Paraguay	2.0	2.9	1.9	1.1	1.3	0.8	5.28	-3.12	-0.34
Bolivia	1.6	1.9	1.9	0.9	0.9	0.8	3.02	1.19	0.27
Uruguay	1.3	1.8	1.5	0.7	0.8	0.7	2.44	0.84	0.92
Subtotal South America	*1.9*	*2.2*	2.2	*1.0*	*1.0*	*1.0*	*0.01*	*-0.02*	*0.00*
United States	2.3	2.5	2.8	1.2	1.2	1.3	1.62	0.14	0.76
China	1.5	1.8	1.8	0.8	0.8	0.8	4.21	-0.12	1.46
India	1.0	1.0	1.1	0.5	0.5	0.5	2.10	-0.53	0.66
Others	1.5	1.5	1.6	0.8	0.7	0.7	0.25	-0.56	0.71

Source: FAO/RLCP based on FAOSTAT figures.

Table I.4 – Value and share of aggregated exports of soybean and soybean products (meal and oil) in selected years

Country	1990		1996		2004		Annual rate 1990-2004
	Value	Share	Value	Share	Value	Share	
	US dollar millions	(%)	US dollar millions	(%)	US dollar millions	(%)	(%)
Mundo	**12,975**	**100.0**	**21,265**	**100.0**	**31,788**	**100.0**	**5.6**
Brazil	2,854	22.0	4,462	21.0	10,048	31.6	8.7
Argentina	2,025	15.6	3,473	16.3	7,674	24.1	9.0
Paraguay	283	2.2	463	2.2	861	2.7	8.5
Bolivia	38	0.3	182	0.9	408	1.3	18.6
Uruguay	0	0.0	0	0.0	83	0.3	--
South America	*5,200*	*40.1*	*8,581*	*40.4*	*19,073*	*60.0*	*11.2*
United States	4,885	37.6	9,211	43.3	8,019	25.2	3.1
Netherlands	860	6.6	893	4.2	1,486	4.7	3.1
Others	2,031	15.6	2,581	12.1	3,209	10.1	2.8

Source: FAO/RLCP based on UN COMTRADE figures.

ANNEX II – Baseline outlook for the soybean complex

II.1 Argentina

After growing at an average annual rate of about 12 percent during the period 1998-2004, soybean production in Argentina will grow at a rate of about 4 percent between 2005 and 2014. Production will therefore increase from 35 million tonnes in 2004 to about 50 million in 2014. Among other factors, this expansion is associated with an average annual increase in the international price of soybeans lower than that observed in the period 1998-2004[102], an average increase in cultivated area of 2 percent per year, and an annual average increase in yield of 1.3 percent. The cultivated area will therefore rise from 13 million hectares in 2004 to 16 million in 2014, while yield will increase from 2.8 to 3.2 tonnes per hectare.

Regarding soybean crushing, the projections indicate that the processed volume will increase at an average annual rate of 2.5 percent, rising from 26 million tonnes in 2004 to 33 million in 2014. However, the proportion of output allocated to processing will gradually decrease from 72 to 65 percent during the period 2005-2014. As domestic consumption of soybean and soybean products is relatively small, the exports of soybean seed will increase by about 6 percent per year, reaching 17 million tonnes in 2014. The external sales of soybean meal and oil will increase by about 3.5 percent and 3.1 percent per year totaling 25 million and 6 million tonnes in that same year, respectively.

II.2 Bolivia

According to the projections made, soybean production in Bolivia will continue its upward trend reaching about 3 million tonnes in 2014, which is 59 percent higher than what was observed in 2005. This growth will result from an increase in cultivated area (it will expand from about 1 million hectares at present to 1.3 million in 2014) and an increase in yield, which will rise from 2.2 to 2.5 tonnes per hectare between 2005 and 2014.

The expected expansion in soybean production will result in an increase in the quantity processed from 1.8 million tonnes in 2005 to 2.7 million in 2014. However, in view of the priority given to the production of soybean meal and oil, the exports of soybean seed will correspond to less than 7 percent of soybean output in 2014, i.e. Bolivia will only export 214 000 tonnes of soybean seed in that year.

II.3 Brazil

Soybean production in Brazil has grown at an extraordinary pace, particularly in the period 2001-2004 when it increased by an average annual rate of 15 percent. As the international and domestic prices of soybeans are expected to follow a less steep upward trend until the middle of the next decade than the one observed in 2001-2004, production should increase at an average annual rate of 3.5 percent between 2005 and 2014, reaching a total of 79 million tonnes of soybeans at the end of that period. This expansion is associated also with an average annual increase of 2 percent in soybean cultivated area and of 1.5 percent in yield. Soybean cultivated area is expected to increase from 23 million hectares in 2005 to 27 million in 2014 and yield from 2.6 to 3 tonnes per hectare. In contrast to what was observed in 2001-2004, when soybean cultivated area increased by about 7 million hectares, this

[102] The estimated increase in the international price of soybeans will be 1.7 percent in the period 2005-2014 in contrast to 4.3 percent in 1998-2004. The price of a tonne of soybeans will therefore increase from US$228 in 2005 to US$264 in 2014.

projection implies an increase of 4 million hectares. Brazilian experts anticipate that much of this additional area will be located in the Centre-West, North and Northeast regions of the country.

Regarding the destination of the soybeans produced, the projections for the period 2005-2014 indicate that, assuming no major change will take place in Brazil's current trade policy, exports of soybean seed will grow more rapidly (3.3 percent per year) than the requirements of the processing industry (2.6 percent). However, the latter will continue to exceed exports of soybean seed in 2014[103]. Domestic production of soybean meal and oil will increase at an average annual rate of 2.6 percent during the period 2005-2014, which is more than enough to meet domestic demand and to export increasingly larger volumes which, in 2014, will amount to 20 million tonnes of soybean meal and 4 million tonnes of soybean oil.

II.4 Paraguay

During the period 2005-2014, soybean production will grow at lower rates than in the previous ten years. However, because of a favourable evolution in the domestic nominal price, production will increase at a higher annual average rate than in the other countries of the region, rising from 3.5 million tonnes in 2005 to 6 million in 2014. This increase is expected to come mainly from an expansion of cropped area (at an average annual rate of growth of 3.6 percent) and, to a lesser extent, from an increase in yield (1.3 percent).

Paraguay has traditionally exported a larger proportion of its soybean seed[104], retaining less for its processing industry. However, according to the projections this situation will gradually change during the period 2005-2014. The exports of soybean seed will continue to rise but at a steadily lower annual rate, down to a relatively stable level of 3 million tonnes in the last three years of the period. In contrast, the demand from the processing industry will increase rapidly with the result that in 2014 the processed volume (2.7 million tonnes) will almost equal the exports of soybean seed. In this context, given a relatively small domestic demand for soybean products the exports of soybean meal and oil will increase 50 percent and 44 percent, respectively, between 2005 and 2014, the former reaching 1.6 million tonnes in the last year of this period and the latter 285 000 tonnes.

II.5 Uruguay

Soybean production will continue to increase in Uruguay during the next 8 years, although at an average annual rate of 5 percent vis-à-vis 9.5 percent in 2004-2006. Production should reach 860 000 tonnes in 2014 as a result of an increase in cropped area and yield[105] to 399 000 hectares and 2.2 tonnes per hectare respectively.

The soybean sector has only recently gained economic significance; therefore the demand from the domestic processing industry is still small - no more than 4 percent of total output. According to the projections made, this situation will continue in the period 2007-2014. Specifically, soybean exports will increase from 579 000 to 813 000 tonnes, representing about 94 percent of domestic production.

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[103] The processing industry is expected to absorb 42 million tonnes, while exports of soybean seed will total 37 million tonnes.
[104] Between 55 and 60 percent of soybean production.
[105] The cultivated area will increase by an average annual rate of 3.3 percent, while yield will increase by an average annual rate of 1.7 percent.

ANNEX III – Outlook for the soybean sector under different scenarios

III.1 Yield scenario

According to Table 4.1 of this synthesis document, projections of higher than baseline yields will result in soybean production about 10 percent higher than the baseline in Argentina and Brazil, and 17 percent in Paraguay in 2014. Based on the model assumptions, the scenario of higher yield projects the highest level of soybean production for Argentina and Paraguay in 2014 (56 million and 7 million tonnes respectively).

Higher production should significantly decrease domestic and international soybean prices in the period in question, with the result that the cropped area in Argentina and Brazil in 2014 should be slightly less (4 to 5 percent lower) than the baseline projection, while the cropped area in Paraguay will only fall slightly (by 0.14 percent)[106].

In addition to the above, projected exports of soybean seed will exceed the baseline, especially in Argentina and Paraguay where they will be 35 percent and 25 percent higher than the baseline in 2014, reaching 23 million and 4 million tonnes respectively. Brazil will export 43 million tonnes of soybean seed in 2014, 17 percent higher than the baseline.

Regarding the exports of soybean products, the estimates for the higher-yield scenario indicate that only Paraguay will attain significantly higher levels than the baseline[107].

The deviations from the baseline caused by below-baseline yield assumptions display the opposite sign compared to the previously described scenario, yet their magnitudes are not congruent because of asymmetries in the assumptions. In the lower-yield scenario, international and domestic prices increase in Argentina, Brazil and Paraguay in relation to the baseline scenario. Brazil will increase its cropped area, production and exports of soybean seed relative to the baseline[108]. These results are largely due to the fact that the reductions in yield envisaged for Brazil are lower than those expected for Argentina and Paraguay[109]. Thus, because it will experience a much more limited fall in productivity than its competitors, Brazil will increase its share of the international market.

This result highlights the importance of maintaining competitive yield growth in adverse circumstances. In addition, if it is considered that in this specific higher-yield scenario the cropped area will decline and that soybean production and exports increase as a result of greater productivity, the former result could allay the fears of those who believe that an expansion of soybean cultivation will have a negative impact on the Amazon forest.

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[106] In the case of Paraguay, returns are considered to be determined by the movement of prices, but the levels are small in comparison to the initial price shock (due to higher yield), given that this is countered by the increase or reduction in yield in the opposite direction. Another reason is that the prices of other commodities react in the model in the same direction as soybean. If their yields remain unchanged, the other returns correspond closely to their price movements, so there will be no incentive to substitute cropland.

[107] While the difference in Argentina and Brazil will not exceed 3 percent in 2014, in Paraguay it will be 10 percent higher in the case of soymeal exports and 16 percent higher in the case of soybean oil exports.

[108] The projections for 2014 indicate a marginal increase (2 percent) of soybean cultivated area in Argentina against the baseline while production and exports will be 7 percent and 20 percent lower respectively. The estimates for Paraguay are a reduction in cultivated area (2 percent), of production (15 percent), and of soybean exports (25 percent).

[109] The assumption is that yield will fall 1 percent in Brazil in 2014, while Argentina will experience a decline of 9 percent and the United States and Paraguay 13 percent.

III.2 Production cost scenario

The low cost of production has been one of the main determinants of the exceptional expansion of soybean production in South America. According to the experts who drew up the relevant scenarios, Brazil could face a more favourable situation than Argentina and Paraguay, as it would have more possibilities of reducing its production costs and fewer possibilities that these will increase. Projections for a lower production cost scenario indicate that in 2014 Brazil's production will be 15 percent higher than the baseline projection, amounting to 91 million tonnes; Paraguay's will be 7 million tonnes[110], while Argentina's will increase to 48 million tonnes, which is 4 percent below the baseline projection[111],

As in the case of higher yield, estimates for the lower production cost scenario also point to lower international and domestic prices (about 7 percent)[112] than the baseline projections for 2014.

In a scenario of lower production cost than the baseline, the cropped area in Brazil and Paraguay will increase gradually, peaking in 2014 at 30 million hectares and 2.3 million hectares respectively. Argentina will also see an increase in cropped area over time but, in contrast to Brazil and Paraguay, this will remain below the baseline figure, at some 15 million hectares in 2014.

Regarding the exports of soybean seed, Brazil's exports will steadily rise above the baseline values up to a maximum difference of 31 percent in 2014, with exports of 48 million tonnes. Paraguay's exports will also be above the baseline estimates, especially in the last 8 years of the projection period, during which they will be 20 to 25 percent above the baseline values. In contrast, Argentina's exports of soybean seed in this scenario will gradually fall below the baseline projection reaching only about 15 million tonnes in 2014, 11 percent below the baseline.

In contrast to the projection for lower production cost, higher cost will imply a reduction in cropping profitability. The higher production cost scenario therefore estimates that the cropped area, soybean production and exports of soybean seed will be below baseline levels in Argentina, Brazil and Paraguay during at least the last three years of the projection period. The difference with the baseline will be larger for Argentina because, according to the national experts, this country faces greater costs threats than Brazil and Paraguay. The estimated total soybean area in these three countries in 2014 will be about 4 million hectares lower than baseline, Argentina accounting for 85 percent of that reduction, Brazil 13 percent and Paraguay 2 percent.

Thus, according to the national experts' view of the production cost scenario, Brazil, first, and Paraguay, second, will register higher levels of production, cropped area and soybean exports than the baseline in the case of lower production cost. In contrast, in a situation of higher production cost than the baseline, these variables will fall less dramatically in both countries.

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[110] This estimate is 11 percent higher than the baseline projection.

[111] Argentina's lower level of production in relation to the baseline is due to the fact that the 1 percent cost decrease in 2014 is not sufficient to offset the drop in the international price of soybeans caused by the production growth of this crop in Brazil associated with a 16 percent cost reduction. The outcome of these two effects is an economic return that is 10 percent lower than that of the baseline in 2014. As a result, estimated soybean production for 2014 is 4 percent lower than the baseline.

[112] In Argentina, however, the difference will be about 10 percent as the price elasticity estimated by the model is greater than one.

III.3 Import demand from China scenario

China is the most important market for exports of soybean seed from South America. The simulation therefore introduced a 20 percent increase in Chinese demand for processing and soybean products, an increase that was uniformly distributed throughout the period 2005-2014, so that the increase in 2005 was 2 percent higher than 2004 and 20 percent higher in 2014. There was also simulation of a comparable fall in Chinese demand.

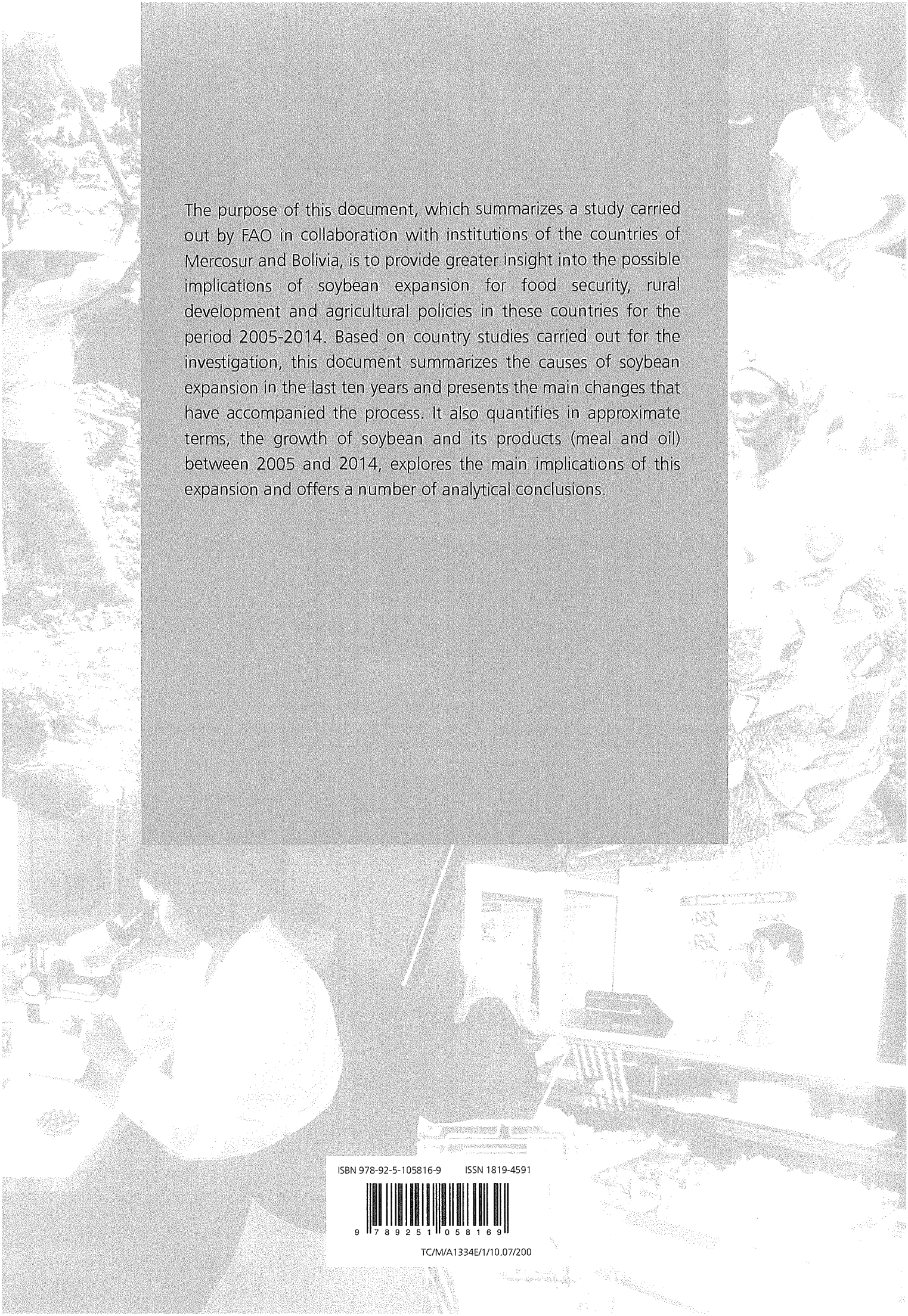
The results indicate that in 2014, under the increased demand simulation, China will import 55 million tonnes of soybean seed and 4 million tonnes of soybean oil, against 32 million and 4 million tonnes respectively in the opposite scenario[113].

International and domestic soybean prices will move in parallel with these positive and negative changes in demand, and in 2014 will differ by about 5 percent from the baseline scenario in Argentina, Brazil and Paraguay[114]. Production will also mirror the change in import demand. However, changes in Chinese demand will affect Brazil's production more strongly than Argentina and Paraguay's production because of Brazil's greater capacity of response to price variations. In this context, under the scenario of increased Chinese demand, the production of these countries will differ from the baseline by 5 percent, 3 percent and 2 percent respectively in 2014, giving the production levels reported in Table 4.1 of this document. As this table shows, those quantities will result from a larger cropped area than the baseline, especially in Argentina where the estimate for 2014 is the highest projected area for that country (16 million hectares).

With respect to soybean exports, higher Chinese demand than the baseline scenario will increase soybean exports from Argentina, Brazil and Paraguay to 19 million, 41 million and 3 million tonnes respectively (these values are higher than the baseline estimates). As Table 4.1 shows, soymeal and soybean oil exports will respond only marginally because the additional meal and oil needs in China are sourced primarily through domestic crush. China does not increase its meal imports; in Brazil and Paraguay domestic crush demand falls as a result of higher seed prices. Argentina's crushing industry enjoys a competitive advantage because of its tax structure replacing some of Brazil's meal exports.

[113] These values correspond respectively to a 26 percent increase and a 13 percent reduction in relation to the baseline.

[114] In Argentina, however, the difference will be 7 percent as the price elasticity estimated by the model is greater than one.



The purpose of this document, which summarizes a study carried out by FAO in collaboration with institutions of the countries of Mercosur and Bolivia, is to provide greater insight into the possible implications of soybean expansion for food security, rural development and agricultural policies in these countries for the period 2005-2014. Based on country studies carried out for the investigation, this document summarizes the causes of soybean expansion in the last ten years and presents the main changes that have accompanied the process. It also quantifies in approximate terms, the growth of soybean and its products (meal and oil) between 2005 and 2014, explores the main implications of this expansion and offers a number of analytical conclusions.

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