Global Assessment of Biomass and Bioproduct Impacts
on Socio-economics and Sustainability

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Global-Bio-Pact Case Study

Socio-Economic Impacts of the Soy Chain in Argentina

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Preface

This report was elaborated in the framework of the Global-Bio-Pact project (Global Assessment of Biomass and Bioproduct Impacts on Socio-economics and Sustainability) which is supported by the European Commission in the Seventh Framework Programme for Research (FP7). Global-Bio-Pact is coordinated by WIP Renewable Energies and runs from February 2010 to January 2013.

The main aim of Global-Bio-Pact is the improvement and harmonisation of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative socio-economic impacts. Thereby, emphasis is placed on a detailed assessment of the socio-economic impacts of raw material production and a variety of biomass conversion chains. The impact of biomass production on global and local food security and the links between environmental and socio-economic impacts are analysed. Furthermore, the Global-Bio-Pact project investigates the impact of biomass production on food security and the interrelationship of global sustainability certification systems with international trade of biomass and bioproducts as well as with public perception of biomass production for industrial uses. Finally, Global-Bio-Pact focuses on socio-economic sustainability criteria and indicators for inclusion into certification schemes, and the project elaborates recommendations on how to best integrate socio-economic sustainability criteria in European legislation and policies on biomass and bioproducts.

An core activity of Global-Bio-Pact is the description of socio-economic impacts in different countries and continents in order to collect practical experience about socio-economic impacts of bioproducts and biofuels under different environmental, legal, social, and economical framework conditions. The results of these surveys are described in different case studies.

The present report presents the Global-Bio-Pact Case Study for soybean value chain in Argentina. This Case Study was elaborated by INTA

1 Introduction

A strong public debate on sustainability aspects for biomass use for energy and products emerged in the last few years. This debate focused mainly on negative social and environmental impacts. In consequence, several initiatives were set-up, which are engaged in developing tools to ensure sustainability of biofuels. One option to ensure the sustainability of biofuels is the application of certification systems.

The main aim of the Global-Bio-Pactproject is the improvement of global sustainability certification systems for biomass production, conversion systems and trade in order to prevent negative and to promote positive socio-economic impacts. Thereby, emphasis is placed on a detailed assessment of the socio-economic impacts of feedstock production and a variety of biomass conversion chains.

In order to generate data on the ground, five in-depth case studies for socio-economic impacts were investigated in the framework of Global-Bio-Pact:

- Biodiesel from soy in Argentina
- Palm oil and biodiesel in Indonesia
- Bioethanol from sugarcane in Brazil
- Bioethanol from sugarcane in Costa Rica
- Jatropha oil and biodiesel in Tanzania
- Jatropha oil and biodiesel in Mali
- 2nd generation biofuels and products from lignocellulose material in Canada

The present report presents the Global-Bio-Pact Case Study for soybean value chain in Argentina. This Case Study was elaborated by INTA

In order to start a complete study with example cases in Argentina within the Global-Bio-Pact framework there is a need to pursue a complete analysis of the soybean complex due to its magnitude and importance for the country.

Soybean production is immersed within a productive system that cannot be analyzed in an isolated approach. A number of political and market factors both nationally and internationally explains its development and growth throughout the globe. The analysis of those factors will help to find measures that will implicate a more harmonious development of productive systems.

In Argentina’s case the evolution of the agricultural system with soybean production as perhaps the most important asset over the last few years is characterized by a continuous technological improvement.

This evolvement has allowed a substantial development of the whole agricultural system and has set the base that needs to be maintained in order to fulfill the growing requirements environmental and socially wise that societies demand.

In the social and environmental aspects the institutional aspect is crucial from the government and private side. Argentina has developed a very important and sophisticated network of institutions related to agriculture and the agribusiness as a whole. A growth of the influence of several organizations has been significant. Just to name the most important ones: INTA, AACREA, PROSOJA and AAPRESID mainly focused on the primary production; INTI,ACSOJA, MAIZAR, ASAGA, CARBIO & ABH more orientated to the agroindustry and agribusiness.

An enormous evolution regarding sustainable development awareness is in place in the whole agricultural system with special emphasis in soybean production. This materializes in the whole research made by the mentioned organizations.

There is also a parallel concern on social aspects coming from the public side (municipal, provincial and federal governments) and the private sector through new trends in enterprise management as fair trade social enterprise responsibility and certification schemes. The development of this trend has been institutionalizedthrough the Social

responsibility institute with specific tools to address this important issue (http://www.iarse.org/new_site/site/index.php?put=indicadores).
There are important advances that tend to achieve mechanisms allowing sustainable development premises to be transformed in concrete decisions such as:

- Criteria, indicators development
- Good agricultural and agroindustrial practices
- Certified agriculture
- Certification biofuel schemes CARBIO, GBEP RSB among others

2 Case Study selection

Since the impacts of the production of biofuels and bio products depends on the investigated scale, different levels were investigated in all Global-Bio-Pact Case Studies, including the national, regional, and local/company/project level (Figure 1). In each Case Study country of the Global-Bio-Pact project the following assessments were made:

- One study at national level
- Two studies at local, company or project level

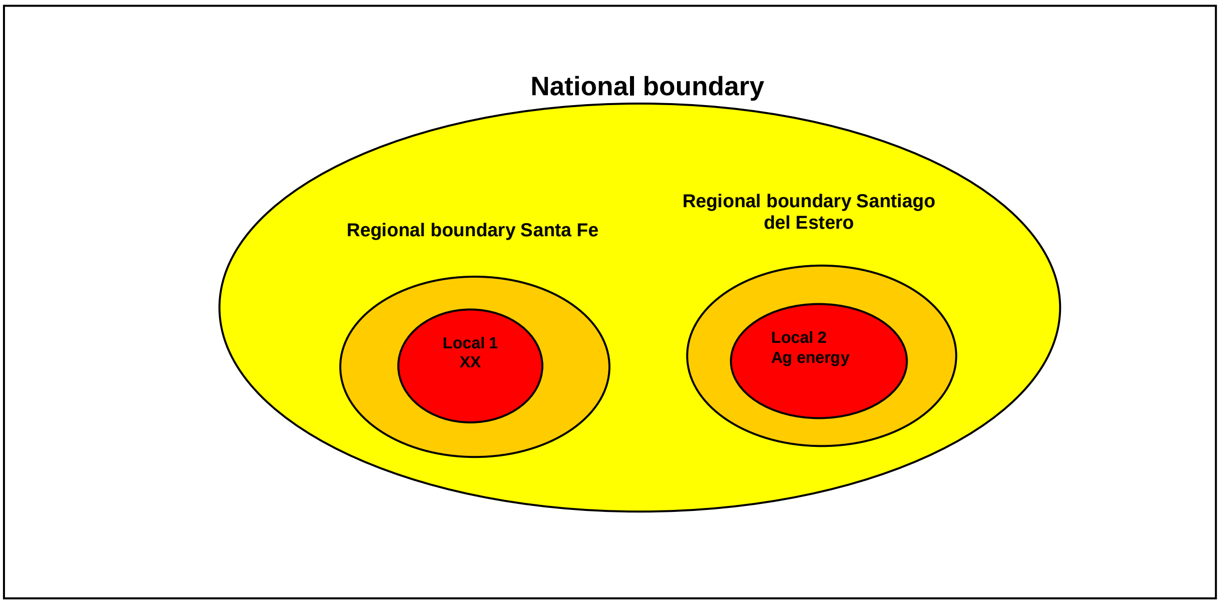


Figure 1: System boundaries of the Global-Bio-Pact project

2.1 Case Studies at national level

The Case Studies at the national level were selected in order to balance the geographical distribution (Africa, Latin America, Asia, Europe, and N-America), feedstock sources (soy, palm oil, and jatropha, sugarcane, and lignocellulose feedstock), conversion technologies (e.g. fermentation, pressing, trans esterification, hydrolysis, gasification) and products (biodiesel, pure plant oil, ethanol, bio products, 2nd generation technologies). Thereby, the assessment focuses on existing conversion technologies since these are the current hotspots of socio-economic concern, but also include impacts of future technologies which are not yet commercially available.

The present report presents the Global-Bio-Pact Case Study for soy chain in Argentina

2.2 Case Studies at regional level

In this project, the regional level was defined as a homogenous region in climate, soil, and socio-economic parameters. The size of the region depends on the country and can be a province or district.

In the present report, two regions were selected as Case Study region in coincidence with the two local levels.

This is a strong difference in Argentina case since the agricultural production systems are not suitable for being addressed at local levels.

The two regional/local level areas selected belong to two different ago ecosystems one based on the central productive area and the second based on a growing new area based on the north part of the country.

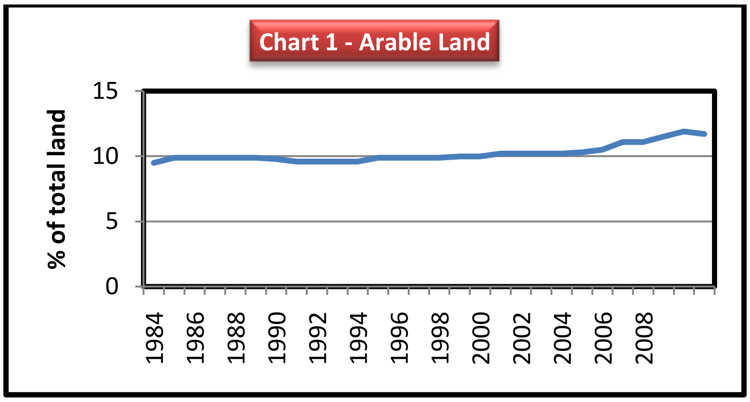
3 General description of the Case Study

3.1 Case Study at the national level: Argentina

3.1.1 Land use

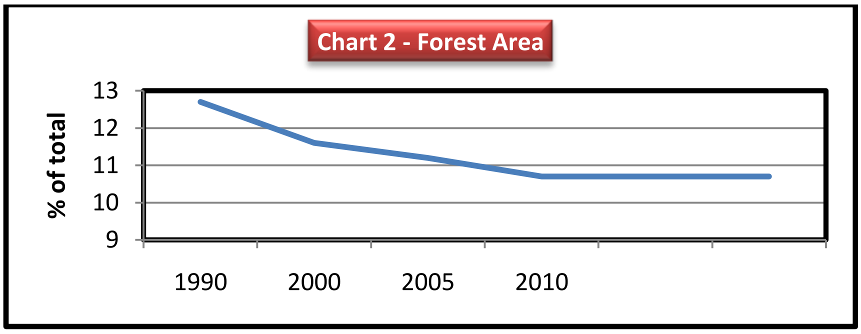
Argentina land area sits at 273,669,000 hectares according to the World Bank.

In terms of arable land the number has been increasing since the 80's and is near 11% of the total land area.



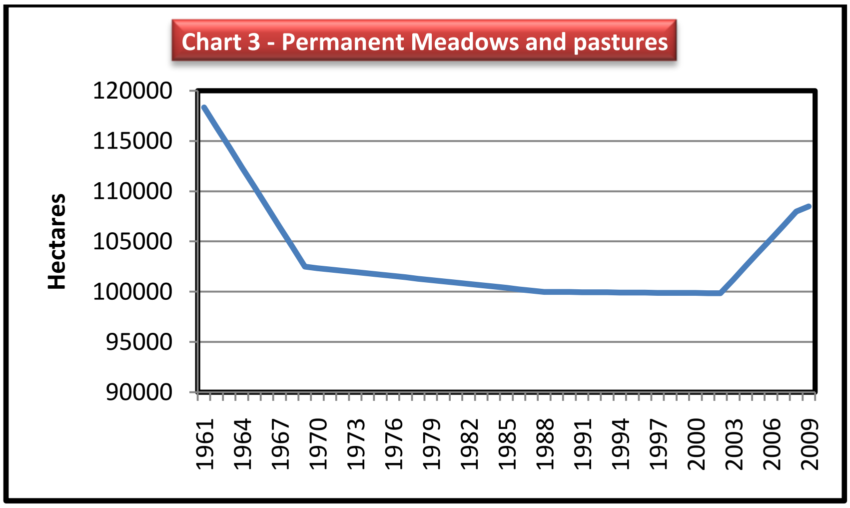
Source: Ministry of Agriculture

The forest area has been decreasing as a percentage of the total land since 1990 basically because of the frontier expansion due to the advance of agriculture over the last few years, gaining territories that were not used for this kind of production and making it suitable for it.



Source: Ministry of Agriculture

Lastly in terms of meadows and pastures a recovery in terms of hectares is observable since the recovery of the agricultural sector of Argentina thanks to the technological advance and the importance of the growth of commodities prices.



Source: Ministry of Agriculture

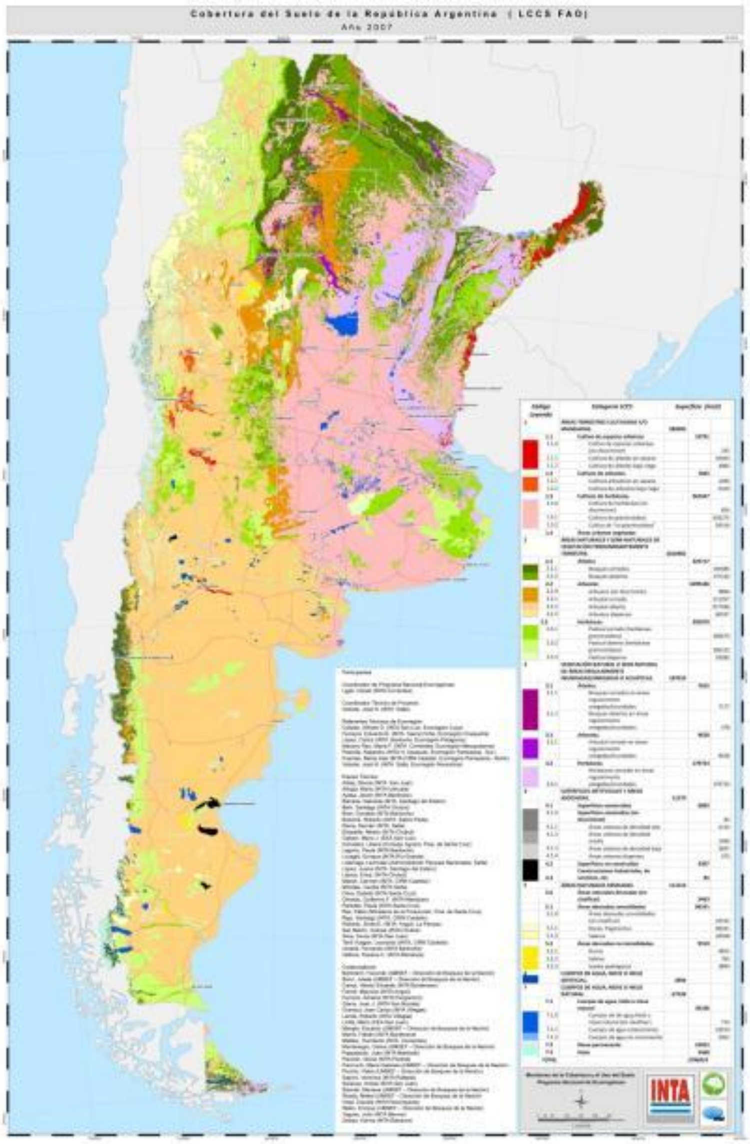


Figure 2: Map of the land use of Argentina

3.1.2 Economy

Argentina's recovery from its worst economic crisis of its history since 2002 has been remarkable.

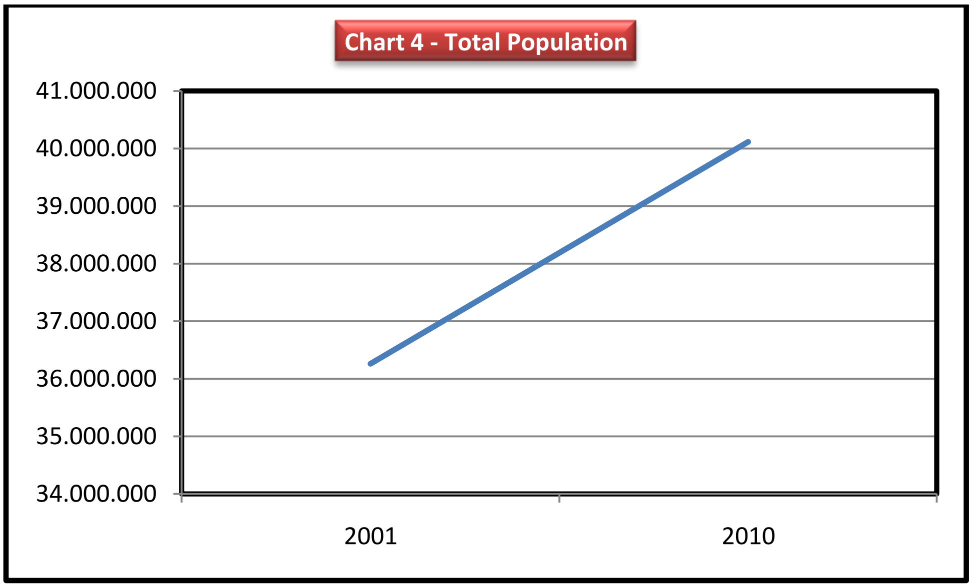
The world commodities prices boom has helped the fast recovery since Argentina benefits from rich natural resources, a highly educated population, a globally competitive agricultural sector, and a diversified industrial base. The move after the 2001-2002 crisis to a more flexible exchange rate regime, along with sustained global and regional growth, a boost in domestic aggregate demand via monetary, fiscal, and income distribution policies, and were catalytic factors in supporting 5 consecutive years of greater than 8% annual GDP growth between 2003 and 2007. The economic recovery also helped the accumulation of international reserves. The reserves, combined with the absence of fresh borrowing from the international capital markets, helped insulate the economy from external shocks. A higher tax burden, improved tax collection efforts, and the recovery's strong impact on tax revenues supported the government's successful efforts to maintain primary fiscal surpluses since 2003.

Global financial turmoil and rapid declines in world commodity prices and economic growth during 2008 and 2009 resulted in diminished growth in 2008 and a mild recession in 2009. While the downtown was less severe in Argentina than elsewhere, the deterioration of both domestic and international demand complicated the fiscal situations of both the federal government and the provinces. The agricultural sector has helped boosting economic growth since 2001 up to date explaining near 10% of Argentina's GDP in 2010 but also explaining more than ¼ of total exports. In the next chart we can observe the steady growth of Argentina's exports and the evolution of oilseeds exports accounting for near 7% of the total.

Poverty has declined since the economic crisis of 2001 according to Argentina's INDEC and the Gini index as well declining from 0.541 in 2003 to 0.442 in 2010.

3.1.3 Population

According to INDEC in 2001 census Argentina had a population of 36,260,130 inhabitants, and preliminary results from the 2010 census [INDEC] census were of 40,091,359 inhabitants as stated in the next chart.



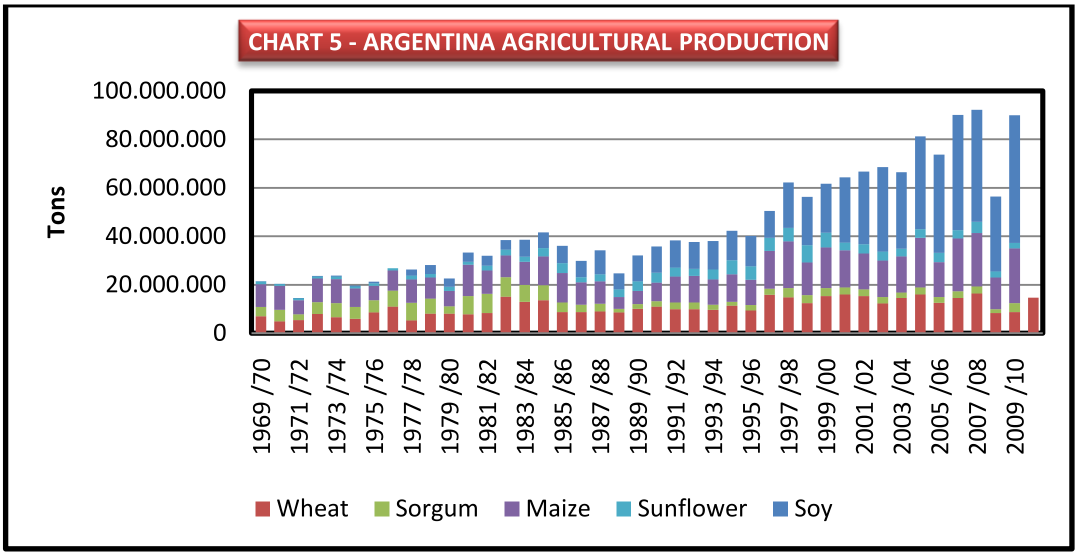
Source: INDEC

This means that the population has increased near 11% in a 10 year span, this is not an enormous amount and is quite near the world average.

Argentina ranks third in South America in total population and 33rd globally. Population density is of 15 persons per square kilometre of land area, well below the world average of 50 persons. The population growth rate in 2008 was estimated to be 0.92% annually, with a birth rate of 16.32 live births per 1,000 inhabitants and a mortality rate of 7.54 deaths per 1,000 inhabitants. The net migration rate is zero immigrants per 1,000 inhabitants.

The proportion of people under 15, at 24.6%, is somewhat below the world average (28%), and the cohort of people 65 and older is relatively high, at 10.8%. The percentage of senior citizens in Argentina has long been second only to Uruguay in Latin America and well above the world average, which is currently 7%.

3.1.4 Agricultural sector



Source: Secretary of Energy

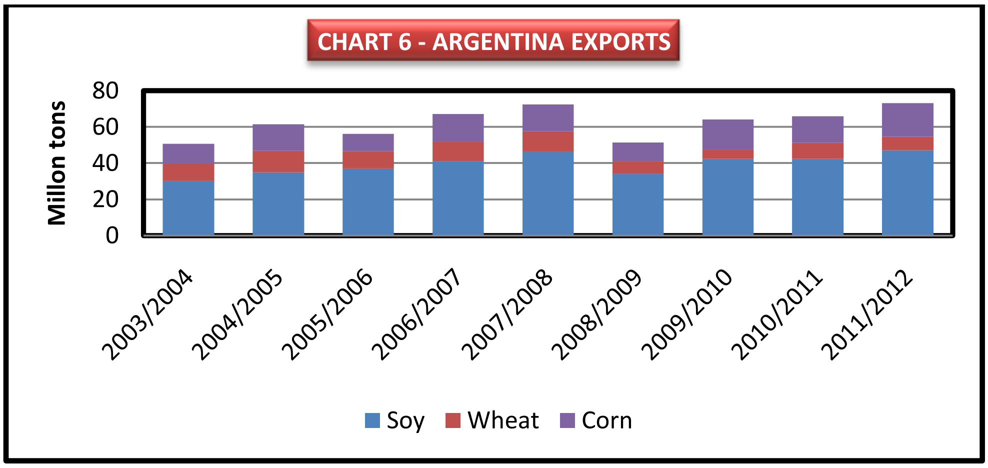
Argentina's agricultural production is leaded by wheat, sorghum, maize, sunflower and soy accounting for more than 100 million tons in 2009/2010 (last data available).

Soy production has been steadily growing over the last few years thanks to high international prices and a state of the art technology over the core sector in Argentina (Buenos Aires, Santa Fe, Cordoba, and La Pampa) that was followed by an expansion of the agricultural frontier to lands that were not historically suited for agricultural exploitation.

Regarding the leading products, Argentina doesn't import them (only a minor amount of soy seeds in the case the local production requires it in order to process it for soymeal or soybean oil).

Regarding soy production over the last five years soy biodiesel has gained importance in Argentina's agro production reaching in 2011 3 million per year tons of soy biodiesel installed capacity production.

Argentina exports more than 80 million tons of the main commodities mentioned earlier accounting for more than 40% of the primary goods exported.



Source: USDA PSD database

3.1.5 Forestry sector

In Argentina there are around 33 million ha of natural forests and 1.1 million ha of planted forests. Planted forests are mainly based on Pines and Eucalyptus, with smaller areas with other species.

A large portion of the planted forests were established along the last 2-3 decades in the Provinces of Misiones, Corrientes and Entre Rios. Existing planted forests have an estimated sustainable production capacity of 20-25 million cubic meters per year, while the current annual consumption of plantation timber is 8 million cubic meters (90% of the Argentina industrial wood consumption). This indicates that the plantation production capacity has a surplus of more than 10 million cubic meters per year.

There is a monitor of native forests in charge of the secretary of environment available at: http://www.ambiente.gov.ar/?idarticulo=311

The wood surplus is a result of the high productivity of the planted forests and a relatively small demand, mainly due to lack of investments in the industrial developments. The imports of forest products are larger than exports, and the county faces a trade deficit.

Pulp and paper industry is small and needs to be modernized and enlarged. The solid wood industry also needs to gain scale and move into value added products, developing, for example, the furniture industry to replace imports. Other local demands for wood are limited. The consumption of wood for industrial energy or charcoal production, as happens in Brazil, is not significant.

3.1.6 Land ownership concentration

Argentina's situation regarding land ownership concentration is worth noting. According to the 2008 agricultural census, more than 60,000 farms shut down between 2002 and 2008, while the average size of farms increased from 421 to 538 hectares. The shift to soy has replaced cultivation of many grains and vegetables and even the country's beef production. Let's keep in mind that soy historically hasn't been grown in Argentina. Soy was brought in during the 1960's during the Green Revolution as will see during this research. Trans genetic soy has been brought to lands where before cultivation wouldn't have been possible. The low production cost of soy helped this process. Soy has replaced other crops, gaining areas that were historically for cattle grazing and dairy production.

But one of the breakthroughs in Argentina's case is the appearance of a new model of land possession. Traditionally the agricultural production model was based in land possession (or rented) destined to the development of a low amount of activities with a high level of integration between them using a high dosage of capital.

On the other hand, the new model is based in a “no verticality” way of producing and mercerization of the production.

It has five pillars:

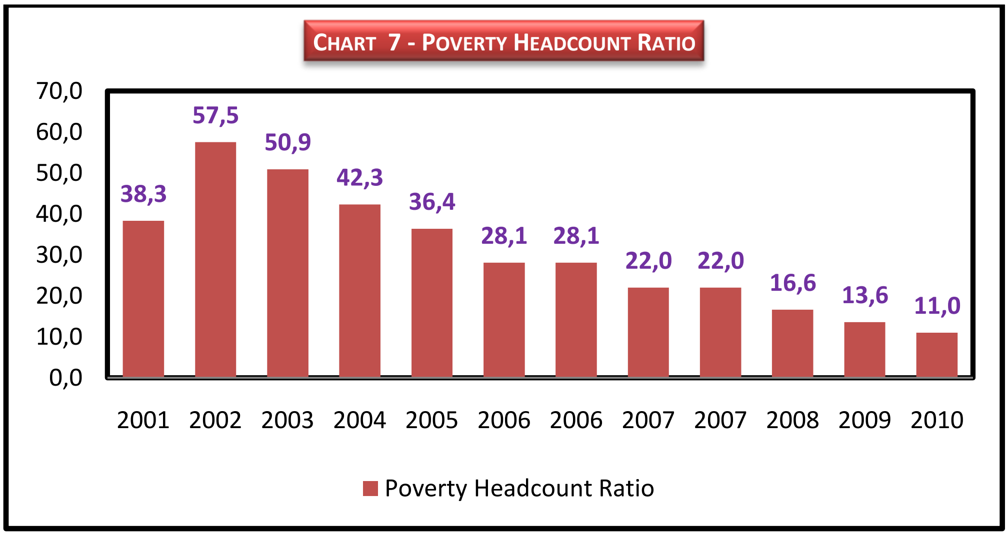
1) Separation between land ownership and companies that uses the land for production purposes. The contractors are the dynamic actors of this kind of model. Parallel a large number of service/inputs providers appears given the new demands that the companies may have, this means that a new web of producers, contractors and service/inputs suppliers is formed.
2) Appearance of companies that coordinate financial capitals, decide which activities to develop and hire land and labor associated to and production.
3) All the transactions are by contract.
4) Incorporation of state of the art technology
5) Separation between the place where the production is taking place and the territorial origin of the people working in the land. Migrations are high within the country during the farming season generating a high volume of people traveling through the country and in this way helping different regional economies due to the increase in consumption

3.1.7 Food security

Argentina does not have a food security problem nationwide in part because of the government intervention since 2009 with a variety of measures to try and grapple with the problem, including the Universal Child Assignment Plan, which seeks to give a monthly sum of around 270 pesos (US$ 63) per child to working families under the poverty line.

But the economy (and the growth of government spending because of the economicrecovery)is the main reason for the reduction of poverty.

In the following chart this situation is better described.



Source: Cedlas

In 2002, in the midst of the worst economic crisis of Argentina’s history 57% of the population was below the poverty line and that number has been decreasing ever since.

3.1.8 Energy sector

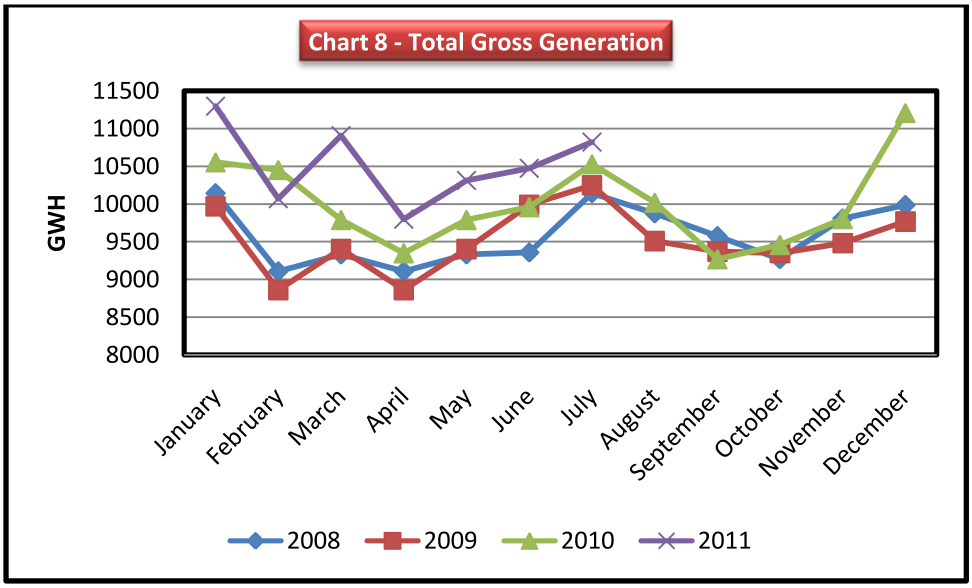
The energy industry in Argentina has been dominated by the natural gas. The reserve production ratio is decreasing, and the country is increasing imports from Bolivia from 2001 until this year. In 2010 10% of all energy consumption was natural gas imported from Bolivia and GNL (by ship). **But new conditions could change the present situation. The increased price of natural gas from Bolivia is introducing a different scenario, in terms of increase the participation of other sources of energy**. This year, total imported natural gas from Bolivia may average 20 million m^3 per day, at an average of 10U$S per million BTU. Total estimated cost of natural gas from Bolivia may reach U$s 2,600million.

Some facts:

- In April 2004, the Argentine government announced reductions on natural gas exports to Chile in order to avoid curtailments on domestic demand.
- The Argentine government restarted permanent importations of natural gas from Bolivia in 2004 as well as occasionally importing electricity from Brazil. In addition, significant quantities of fuel oil and diesel were imported from Venezuela during 2004 in order to ensure full fuel supply for thermal power plants in case natural gas was not available.
- In 2005, half the country's total trade balance was provided by energy exports (U$S 6,400 millions)
- In 2010 were imported 3.1 million cubic meters of diesel oil. This year, the tax relief regime ("importación con cupo") may provide the importation of more than 4.5 million cubic meters of diesel oil.

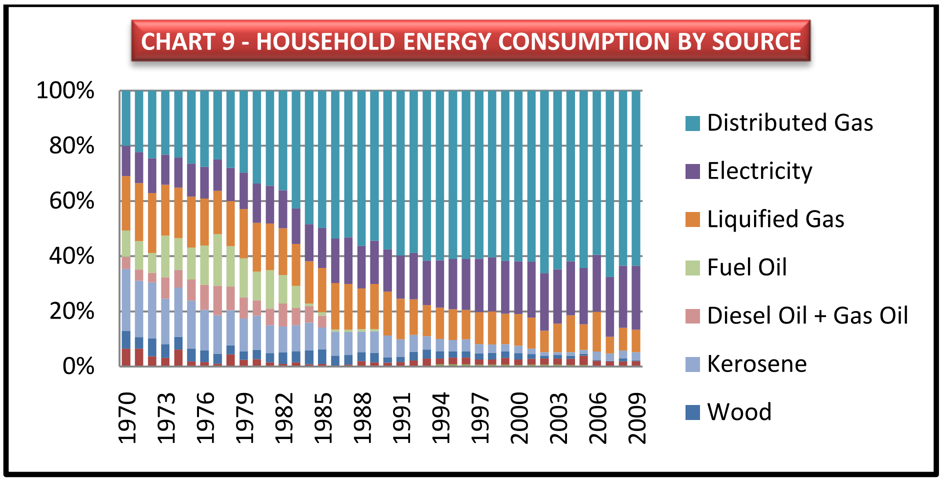
Frozen tariffs and distorted prices blocked most of the investment recovery for those companies existing at the time the crisis of 2001 started. In the particular case of the power market, the measures adopted led to a significant imbalance between what the demand paid and what generators had to receive, which resulted in a significant credit requested from generators.

The energy sector faces today an economic long-run mismatch between what the economy needs from the energy industry and what this industry can offer to the economy under the current “relative prices scenario.” In practice, this meant a lack of investments in all energy subsectors since the end of 2001. Consequently, domestic demand growth was gradually absorbing installed capacity, including those investments originally committed to exportations, because the horizon of hydrocarbons reserves was significantly reduced, particularly on natural gas. The energy trade deficit is projected at U$S 20,000 million by 2025.



Source: Secretary of Energy

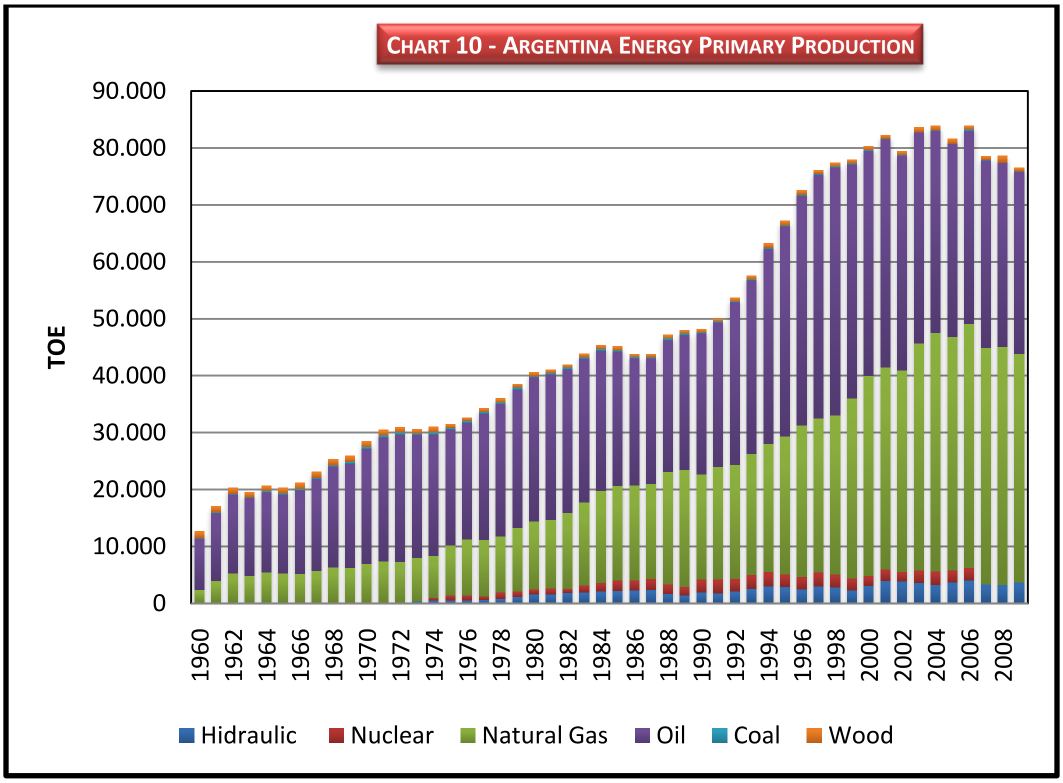
It is also interesting to observe the evolution of household consumption in terms of energy, as we can see distributed gas is by far the most used source of energy



Source: Secretary of Energy

Energy Production

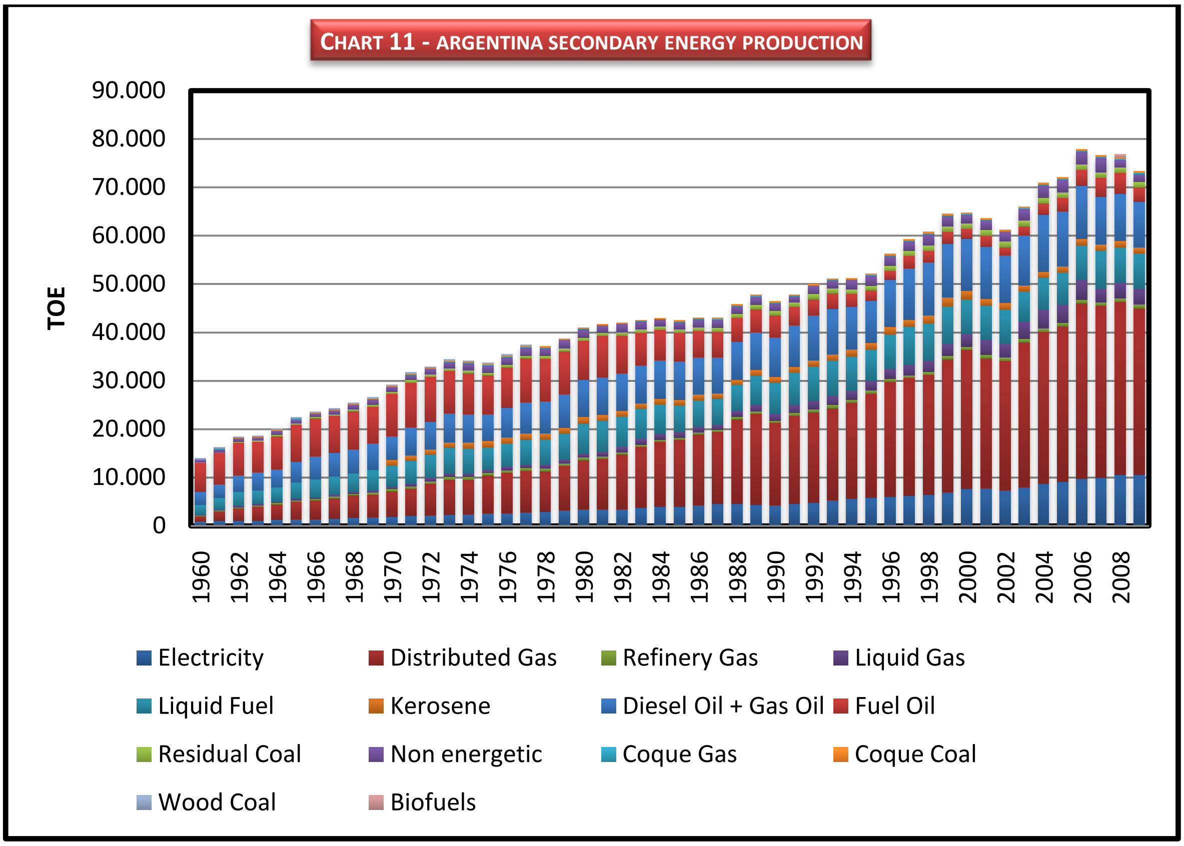
Taking into account primary energy production the information it is easy to understand the necessity of Argentina in terms of exploring new ways of energy production.



Source: Secretary of Energy

The energy matrix relies heavily on oil and natural gas extraction. Argentina's reserves of both minerals has been decreasing heavily and this generated an increase in energy imports.

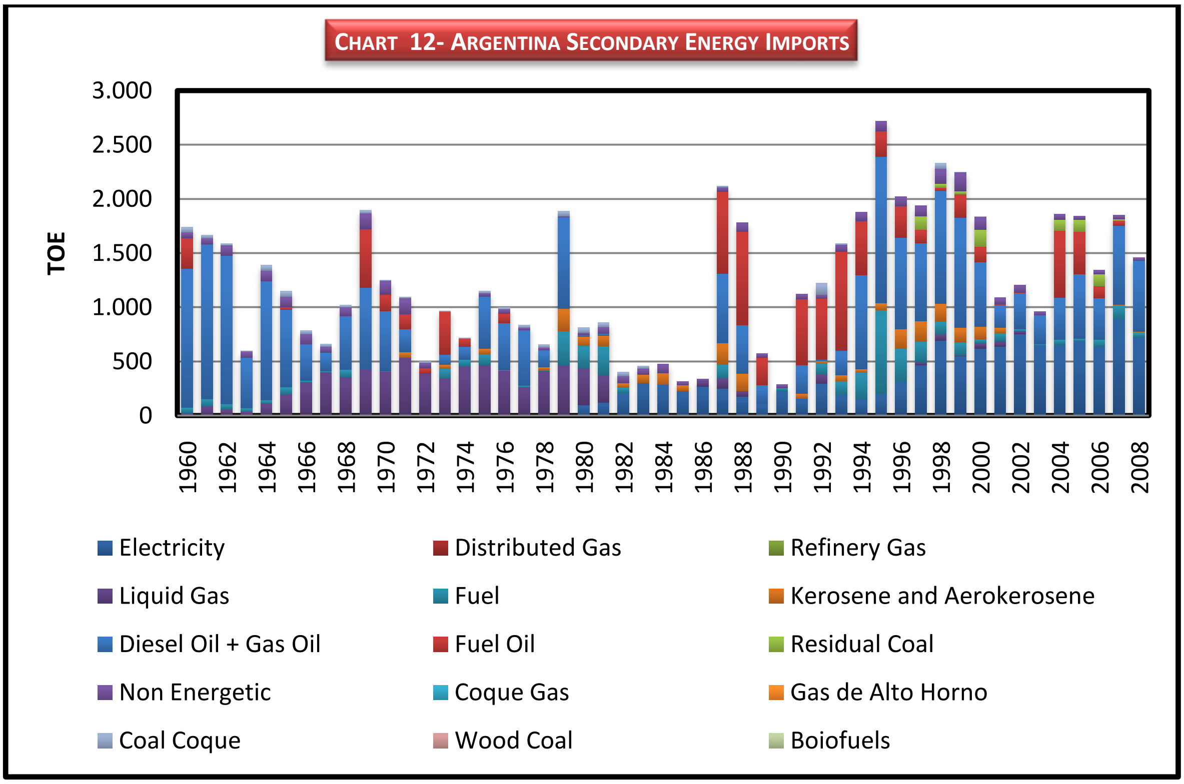
The best way for understanding Argentina energy sector however it's thru the secondary production.



Source: Secretary of Energy

Over the last few years the preponderance of gas has been strong, explaining near 47% of Argentina energy generation.

But once again the production capacity over the last few years could not hold the increasing demands and imports has took place.



Source: Secretary of Energy

GENREN

The Genren is a program designed by the Secretary of Energy of Argentina that seeks the generation of energy from renewable sources.

The tender from the government to generate 1,015 MW from renewable sources such as Eolic, solar, biomass, geotermical, mini-hidroelectrical and biogás has emerged as a new market for soy biodiesel producers all over the country.

The original tender seeked offers for a total of 150 MW generated by thermic equipment working on biodiesel (instead of gasoil or natural gas) and , by doing that, generating renewable energy.

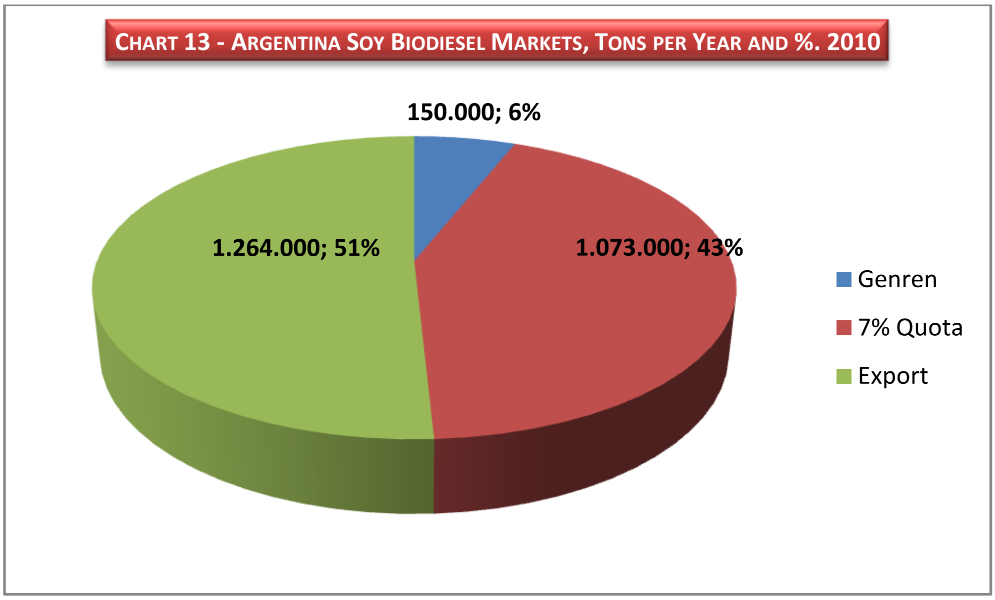
The market offered 7 proposals for a total of 155 MW. From these, the government chose 4 of them by a total of 110 MW of thermic energy from biodiesel.

These 4 projects will require a total estimate of 150,000 tn/year of biodiesel in order to fulfill the 110 MW generated, opening an opportunity to biodiesel producers all over the country and for the two cases that will be analyzed in this research.

This program also helps understanding the outstanding interest for elevating the soy biodiesel installed capacity.

In this point an enormous potential is opened since the installation of this kind of equipment is quick and simple and once connected to the electric distribution the generation is instantly.

This program elevates the number of markets for Argentina soy biodiesel now standing at three:



Source: CADER

3.1.9 Policy framework

Public policies were designed to encourage the development of renewable energy sources. Since the late 1990s, several different resolutions were formulated to support liquid biofuels. In 2001, the Secretary of Energy formulated the 'Competitiveness Plan for Biodiesel', giving tax exemptions for 10 years from the fuel transfer tax on the national level and for revenues and property on the provincial level to biodiesel producers. This policy has shaped the biodiesel market until 2004/2005, together with other legislative efforts trying to promote liquid biofuels.

In 2006, the Argentinean Senate approved a new law on the promotion of biofuels, which seems so far the most overarching promotion mechanism for biofuels in Argentina. The law 26.093/2006 involves a regulatory and promotion regime for the sustainable production and consumption of biofuels). It was finalized in April 2006 and approved by the Argentinean Senate in May 2006. For the design of the law, a National Commission for Biofuels was created. The commission issued a regulatory decree in February 2007.

The most important contents of the law 26.093/2006 and its decree are as follows: the description of the governmental support framework and its production criteria for tax exemptions over 15 years, the criteria to be granted tax exemptions.

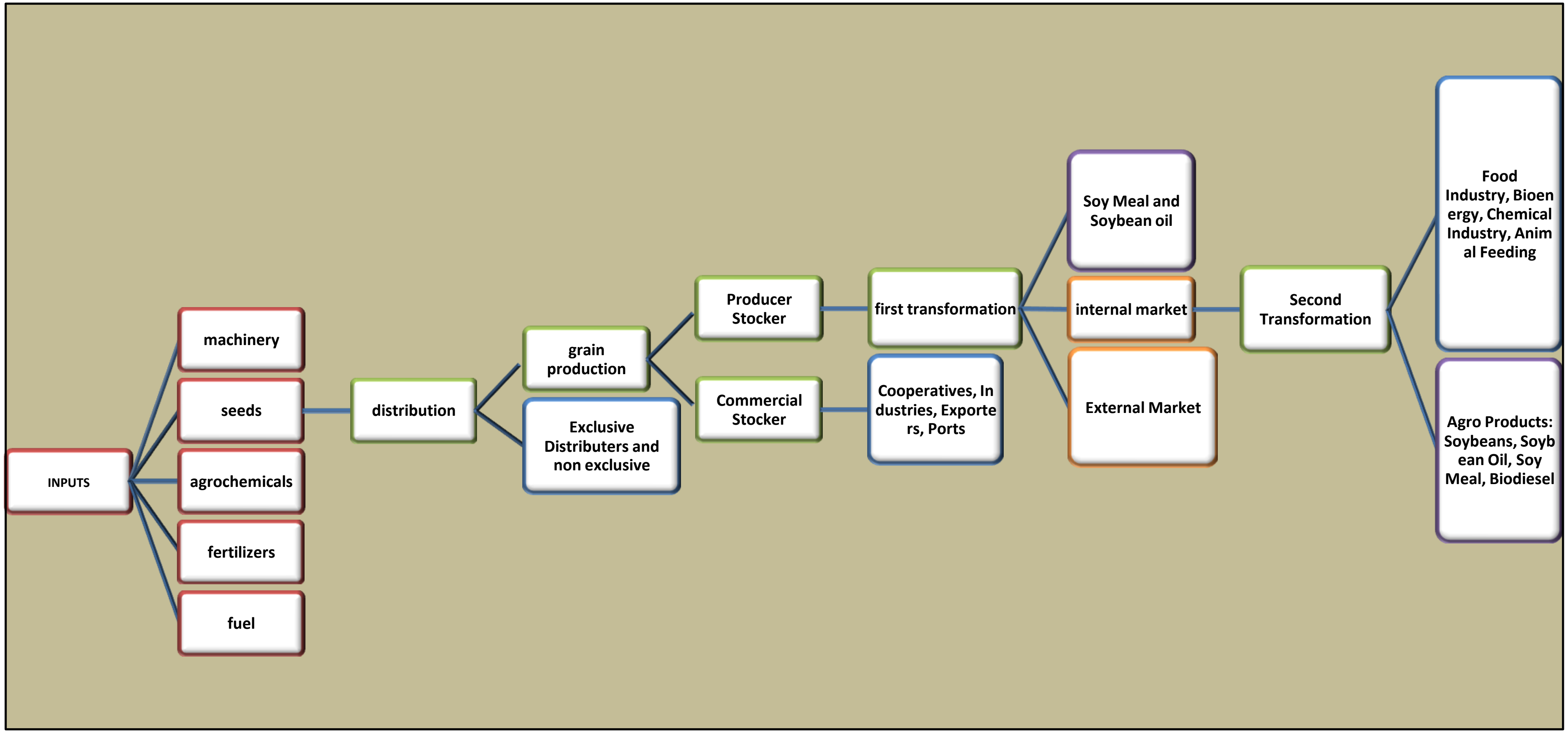
The two most important are as follows: At least 50% of the plant has to be owned either by the state, province or municipality, or any physical and juridical person who is active in the agricultural sector. The detailed requirements for this are set by the national application authority. The facilities have to comply with the quality and efficiency requirements as set by the national application authority. The ranking criteria for recipients of tax exemptions with small and medium sized enterprises (SMEs), agricultural producers and regional economies will be prioritized. The set-up and definition of a national application authority under the Secretary of Energy for biofuels and its functions.The definition of 'biofuels' (biodiesel, bioethanol and biogas) as well as the assignment for the national application authority to define and control their quality requirements (for selling as well as auto consumption).The definition of a (minimum) 5%blending requirement (on volume basis) for petrol with anhydrous bioethanol and diesel with biodiesel from the beginning of 2010. At the same time, the Law 26,190 enacted in December 2006 proposed to achieve a contribution from renewable energy sources to reach 8% of national electricity consumption, within 10 years after the enactment of this scheme.

Willing incentives led the production of local biofuel in 2009 to represent 1.4% of global production (23,700 bpd), while in 2006 their share was just 0.1%, mainly due to the increase in volume produced of biodiesel, that reached 7.5% of global production (in 2006 this ratio was 0.4%).

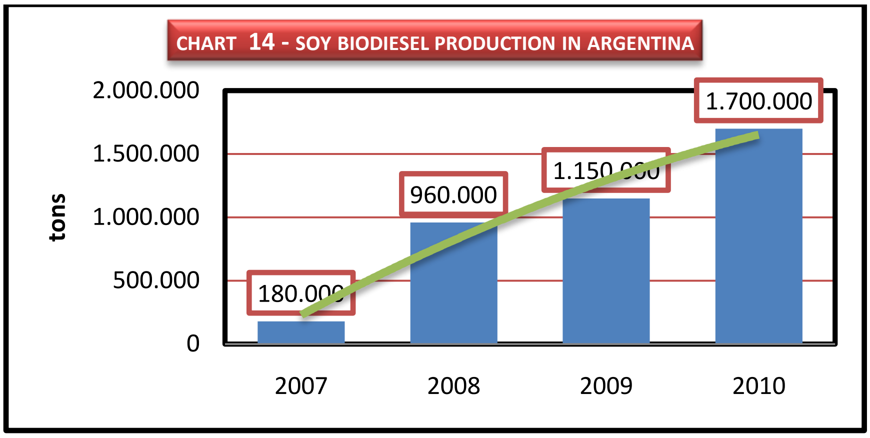
Table **Legal and Regulatory Framework for Biodiesel**

Resolution 129/01:	Defines biodiesel.
Law 26.093/06:	Biofuels law. Biodiesel and ethanol mandates. Participating enterprises. Application Authority.
Decree 109/07:	Regulations for Biofuels Law.
Resolution 266/08:	Registry of universities authorized to perform technical, environmental, and safety audits on biofuels plants.
Resolution 1296/08:	Fire safety requirements for biofuels plants.
Resolution 6/10:	Quality specifications for biodiesel.
Resolution 7/10:	Announces the list of producers that comprise the domestic mandate during calendar 2010, as well as the formula used to determine the wholesale price.
Texts for each of the above legal framework can be found on CADER's website at www.argentinarenovables.org/leyes.php, in Spanish only.	

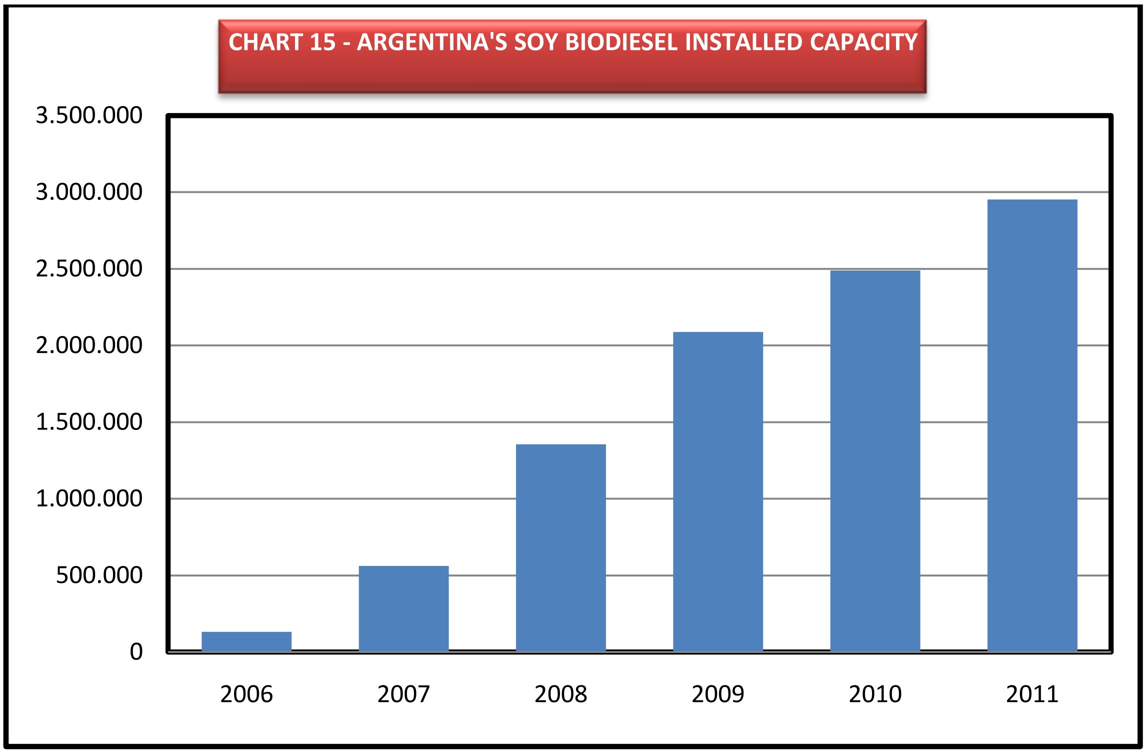
Figure 3: **Flowchart of the supply chain of soy in Argentina**



Since the two cases are from soy biodiesel plants and given that Argentina's potential in soy biodiesel production is growing by the minute it is worth starting the analysis with the production over recent years



Source: CADER



Source: Secretary of Energy

At the end of 2010 Argentina's installed capacity was 24 times the capacity of 2006's and will be even higher in 2011. This could mean that the soy biodiesel sector could become a relevant one in a short term. Argentina currently possesses state of the art soy biodiesel production facilities, in line with top quality standards. Same technologies as in developed countries (USA, Germany, Italy, etc.) are used.

Argentina soy biodiesel industry currently posses

- Short distances between production areas and ports
- State of the art storage capacity in ports, environmental friendly facilities in terms of greenhouse gases emissions.
- Leading crushing industry recognized in the world by its efficiency over other similar facilities worldwide.

- High efficiency levels reaching 97.5% in the trans esterification phase, meaning that from 1,000 kg of soy oil 975 kilograms of soy biodiesel are made.
- Usage of private ports for loading, located inside the soy oil and soy biodiesel facilities, minimizing the need of transportation.
- High participation of hundreds of companies in all the chain of value.

A vital point to be mentioned is that Argentina's soy biodiesel market is nowadays promoted.The growth since 2007 has been motivated by the Soy biodiesel Law enacted in that year. (Law 26.093), creating an especial regime for 15 years an that establishes a 7% cut of soy biodiesel in diesel fuels in order to increment the production incentives. The reasons for the Goverment to stimulate soy biodiesel production are the need of alternative fuel options in order to change the energetic dependence over fosil fuels.

There are several motives in order to promote Argentina's soy biodiesel production, such as:

- Carbone dioxide emission reduction
- Posibility of finding an alternative to the shortage of fosil fuels given the upward tendency of fuel demand.
- Adding value to traditional exports of the soybean complex allowing the evolution of internal economies.
- Labor generation given that even though soy biodiesel facilites does not require to much human labor they generate demand for domestic companies services

Argentina is currently considered as one of the countries more capacitated to participate in the bioenergy international market given its comparative advantage in crop harvesting, land extension and geographic diversity, allowing to project non traditional crops production in order to feed the bioenergy industry.As mentioned before Argentina is leader in soy and sunflower production or within the leaders worldwide. Given its export orientation Argentina is the leading country in soybean oil and sunflower oil exports. For the soybean oil industry, soy biodiesel is a clear evidence of a sinergic effect.Argentina's demand of soy biodiesel is driven mainly by the 7% quota that fuels must have in soy biodiesel. This policy helps explaining the phenomenal growth of the soy biodiesel production in Argentina. In the next table we will be able to see the evolution of the quota.

Table 1 : Argentina Soy Biodiesel quota

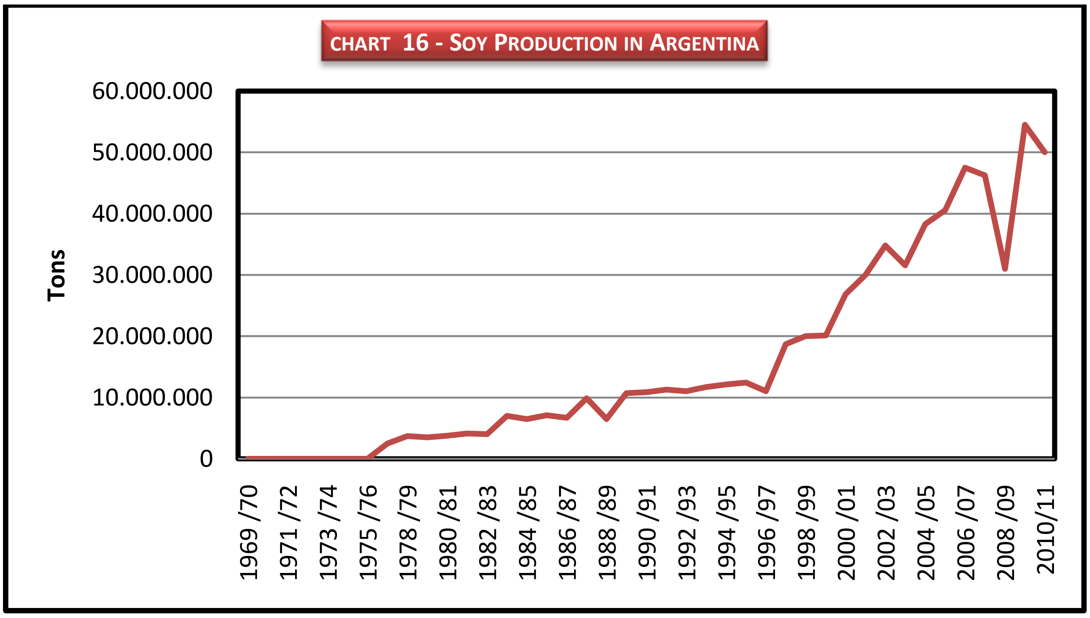
#	Corporation	Capacity	5% Quota	2%	7% Quota
1	Unitec Bio S.A	230,000	113,097	9,440	122,537
2	Viluco S.A	200,000	108,594	8,488	117,082
3	Explora S.A	120,000	89,091	4,784	93,875
4	Diaser S.A	96,000	79,459	3,744	83,203
5	Renova S.A	480,000	33,750	17,266	51,016
6	Oil Fox S.A	50,000	0	50,000	50,000
7	Aripar Cereales S.A	50,000	50,000	0	50,000
8	Patagonia Bioenergia S.A	250,000	33,130	16,111	49,241

9	Vicentin S.A	63,400	23,928	24,913	48,841
10	AOM S.A	48,000	48,000	0	48,000
11	Ecofuel S.A	240,000	29,108	16,320	45,428
12	Biomadero s.a	72,000	44,152	1,125	45,277
13	LDC Argentina S.A	305,000	27,500	16,898	44,398
14	Molinos Rio de la Plata S.A	100,000	27,810	13,407	41,217
15	Maikop S.A	40,000	40,000	0	40,000
16	Rosario Bioenergy S.A	36,000	36,000	0	36,000
17	Diferoil S.A	30,000	30,000	0	30,000
18	Soy Energy S.A	18,000	18,000	0	18,000
19	Pitey S.A	18,000	18,000	0	18,000
20	Hector Bolzan	10,800	0	10,800	10,800
21	Ecopor S.A	10,200	10,200	0	10,200
22	New Fuel S.A	10,000	0	10,000	10,000
23	Era SRL	9,600	0	9,600	9,600
	Total (tons per year)	**2,487,000**	**859,819**	**212,896**	**1,072,715**

The 7% quota is a near perfect proxy of soy biodiesel consumption inside Argentina and that means that the country is consuming more than a million tons per year of soy biodiesel.

Once the quota is pushed up to 10% the amount will also grow.

In terms of soy production the growth since the recovery of 2002 economic crisis is noteworthy

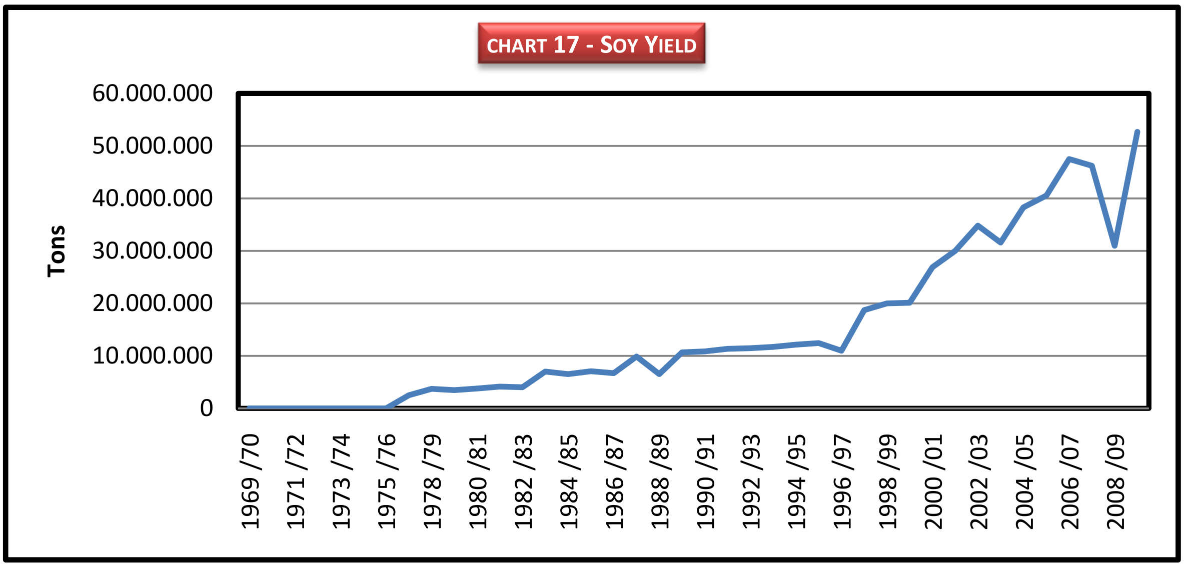


Source: Ministry of Agriculture

From the chart we can conclude that soybean production over the last 25 years experienced an unprecedent growth taking aside minor fluctuations. The fall in production observed in the 07/08 and 08/09 campaigns were associated with the unfavourable climatic conditions and the international economical crisis. Nervertheless the series shows a recovery since the 09/10 campaign, setting a new record in soy production with more than 54 millon tons.

Argentina also had an internal crisis due to the clash between the Government and the farming sector which led to a farm strike. Such clash was origined by the intention of the goverment to raise taxes on exports

In terms of average yield the growth in recent years is also noteworthy.



Source: Ministry of Agriculture

Geographically, the comparative advantages of the so-called core area (comprising the provinces of Buenos Aires, Cordoba, Santa Fe and Entre Rios) covers approximately 30 million hectares. According to official figures from the Ministry of Agriculture, over 85% of soybean production is located in the aforementioned provinces, although the incentives generated by the internacional pricing scheme, the production frontier has been expanding into the north.

However, the above advantages do not exhaust the reasons for the dramatic growth in production. In this sense, should be distinguished a number of progress on the production process to help explain the phenomenon.

The first has to do with the introduction of biotechnology. More precisely, the glyphosate resistance gene was introduced into the local varieties of soybean, significantly improving weed control.

This development was accompanied by a new paradigm of production: no-tilling. This system does not use the plow and is considered the greatest exponent of conservation agriculture. Thus, the improved crop yields from the hand of the better water and better crop response to fertilizers. This system also allowed obtaining two crops in one year, through the production of winter wheat before soybean in the spring and summer, due to increased water use efficiency and maximizing efficiency in times of soybean planting.

At the same time, local industry developed the farm machinery needed to meet the requirements of no tilling, while the adoption of so-called bag silos reduced logistics costs for producers. The improved yields produced the necessary incentives for the development of soybean production.

Additionally, within the productive chain significant organizational innovations were broadly characterized by the figure of contracted agriculture. The analysis focuses on

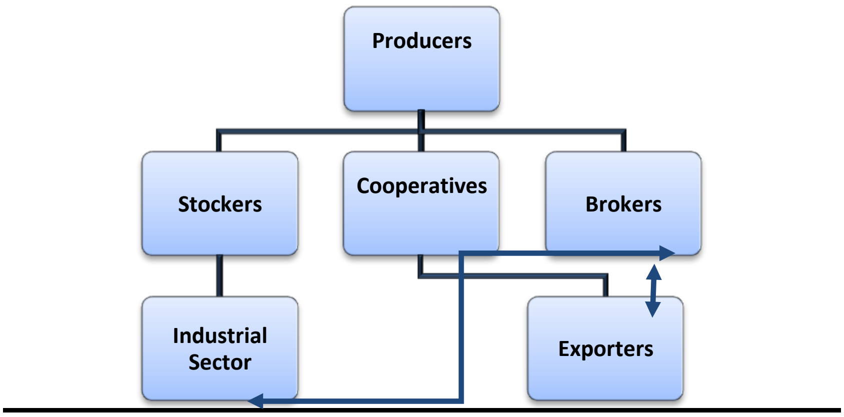
forms of organization of production, we can state that, until recently, the development of agriculture based on Pampean highly integrated production units.
This form of organization contrasts sharply with a new model that has been preeminent a few decades ago.. Over the past two decades, the primary production model, was articulated in terms of a clear separation between stages-primary production, marketing, services-, and high vertical integration within each stage-producing developing many activities "gates inside "with a high coefficient capital/output-. In this sense, producers and providers of services created and strengthened partnerships with increasing participation by third parties. Thus, the contracts became more complex and the relationships between different actors took on greater depth. These new forms of organization of production resulted in lower transaction costs and strengthen relationships of trust between agents. Furthermore, this phenomenon encouraged the adoption of new technologies, thanks to economies of scale of the growing inter-relationship between the actors, and the expansion of the production frontier (for more information see Bisang 2008 and 2009).

Actors of the supply chain of the soy chain in Argentina

Following a research made by the “Bolsa de Comercio de Rosario” The Agriculture products commercialization is quite different than other goods commercialization, such as industrial ones, in several points that determine the further organization of the complex as a whole:

1. Production is spread in thousands of producers
2. Most part of agricultural products are harvested and put in the market in the short term (seasonality). This means that given a steady demand the price of these products tend to decrease during the harvest period and to increase once the stock became depleted.
3. For ecological and profitability reasons agriculture production is concentrated in a region basis
4. Small number of internal demanders (exporters and processors). The participation of cereal brokers enables the concentration of the disperse stocks.
5. Obviously climatic factors bears in the final production and therefore in the final prices.
6. With difference to most of the oil crop complex in the world as rape seed -, the Argentina oil complex pays taxes when it export its products and in several cases also import rates in the destiny markets.
7. Local prices of all intermediate products are freely defines by the difference forces acting in it.
8. The fact that most of the production is export oriented means that internal prices are highly influenced by international prices.

Scheme: Actors in Agro-Products commercialization



In the above scheme we can observe a summarized interaction between the different actors in the agricultural production. It does not have to be taken literally but for an informational approach it is a good reflection of how the Argentinean agro sector is structured.

The brokers are an important link in this whole system given that they can interact in the whole chain of commercialization. In the last couple of years the broker's activity has been growing considerably, selling products powered by the producers.

Its retribution consists of a variable commission. They also bring transparency to the whole operation given that they are grouped in a Stock exchange such as Rosario's.

3.2 Case Study at the local level: First Case Study Biodiesel Plant, Roldán, Province of Santa Fe, Argentina

3.2.1 Location of the Case Study

The First Case Study Biodiesel Plant (anonymous) is located in San Lorenzo in the heart of Santa Fe province and in the soy core area of Argentina.

Table 2 : Santa Fe Population

Department	Population		Absolut Variation	Relative Variaton (%)
	2001	2010		
Total	**3.000.701**	**3.194.537**	**193.836**	**6,5**
Belgrano	41.449	44.788	3.339	8,1
Caseros	79.096	82.100	3.004	3,8
Castellanos	162.165	178.092	15.927	9,8
Constitución	83.045	86.910	3.865	4,7
Garay	19.913	20.890	977	4,9
General López	182.113	191.024	8.911	4,9
General Obligado	166.436	176.410	9.974	6,0
Iriondo	65.486	66.675	1.189	1,8
La Capital	489.505	525.093	35.588	7,3
Las Colonias	95.202	104.946	9.744	10,2
9 de Julio	28.273	29.832	1.559	5,5
Rosario	1.121.441	1.193.605	72.164	6,4
San Cristóbal	64.935	68.878	3.943	6,1
San Javier	29.912	30.959	1.047	3,5
San Jerónimo	77.253	80.840	3.587	4,6
San Justo	40.379	40.904	525	1,3
San Lorenzo	**142.097**	**157.255**	**15.158**	**10,7**
San Martín	60.698	63.842	3.144	5,2
Vera	51.303	51.494	191	0,4

Source: INDEC

Analysing the data provided by the last two population census we can observe that the average growth of San Lorenzo department, where our case study is located, is by far the largest of the whole province.

This is explained in part by the diversification of the soy chain and the location in this department.

Our case study obviously does not explain this growth over the last 10 years but it does explain why the company chose to invest in the area.

The proximity to the port area and feedstock also helps explaining it but the amount of labour that can be found in San Lorenzo cannot be underestimated.

3.2.2 Description of project/company

The First Case Study Biodiesel Plant is dedicated to biodiesel production and commercialization with one the biggest and more advanced plants in the world.

The company exports 75% of its production to the most demanding markets of the world. The biodiesel produced by the First Case Study Biodiesel Plant possesses the highest international quality moreover throughout the production process they operate in an environmentally responsible way. Since 2010, the company also supplies the domestic market contributing to the diversification of the country's energy grid and improvement of the sustainability of its fuels. The plant receives near 900 tons of soybean oil per day producing in the same span 724 tons of soy biodiesel.

3.2.3 Flowchart of the supply chain

The First Case Study Biodiesel Plant uses Desmet Ballestra technology helping reach 250.000 tons per year of soy biodiesel production.

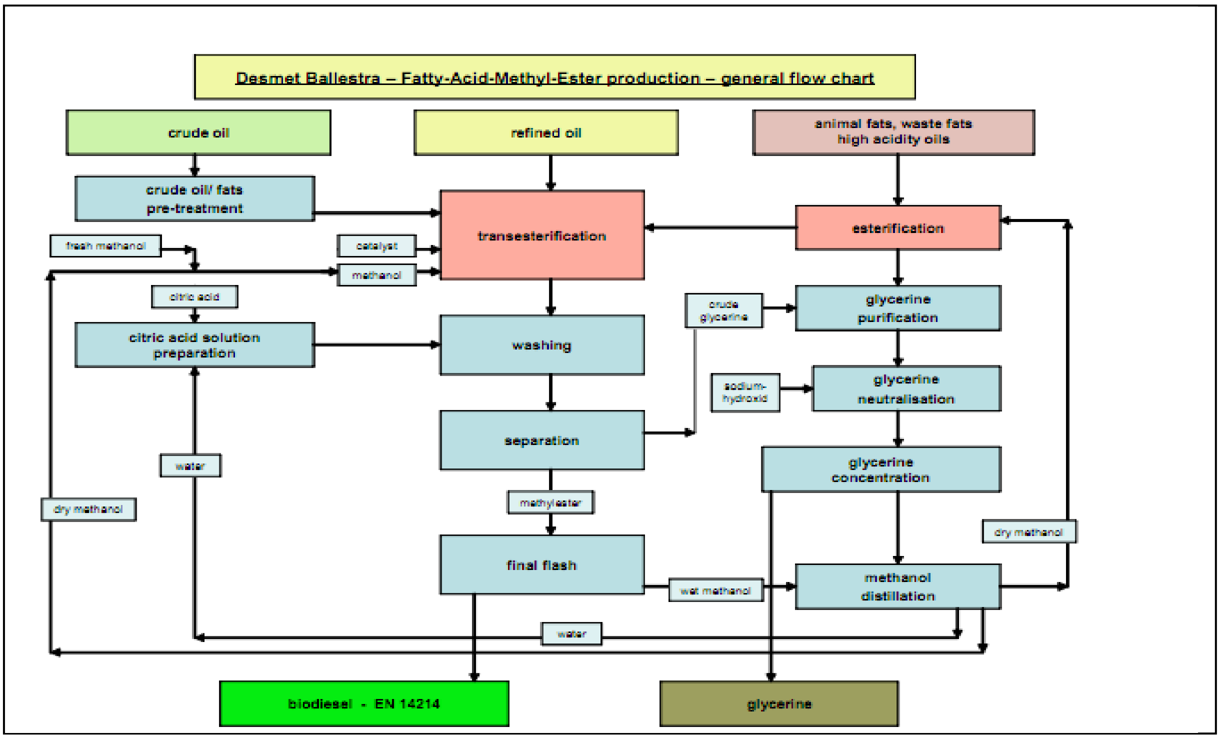


Figure 4: **Flowchart of the supply chain of soy biodiesel in Argentina of the First Case Study Biodiesel Plant**

Production process begins with a physical refinery process, for the removal of impurities e.g. proteins, gums, free fatty acids, oxidation compounds, and colour bodies and neutralizing the free fatty acids, reducing phosphorus contents and acidity. Acids (chloridric or phosphoric typically) are used to degum the base oil and remove any high free-fatty acids. The amount of acids needed is dependent on the incoming base oil; however, only a small amount (compared to alcohol and the catalyst) is used in the biodiesel process. Typically, the amount is less than 0.5% of the total biodiesel volume produced. The next operation is centrifugation for de-gumming for separation of gums and impurities. Next step is bleaching with silica adsorbents for removal of residual soaps after neutralization (”Trysil”). Neutralized oil is then mixed with methanol and sodium methylate (also called sodium methoxide) in trans esterification reactors.

The crude glycerineby-product is about 12 % of the biodiesel produced. The crude glycerineruns through the glycerine column to recover the un-reacted methanol. The methanol in the biodiesel is recovered and sent to the methanol column for clean-up prior to recycling back to the reactor. The produced glycerol was 85 % purity according to the HPLC analysis and could be used in industrial uses or exposed to further purification for pharmaceutical uses. Free fatty acids of 2 % of the oil weight are obtained, as well as sodium phosphate salts.

The biodiesel is washed with water at low pressure and in the next step water and solids are removed by the centrifuge, going from there to the dryer at low pressure and finally is piped to the storage tanks.

Some of the most important chemical and physical quality control parameters of the produced biodiesel are measured and compared with the petroleum diesel parameters. These parameters such as viscosity, flash point, pour point, cloud point, carbon residue, acid value and calorific value are continuously tested at the quality control laboratory, checking if them have acceptable values and are in agreement with the petroleum diesel parameters. The quality control laboratory was worth a six hundred thousand dollar at one of the visited plants of 250.000 tn/year of Bio (with a projected production doubled as per 2012) and a figure of five hundred thousand dollar was given as the value at another plant of 420.000 tn/year of Bio.

Water recovered during drying of the esters and glycerol fractions is recycled in part, going to activated sludge biological treatment plant at the facility. The wastewater characterization from biodiesel process is tested using techniques such as Chemical Oxygen Demand (COD), Total Organic Carbon (TOC) and gas chromatography for the measurement of methanol. At one this plant, this waste stream was about 1560 m^3 per month, and the treated wastewater COD was about between 25 to 50.

Crude, degummed soybean oil was specified as the feedstock. Annual production capacity of the plants in this report was more of two hundred thousand metric tons. Facility construction costs were estimated at 45 million dollars for a typical plant of 240000 t bio/yea. At a value of 464,850 U$S/kg for feedstock soybean oil, a biodiesel production cost of 546,313 U$S/t was calculated. The single greatest contributor to this value was the cost of the oil feedstock, which accounted for 85% of total estimated production costs. Process economics included the recovery of co-product glycerol generated during biodiesel production, and its sale into the commercial glycerol market as an 80% w/w aqueous solution, revealed that it don´t has impact at the calculated cost.

There is no relation with specific farm or way of production a general description of the most used system is included:

No Till (NT) has spread throughout different regions which used to be considered not suitable for agriculture due to their climate and soil conditions. The adoption of this technology has allowed for the expansion of agriculture to marginal areas in terms of rain or soil fertility. The economic and social development combined with the environmental advantages and the recognition of No Till as a sustainable production system guarantee the expansion of NT into areas where its adoption is still low. In Argentina, the rapid expansion of the surface area under No Till –from 9 million hectares in 1999 to 25 million hectares in 2009- shows the increasing interest in technology applied to agriculture.

No till is a production system based on the absence of tillage and the presence of a permanent soil cover (crops or crop residues). Based on a collection of Good Agricultural Practices, this system allows producing without degrading the soil, while improving its physical, chemical and biological conditions. Also, it allows using soil water more efficiently – a natural resource that is commonly a limiting factor in dry land crops production.

3.3 Case Study at the local level: Viluco, Frias, Santiago del Estero Province, Argentina

3.3.1 Location of the Case Study

Viluco plant is located in the southwest of Santiago del Estero Province, it is the third aglomerate of the province and is near the border of Catamarca. It is the most important city of the Choya Department inside the Province.

This zone does not belong to the soy core area meaning that this plant is within the boundaries of the so called agricultural frontier expansion.

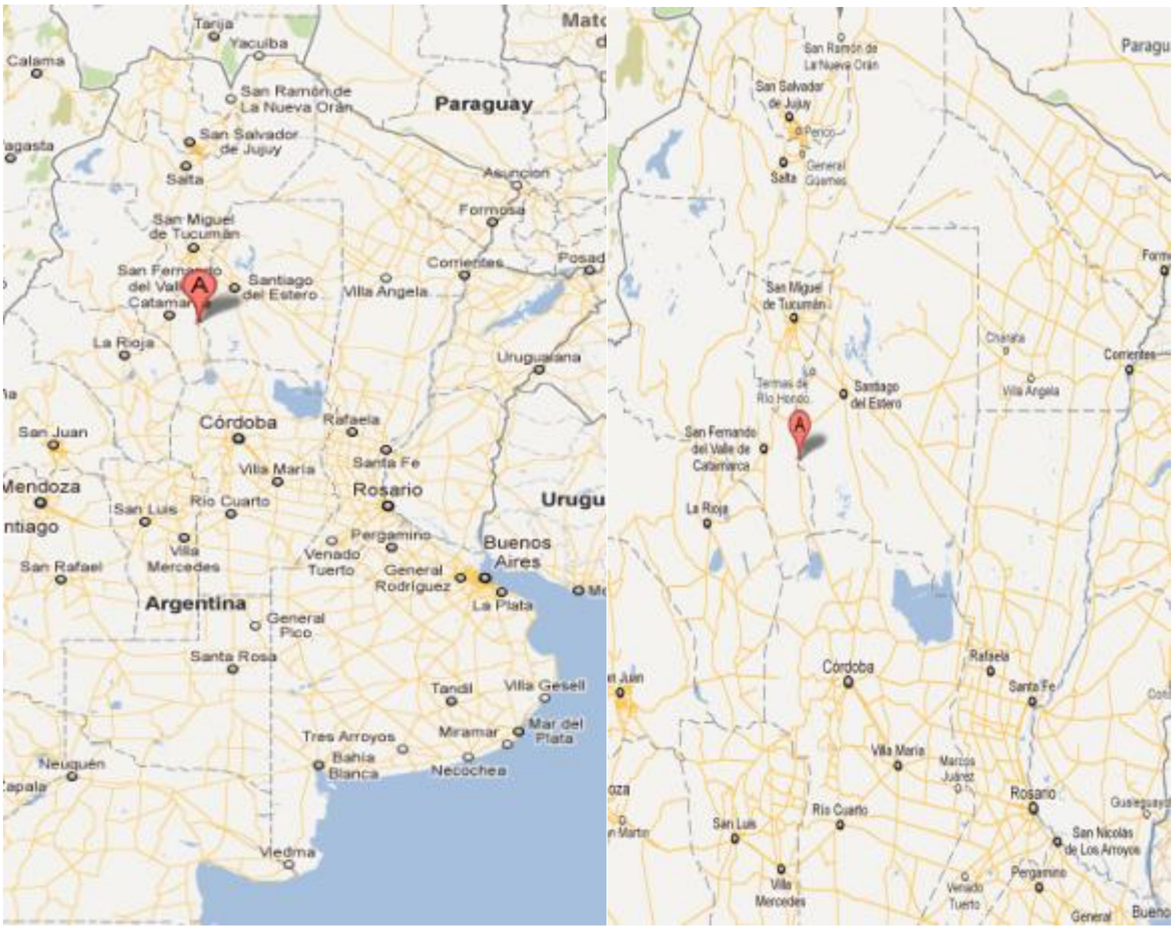


Table 3 : Santiago del Estero Population

Deparment	Population 2001	Population 2010	Absolute Variation	Relative Variation
Total	**804.457**	**874.006**	**69.549**	**8,6**
Aguirre	7.035	7.610	575	8,2
Alberdi	15.617	17.252	1.635	10,5
Atamisqui	9.809	10.923	1.114	11,4
Avellaneda	19.348	20.763	1.415	7,3
Banda	128.387	142.279	13.892	10,8
Belgrano	7.950	9.243	1.293	16,3
Capital	244.567	267.125	22.558	9,2
Choya	**33.720**	**34.667**	**947**	**2,8**
Copo	26.984	31.404	4.420	**16,4**
Figueroa	17.495	17.820	325	1,9
General Taboada	36.683	38.105	1.422	3,9
Guasayán	7.404	7.602	198	2,7
Jiménez	13.170	14.352	1.182	9,0
Juan F. Ibarra	16.937	18.051	1.114	6,6
Loreto	17.442	20.036	2.594	14,9
Mitre	1.813	1.890	77	4,2
Moreno	28.053	32.130	4.077	14,5
Ojo de Agua	13.352	14.008	656	4,9
Pellegrini	19.517	20.514	997	5,1
Quebrachos	11.331	10.568	-763	-6,7
Río Hondo	50.781	54.867	4.086	8,0
Rivadavia	4.916	5.015	99	2,0
Robles	40.060	44.415	4.355	10,9
Salavina	10.664	11.217	553	5,2
San Martín	9.148	9.831	683	7,5
Sarmiento	4.669	4.607	-62	-1,3
Silípica	7.605	7.712	107	1,4

Source: INDEC

In this case when we look to the local population of the department where the plant is located we cannot conclude the same as in the case before. But this is not unexpected given that the plant is located in a no core soy zone and it's relatively new in the area. In the future we will be able to conclude if a migration to the Choya zone took place since the opening of the Viluco plant.

3.3.2 Description of project/company

It started in 1973 as a construction corporation and during 37 years it contributed to the growth and modernization of Tucuman Province working on houses and building constructions with private and public capital.

In 1995 the diversification into the agricultural sector began with strong presence in Santiago del Estero, Salta, Tucumán, Jujuy and Catamarca.

The corporation got to administrate more than 15.000 bovine heads and to produce 108.000 annual tons of soy and more than 70.000 tons of maize.

In 2010 the construction branch was shut down and now is working under COVIL S.A.

The industrial complex AG Energy Plant is located in Frias, Santiago del Estero and has 4 process plant and one movement plant (reception, inputs/products dispatch and stocking).

The process begins with the reception of the soybean grains (from the feedstock production owned by the company or by third parties which arrives to the plant either by truck or rail.

The grains are unloaded thru unloading platforms and are taken into precleaning where the soybean grains are separated from the dust of the field work.

Once cleaned the grains are stocked in different locations (concrete silo or bags).

From the silos the grains are transported to the process plant where the industrial process begins. The first plant is the PREPARATION plant; the objective is to separate the husk from the grain and to laminate the latter into grain laminates.

As a sub product the “husk pellets” are obtained and are loaded into trucks for sale.

The soybean laminates are taken into a second process plant called EXTRACTION where they are covered with hexane in order to extract the oil laminate.

This is when the soymeal is separated from the soybean oil. In this plant the soymeal is obtained as a sub product. The soymeal is transported into the soy cell where is stocked for later dispatch either by truck or train.

The oil extracted is pumped into the next plant, PRETREATMENT. This is where the oil is treated in order to get refined oil. For that purpose the oil is treated witch phosphoric acid and caustic soda with water. As a sub product the flock is obtained and stocked in tanks for the later unloading into trucks for sale.

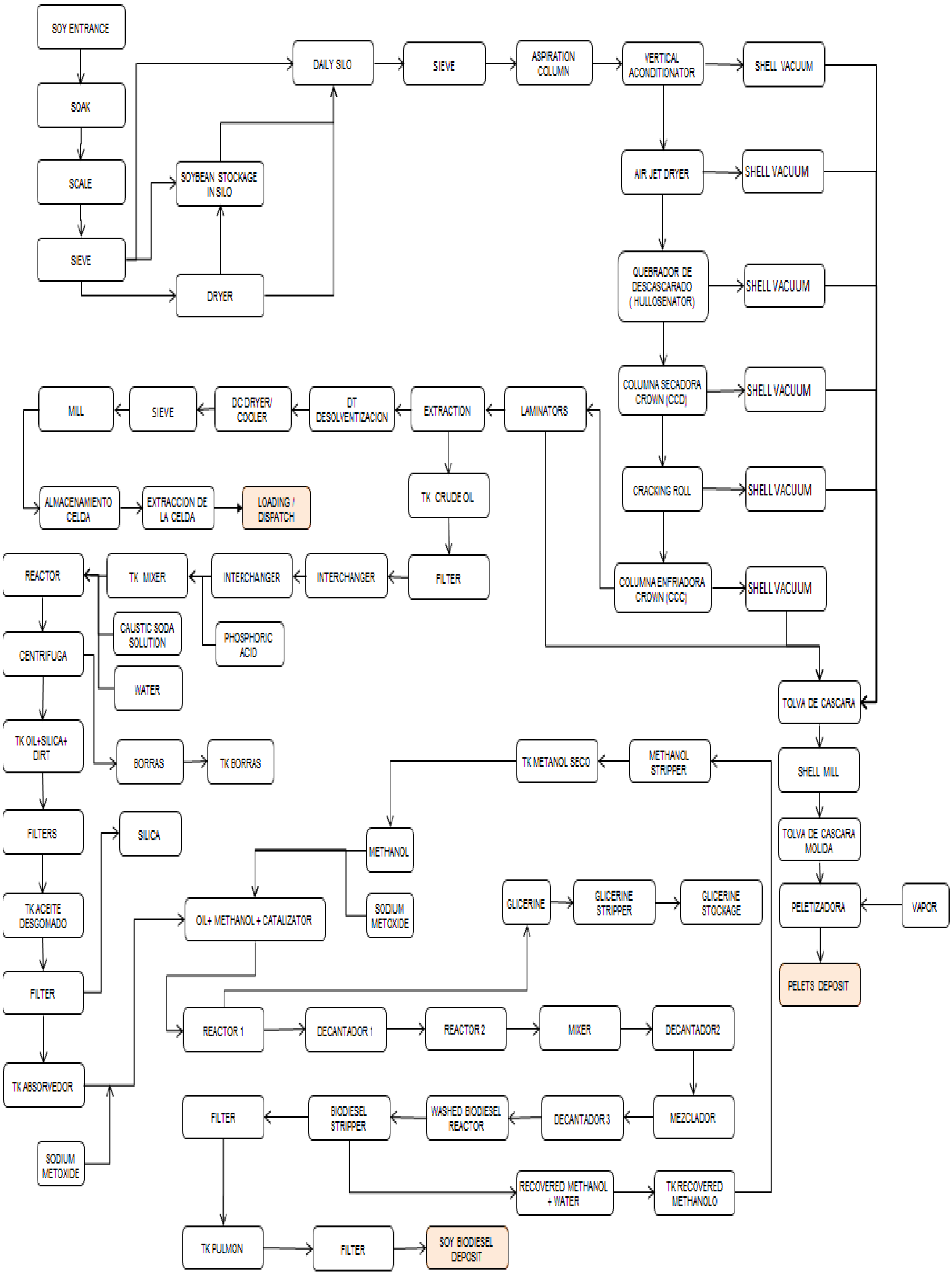
The refined oil is pumped into the last plant called TRANSESTERIFICATION where, thru methanol and sodium metoxide, the refined oil is turned into soy biodiesel and glycerin.

Both are stocked in tanks for the later unloading into trucks and its sale.

All the products are produced according to international quality standards and passed thru strict quality controls performed in the plants laboratories.

The plants worked with natural gas and electric energy. The gas is utilized mainly to create vapor and the electric energy is used for using the machinery.

3.3.3 Flowchart



3.3.4 Santa Fe and Santiago del Estero by numbers

As a sum-up it is worth having a look to the main variables regarding the two provinces where the selected cases are located.

It is important to understand that Santa Fe is the third province in importance of the whole country and that Santiago del Estero is in one of the most marginated regions of Argentina. This makes the AG Energy plant a very important piece for the economic recovery of the region as a whole given that it provides production and work for an important part of the location

Table 4: Santiago del Estero and Santa Fe Statistics

	Santiago del Estero	Santa Fe	
GGP (gros geographical product - 2009)	791.204	15.150.037	Euros
Annual Growth (2009)	9,9	7,7	Percent
Poblation (2001 Census)	804.457	3.000.701	
Poblation (2010 Census)	874.006	3.194.537	

	Santiago del Estero		Santa Fe	
Main Crops (2009-2010)	Implanted (has)	Production (tn)	Implanted (has)	Production (tn)
Soy	808.400	2.949.636	3.074.975	10.432.721
Maize	133.140	625.970	412.250	4.006.170
Wheat	137.890	220.620	438.780	1.761.890

Source: INDEC

The differences between both provinces are important taking into account every variable presented in both tables.

The difference between the annual growths in 2009 has been discussed. The main reason for the difference is that Santa Fe's economy is more developed than Santiago's and this has an impact in the growth rate.

4. Socio-economic impacts of the soy chain

3.4 Economics

3.4.1 Macroeconomics in the soy chain in Argentina

Argentina's economy accounts for 0.85% of global GDP, with per capita income estimated at U.S. $ 15,800 (at purchasing power parity) by 2010, reaching the place 52 on a total of 178 countries surveyed by the International Monetary Fund, covering the world scene in a place in medium-developed economies. At the regional level, meanwhile, is the third economy of Latin America, behind Brazil and Mexico. In the past eight years, it started one of the most important growth processes of its history, tracking an average advance of 7.6% per year, currently standing at 49% above the previous peak of activity in 1998.

In terms of production structure, the agricultural sector represents 10% of GDP, industry 20.7% and services 60%, measured at current prices. Other important sectors are construction and mining, that represents 5.7% and 3.6% respectively.

During the last twenty years Argentina's economy performed a series of reforms that allowed it to modernize its production equipment. The agricultural sector did not remain outside this process, and according to his story constitute a pillar of economic growth in the last decade. More precisely, the production of major crops (wheat, corn, soybean and sunflower) increased 167% during the period 1990-2010, with a strong export bias, while agricultural production accounts for 45% of the Argentina's export matrix. In this way, Argentina's economy managed to successfully capitalize the signals sent by international markets during this period, following the dramatic rise in the price of commodities of 56% above the average of the 90's. From the foregoing and in order to dissociate the domestic price level of the current international sector exports are subject to an effective tax rate higher than 20%.

In its effort to control prices, the government has intervened heavily also on beef exports, which are currently limited to about 70% of year-earlier levels. Despite this, local prices have continued to surge due to increasing international and domestic demand amid tight supply.

There is now widespread evidence of a sharp decline in cattle-raising as farmers - squeezed by rising prices of diesel, land and labor - turn to more profitable products, such as soy, corn and other cereals. Farmers are going more and more for the product that gives them the most security, which is soy.

This trend will threaten Argentina's position as the world's third-largest beef exporter after Brazil and Australia.

3.4.1.1 Agricultural price prior to the reforms of the mid-1980s/early 1990s

Until approximately the mid-1980s, agricultural price interventions were largely a byproduct of a development strategy claiming the best way to grow was by adopting a protectionist policy that encouraged import-substituting industrialization. That policy also raised budgetary resources in the form of import tax revenue, which were supplemented in Argentina by agricultural export taxes. Both sets of policies harmed the region's most competitive farmers.

Between the1950s and the 1980s there were concerns about high rates of inflation, especially where the urban populations had a strong political influence. Policy makers were under pressure to avoid large increases in food prices, which would potentially impact wage rates and thereby (according to the prevailing theory) accelerate inflation through the so called “cost push” effect.

In addition to fiscal and inflation objectives that made farm export taxes attractive, there was a widespread belief in the 1950s and 1960s by policy makers and followers of the “structuralist school” associated with Prebisch (1950, 1959, 1964) that efficiency losses from extracting rents from agriculture were low, and that their main impact would be to reduce land rents and values.

Argentina is a prime example of where the view persisted that farmers in Latin America were unresponsive to price incentives. While the belief of farmer unresponsiveness to incentive has largely disappeared now, a few countries –Argentina is one – still tax agricultural exports for fiscal revenues and to lower consumer food prices.

An empirical study of agricultural pricing policies led by Krueger, Schiff and Valdes (1991) included five Latin American countries for the period 1960-1984. Its main findings are fourfold. First, over the period examined and farm products selected, direct interventions affecting imports were positive on average while those on exports were negative. Second, aggregating over all selected products, the net effect was negative, indicating that the direct tax on exportable dominated protection on importable. Third, the rate of indirect taxation on agriculture (due to industrial protection policy and overvaluation of the real exchange rate) was large, and dominated the rate of direct taxation. Fourth, direct price policies stabilized agricultural prices relative to world prices while indirect policies contributed little if anything to food price stability.

The study found direct protection to agricultural importable averaged 13 percent, and for exportable amounted to 6 percent. The indirect taxation rate in the region averaged 21 percent, so the total taxation rate (direct and indirect) averaged 28 percent. The highest direct taxation was found in Argentina. As a percent of agricultural GDP, net income transfers out of agriculture (direct and indirect) reached 84 percent in Argentina, 56 percent in Chile, 43 percent in the Dominican Republic and 42 percent in Colombia.

3.4.1.2 Economic reforms from the mid-1980s/early 1990s

By the1980s there was disillusionment with the results of the import substitution strategy, and wider acceptance of theoretical developments regarding the causes of inflation and macroeconomic instability in general. A macroeconomic framework designed for open economies gradually displaced during the 1980s and early 1990s the closed economy approach in most Latin American countries. Governments introduced economy-wide reforms with special emphasis on macroeconomic stabilization, deregulation, unilateral trade liberalization and privatization. The goal of the reformers was to create a better climate for productivity and private investment in all economic sectors, including agriculture.

In most Latin American countries the major change in trade policy was the partial or total removal of most quantitative restrictions on imports and exports, the elimination of export taxes, and a program of gradual reduction in the levels of import tariffs. This yielded incentives to move resources from import-competing to export-oriented sectors, including in agriculture, which enhanced competitiveness and led to greater integration with the world economy.

By the mid-1990s the exchange rate was recognized as the most important “price” affecting the agricultural economy. At the outset of the reforms, it was expected that trade liberalization and the reduction of the fiscal deficit would lead to a depreciation of the real exchange rate (Krueger, Schiff and Valdés 1988). Yet the reforms were followed by a significant appreciation of the currency associated with the opening of the capital account, greater inward foreign investment, and a major increase in domestic real interest rates.

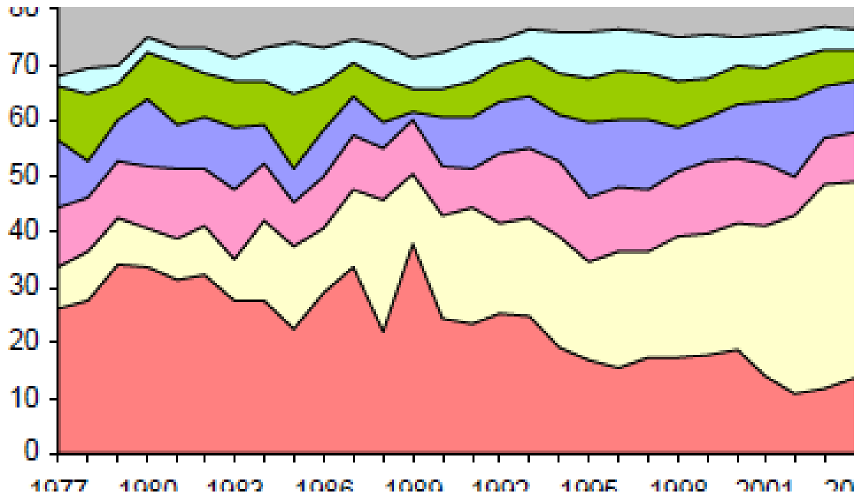
Reforms in the service sector also played a critical role. Deregulation and privatization had a major impact on the availability in the marketplace of more-reliable and lower-cost services used in agriculture such as ports, airlines and shipping transport. The timing of reforms differed somewhat across countries.

Argentina has simpler interventions: those agricultural exportablethat are also wage goods have been subjected to export taxes, complemented in some years with export bans.

Sources 2.1.1 y 2.1.2: Anderson, Kym (University of Adelaide) and Valdés, Alberto (Pontifical Catholic University of Chile), “Distortions to Agricultural Incentives in Latin America”, Agricultural Distortions Working Paper 60, December 2007. This is a product of a research project on Distortions to Agricultural Incentives, under the leadership of Kym Anderson of the World Bank’s Development Research Group. It appears as Ch. 1 in Anderson, K. and A. Valdés (eds.) Distortions to Agricultural Incentives in Latin America, Washington DC: World Bank, forthcoming September 2008.

The six main primary outputs of Argentine agriculture in 2005, in order of importance, were soybean, cattle-raising, raw milk, corn, wheat, and sunflower. In 2007 prices they represented 73 percent of total value of agriculture production, and their shares over the past 30 years are shown in Chart 1:.

Industry shares of gross values of farm production at distorted prices, covered products, Argentina, 1977 to 2005



Source: Sturzenegger, Adolfo C., Salazni, Mariana, “Distortions to Agricultural Incentives in Argentina”, Agricultural Distortions Working Paper 11, December 2007, World Bank

In the mid-1980s the World Bank conducted a multi-volume study — The Political Economy of Agricultural Pricing Policy —under the direction of Anne Krueger, Maurice Schiff and Alberto Valdes. The study included 18 country cases, one of which was Argentina. The KSV study for Latin America was the first of three regional volumes to emerge (Krueger, Schiff and Valdes 1991).

The main purpose of the Argentina chapter and the more-detailed background report (Sturzenegger 1990, 1991) was to measure agricultural distortions in Argentina for the period 1960-85, and to find a political economy explanation for the existence of such distortions. The products selected, all exportable, were wheat, corn, sorghum, soybean, sunflower and beef. The first five were classified as primary products and beef was classified as a lightly processed product. In the case of soybean and sunflower, the period covered was 1976-85 because of the non-availability of reliable data before 1976. Both direct and indirect intervention in agriculture was measured. Nominal direct protection rates (NPRD) were measured at the farm level by comparing prices with intervention (observed prices) and without intervention (opportunity prices).

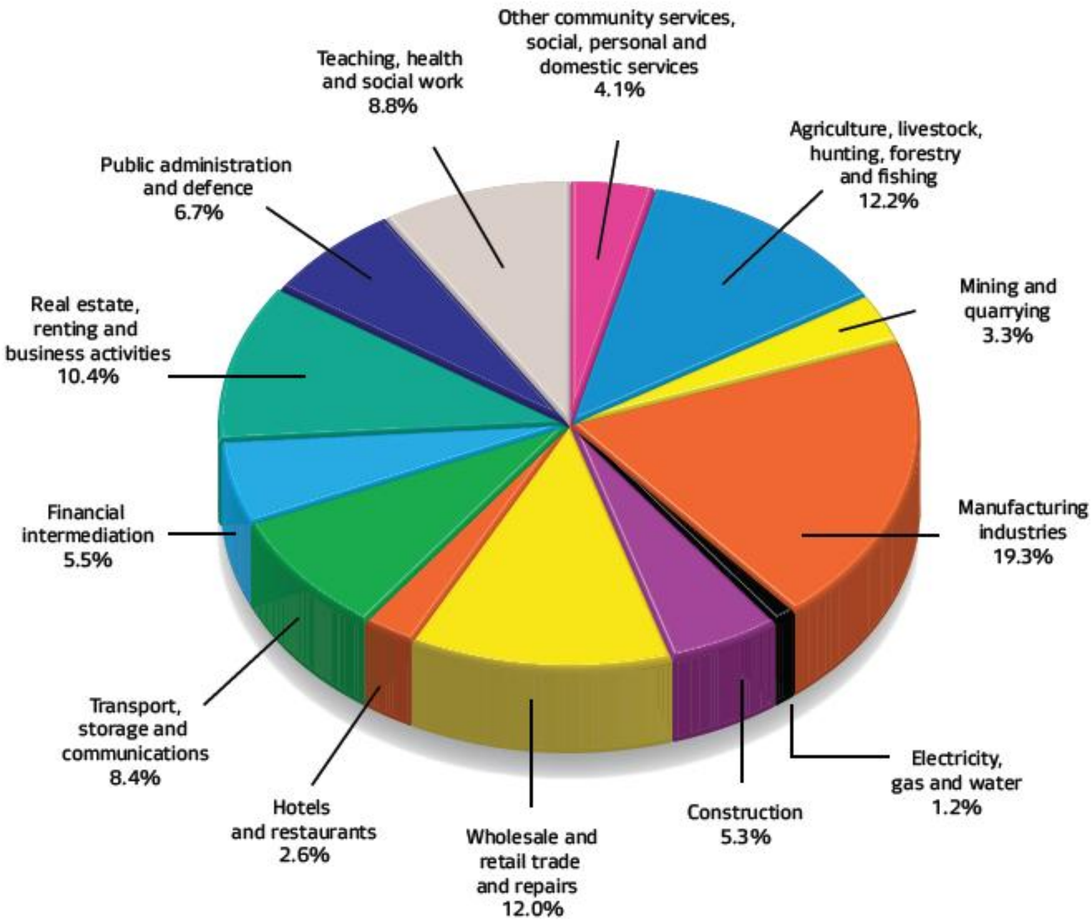
Four main results emerged from that study: high (in absolute value) negative rates of total protection for all selected products, without any significant trend and low dispersion, high (in absolute value) negative rates of direct protection for all selected products with high dispersion; high (in absolute value) negative rates of indirect protection with high dispersion

Source: Sturzenegger, Adolfo C., Salazni, Mariana, "Distortions to Agricultural Incentives in Argentina", Agricultural Distortions Working Paper 11, December 2007, World Bank

Table5- Main Economic Indicators

	2003	2004	2005	2006	2007	2008	2009	2010
Gdp Growth rate	8.8%	9.0%	9.2%	8.5%	8.7%	6.8%	0.9%	7.1%
GDP (PPP, USD million)	333,399	373,041	419,568	469,913	525,196	572,668	584,392	609,015
GDP (USD million)	128,078	152,158	181,967	212,868	260,682	326,872	306,754	377,000
Exports of goods and services (USD million)	34,439	39,864	47,021	54,569	66,343	82,034	66,576	n/a
Imports of goods and services (USD million)	18,827	27,930	34,926	41,111	53,400	67,751	48,751	n/a
Goods and services trade balance USD million)	15,611	11,934	12,095	13,458	12,943	14,283	17,825	n/a
Trade Surplus (% of GDP)	12.20%	7.80%	6.60%	6.30%	5.00%	4.40%	5.80%	4.59%
Current Account surplus (% of GDP)	6.40%	2.10%	2.90%	3.60%	2.80%	2.10%	3.70%	1.80%
Primary Fiscal surplus (% of gdp)	2.30%	3.90%	3.70%	3.50%	3.20%	3.10%	1.50%	1.20%
Gross capital formation (% of GDP at current prices)	15.10%	19.20%	21.50%	23.40%	24.20%	23.30%	20.90%	20.70%
Gross national savings (% of gdp at current prices)	19.60%	20.60%	23.70%	26.40%	26.60%	26.80%	24.40%	n/a
Foreign Direct Investment (USD million)	1,652	4,125	5,265	5,537	6,473	9,726	3,902	n/a
Exchange rate ($/usd, annual average)	2.95	2.94	2.92	3.07	3.12	3.16	3.73	3.96
International Reserves (USD millon)	14,119	19,646	28,077	32,037	46,176	46,386	47,815	51,636
Unemployment Rate (% of EAP)	17.30%	13.60%	11.60%	10.20%	8.50%	7.90%	8.70%	8.20%

Chart: Composition of GDP by economic activity, first half of 2010
As a percentage of the total, at current prices



Source: Undersecretariat for Investment Development based on data from INDEC.

3.4.1.3 Meat Sector Outlook

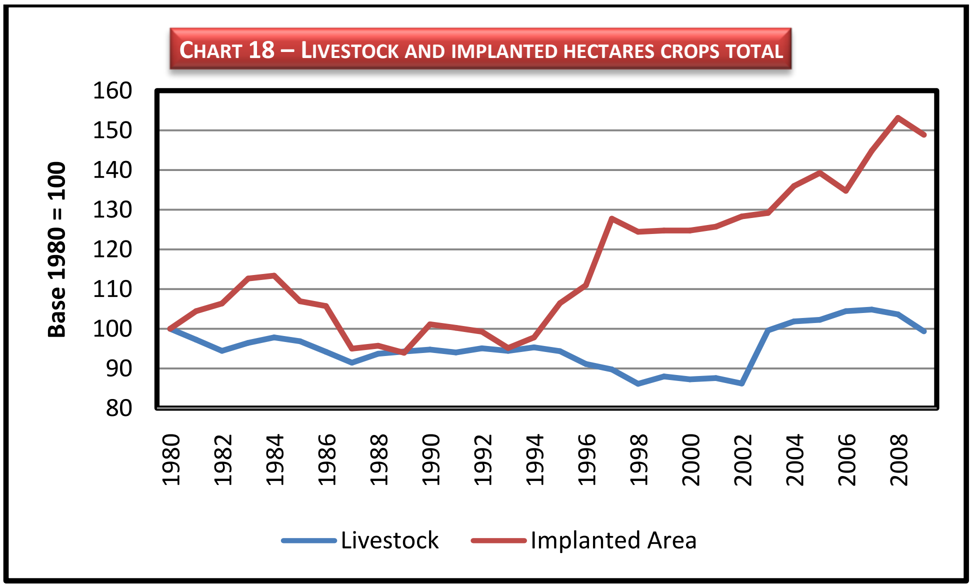
Another thing to have in mind is the possible correlation between agricultural frontier expansion over livestock areas growing the amount of hectares available for soy production in the process.

A practical difficulty however is in place, the lack of information for Argentina is harmful, especially regarding the amount of hectares destined to livestock

Therefore we propose another perspective comparing the evolution of livestock and planted area in Argentina

In that comparison we draw an important conclusion: between 1980 and 2002 the correlation between livestock and planted areas was -0,71, but between 2003 and 2009 that correlation changed to 0,21.

That breakthrough is an important one in order to understand the phenomenon even though it’s statistic signification seems to be poor.

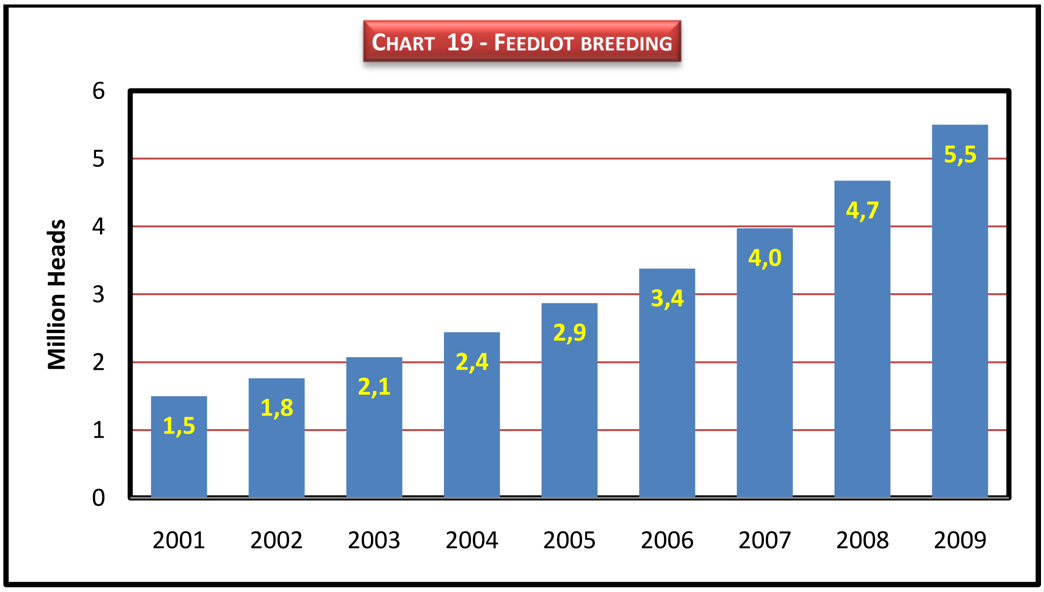


Source: Author’s elaboration

Even though there are several hypothesis for the explanation of this change in scenario one of the most plausible is the emergence of feed lot breeding as a way to replace the traditionally cattle areas.

This system went from breeding 1.5 bovine heads in 2001 to 5.5 million heads in 2009 and this could help explaining both the growth in bovine stock and in total implanted areasthroughout the country.

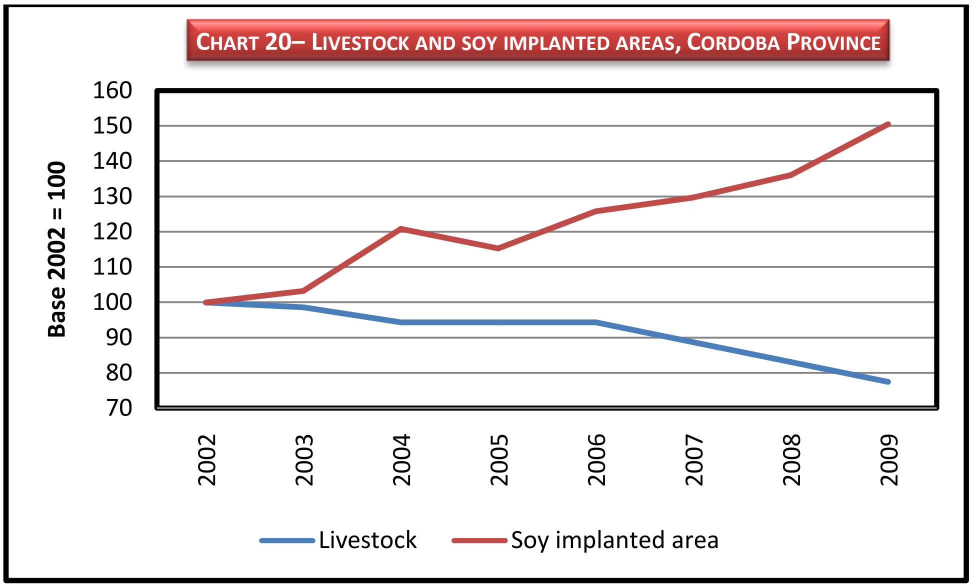
From our estimations (official data is not available) the annual growth between 2001 and 2009 implies a growth of breeding thru feedlots of 17% annually.



Source: Author’s Elaboration

Nevertheless the central point in terms of our research is if hard data is observed in order to rule in favor of the hypothesis that agro products such as soybean have replaced historical cattle lands.

A second approach, more refined, can be obtained if instead of total implanted areas soybean areas are used.



Source: Author's elaboration

It's clear that since 1980 the soybean planted areas has outnumbered livestock.

Livestock has maintained pretty mucho in the same level since 1980 and soybean production has roared 8, 6 times.

That same relationship can be observed taking into account the growth rate of both.

Table 22 – Livestock growth rate and soy implanted areas growth rate

	Livestock	Soy implanted areas
80	-0.6%	9.7%
90	-0.7%	6.2%
00	1.3%	8.1%

Source: Author's elaboration

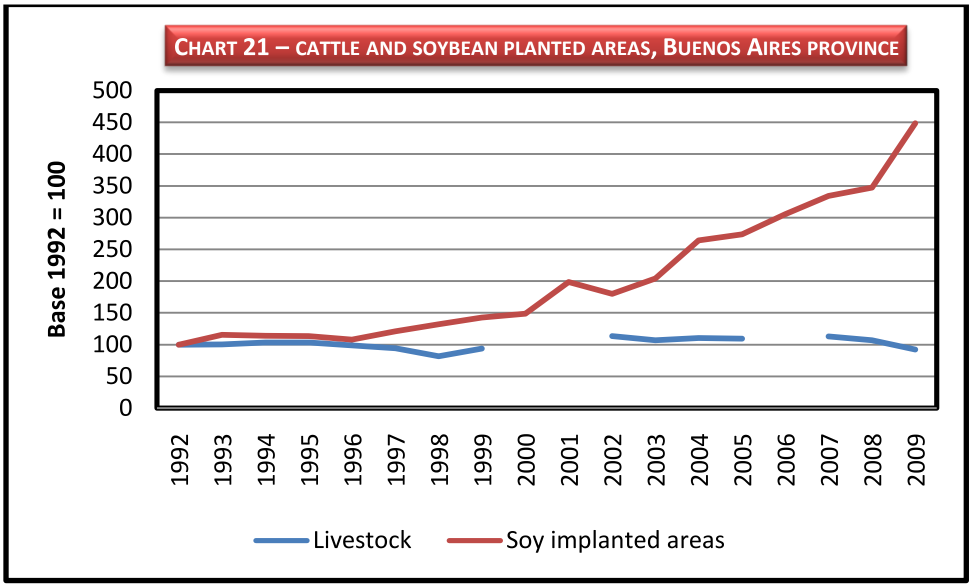
Data suggest that soybean expansion shared a downward tendency in livestock, which could be started to reverse over the last decade because of the emergence of feed lots.

At this moment, there seems to be evidence to sustain that the advance of agriculture and soybean production has been correlated with a diminishing livestock thru the occupation of traditionally farming areas.

A more polished observation can be obtained if we focus in the province data, particularly in the Pampean region (Buenos Aires, Córdoba, Santa Fe, La pampa)

This is known as the "core zone" regarding soybean and therefore our focus on it.

Starting with Buenos Aires its clear the advance over the last two decades of soybean areas and the stagnancy of livestock

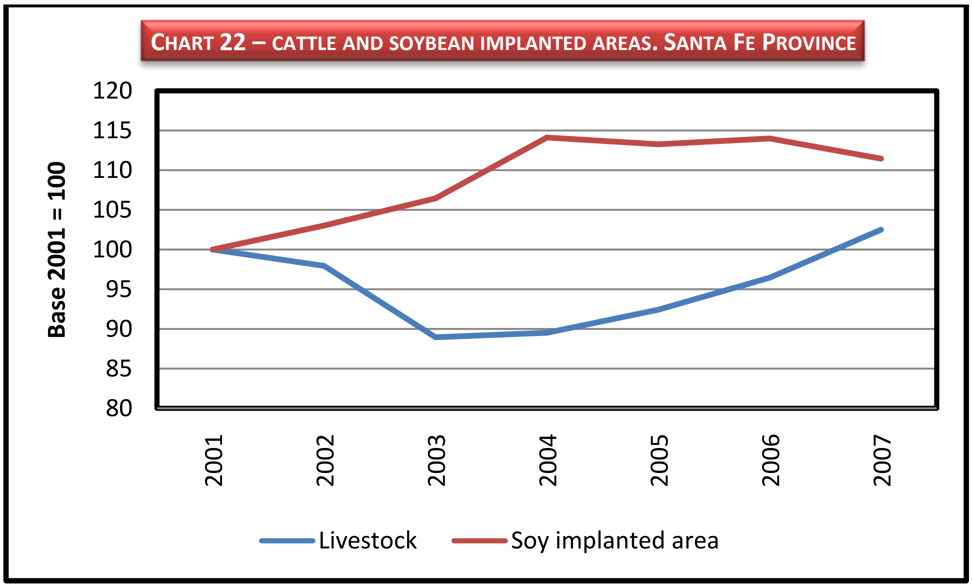


Source: Ministry of Agriculture

These results, in line with the national data, seem to suggest the existence of problems regarding the advance of livestock, mainly because of the diminishing amount of farming areas produced by the advance of soybean production in particular.

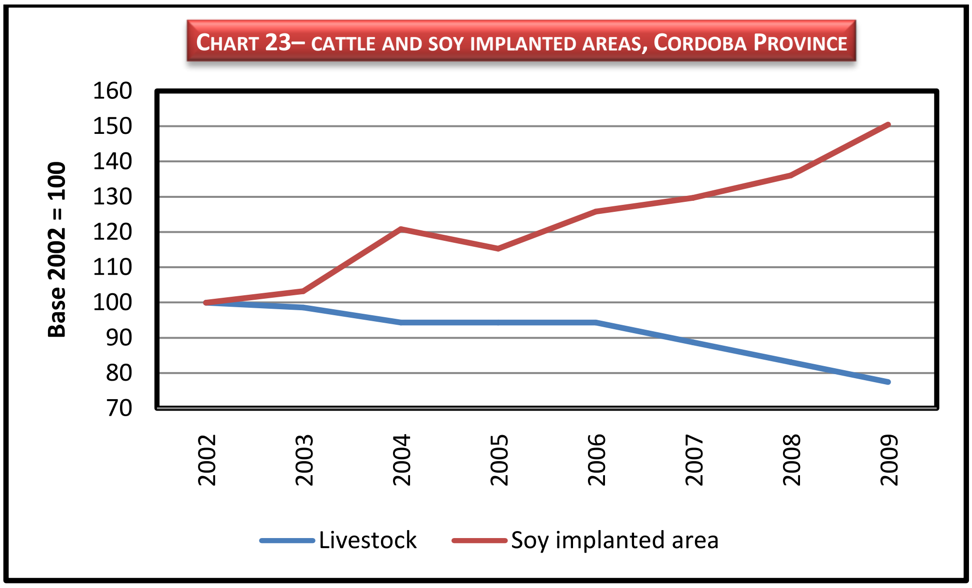
In Santa Fe's case there is a clear negative correlation between soybeans planted areas and livestock even though the data panel is rather short.

Since 2003 the livestock grows in part because of the emergence of feed lots, which tended to offset the negative correlation



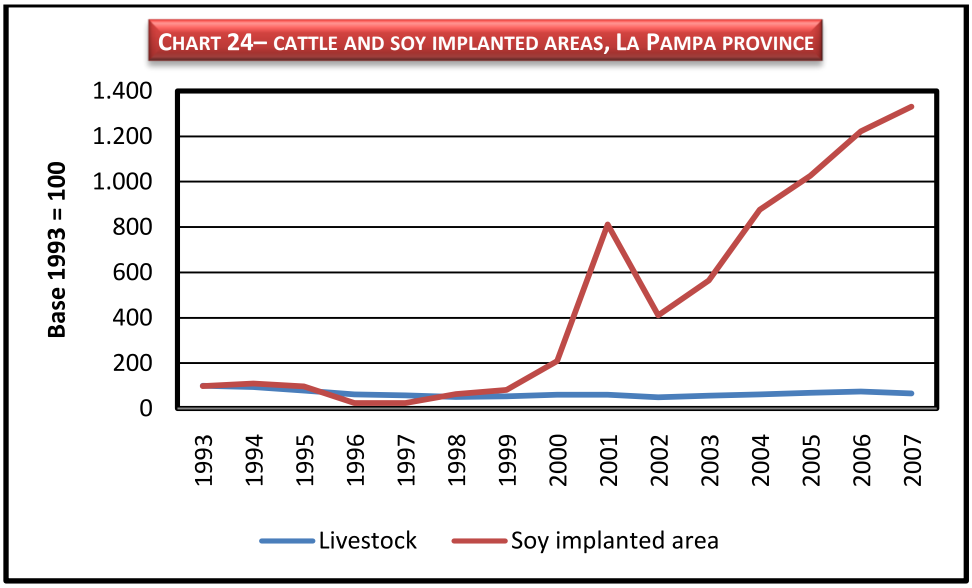
Source: Ministery of Agriculture

In Cordoba's case a similar conclusion can be drawn, but in contrast with Santa Fe's case the livestock does not show signs of recovery.



Source: Ministry of Agriculture

Finally, in La Pampa's case the relationship is more evident



Source: Ministry of Agriculture

In the 2000's a recovery in livestock took place (8, 5%), but the emergence of soybean production roared 537%.

It seems plausible to conclude a negative correlation between the emergence of soybean production and the stagnation of livestock.

In a more formal way, we try to link the evolvement of soybean planted areas and livestock using an econometric model.

Table – Cattle stock – Soybean implanted areas estimation

Period	Estimation	Soybean Implanted Areas	Meat Price
1980-1999	Coef	-0.02	0.10
	DS	0.01	0.05
	p-Valor	0.00	0.05
	R2 adjusted: 0.66		
1980-2009	Coef	0.01	0.30
	DS	0.00	0.06
	p-Valor	0.02	0.00
	R2 ajdusted: 0.52		

Source: Author's elaboration

There are two important conclusions: the first one is the fact that between 1980-1999 soybeans planted areas have shown a negative significant relationship with livestock, confirming that soybean advance has been in part over livestock areas.

Furthermore, there is a positive relationship between beef price and livestock as expected.

The second conclusion is the notable reversion of this relationship when the data expands to the 2000's; in that span the relationship is positive.

This should be explained by the emergence of feed lots in order to transform livestock production.

3.4.1.4 Feedstock production

Argentina's primary sector—agriculture, hunting, forestry, fishing and mining—represents 16% of the economy.

The agriculture sector in Argentina is export-oriented. In 2005, the country's agricultural exports accounted for one fourth of total exports. Argentina's agriculture sector accounted for 9.2% of its total GDP in 2008. Agricultural products produced in Argentina include sunflower seeds, lemons, soybeans, grapes, corn, tobacco, peanuts, tea, wheat, and livestock. Argentina is among the world's leaders in soybean and cereal production, and is also the largest beef exporter in the world.

The country is a leading producer and exporter of commodities and raw materials, with over 60% of its 280 million hectares dedicated to agricultural production. Agriculture has reached high productivity levels, achieving per hectare yields of soybean and wheat well above those of other world leading producers. Furthermore, the country continues to lead the way in the development and implementation of direct-sowing techniques. From 2005 to 2009, 41.3 million tons of soybeans were harvested on average per year, making Argentina the world's third largest soybean producer. In addition, 17.8 million tons of corn, 13 million tons of wheat and 3.6 million tons of sunflower seeds, the top Pampean crops, were harvested on average per year during the same period.

Argentina stands at the forefront of biotechnology applications for agriculture and human health, in addition to animal health. Noteworthy work being carried out includes efforts to develop innovative applications for seeds, inoculants and micro-propagation techniques. Argentina is a strong organic producer; with 90% of its organic production destined for export markets, particularly the EU and the U.S. In stark contrast, Argentina is also a world leader in the use of GM seed. The country is the third largest GM-crop grower in the world (with 21.3 million hectares, equivalent to 16% of the total surface area cultivated with GM crops worldwide). Over 70% of Argentina's soybeans are genetically modified, and approximately one-third of all corn fields in Argentina contain GM corn. In 2008, the most severe drought in 100 years hit Argentina and Brazil, causing significant losses in cattle, wheat, and soy bean and corn production. Furthermore, Argentina is one of the few countries in the world with animal cloning technology.

Argentina also possesses a wealth of mineral resources, mostly concentrated along the Andes mountain range, which include significant deposits of lead, zinc, tin, silver, and potassium, copper and gold. The province of San Juan is home to one of the most important reserves of gold and silver on the planet; while to the east of the Cuyo region (in the provinces of La Rioja, Mendoza, San Juan and San Luis) with its chalky lime soil, there are major gold, silver, lead and zinc deposits; and further to the southeast, copper and molybdenum reserves. The country also has some of the largest lithium deposits in the world, a mineral increasingly in demand due to its low environmental impact and use for cellular phone and car batteries.

The mining sector has grown dramatically in recent years. Thanks to over 400 mining projects, record levels of investment have been matched by similarly high rates of exploration, exports and job creation. Investment for exploration activities, project development and mineral production has come from 30 different countries on five continents, up substantially from 2003. For 2015, output levels are forecast to be worth some US$ 36 billion, while exports are expected to rise to US$ 28 billion.

3.4.1.5 Feedstock conversion

The changes in Argentina feedstock conversion capabilities are remarkable.

In this sense, while in 1993 the milling capacity was 8.2 mills. of tn., in 2008 this capacity had increased to 55.4 mill. Oftn and today is nearing the 60 million tons.

The processing industry offers many products such as pellets and oil. A second process has allowed the development of the biofuel business. Indeed, as noted by Hilbert (2007), recent high oil prices have shown that liquid biofuels can be a cost-competitive alternative to traditional transport fuels. However, the competitive edge for liquid biofuel production seems to lie with developing countries that have favorable climatic and environmental conditions for plant growth, low labor costs, low energy input in agricultural production and hence low production costs for energy crops. Therefore liquid biofuel trade offers developing countries, and especially their rural areas, heavily needed economic incentives. In this paper, Hilbert aims to describe and evaluate the emergence of markets for liquid biofuels in Argentina. It reveals that biodiesel production for international supply is likely to emerge in the short run (up to 2010), giving the opportunity to be switched back to local supply in the medium run (post-2010). It also suggests that a bioethanol market (demand and supply) does not seem to be likely in the short run, and it is highly uncertain in the medium run as the most influential actors oppose its development.

The industry's growth was awesome. The production of local biofuel in 2009 to represent 1.4% of global production (23,700 bpd), while in 2006 their share was just 0.1%, mainly due to the increase in volume produced of biodiesel, that reached 7.5% of global production (in 2006 this ratio was 0.4%).

Regarding biodiesel, Argentina exported in 2008 1, 2 million tons of biodiesel, basically soybean produced. Almost all the production was exported with FOB prices that varied between 1,000 and 1,400 US$/tn. Due to the limited biodiesel consumption in Argentina, the role the country will have in a near future in this area is very important. It is estimated that Argentina will potentially produce by 2011 4 million tons of biodiesel based in soybean, and a great amount will be commercialized to the foreign markets.

For the bioenergy production chain for soybean, after harvesting, the product is transported to the Rosario zone for oil extraction. This is the closest processing unit for soybean production in the region. In Argentina, only larger agricultural companies will directly export the soybean to the oil extraction companies, as we will see later. The smaller to medium sized producers sell their soybean in practice via cooperatives or stocking companies spread in the country, which take care of the merchandise and send it to industry or to the harbor, where it is commercialized via the stock market. After oil extraction, the crude soybean oil is transported to Rosario to be converted to biodiesel. This end-product is exported to Rotterdam or used in the local market.

As the quoted Hilbert's work (2007) says, along the biodiesel value chain, the main actors are the vegetable oil milling facilities and the crude oil industry. Both positions detent market power arising from their oligopoly structures. Nevertheless, no company was observed that has an integrated position along the whole biodiesel value chain. Apart from sharing 85% of the vegetable milling capacity among the six major companies five of which have already set up a biodiesel plant—the vegetable milling facilities have a strong link along the value chain as they are directly linked to the agricultural sector.

As the raw material is readily available and cheap, and milling capacities are sufficient, the vegetable oil companies have a strong interest in large-scale production of biodiesel. Their current activities are already export oriented and it seems that their main interest lies in exporting biodiesel (mainly to Europe).

But since the enactment of different pieces of legislation Argentina consumption of soy biodiesel began to growth boosting the production of the fuel and marking a good perspective for the future in terms of production.

In May 2006 Argentine Biofuels Law 26.093 was enacted. Its focus was the development of a domestic biofuels market, and it established a B5 and E5 requirement beginning January 1st, 2010. However, a global biofuels industry had already been launched by the time the law was enforced, and many large consumers such as Europe and the United States had already established ambitious targets. The Argentine private sector, led by the large oilseed crushers, saw a market opportunity and was among the first to build large biodiesel plants, typically using foreign technology, and focusing on export markets – which ended up being primarily in Europe. Argentina is, in fact, only one of two countries that developed their export markets ahead of their domestic one driven by an abundance of feedstock, comparatively smaller domestic markets, and a desire to generate hard currency through exports.

The Legislative Branch's biofuels law gave the general basis on "what must be done in this matter; the Executive Branch of government was responsible for its regulation or the how the law would be implemented.

Since the different drivers and forces and the multiple factors at a national and international level to be considered, the regulations were slow. Law 26.093 wasn't regulated until late 2007 by Resolution 109/07, but by then a number of biodiesel plants were already operating. Also, a very important resolution referred to the safety requirements. These rulings, along with Resolutions 226/08; 1296/08; 6/10 and 7/10 constitute the basic framework on which the biodiesel industry works at a national level. Although this framework is already in place there are several administrative acts as the update of the reference price that brings up considerable turbulence when delays occur.

Legal and Regulatory Framework for Biodiesel

- **Resolution 129/01**: Defines biodiesel.
- **Law 26.093/06**: Biofuels law. Biodiesel and ethanol mandates. Participating enterprises. Application Authority.
- **Decree 109/07**: Regulations for Biofuels Law.
- **Resolution 266/08**: Registry of universities authorized to perform technical, environmental, and safety audits on biofuels plants.
- **Resolution 1296/08**: Fire safety requirements for biofuels plants.
- **Resolution 6/10**: Quality specifications for biodiesel.
- **Resolution 7/10**: Announces the list of producers that comprise the domestic mandate during calendar 2010, as well as the formula used to determine the wholesale price.

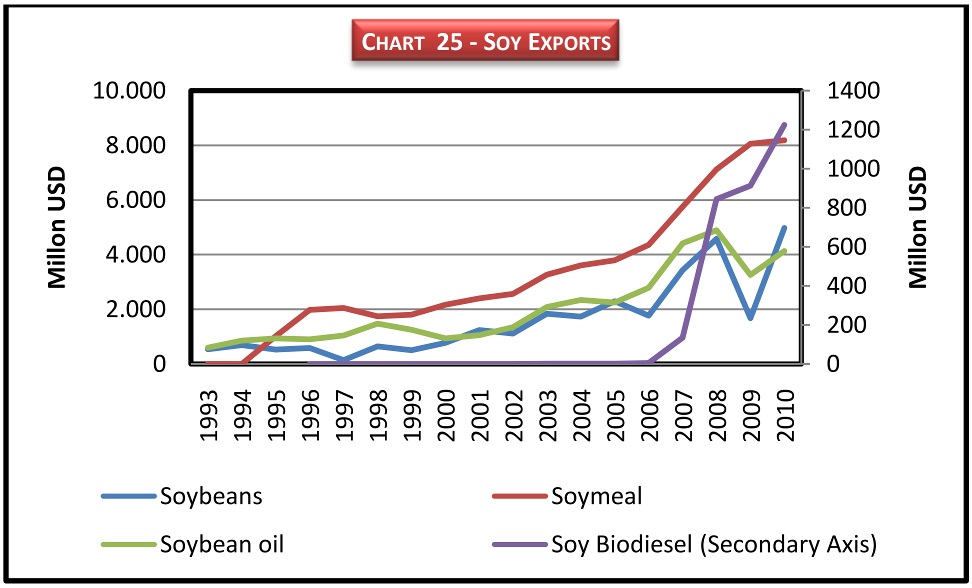
In general, the large petrol companies have been more hesitant towards the interest in thetrans esterification of biodiesel. Generally, it seems that petrol companies show interest in the production of biodiesel due to two main reasons. Firstly, the rising opportunity costs between the imports of diesel at currently 3% of the annual internal consumption rate, while the country has a strategic position in the production and export of vegetable oil. Secondly, transport fuel prices in Argentina are ‘capped’ and do not reflect the real internal market value (Acosta et al., 2006). Hence, profit margins for petrol companies are thin and their interest in biofuels is therefore based on new evolving international markets for biodiesel—mainly Europe.

3.4.1.6 Soy impact on production and exports

The economic importance of soybean production in Argentina has already been mentioned throughout this research but it is worth having a look to the information available in order to measure the impact by the numbers.

As we have already shown the production has grown 500% in a 20 year span in part thanks to the technological advance in soybean production since the introduction of transgenic seeds in the mid 90’s.

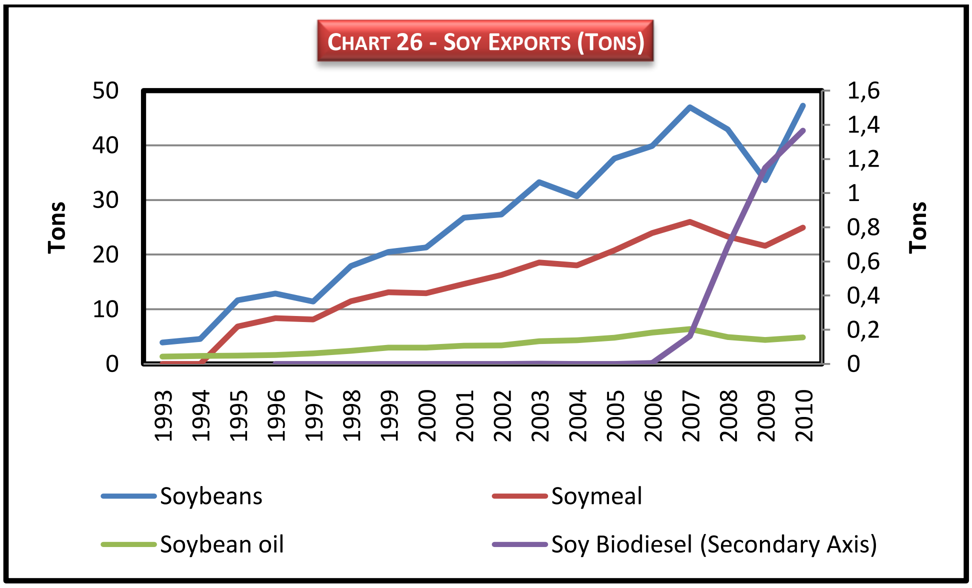
But if we take a look to the exports the impact of soy production is much clearer.



Source: USDA Database

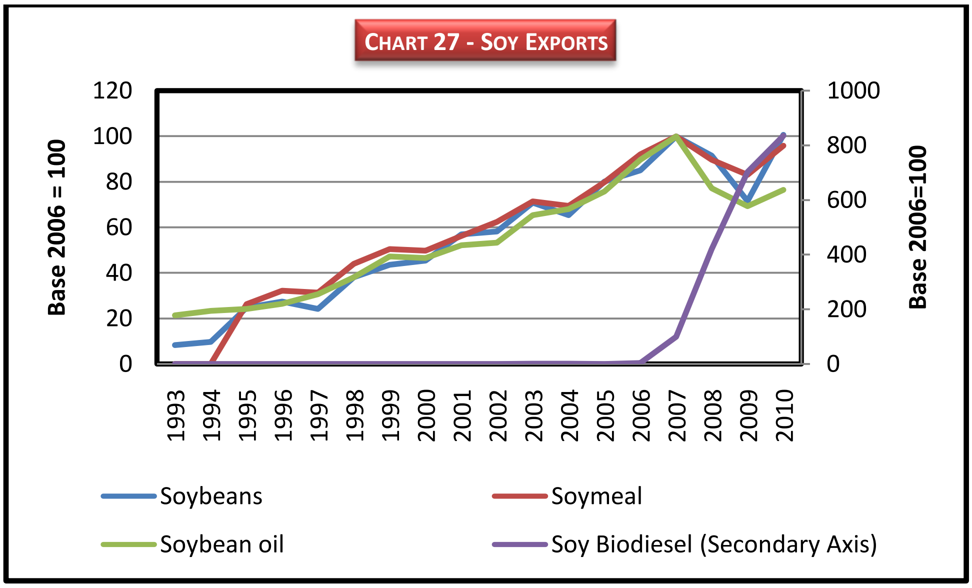
As we can see in the chart since the mid 90's soybean exports has grown without precedent and helps understanding the impact that the crop has had for Argentina's economy.

In terms of tons the situation is similar and helps understating the importance for the whole production sector.



Source: USDA Database

It is interesting to measure the impact of soy production in terms of growth rate in order to understand how soy biodiesel has been gaining importance for the soy complex as a whole.



Source: USDA Database

As we can observe soy biodiesel exports has grown near 800% in a four year span and it is expected to continue growing given that the installed capacity of Argentina is still expanding as we show throughout this research.

3.4.2 Microeconomics in the First Case Study Plant

3.4.2.1 Feedstock production

The First Case Study Plantdoes not have a feedstock production facility as it buys the feedstock from different providers; this is why the analysis and research has been made within the feedstock conversion scope.

The gathering of information has been made through a set of interviews and visits to the First Case Study Plant located in the heart of the soy core area of Santa Fe province.

Feedstock conversion

Table 1: Input costs of the conversion unit for the First Case Study Plant case study in 2011

Input costs	**Quantity** **(per unit end product)**	**Price** **(per unit end product)**
Electricity	Electricity: 37.3 KwH/Mton Gas: 26.5 m3/Mton	6 euro/mton
Feedstock (SBO)	21.666 soy bean oil tons per month	198.93 per soy biodiesel ton
Water	No	No – pit water
Equipment	n/a	n/a
Labor	71	22.31 euro per worker per soy biodiesel ton
Citric Acid	0.8 kg per soy biodiesel ton	1.61 euro per soy biodiesel ton
Methanol	93 kgs per soy biodiesel ton	6.94 per soy biodiesel ton

From the information gathered by visits tothe First Case Study Plant we can observe that labor costs and feedstock costs are the most important of the plant, this is somewhat predictable.

The First Case Study Plantcurrently employs 71 workers, given that this is a state of the art plant technology wise the most part of its workers are either full skilled or semi-skilled.

It has to be kept in minds that for example a heavy part of the workers are destined to the logistics part of the plant. Given that the plant does not have feedstock production the logistics by truck are very important in order to have the plant at full capacity producing soy biodiesel, this is why the logistic workers are considered skilled for the purposes of this research.

Summing up the First Case Study Plant has 71 workers that are divided as follows:

6 are management workers, 7 are destined to the laboratory, 25 are destined to the production of the soy biodiesel, 13 are for maintenance, 18 are destined to logistics and 2 are destined to security.

Table 2: Input costs of the conversion unit for the First Case Study Plant case study in 2011

Function	**Number of workers**	**Average wage in EURO/month**	**Average cost in EURO/month**
Average wage rate	**71**	**2514**	**178519**
Unskilled labor	2	1600	3200
Semi-skilled labor	38	2492	94719
Skilled labor	31	2700	80600

Table 3: Wage levels for feedstock conversion of local the First Case Study Plant in 2011

Labor expenses		
Average wage rate	86	EURO/day
Unskilled labor	6.66	EURO/hour
Semi-skilled labor	10.38	EURO/hour
Skilled labor	11.25	EURO/hour

3.4.3 Microeconomics in the soy chain in AG Bioenergy plant

3.4.3.1 Feedstock production

The main difference between the two cases selected is that AG Bioenergy plant is an integrated one meaning that it provides for its own feedstock. This changes the cost structure giving some autonomy for the later production of soy biodiesel.

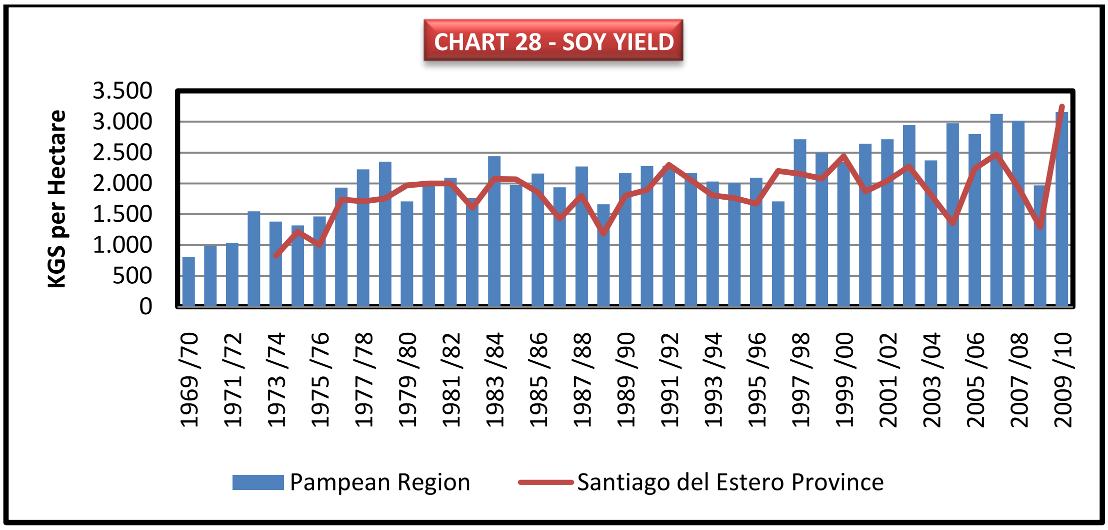
The Santiago del Estero area is quite different from the pampean zone and was not historically suited for soy implantation given that the annual precipitations difficult the production of the crop.

But in terms of soil the area is fitted for a large scales production and, given that the technology package is the same nation-wide for the production of soy , this encourage different facilities to develop a fully integrated plan in order to continue growing in the soy biodiesel market.

The Frias zone is located in semiarid zone with an average of 2% of organic material.

The soy expansion is limited to the isohyet of 800mm between the eastern and center area of the province in order to avoid the rains problems.

Given that the technology package is quite the same for the whole soy area (pampean and extra pampean) and that the yield of soy production is lower in Santiago del Estero (except for the last campaign that has shown similar yields) it is expected that the average cost for feedstock production in the Frias area to be higher than in the pampean case for example.



Source: INDEC

Between the input differences in Santiago del Estero areavs. Pampean Region it is worth mentioning that the soil does not require fertilization.

But these lower costs are lost when the transport is taken into account. Given that the Province is located outside the port area it is accepted a higher cost than in the soy core area.

But in the particular case of Viluco this is not important given that the feedstock production and feedstock conversion are integrated, mitigating this situation.

Table 4: Costs for feedstock production of local case study 2(Viluco) in 2011

		Expenses per hectare (EURO/ha)											
	Yield (m3 or kg /ha)	Field clearing	Field preparation	Planting material	Irrigation	transplanting	Tools for cultivation	fertilizer	Pesticides (quantity as	Tools for Harvesting,	storage	packing	transport (long)
Year 0	50,976			36,20	No	No		0,00	61,31	46,43	8,55		26,14
Year 1	50,976			36,20	No	No		0,00	61,31	46,43	8,55		26,14
Year 2	50,976			36,20	No	No		0,00	61,31	46,43	8,55		26,14
Year 3	50,976			36,20	No	No		0,00	61,31	46,43	8,55		26,14
Year 4	50,976			36,20	No	No		0,00	61,31	46,43	8,55		26,14
Year 5	50,976			36,20	No	No		0,00	61,31	46,43	8,55		26,14
Etc. until Year 24	50,976			36,20	No	No		0,00	61,31	46,43	8,55		26,14

Table 5: Labour requirements for feedstock production local case study 2 (Viluco) in 2011

		Labor requirements (hours or days/ha)[1]										
	Yield (m^3 or kg /ha)	Land clearing	Field preparation	Planting	Irrigation	Weed control	Pruning	Fertilizing	Pest and disease control	Harvesting[2]	PHA (post-harvest activities)[2]	Packing/transport[2]
Year 0	50.976	no	no	0.30 hour	no	no	no	0.04	0.12	0.1333	0.07	0.05
Year 1	50.976	no	no	0.30 hour	no	no	no	0.04	0.12	0.1333	0.07	0.05
Year 2	50.976	no	no	0.30 hour	no	no	no	0.04	0.12	0.1333	0.07	0.05
Year 3	50.976	no	no	0.30 hour	no	no	no	0.04	0.12	0.1333	0.07	0.05
Year 4	50.976	no	no	0.30 hour	no	no	no	0.04	0.12	0.1333	0.07	0.05
Year 5	50.976	no	no	0.30 hour	no	no	no	0.04	0.12	0.1333	0.07	0.05

Table 6: Wage levels for feedstock production of local case study 2 (AG Bioenergy) in 2011

Labor expenses		
Average wage rate	44	EURO/day
Unskilled labour	25	EURO /hour
Semi-skilled labour	41.5	EURO /hour
Skilled labour	46.5	EURO /hour

3.4.3.2 Feedstock conversion

As an integrated plant that produces makes both feedstock production and feedstock production in the Viluco case we have been able to gather detailed information on inputs and its costs.

As we can see in the next table the most important cost (in tons of soy) comes from the feedstock (soy later turned into soybean oil for producing soy biodiesel) and the labor costs.

In the period observed Viluco employed near 250 people only for the feedstock conversion and it plans to incorporate more in the near future in order to continue improving its production.

The total cost for one ton of soy used for the production of soy biodiesel is near 22 euros taking into account the most important inputs.

Table 7: Input costs of the conversion unit for the Viluco case study in 2011

Input costs	Quantity (per unit end product)	Price (per unit end product)
Electricity	47,84 KWH	3,58 EURO per Soy ton
Feedstock	62.024,70 TONS	198,93 EURO per Soy ton
Water	N/A	N/A
Equipment	N/A	N/A
Labour	247 People	5,86 EURO per Soy ton
Gas	35,96 M3	4,15 EURO per Soy ton
Hexane	0,63 Kg	0,44 EURO per Soy ton
Phosphoric acid	0,28 Kg	0,26 EURO per Soy ton
Caustic Soda	0,43 Kg	0,18 EURO per Soy ton
Silica Gel	0,53 Kg	0,50 EURO per Soy ton
Metanol	21,99 Kg	6,94 EURO per Soy ton
Sodium Metilate 30%	3,97 Kg	2,72 EURO per Soy ton
clorhidric acid	2,44 Kg	0,25 EURO per Soy ton
Antioxidants	0,04 Kg	0,22 EURO per Soy ton
Industrial Nitrogen	0,84 Liters	0,06 EURO per Soy ton
Industrial Salt	0,52 Liters	0,02 EURO per Soy ton

Table 8: Input costs of the conversion unit for the local case study 2 (Viluco) in 2011

Function	Number of workers	Average wage in EURO/month	Average cost in EURO/month
Average wage rate	284	2666	643733
Unskilled labor	43	1500	64500
Semi-skilled labor	119	2500	297500
Skilled labor	122	2800	341600

Table 9: Wage levels for feedstock conversion of local case study 2 (Viluco) in 2011

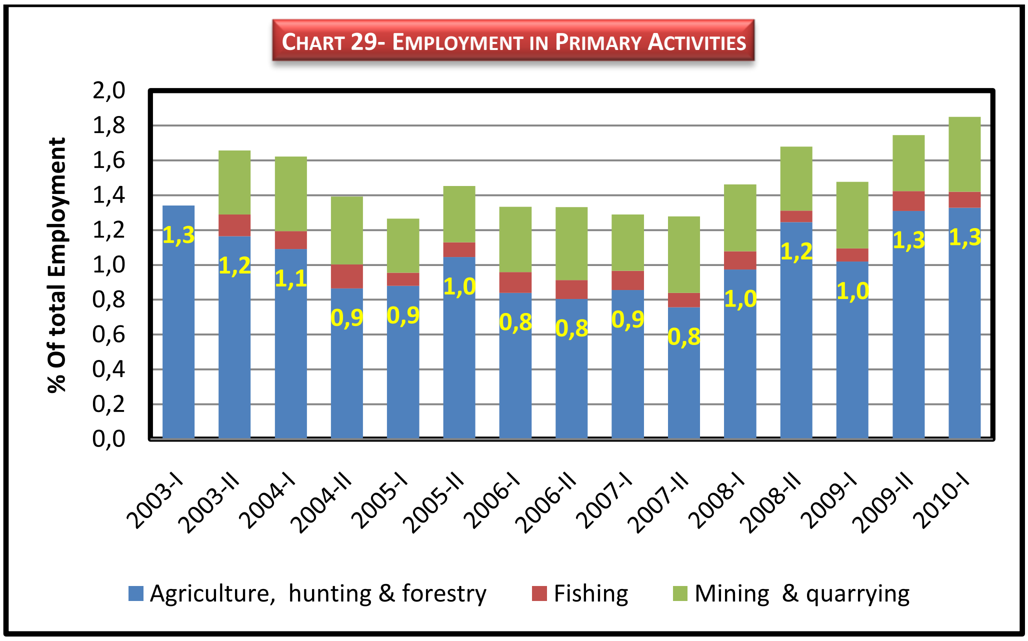
Labor expenses		
Average wage rate	88	EURO/day
Unskilled labor	50	EURO/hour
Semi-skilled labor	83.3	EURO/hour
Skilled labor	93.3	EURO/hour

3.5 Employment generation

3.5.1 Employment generation in the soy chain in Argentina

3.5.1.1 Feedstock production

The best proxy for understanding how the employment generation works in the feedstock production level of Argentina is by looking into the employment rate in primary activities. Given though the soy production is seasonal it is assumed that a worker can work in a soy farm for some months and later work producing other crop.



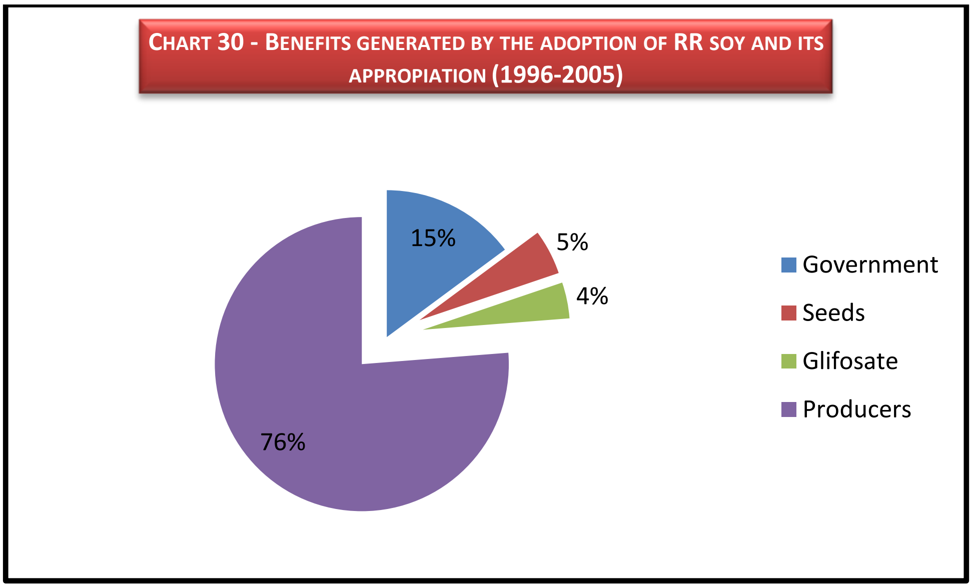
Source: Author's elaboration with CEDLAS information

As we can see the tendency since 2007 has been growing for the agricultural sector employment with the exception of the first semester of 2009.

This is explained by the full effect of the international crisis that produced a decrease in the world economy that impacted commodities trading (but not their prices).

Another point worth mentioning is that agriculture explains more than 80% of the total employment in primary activities, something that helps explaining the share of the agriculture in Argentina's economy.

Measuring the employment generation in both cases has proven to be difficult this is why we can rely on the appropriation by sectors since the introduction of RR soy.



Source: Argenbio

Even though this study made by Argenbio in 2007 is outdated the proportions are expected to remain pretty much the same given that the government appropriation is weighted by the export tax rate that has remained unchanged since 2007.

Impacts of the soy chain in terms of employment

Measuring the number of jobs generated since the soy "boom" in Argentina is a difficult task given the amount of activities linked to the chain and the lack of statistics to extrapolate the reality of the change produced by the chain.
However Trigo and Cap (2006) correlated the growth in GDP until 2006 with the jobs generated by the chain.
This works as a very good proxy for understanding how important this chain is for Argentina's economy.
In the mentioned work the authors found that the introduction of the RR soy in Argentina since 1996 generated more than a million jobs until 2006.
Taking that into account it is expectable that since the soy production has grown since 2006 by big margins the number of jobs generated directly and indirectly by the soy chain had gone up.

The cause is easy to sustain: In 2006 soy biodiesel in Argentina was in a start-up phase. Nowadays the implementation of the 7% quota and the instalment of large corporations producing biofuels all over the country generated not only jobs in the plants but jobs in the whole feedstock chain and more jobs in transport.

Soy biodiesel also generated investments in roads, ports , silos, etc. All this is still in the making but the estimations in terms of jobs generation look bright in the present and in the future.

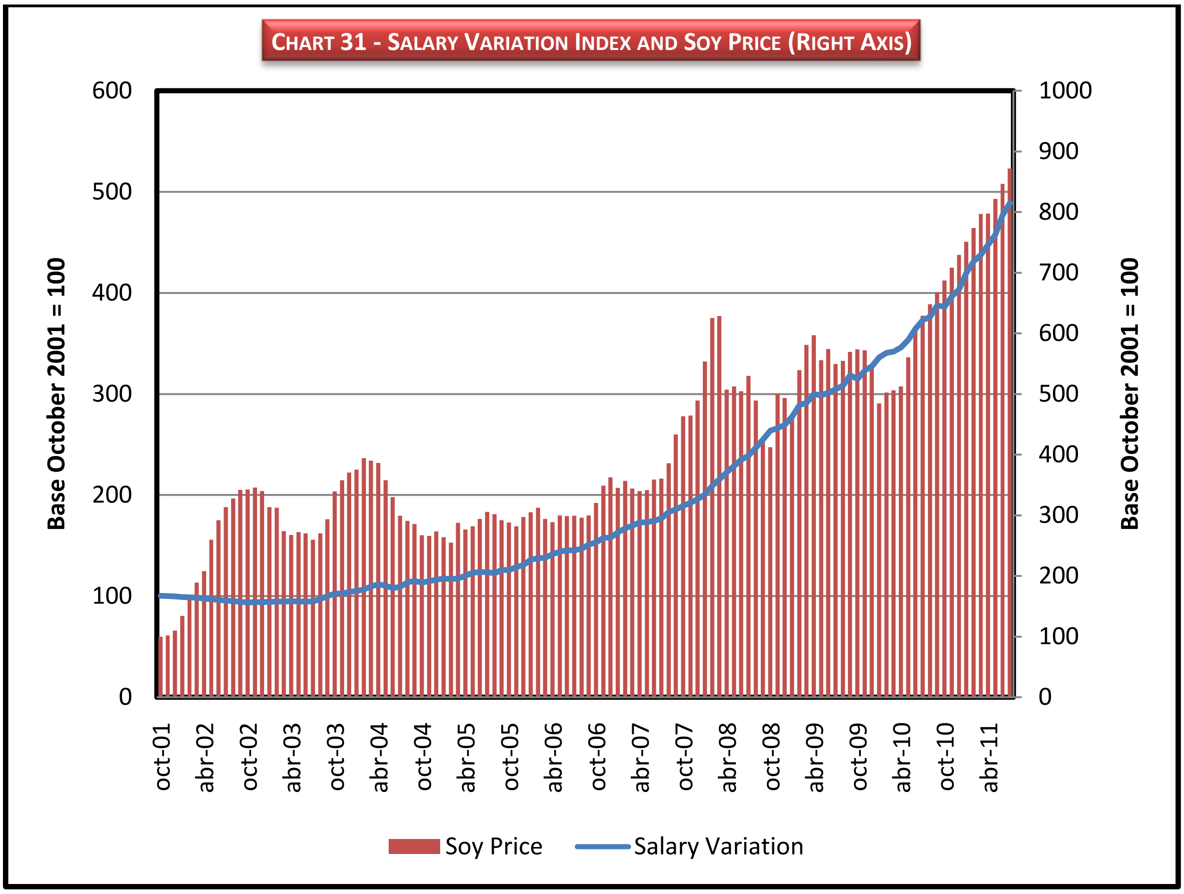
3.6 Working conditions

3.6.1 Working conditions in the soy chain in Argentina

The best way to understand the evolution of the working conditions of Argentina soy chain sector is by observing the evolution of the non-registered salaries published by the INDEC (the statistics institute of Argentina).

The non-registered label is used because of the seasonality of the soy sector work that in many cases does not work in the land for the whole year.

So this is a pretty accurate way to observe the evolution of such conditions.

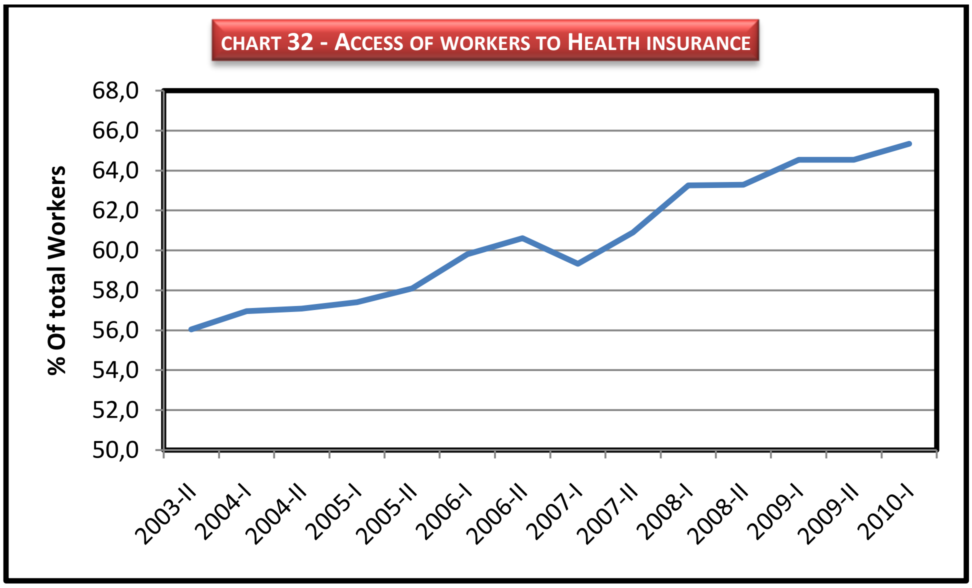


Source: Author's elaboration using CEDLAS database

As we can see the extraordinary growth of soy prices was in a certain way followed by the salaries of the non-registered sector, a good proxy of the salaries of the agricultural sector in particular and of the soybean sector in particular.

One of the policies of the Argentinean government has been the gain of salary power for the working class and this can be observed in this chart.

Another way of looking into the working conditions of Argentina is by observing the access to health insurance of the workers.



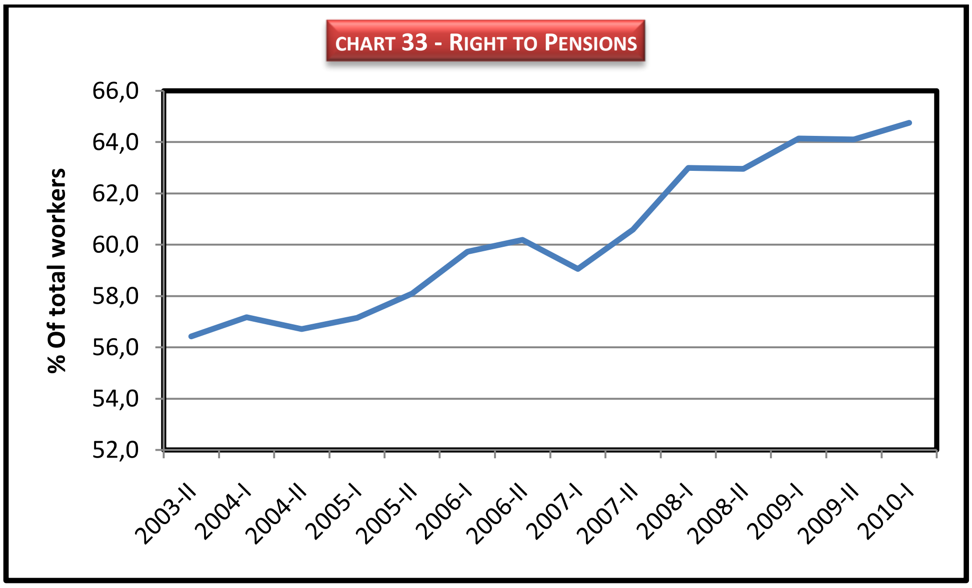
Source: Author's elaboration using CEDLAS database

The chart shows that near 65 of the working class has gained access to health insurance, this shows an improvement condition-wise.

It has to be keeping in mind that in 2003 only 56% of the workers had access to the health insurance and that the recovery of the economy made possible this improvement.

The gap in 2007 is explained by the change of the pension system in Argentina that was both private and public and by a change in legislation became only public.

Lastly, this gap can also be observed when the right to pensions is considered, and also the improvement in working conditions can be explained using this kind of information given that now almost 65% of the workers have gained access to pensions comparing it with 56% in 2003.



Source: Author's elaboration using INDEC database

Salary Negotiation

It is important to mention how the salaries are negotiated in Argentina since the recovery of the economic crisis of early 2000's. Since that point the labourunion (each activity has it own union) negotiates directly with the owners of the different production activities and from that negotiation the new salary is agreed.

Some unions set the tone of the later discussion. In Argentina case the truck drivers' union is one of the most important in terms of salary base and sets the base of the year salary for the other unions.

This is not a coincidence given that almost 90% of Argentina production is transported by truck.

In our two case studies the structure of salary negotiation is quite similar. In this case the union that represent most of the workers is the oilers ("aceiteros") and each year a raise is negotiated with the companies.

This also helps understanding that all of the workers are legalized in terms of social security, accidents preventions (ART), etc.

Law regulation

Another way of having knowledge about the working conditions in Argentina is to have a look to the laws that regulate the system:

The primary law is the Employment Contract Law No 20,744 ("LCT"). The Law No 11,544 is also significant and regulates matters such as working hours, and the Law No 24,557 refers to occupational accidents and professional diseases. The Laws Nos 24,013 and 25,323 provide increases to labor indemnities in the event of labor fraud, and also –in the former case– it regulates various matters on the subject of employment.

The Law No 14,250 (1953) regulates all matters concerning Union Agreements, i.e. agreements entered into between entities representing the relevant workers and businesses, the purpose of which is to regulate any employment contracts within their scope of applicability. The law is still in force to date, but with amendments, the latest of which is the Law No 25,877 (2004). We should also note the enactment of the Law No 23, 551, which provides legislation in relation to trade unions. Finally, the Law No 14.786 regulates union disputes and the Government's role therein.

In terms of risk law , the Occupational Risk Law No 24,557 (LRT), as regulated, provides the regulatory environment for an occupational accident and certain professional illnesses included in a list prepared by the National Executive.

The law provides a system of payments in kind (medical and pharmaceutical assistance; prostheses and orthopedic items; rehabilitation; professional re-qualification and funeral services) and money payments (as a lump-sum or in installments; referring to temporary or permanent disability to work; which may be temporary or final, in whole or in part; gross disability; death) for the benefit of a worker (or its successors), which contemplates any contingencies sustained by the worker, and the subsequent rehabilitation and occupational re-insertion thereof.

The duty to make payments in money or in kind under the LRT relates to certain private-law for-profit institutions referred to as Occupational Risk Insurers (ARTs). It is the duty of an employer to insure its permanent employees in an ART, by the payment of a monthly installment.

Several notions of the system are being subject to judicial review, such as the type of redress, the scope of liability of an employee, or ascertaining the occupational nature of certain illnesses.

3.7 Health issues

3.7.1 Health issues in the soy chain in Argentina

Given that there are not considerable heath issues within the soy chain it is our belief that the sanitary conditions of Argentina's soy chain should be mentioned.

Another thing to keep in mind is that the control regarding health and sanitary conditions are widespread to the whole agricultural system and that's why it is not viable to study the feedstock production and conversion in a separate manner.

As mentioned by Regunaga (2009) Argentina has had since many decades ago a high priority in the high quality and sanitary conditions of the grains and oilseeds produced and traded.

Between the 1940's and 1980's the National Grain Board was in charge of the public controls and the management of the standards for both domestic and international trade of such products.

But since the 1990's because of the shutdown of the National Grain Board such policies are conducted by the SENASA (a national service in charge of sanitary and quality controls of all primary and processed agricultural products).

It is important to mention that quality and health issues are top priorities for the government of Argentina given the importance of the agricultural sector in general and the soybean chain in particular for the economy.

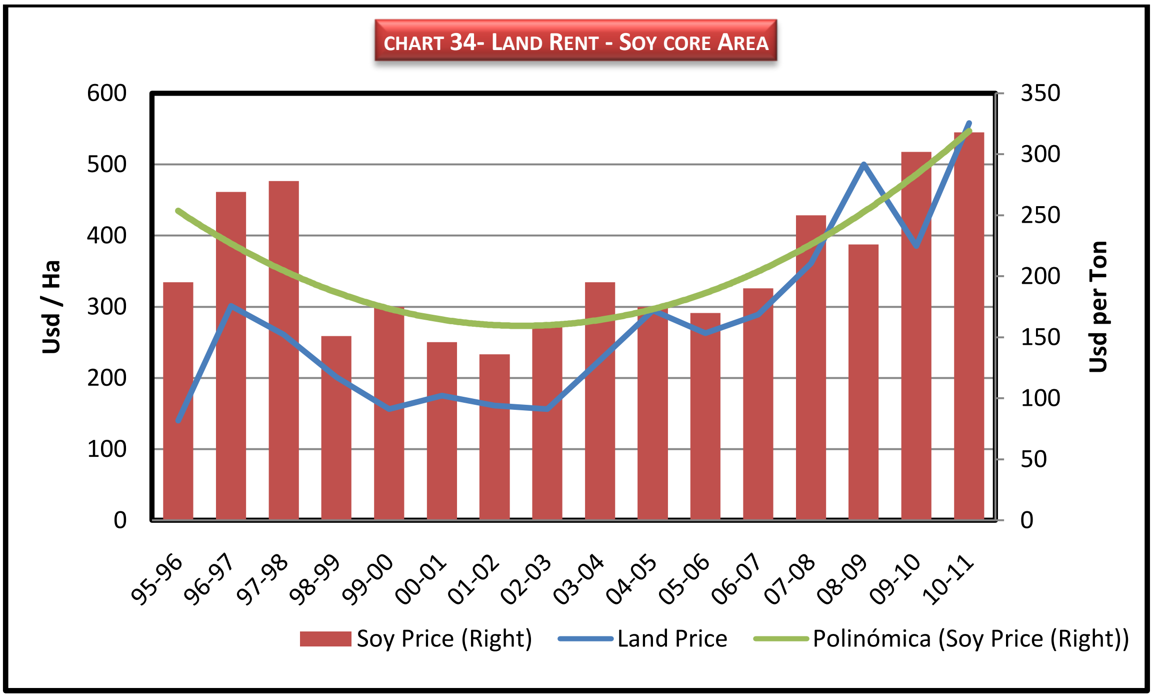
Traceability is becoming a need in some cases, particularly for differentiated products. A service currently required for some special contracts is the certification of non GMO crops and products, involving traceability from the farm to the ports; such services are provided by specialized private firms which conduct the analysis atpublic laboratories (INTA) or those provided by the Arbitration Chambers.

3.8 Land use competition and conflicts

3.8.1 Land use competition and conflicts in the soy chain in Argentina

One phenomenon to keep in mind in order to analyze the land competition and its conflicts within the soy core area is that the price of the crop has had the rise in the land rent as a counterpart.

This is a key variable given that most of Argentina crop production is done by renting the land instead of owning it.



Source: Author's elaboration

The trend line speaks for itself in order to understand the situation of Argentina soy core area.

The process of expansion of soybean depends of the soybean production area. There are two main ways of expansion, first by expanding the agricultural frontier and secondly by replacing other activities. The expansion implies direct land-use changes from natural ecosystems to soybean plantations, and indirect land-use changes to relocate the displaced productions. Traditionally, soybeans have been cultivated in the Pampean region (Central region). The marginal areas where soybean cultivation has been expanded are the Northeast and Northwest regions of Argentina as we have already seen throughout this research.

A study made by Luis Panichelli mentions that "direct land-use changes have occurred in the North region as expenses on sub-tropical dry forests, mainly the Yungas and the Chaquenean Forest: 118 000 ha have been deforested between 1998 and 2002 for soybean production in Chaco, 160 000 in Salta and 223 000 in Santiago del Estero" (Panichelli L.).

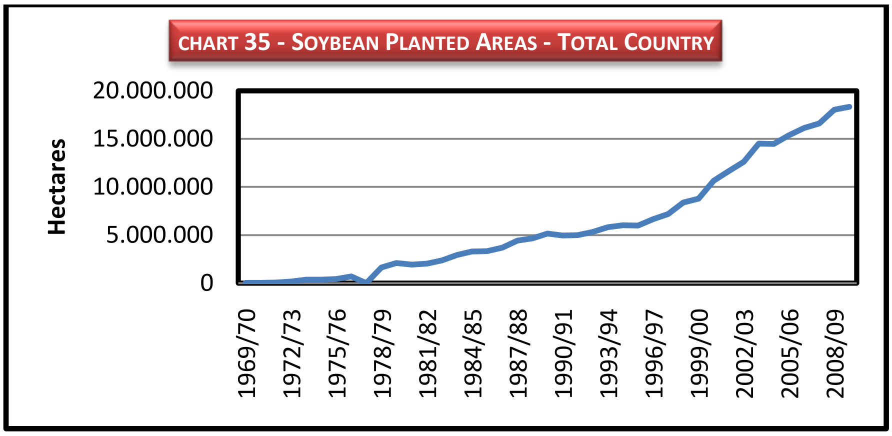
A study made by Carballo Stella et al. uses satellite information's for monitoring the deforested surface since 1986 to 2007. According to this study, the expansion occurs in the Pampean region displacing cattle breeding areas and the areas near the Pampean region causing deforestation of native forest. In the last twenty years the agricultural area has gained 10 million hectares of surface from other land use, in which 2 million hectares were native forest. In the province of Salta more than 500000 hectares were dismantled in the period between 1990-2004, in Santiago del Estero 1000000 hectares were also dismantled. The surface area dismantled during the same period in Tucuman was 150000 hectares, 150000 hectares in Chaco and 200000 hectares in the north of Cordoba (Carballo S. Et al.).

Indirect land-use changes consist in a shift from dairy farms and cattle breeding areas, shift from annual crops production (mainly corn, cotton, and sunflower) and a decrease in rotation with pastures. The displaced activity differs by regions, mainly between the traditional soybean cultivation area (Santa Fe, Cordoba, Buenos Aires and Entre Rios) and the marginal area (Santiago del Estero, Salta, Chaco, and Tucuman).

The general trend in the total country showed in that period a decrease in the surface area planted of others crops than soybean, whereas the soybean surface area planted increased. However, the production of these other crops still continued to rise, as well as soybeans production increased but with a higher rate.

All this phenomena occurred previously to the appearance of soybean oil biodiesel on the country and were caused by the market price indicators although the government policy as was shown worked in the way of reducing those incentives.

The occupation of new lands suited for agriculture has been one of the most remarkable facts in Argentina's recent history, especially since mid-1990's, technological improvements made historically regulated areas now production suited, generating and important expansion of the agricultural frontier, reaching the northeast and northwest of the country.



Source: INDEC

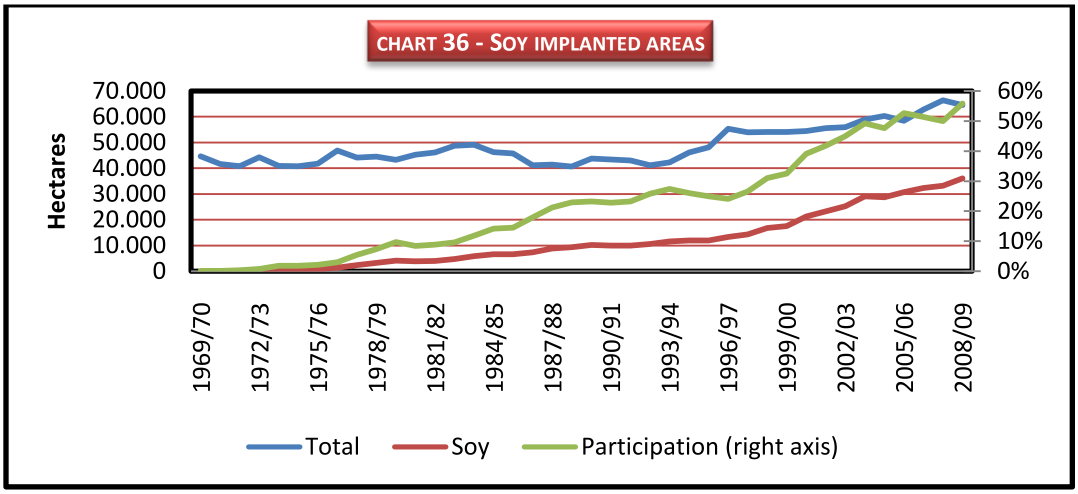
As we can conclude there is clear cut since the 1970's towards planted area expansion.

Such growth picked in the 2000's, with a 22, 8% variation comparing it with 1990's.

From this point of view it is evident that the agriculture advance is crystal clear in Argentina as a whole.

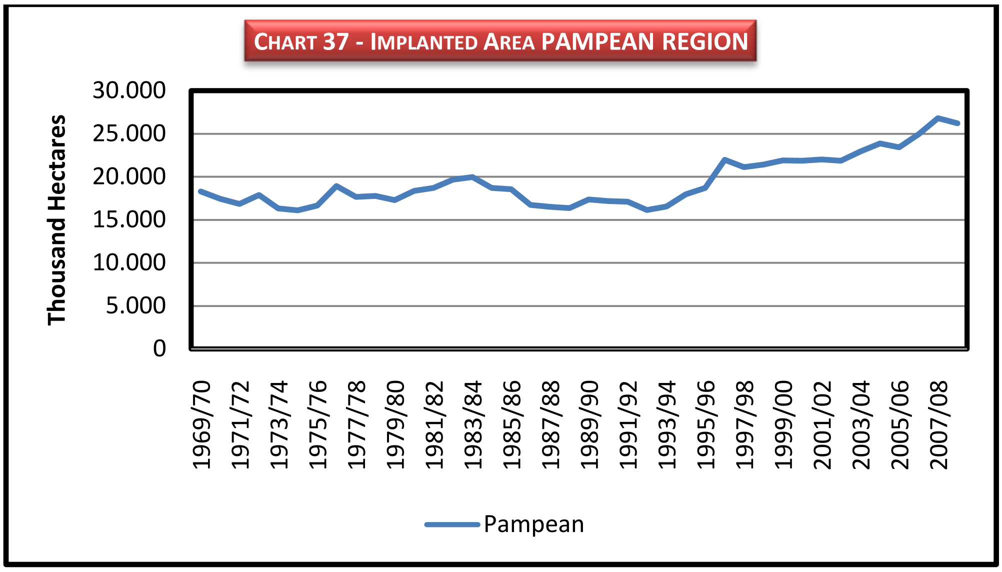
Soybean planted area growth in Argentina has been specially up scaled as we addressed previously, in 1969/70 campaign soybean planted areas accounted for 0,1% of the total planted areas in the country. The actual proportion now is 55, 9%, being by far the biggest crop in Argentina.

This helps the expansion of soy biodiesel production transforming Argentina in a world leader production-wise.

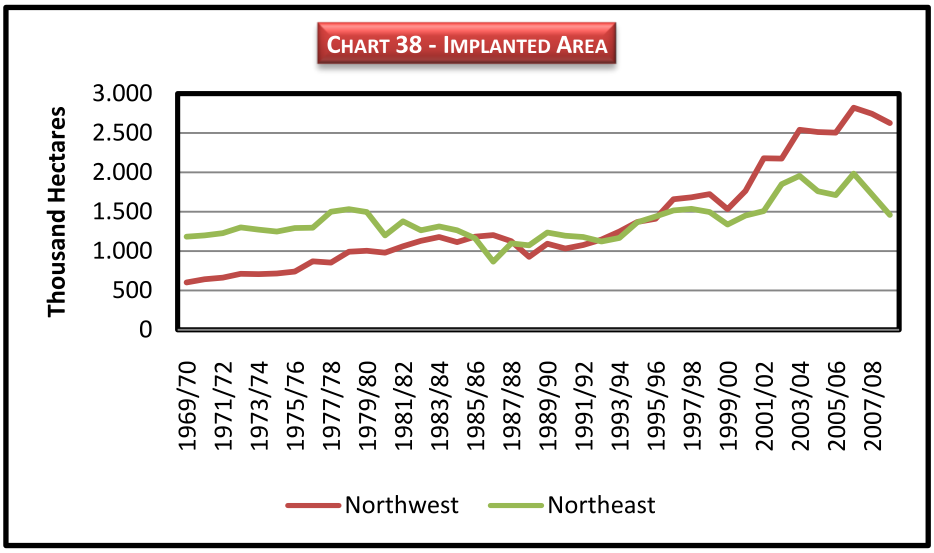


Source: INDEC

Another topic of analysis is the geographical distribution of planted areas. As shown in the next chart, for the last quarter century there has been a clear growing tendency of planted area in Argentina's Pampean Region (La Pampa, Santa Fe, Buenos Aires, Córdoba, San Luis y Entre Ríos), Northwestern Region (Salta, Santiago del Estero y Tucumán) and in Northeastern Region (Chaco, Corrientes, Formosa y Misiones)

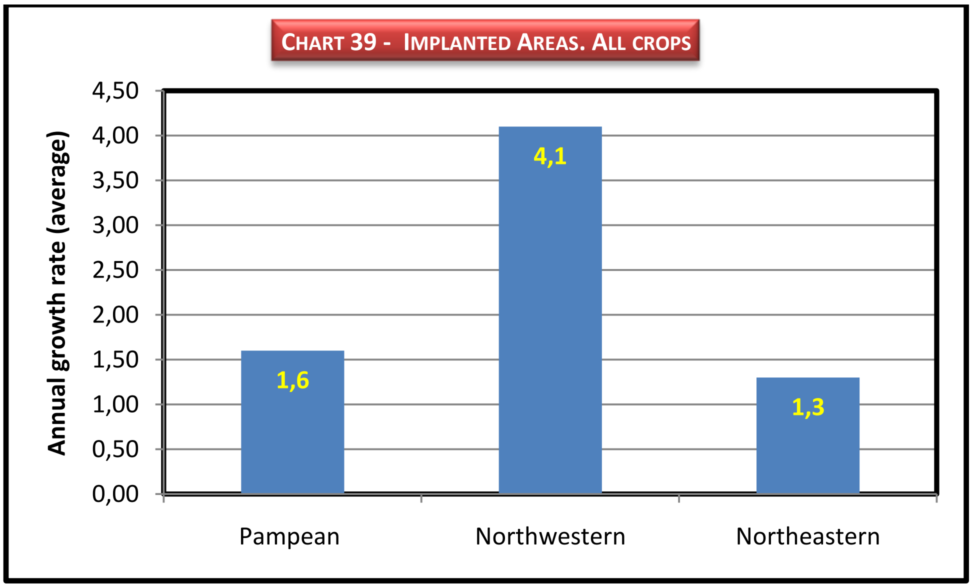


Source: Ministry of Agriculture



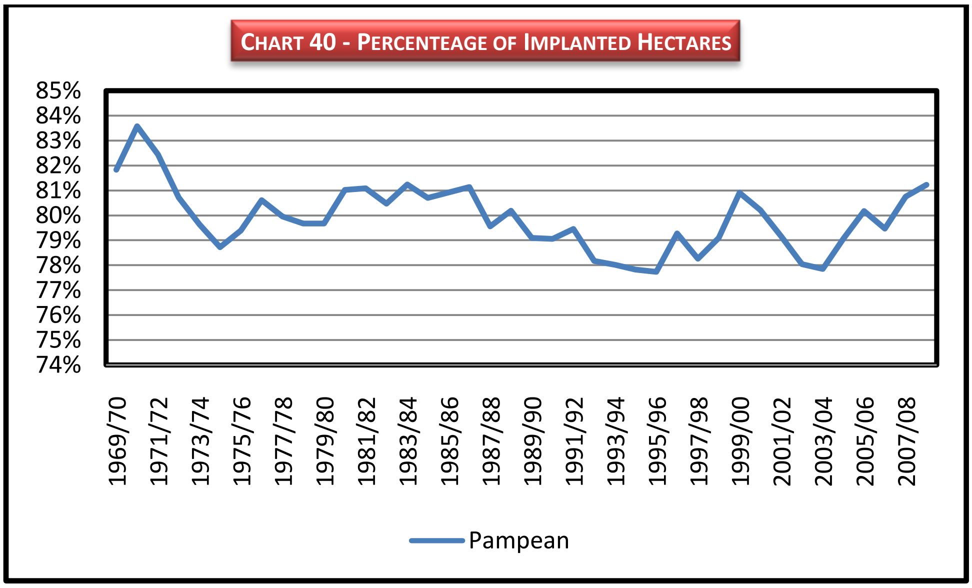
Source: Ministery of Agriculture

Since the 1985/86 campaing (last 25 years), the increment on implanted areas in Northwestern region has been bigger than both Pampean and Northeastern regions. A bigger Northwest Region participation has been taking place, and a frontier expansion as a result of such phenomenom

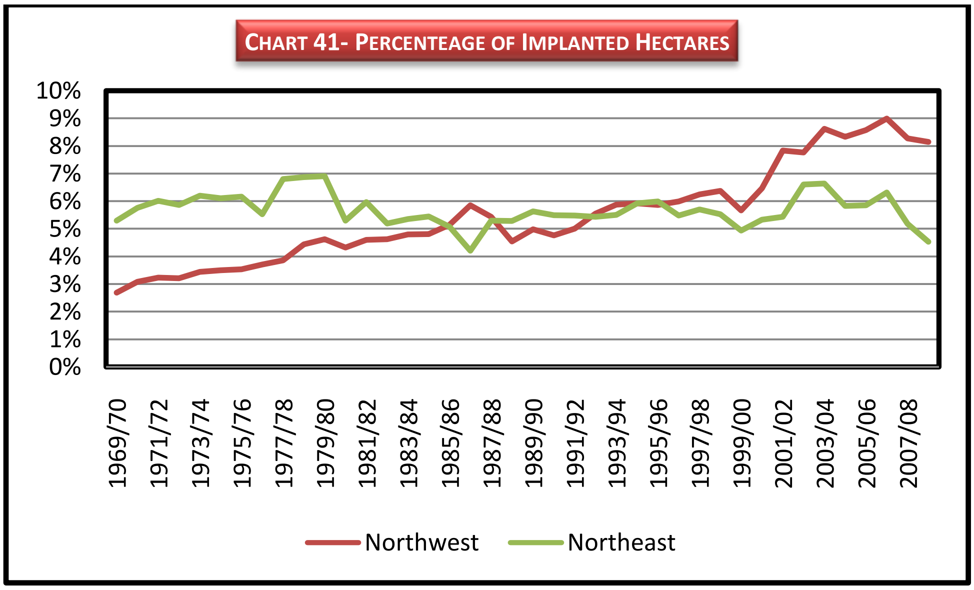


Source: Ministery of Agriculture

As a matter of fact, Northwest region has gained a bigger participation in the total of planted areas countrywide, witch contrasts with a certaing stability (with long rung fluctuations) in both Pampean and Northeastern Regions. From this perspective, the leading zone frontier expansion-wise has been the Northwestern region

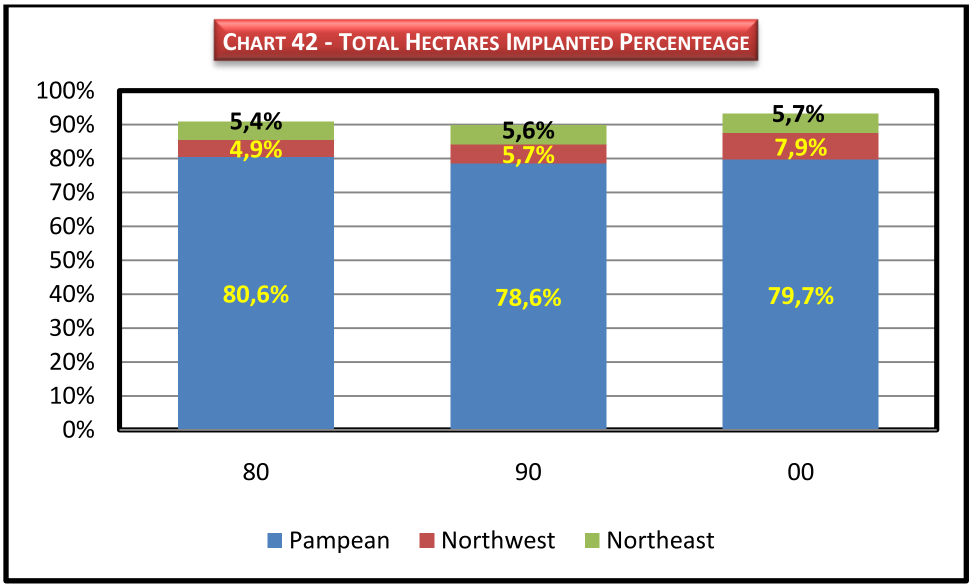


Source: Ministery of Agriculture



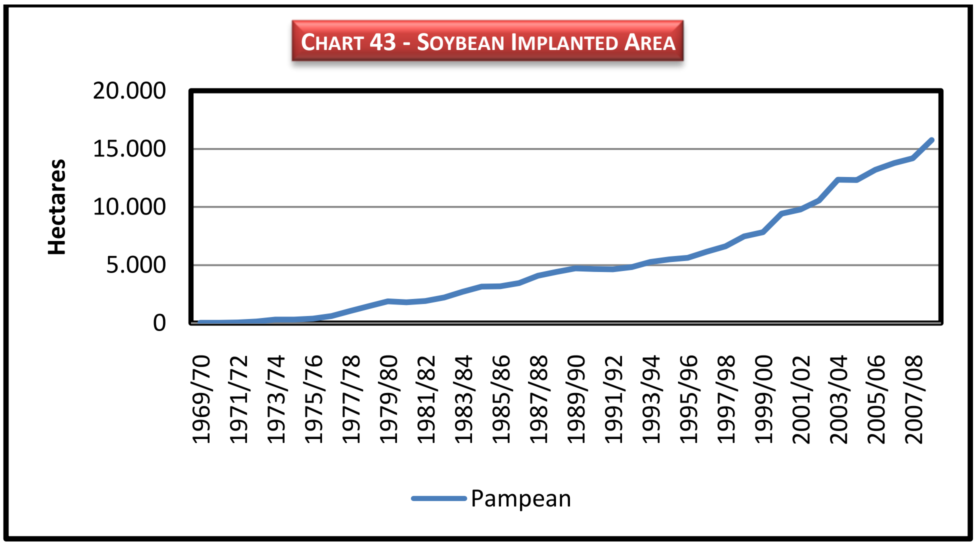
Source: Ministery of Agriculture

In a much clearer way we can observe the behavior in a decade basis, as shown in the next chart, the certain stability in both Pampean and Northeastern regions is offset by Northwestern region, which only accounted for 4,9% of the total in the 1980's and now is towards 7,9%.

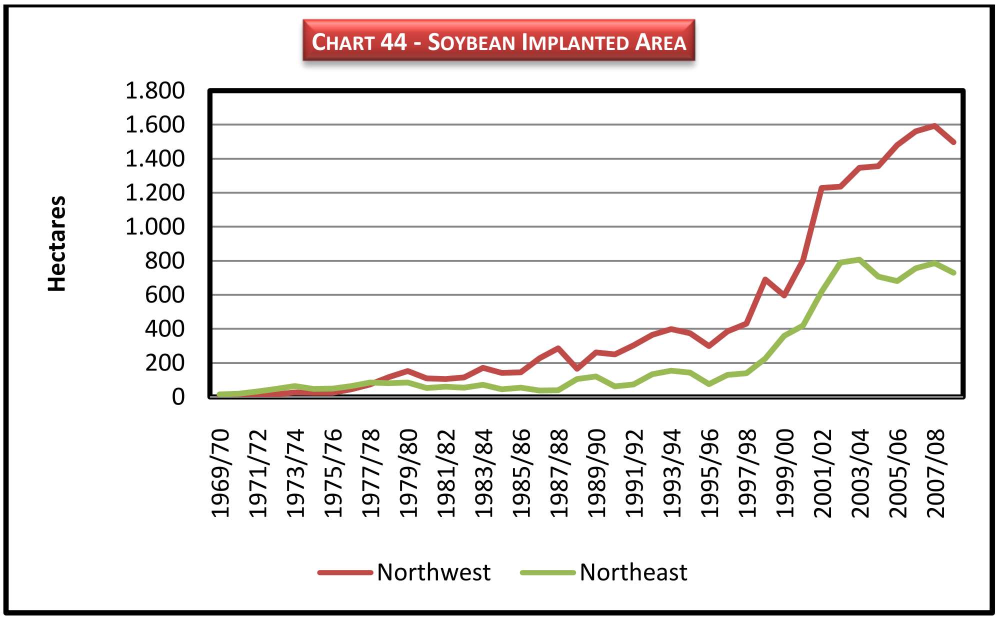


Source: Ministery of Agriculture

Evidence for the advance of agriculture towards previously unexploited areas seems to be solid, and seeing soybean ponderation we can conclude that a large part of such advance must be explained by soybean growth. Northwestern region shows a bigger growing trend than Pampean and Northeastern regions, especially bigger than the latter.



Source: Ministery of Agriculture

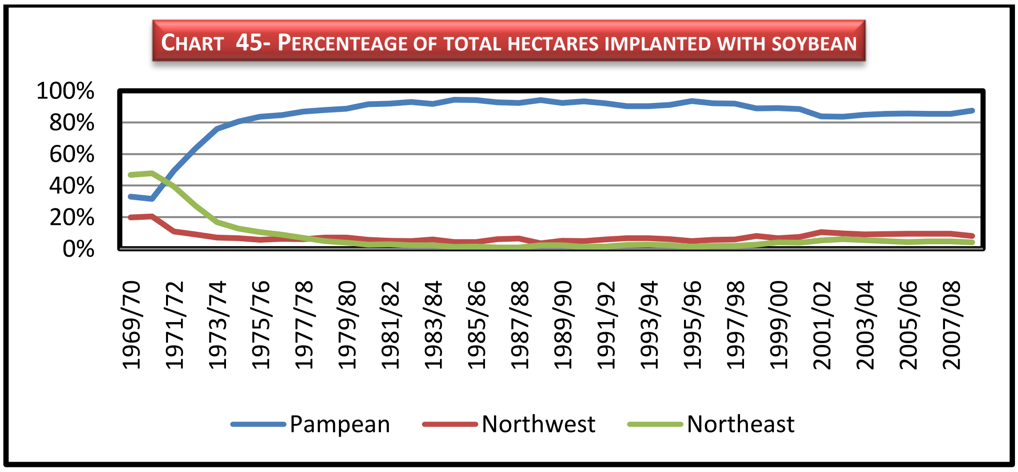


Source: Ministery of Agriculture

Same behavior is shown if we account the regions participations in soybean planted areas. Since the beginning of the 1980's Pampean Region accounted for approximately 90% of the total of hectares destined to soybean, over the last couple of years that participation slipped 6% in favor of both Northeastern and Northwestern regions

It can be clearly seen from the graph that after the implementation of export tax and compensating policies for other crops the rate of expansion in both NW and NE regions decreased significantly due to the lower yields and higher transport costs of this new areas.

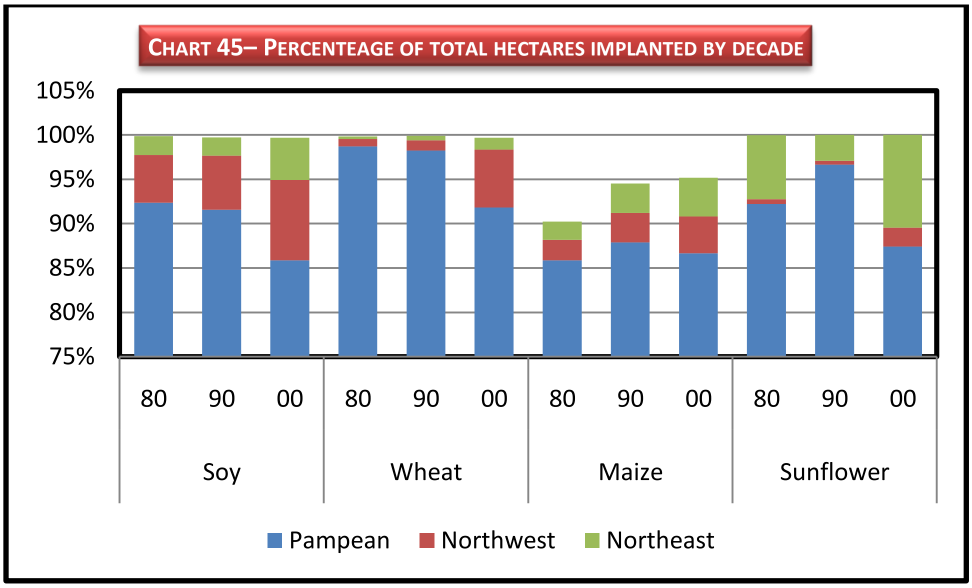
We must add to this the new restrictive legislations put in place in severalprovinces from 2008 onward.



Source: Ministery of Agriculture

This can be viewed as a confirmation regarding the relationship between the expansion towards unexplotied areas and soybean growth.

This conclution is in line with the arguments sustaining that improvements in production techniques makes possible to expand the frontier towards historically non profitable areas



Source: Ministery of Agriculture

As shown in the chart above, the tendency of the loss of participation by the Pampean Region has been generalized for the most part of cultives, maize being the only exception. In both soybean and wheat cases the advance of Northwestern region is evident.

From this perspective the soybean techonological hypothesis seems to lose weight given that 3 of the 4 most important cultives has shown a tendency toward expansion in historically marginated areas. One last thing to consider is that the growth in soybean planted areas in relation to the planted areas total has been notably larger in the Pampean region than in the other two regions in study.

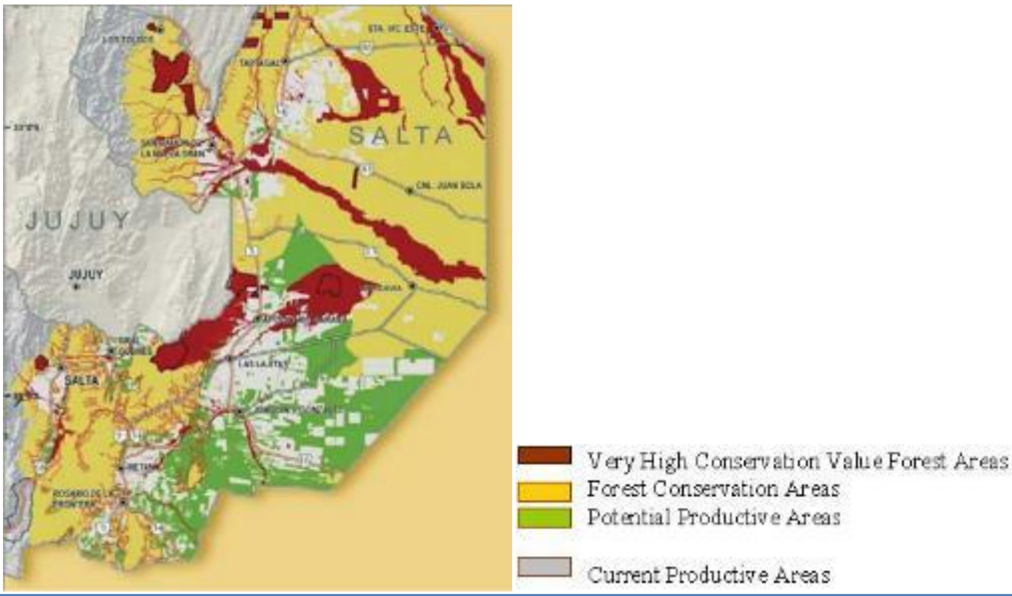
Table 6 –Soybean implanted areas variation over total implanted areas

	PAMPEAN	NORTHWEST	NORTHEAST
80	415%	37%	-11%
90	320%	84%	58%
00	136%	90%	155%

Source: Ministery of Agriculture of Argentina

From this point of view seems evident that soybean has contributed to explain the agricultural frontier expansion, but it is difficult to conclude that the only factor explaining such expansion is the soybean phenomenon.

Regarding soil use in the country a very important law was enforced two years ago, it establishes the minimum requirements for defining the different uses of land by the provinces. Each province as responsible for its territory has to define the different regions ans uses according to the agroecological and social particularities. Most of the main provinces have already establish the different areas witin their boundaries. This will put an end to an unplanned agricultural expansion invading conservation areas.



Example of territorial definition in the province of Salta NW of the country

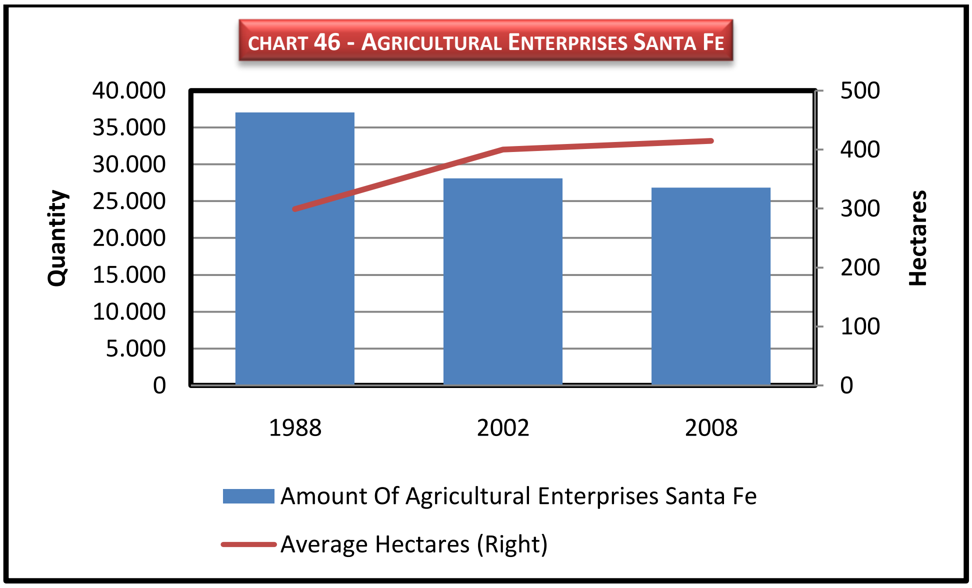
3.8.2 Land use competition and conflicts in the soy chain in the First Case Study plant

The location of the First Case Study plant, in the heart of the soy core area of Argentina functions as a proxy to understand the change in land concentration that has happened in Argentina over the last few years.

The concentration is more important when production is being considered, because economies of scale became very relevant tools for farming competitiveness in Argentina, and many owners prefer to rent all or part of their farms, particularly in the case of land destined to annual crop production.

However, the main transformation process registered in soybean production in Argentina during the last two decades is the emergence of a new organizational production model based on networks, which is replacing the traditional farming system as we stated in the national analysis of the land competition.

In the particular case of Santa Fe province the number of agricultural enterprises has gone down and the average has gone up. This trend repeats in the whole agricultural areas of Argentina and responds to the new type of agricultural production.



Source: Author's elaboration according to INDEC

3.8.3 Land use competition and conflicts in the soy chain in Viluco, Frias, Santiago del Estero

The main difference between the soy core area of Buenos Aires, Santa Fe, Cordoba and the area where Viluco is located is the access to ports. This should elevate the cost for feedstock production and conversion for the areas located outside of the Pampean Region.

But in the case of Viluco this is mitigated given that the plant has its own provision of feedstock.

In the area of Frias and in the whole province a different type of situation is in place when the land ownership is taken into account.

It is worth mentioning that the Santiago del Estero province is not an historical location for soybean production and that the expansion has been fuelled by the introduction of the RR soy and the consequent technological evolution for the implantation of soy.

In the pampean case the expansion of soy lands has been by the rent of land by different producers.

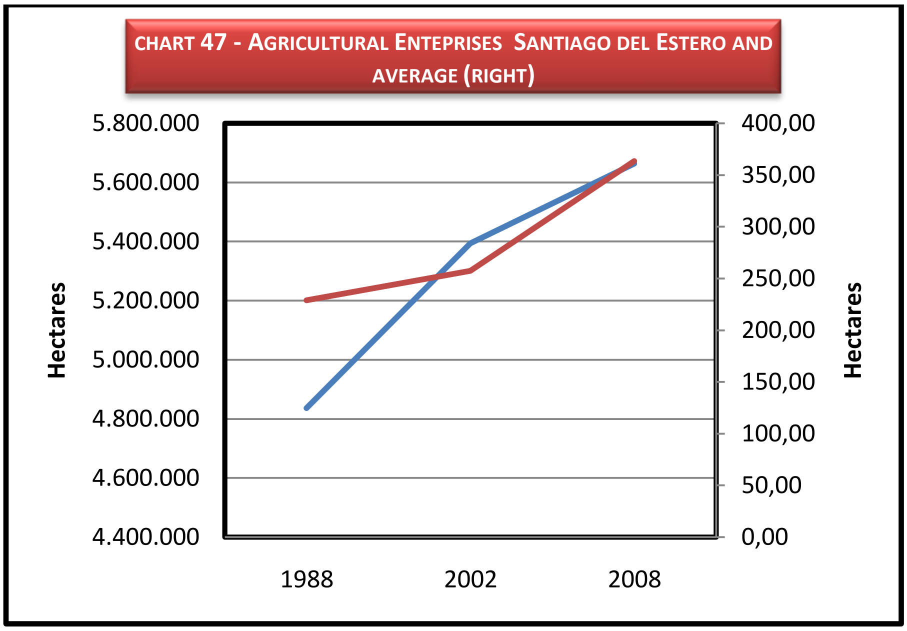
In the case of Santiago del Estero the land expansion has been, on average, by the acquisition of lands by the producers.

This has been possible because of the lower prices of lands in the extra Pampean zone in the beginning of the 2000s.

It has to be kept in mind that in many areas the inversion has been high because of the presence of forests that were not suited for soy plantations.

This expansion means that most of the producers that own land in the Santiago del Estero province are from the Pampean Region.

The most remarkable situation that can be obtained from the INDEC is the change in the average enterprise of Santiago del Estero's soy sector.



Source: INDEC

In the last chart it can be observed how the hectares of the agricultural enterprises (mostly soybean) have been growing both in total hectares and in average.

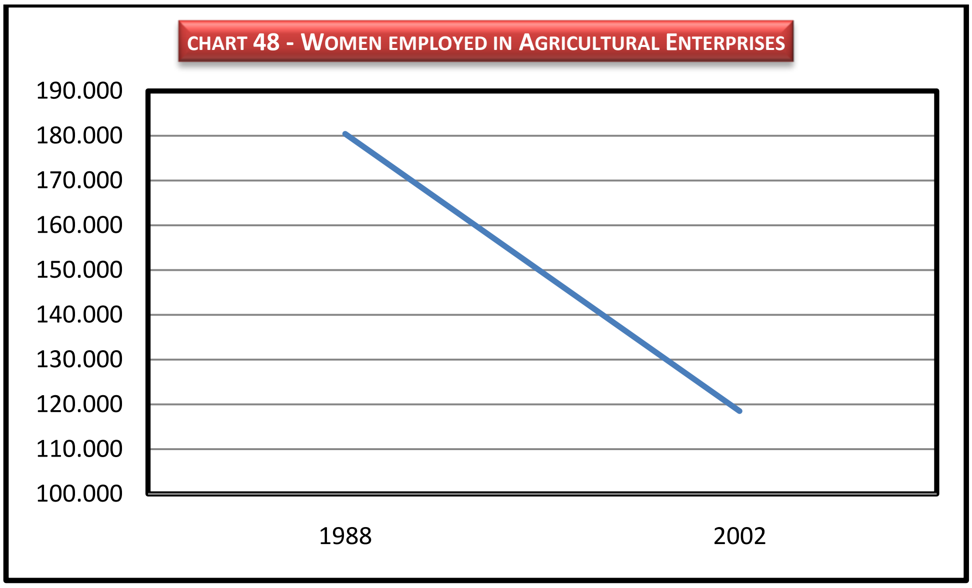
The growth of the average in the agricultural enterprises is explained by the diminution in the amount of enterprises.

In 1988 according to the Agricultural Census 21,122 agricultural enterprises were obtained and by 2008 that number decreased to 15,584. This is explained by the necessity to gather more hectares in a same enterprise to destine in soybean production.

3.9 Gender issues

3.9.1 Gender issues in the soy chain in Argentina

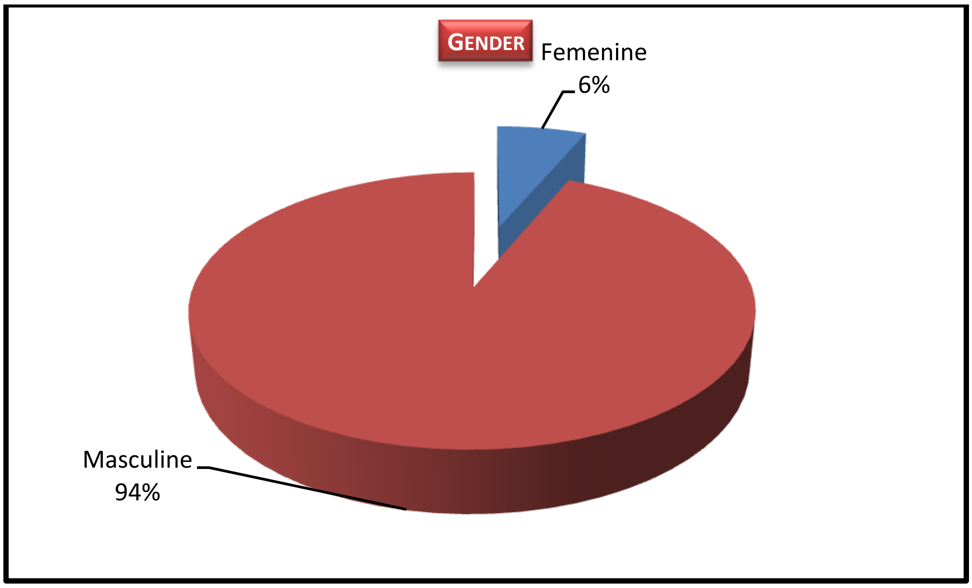
Agricultural production has been historically a man driven activity, Argentina is no exception.The last available data comes from the Agricultural Census of 2002 and it proves that the hypothesis of low participation of women in agricultural enterprises is a reality nation-wide.



Source: Author’s elaboration using INDEC information

3.9.2 Gender issues in soy chain in Viluco

The data available comes from the feedstock production part of the Viluco facility and is in line with the information nationwide given that the feminine labour is a low percentage



5. Environmental impacts

A number of environmental impacts are usually associated with the production and use of biomass for biofuel / bioenergy or biomaterial purposes. These include impacts on **human health** (release of toxic substances, emission of photo oxidants and ozone-depleting gases), on the **quality of ecosystems** (release of toxic substances, emission of acidifying and eutrophying gases, land-use impacts on biodiversity, water and soil) on **climate change** (global warming) and on **resources** (non-renewable energy carriers and minerals).

Out of this list, Article 23(1) of the European Renewable Energy Directive (RED, 2009/28/EC) specifically mentions the impacts on global warming (greenhouse gas emissions) biodiversity, water resources / quality and soil quality (EP & CEC 2009).

Within the Global-Bio-Pact project, these four environmental impacts were addressed. The same environmental impacts have also been selected for the analytical framework within the FAO-funded Bioenergy Environmental Impact Analysis (BIAS) project (FAO 2010).

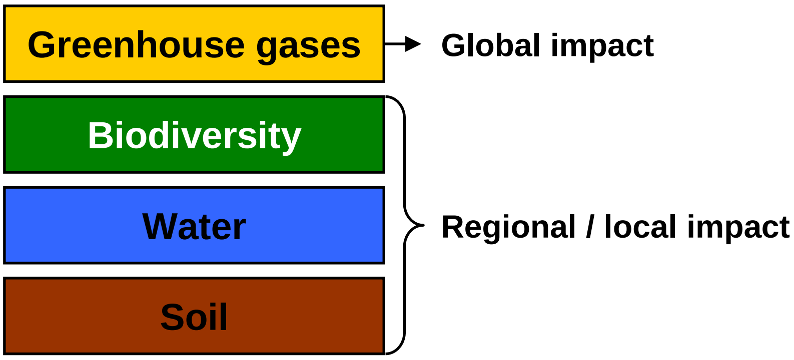


Figure 5: Environmental impacts assessed within the Global-Bio-Pact project (IFEU 2010).

Environmental impacts are occurring at different geographical scales, e.g. at global level (impacts on climate change and on the depletion of the ozone layer) or at regional and local level (impacts on biodiversity, water and soil).

Since the 1970ies, environmental assessment has been developed as a systematic process to identify, analyse and evaluate the environmental effects of products or activities to ensure that the environmental implications of decisions are taken into account *before* the decisions are made. Environmental assessment allows effective integration of environmental considerations and public concerns into decision-making. There are several environmental management techniques (e.g. risk assessment, life cycle assessment, environmental performance evaluation, environmental auditing, and environmental impact assessment). Each of these techniques is appropriate for specific situations.

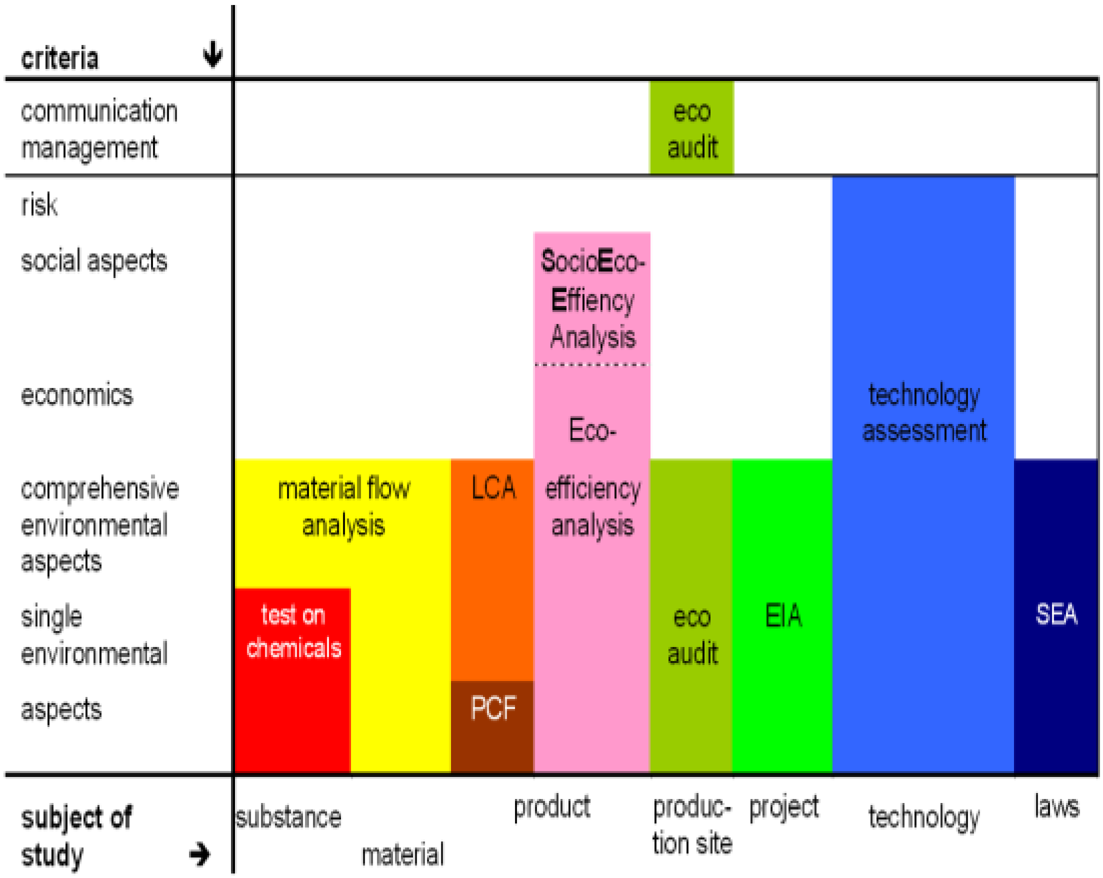


Figure 6: Environmental assessment techniques

The main areas of concern within the Global-Bio-Pact project are the use of land and related ecosystem impacts (biodiversity), the quality of soils, the availability and quality of water, and greenhouse gas emissions. While the latter can be quantified, others can only be described on a qualitative basis (e.g. biodiversity).

Consequently, the environmental assessment within the Global-Bio-Pact project combines elements of Life Cycle Assessment (LCA) with elements of Strategic Environmental Assessment (SEA) and / or Environmental Impact Assessment (EIA). LCA will be used for the quantification of greenhouse gas emissions (having a global impact), whereas SEA and / or EIA will be applied to the other three key environmental impacts (having a regional / local impact).

Elements of Environmental Impact Assessment (EIA) will be used to describe the local environmental impacts of biomass cultivation and conversion. Figure 7 depicts the conventional procedure of an EIA.

As stated in the EIA Directive (85/337/EEC), an EIA shall identify, describe and assess in an appropriate manner, in the light of each individual case […], the direct and indirect effects of a project on the following factors:

- human beings, fauna and flora;
- soil, water, air, climate and the landscape;
- material assets and the cultural heritage;
- The interaction between the factors mentioned in the first, second and third indents.

Elements of the EIA were used to determine the impacts on biodiversity, water resources / quality and soil quality.

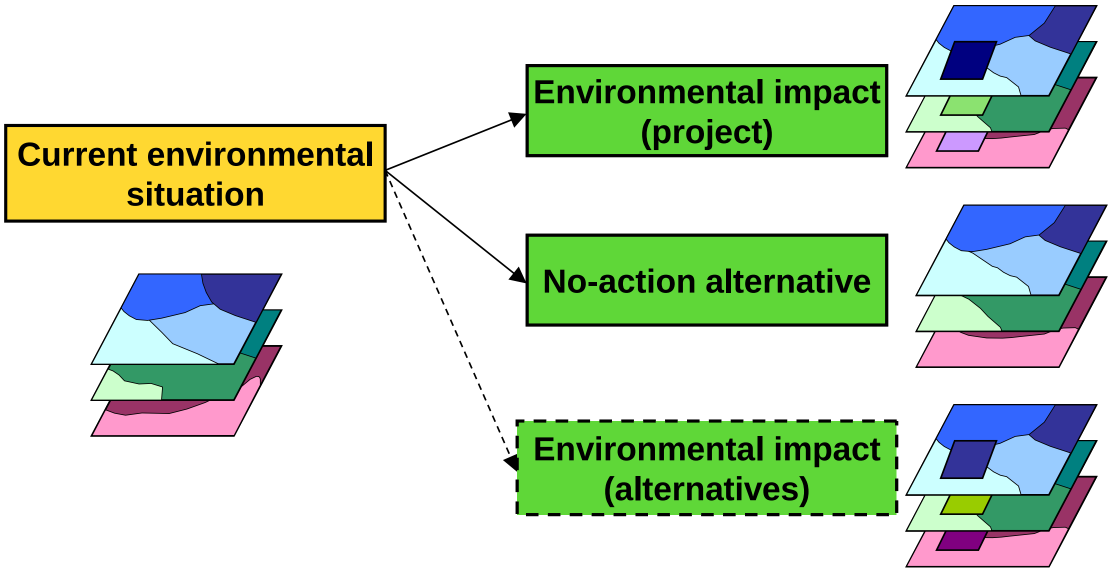


Figure 7: Conventional procedure of an EIA

For the quantification of greenhouse gas emissions, which are having a global impact, the life cycle assessment (LCA) methodology was used. The calculation rules laid down in Annex V of the Renewable Energy Directive (RED, 2009/28/EC) were taken into account.

3.10 Greenhouse gas emissions

For the quantification of greenhouse gas emissions, the life cycle assessment (LCA) methodology will be used. The calculation rules laid down in Annex V of the Renewable Energy Directive (RED, 2009/28/EC) will be taken into account.

For each of the selected case studies, the partners are asked to (separately) provide the information requested in the following sections.

3.10.1 Greenhouse gas emissions in the soy chain in local case study 1

In case study one the plant purchased the oil for the transformation into biodiesel. The production of the feedstock data belong to the main central production area of soybean in Argentina-

According to the feedstock origin 95 % the following areas were selected

Type of Agriculture*[1]		No Till	No Till	No Till
Stage				
Agriculture		**South of Santa Fe (Venado Tuerto)**	**North of Bs. As./South of Santa Fe (Pergamino)**	**South of Córdoba (Rio Cuarto)**
Feedstock (Kg/ha/year)*[2]	Soybean	4.500	3.600	2.750
Energy consumption (MJ/ha/year) *[3]	Diesel	998	998	998
Fertilizers*[4] (Kg/ha/year)	Nitrogen	14	4,4	0
	P_2O_5	78	21	0
	K_2O	0	0	0
Feedstock transportation*[5]				
Transport (km)	Conv. Diesel truck	191	139,9	395
Drying and storage				
Feedstock (Kg/Kg)	Soybean	1	1	1
Energy Consumption	Electricity*[6a] (KWh/ton)	1,2	1,2	1,2
	Natural gas*[6b] (MJ/ton)	141	141	141
	Conv. Diesel*[7] (MJ/ton)	3	3	3
Crushing				
By-product (Kg/Kg of seed)	Vegetable oil	0,194	0,194	0,194
	Meal	0,714	0,714	0,714
Energy Consumption[8]	Electricity (KWh/ton s)	34,3	34,3	34,3
	Natural Gas MJ/ton[9]	4770	4770	4770
	Hexane[10] (MJ/ton)	4,66	4,66	4,66
	Diesel truck*[15]	15	15	15

Source: Hilbert J.A; Donato L.B..; Muzio J.; Huerga I; "Comparative analysis of energy consumption and greenhouse gas emissions from the production of biodiesel from soybean under conventional and no till farming systems", Doc N° IIR-BC-INF-06-09

Description of Case study I xx plant

At case study plant vsited the soybean oil is used as feedstock, like the methanol, and other liquids, arrives on tanker trucks, at an average 28t per truck, soy oil comes from a near crushing facility at 3km..

Picture 1 Feedstock Discharge

Production process begins with a physical refinery process, for the removal of impurities e.g. proteins, gums, free fatty acids, oxidation compounds, and color bodies and neutralizing the free fatty acids, reducing phosphorus contents and acidity. Acids (chloridric or phosphoric typically) are used to degum the base oil and remove any high free-fatty acids. The amount of acids needed is dependent on the incoming base oil; however, only a small amount (compared to alcohol and the catalyst) is used in the biodiesel process. Typically, the amount is less than 0.5% of the total biodiesel volume produced. The next operation is centrifugation for de-gumming for separation of gums and impurities. Next step is bleaching with silica adsorbents for removal of residual soaps after neutralization (”Trysil”). Neutralized oil is then mixed with methanol and sodium methylate (also called sodium methoxide) in transesterification reactors.

 **Picture 2 Waste silica**	 **Picture 3 Waste bleaching earth discharge from filters, about 1,1 to 1,8 kg of waste per tn of oil treated**

	
Picture 4 Westfalia Centrifugal separator, installed cost eight hundred thousand dollar approximately	Picture 5 Methanol column,see from the outside This is for a 250.000 tn/year of Bio plant Cost of a similar column for a 420.000 tn/year of Bio plant is u$s 1.200.000

All these photographs taken at the case I plant near Rosario 25thjuly 2011

The crude glycerin byproduct is about 12 % of the biodiesel produced. The crude glycerin run through the glycerin column to recover the un-reacted methanol. The methanol in the biodiesel is recovered and sent to the methanol column for cleanup prior to recycling back to the reactor. The produced glycerol was 85 % purity according to the HPLC analysis and could be used in industrial uses or exposed to further purification for pharmaceutical uses. Free fatty acids of 2 % of the oil weight are obtained, as well as sodium phosphate salts.

The biodiesel is washed with water at low pressure and in the next step water and solids are removed by the centrifuge, going from there to the dryer at low pressure and finally is piped to the storage tanks.

	
Picture 6 Huge Biodiesel storage tanks (8000 M3)	**Picture 7 Biodiesel storage tanks (1095 M3).**

Photographs taken at case I study plant near Rosario 25thjuly 2011

Some of the most important chemical and physical quality control parameters of the produced biodiesel are measured and compared with the petroleum diesel parameters. These parameters such as viscosity, flash point, pour point, cloud point, carbon residue, acid value and calorific value are continuously tested at the quality control laboratory, checking if them have acceptable values and are in agreement with the petroleum diesel parameters. The quality control laboratory was worth a six hundred thousand dollar at one of the visited plants of 250.000 tn/year of Bio (with a projected production doubled as per 2012) and a figure of five hundred thousand dollar was given as the value at another plant of 420.000 tn/year of Bio.

Picture 8 Ing. Felix Martin standing by a Herzog Cloud Pour Point Robot

Pict nsky Martens Closed Cup Flash Point AnalyzerHFP 339.

Water recovered during drying of the esters and glycerol fractions is recycled in part, going to activated sludge biological treatment plant at the facility. The wastewater characterization from biodiesel process is tested using techniques such as Chemical Oxygen Demand (COD), Total Organic Carbon (TOC) and gas chromatography for the measurement of methanol. At one of the plant visited 25th july 2011, this waste stream was about 1560 m^3 per month, and the treated wastewater COD was about between 25 to 50.

Picture 10 SHIMADZU Gas Chromatograph System Used to analyze the volatile components in liquid samples.

Picture 11 Ing Jorge Hilbert hearing the explanation of the quality laboratory member about an Herzog's HVM 472 Automated Multi-Range Viscometer.

Picture 12 Activated sludge biological treatment plant.

Picture 13 Spectroquant Pharo 300 UV/ VIS spectrophotometer

In the background of the photography it can be seen the preprogrammed test kits for COD test.

Crude, degummed soybean oil was specified as the feedstock. Annual production capacity of the plants in this report was more of two hundred thousands metric tones. Facility construction costs were estimated at 45 million dollars for a typical plant of 240000 t bio/yea. At a value of 464,850 U$S/kg for feedstock soybean oil, a biodiesel production cost of 546,313 U$S/t was calculated. The single greatest contributor to this value was the cost of the oil feedstock, which accounted for 85% of total estimated production costs. Process economics included the recovery of coproduct glycerol generated during biodiesel production, and its sale into the commercial glycerol market as an 80% w/w aqueous solution, revealed that it don´t has impact at the calculated cost.

IN the following table the principal input materials and the costs in the case I study are presented

Item	base cost as 2005	Units	mass/volume balance per tn bio	Units	cost	Units
soybean crude oil	450	u$s/t	1,033	t/t	464,850	u$s/t
Methanol	0,25	u$s/kg	97,186	kg/t	24,297	u$s/t
Catalyst (Na-Methylate)	0,887255	u$s/kg	16,5	kg/t	14,640	u$s/t
Chloridric Acid	0,127451	u$s/kg	10,41	kg/t	1,327	u$s/t
Caustic Soda	0,245098	u$s/kg	4,9	kg/t	1,201	u$s/t
Nitrogen	0,117647	u$s/$Nm^3$	3,91	Nm^3/t	0,460	u$s/t
Phosphoric acid	0,441176	u$s/kg	1,743	kg/t	0,769	u$s/t
Steam	7,938	u$s/t	0,4562	t/t	3,621	u$s/t
Water	0,343	u$s/$m^3$	0,3175	m^3/t	0,109	u$s/t

Electricity	0,070	u$s/kWh	34,791	KWhr/ tn bio	2,435	u$s/t

From the trasnformaton facility the following data was obtained looking at the principal inputs with relevant importance for a GHG emission calculation

Estherification		
By-product (Kg/Kg oil)	**Biodiesel**	0,95
(Kg/Kg oil)	**Glycerine**[11]	0,12
Energy use	**Electricity (KWh/ton bio**[12]	34,8
	Natural gas MJ/Ton biod[13]	1499
	Methanol (Kg/ton seeds)	99

3.10.2 Greenhouse gas emissions in the soy chain in local case study 2 (Viluco)

Since case II all the production chain was contemplate and there was a complete informatics system with real daily data concerning all the steps a complete calculation was performed following the European Directive

- **Estimation model for GHG number:**

For the construction of the methodology and emission calculation GHG the European Directive was taken into account. The specific input data was considered in the cases that were applicable to the production chain.

The different factors are studied and analyzed...

$E = e_{ec} + e_l + e_p + e_{td} + e_u – e_{sca} – e_{ccs} – e_{ccr} – e_{ee}$,

E = eec + el + ep + etd + eu – esca – eccs – eccr – eee,

where *E*	total emissions from the use of the fuel;
eec	emissions from the extraction or cultivation of raw materials;
el	annualized emissions from carbon stock changes caused by land-use change;
ep	emissions from processing;
etd	emissions from transport and distribution;
eu	emissions from the fuel in use;
esca	emission saving from soil carbon accumulation via improved agricultural management;
eccs	emission saving from carbon capture and geological storage;
eccr	emission saving from carbon capture and replacement; and
eee	emission saving from excess electricity from cogeneration.

	Concepto	Including
E =	total emissions from the use of the fuel;	
e_{ec} =	emissions from the extraction or cultivation of raw materials;	Yes
e_l =	annualised emissions from carbon stock changes caused by land-use change;	No According to research data on fields under production before January 2008 with no tillage and crop rotation no carbon change has been detected. This is under monitor surveillance and could be change according to the obtained

		results in the future.
e_p =	emissions from processing;	Yes
e_{td} =	=emissions from transport and distribution;	Yes
e_u =	=emissions from the fuel in use;	No European directive - Annex V - Paragraph 13: “Emissions from the fuel in use, eu, shall be taken to be zero for biofuels and bioliquids
e_{sca} =	emission saving from soil carbon accumulation via improved agricultural management;	No No increase in carbon stocks is considered
e_{ccs} =	emission saving from carbon capture and geological storage;	No No such practices are implemented.
e_{ccr} =	=emission saving from carbon capture and replacement; and	No No biomass is used to replace fossil fuels during the process
e_{ee} =	=emission saving from excess electricity from cogeneration.	No No cogeneration is made in the industrial plant

Greenhouse gas emissions from fuels, E, are expressed in terms of grams of CO2 equivalent per MJ of fuel, gCO2eq/MJ (paragraph 2 annex V

Greenhouse gas emission saving from biofuels and bioliquids were calculated as:

SAVING = (*EF* – *EB*)/*EF*,

where *EB* =total emissions from the biofuel or bioliquid; and

EF =total emissions from the fossil fuel comparator.

The greenhouse gases taken into account for the purposes of point 1 shall be CO2, N2O and CH4. For the purpose of calculating CO2 equivalence, those gases shall be valued as follows: CO2

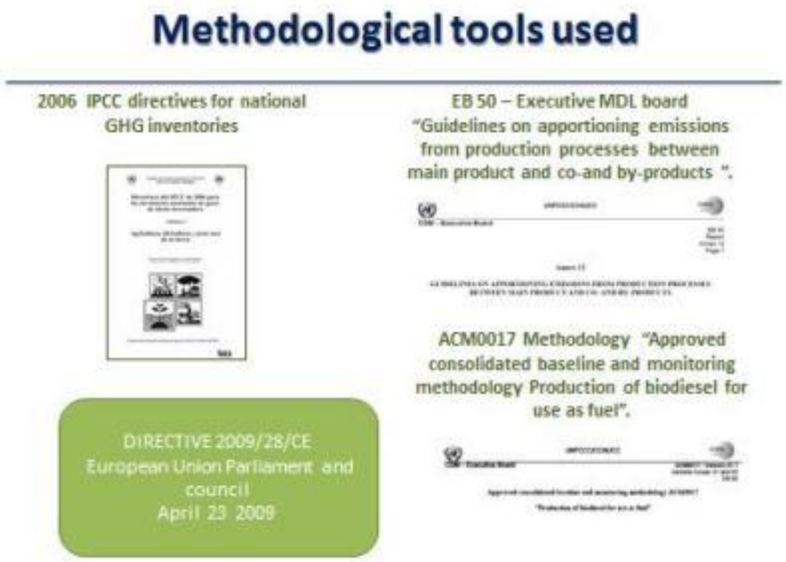
CO2	1
N2O	:296
CH4	:23

According to the internal information system of the company the total cycle of biodiesel production was divided in the following way

- Farming production (e_{ec}): all items till the farm gate are included.

- Raw material freights[1]: includes all transport operations from the fields including short and long freight to intermediate storage facilities.
- Production of biodiesel and coproducts (e_p):
- Emissions from processing, *ep*,l includes emissions from the processing itself; from waste and leakages; and from the production of chemicals or products used in processing.
- Final transport to end use of the product (e_{td}): includes transport by trick to the port and by ship to (Rotterdam).

For calculating each concept value the Guide of IPCC 2006 were used.



Farm production:

According to paragraph 6 Annex V of the EU Directive Emissions from the extraction or cultivation of raw materials, eec, include emissions from the extraction or cultivation process itself; from the collection of raw materials; from waste and leakages; and from the production of chemicals or products used in extraction or cultivation. Capture of CO2 in the cultivation of raw materials was excluded... Estimates of emissions from cultivation may be derived from the use of averages calculated for smaller geographical areas than those used in the calculation of the default values, as an alternative to using actual values.

Since AG-Energy – Viluco Company has a robust and complete information system with data from individual field within each farm; emissions were calculated at plot level and then consolidate at farm level. Additionally as the calculating procedure is very similar for the different crops, all summer crops were analyzed.

We describe nw the sources of information and the calculation procedure:

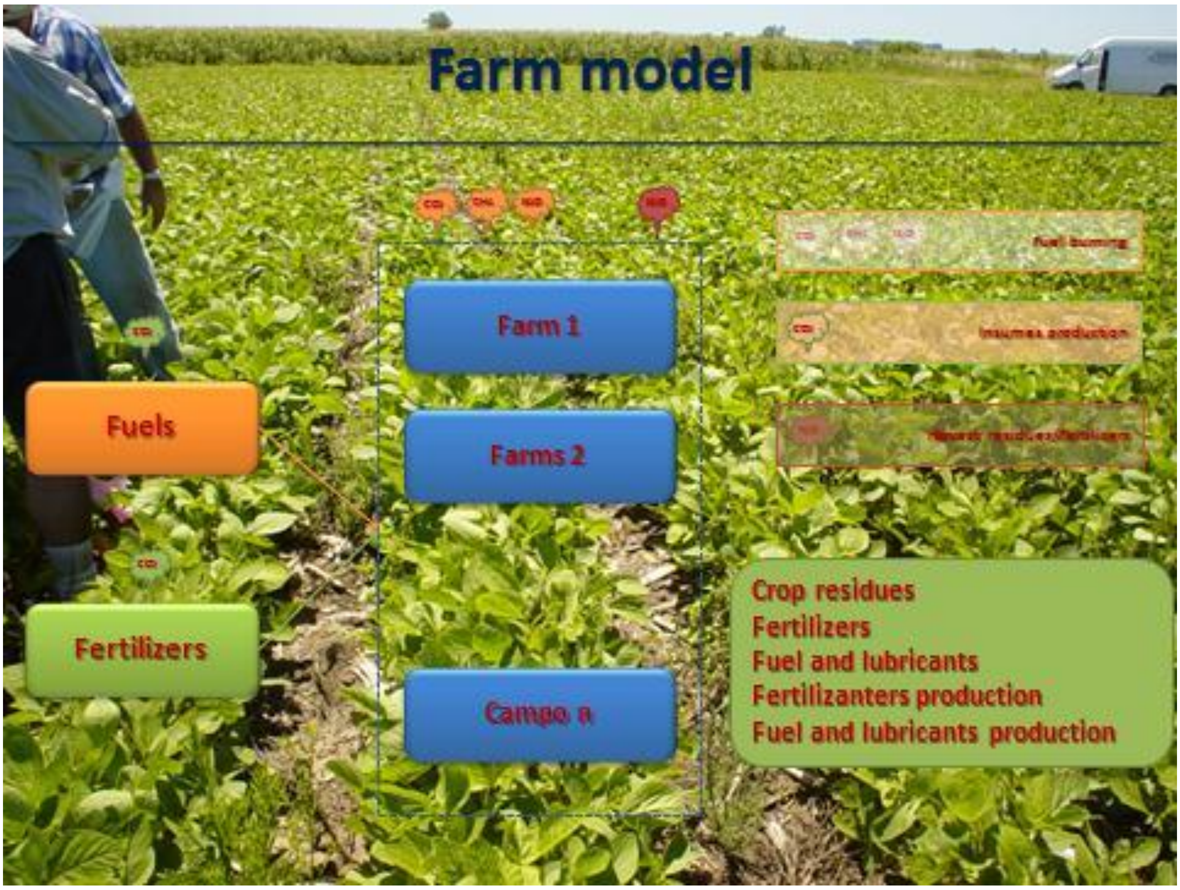
Harvesting residues:

The methodology contained in chapter 11 volume 4 of IPCC guidelines 2006 level 1 were followed. Direct and indirect emissions by lixiviation were taken into account following these steps:

[1] La directiva Europea plantea que dentro de las emisiones del transporte se incluyen las emisiones asociadas a los movimientos de Materias Primas. Para el caso de AG-Energy se ha subdivido el concepto por cuestiones de gestión de la información y se estiman por separado de las emisiones de biocombustible desde la planta al consumo (e_{td}).

- Step 1: Yield calculation in kg/ha.
- Step 2: Agricultural residue N content including the fixation crops and forage removal and return to the soil (F_{CR}) by equation 11.7.
- Step 3: Direct emissions calculation using equation 11.1 from table 11.1.
- Step 4: Indirect emissions by lixiviation calculation using equation 11.10 from table 11.3.

That data used from the informatics system were “crop”, “production by field”, “surface of each field”.



Fertilizers:

In this concept direct and indirect sources are considered in relation to synthetic fertilizer application and use of urea and derivate- For this purpose level 1 stated in chapter 11 volume 4 IPPCC 2006 guidelines were followed.

- Step 1: Amount of fertilizers used per type and composition (F_{SN}).
- Step 2: Direct emissions calculation using equation 11.1 from table 11.1.
- Step 3: Indirect emissions by atmospheric deposition using equation 11.09 from table 11.3.
- Step 4: Indirect emissions by lixiviation using equation 11.10 from table 11.3
- Step 5: Quantity of urea equivalent calculation (F_{UREA}).
- Step 6: Emissions of CO2 by the use of urea from equation 11.3.

The data used from the centralized informatics system were “quantity”, “type of fertilizer” and “compositions” of the fertilizers applied in every field...

Fuel and lubricants:

This concept includes Greenhouse emissions (CO_2-N_2O-CH_4) related to the fuel burning (gasoline + diesel) for all the activities' performed in the farms (planting, harvesting, crop protection and fertilizer application). The following steps were followed.

- Step 1: Estimation of fuel consumption for each activity performed in each field calculating the amount of fuel and lubricants used... In the particular case of the company all the farming operations are subcontracted so mean fuel and lubricant consumption were used according to INTA farm machinery studies.
- Step 2: Direct emissions calculation multiplying the amount in liters by the emission factor[2].

Fertilizer production:

The emissions of the fertilizer production were estimated using e "*A Review of Greenhouse Gas Emission Factors for Fertilizer Production. Sam Wood and Annette Cowie Research and Development Division, State Forests of New South Wales.Cooperative Research Centre for Greenhouse Accounting - For IEA Bioenergy Task 38 - June 2004*".

The total emissions are calculated multiplying the amounts used by the emission factor

Production of fuels and lubricants:

The case of emissions related to fuel and lubricants production the extraction and refinery data used came from "*Approved consolidated baseline and monitoring methodology ACM0017 "Production of biodiesel for use as fuel" - v.01.1 - UNFCCC - CDM Executive Board*". Sincé no data is available for lubricants a 10 % emissions is assumed

The total emissions are calculated multiplying the amounts used by the emission factor.

Farm structural consumption:

All emissions associated with other use consumption of fuels and fertilizers were taken into account and divided by the total amount of harvested crop in tons to assure and even distribution.

Feedstock transport:

All movements from the farms to the industrial facility were included. Since the area is very hot and dry practically no drying of grains occurs. In the following figure all the steps are described

n all transport the emissions produced in both ways were considered.[3] According to the methodology "*Approved consolidated baseline and monitoring methodology ACM0017 "Production of biodiesel for use as fuel" - v.01.1 - UNFCCC - CDM Executive Board*".

Transport by truck:

[2] En el punto "Factores de Emisión" se detallan los coeficientes utilizados y la fuente de información utilizada.
[3] ACM0017 - Página 14 – AVDm: Average distance travelled by vehicles transporting material m (km), ***including the return***trip/s.

In the following table the calculation procedure is described for obtaining the emissions per kilometer:

Emisiones por km recorrido		Unidades	Ecuacion	Valor
	Consumo específico de Gas-Oil	Lt/ 100 Km	Tabla 1.39 - IPCC 1996 - Heavy Duty	29,90
	Consumo ajustado por IDA y Vuelta	Lt/ 100 Km	Según ACM0017 / Version 01.1	59,80
FECO2 LTS	Factor de emision de CO2	KgsCO2/Lts	Ver Hoja Factores de emision Incluye LCA	2,92
CO2	Emisiones CO2 por Transporte por Km	KgsCO2/Km	Ajustado por ida y vuelta	1,74
FEN2O LTS	Factor de emision de N2O	mg N2O/Km	IPCC 2006 - Cuadro 3.2.5 - Pre-Euro Diesel - Autobus - Rural	30,00
N2O	Emisiones N2O por Gas-Oil Transporte	KgN20/Km	Ajustado por ida y vuelta	0,00
FECH4 Lts	Factor de emision de CH4	mg CH4/ km	IPCC 2006 - Cuadro 3.2.5 - Pre-Euro Diesel - Autobus - Rural >	80,00
CH4	Emisiones CH4 por Gas-Oil Transporte	KgCH4/km	Ajustado por ida y vuelta	0,00
$FE_{CO2eq\ Unidad}$	Factor de emision x KM recorrido	$KgsCO_{2eq}$ /Km	FE total x Km	1,76

For the estimation of the entire km to be included y each campaign the data was extracted from the raw material movements general register of the company. In this system all transports are registers according to the document of transport each truck has to complete:" cartas de porte".

Transport by train

The logistics of the company contemplates the possibility of train transport between storage facilities and to the final destination in the processing plant. The calculation performance is similar to the truck.

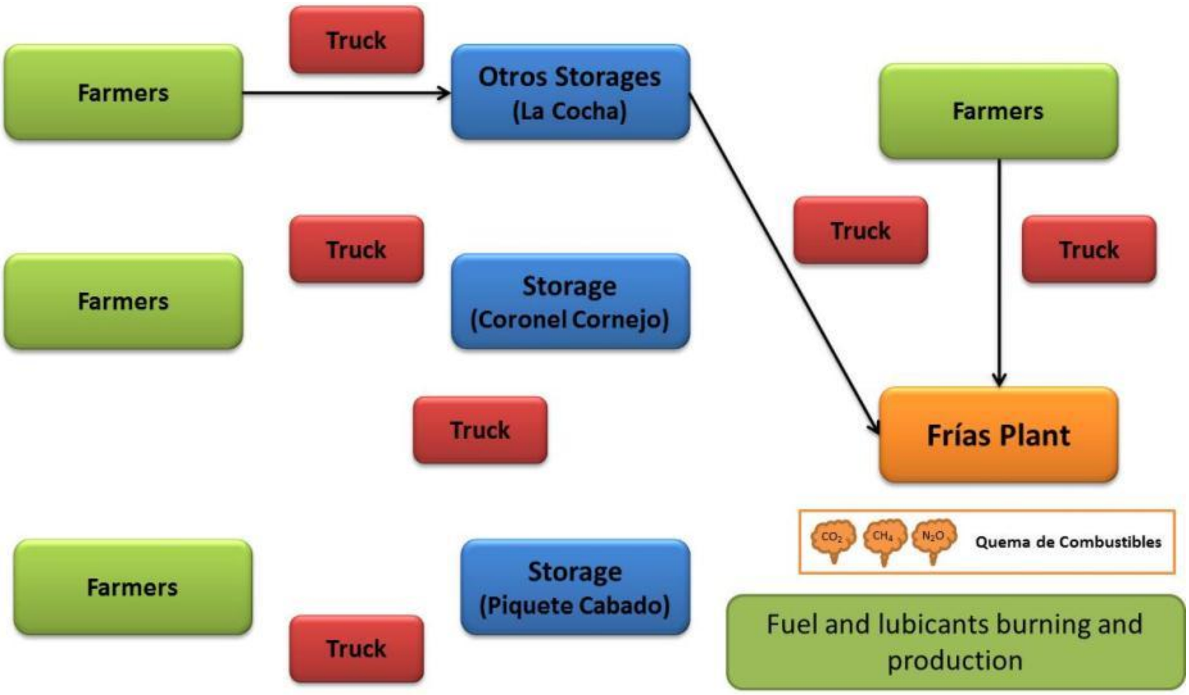
Emisiones por km recorrido		Unidades	Ecuacion	Valor
	Consumo específico de Gas-Oil	Lt/ Km	Locomotora General Motors GT 22 CW (1)	3,40
	Consumo ajustado por IDA y Vuelta	Lt/ Km	Según ACM0017 / Version 01.1	6,80
FECO2 LTS	Factor de emision de CO2	KgsCO2/Lts	Ver Hoja Factores de emision Incluye LCA	2,92
CO2	Emisiones CO2 por Transporte por Km	KgsCO2/Km	Ajustado por ida y vuelta	19,82
FEN2O LTS	Factor de emision de N2O	mg N2O/Km	No hay dato	-
N2O	Emisiones N2O por Gas-Oil Transporte	KgN20/Km	Ajustado por ida y vuelta	-
FECH4 Lts	Factor de emision de CH4	mg CH4/ km	No hay dato	-
CH4	Emisiones CH4 por Gas-Oil Transporte	KgCH4/km	Ajustado por ida y vuelta	-
$FE_{CO2eq\ Unidad}$	Factor de emision x KM recorrido	$KgsCO_{2eq}$ /Km	FE total x Km	19,82

(1) Fuente: www.forotransportes.com/showthread.php?t=4357

In the case of trains we have the consumption per locomotive without consideration of the number of wagons being pushed there are two different steps. The first stage to Tucuman storage facilities normally carries 11 wagons; form Tucuman to Frias the train normally has 22 wagons. A simplified model was used calculating the same fuel consumption in both steps. The number of wagons is calculated according to the declarations of transport.

Multiplying the quantity of wagons by the kilometers travelled and the emission factor per km the overall emissions were calculated.

Transport logistics



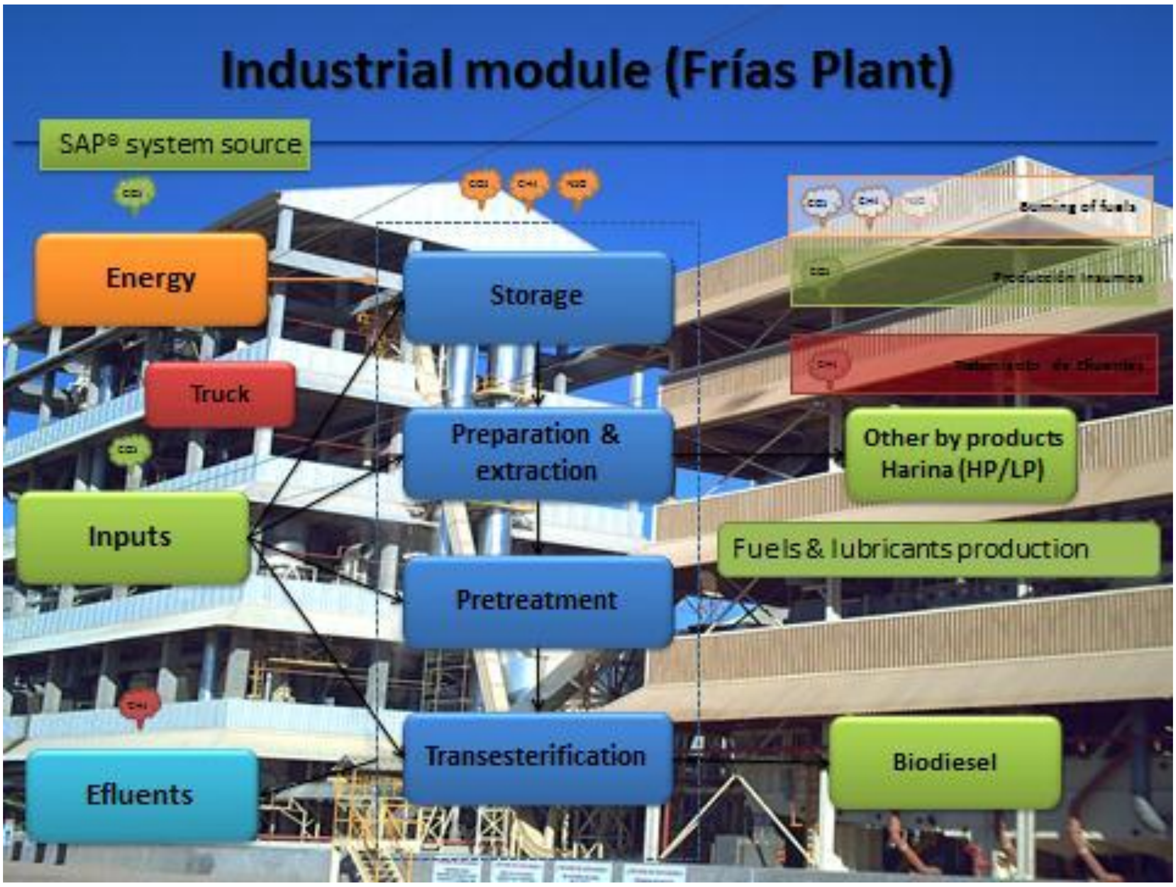
Production of biodiesel and coproducts:

According to point 11 annex V of the EU directive "*Emissions from processing, ep, shall include emissions from the processing itself; from waste and leakages; and from the production of chemicals or products used in processing. In accounting for the consumption of electricity not produced within the fuel production plant, the greenhouse gas emission intensity of the production and distribution of that electricity shall be assumed to be equal to the average emission intensity of the production and distribution of electricity in a defined region. By derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid. 12*".

In Viluco case study in order to correctly distribute the emissions between the different products the overall process was divided into:

- Storage
- Preparation & extraction
- Pre treatment
- Transesterification

A continuación se detallan las fuentes de emisión consideradas para la etapa de transformación:



Energy:

All associated emissions related with fuel and lubricants were considered. In all cases the overall energy consumption of the plant was taken in consideration and the distribution between the different parts of the industrial process was divided according to the following criteria:

- Electric energy: According to the installed power
- Thermal energy: According to the water vapor consumption declared in the contract of the technology provider

In every case the total plant consumption was multiplied by the emission factor and then distributed between the different steps.

Transport of materials and products used in the industrial phase:

The procedure is similar to the ne described; in this case all raw materials origins were detected in order to calculate the exact distance. With this information the total emissions per kg ton or cubic meter of product was calculated.

F

Production of input materials:

Since there was not available data for all the products lubricants and methanol were considered since they are the most important input. In methanol case the following methodology was considered "*Approved consolidated baseline and monitoring* *methodology ACM0017 "Production of biodiesel for use as fuel" - v.01.1 - UNFCCC - CDM Executive Board*".

ID Number:	5
Parameter:	EF_{MeOH_PC}
Data unit:	tCO_2/t methanol
Description:	Specific emission per tonne of produced methanol
Source of data:	Apple 1998: <http://adj.net/sinor/SFR4-99art7.html> and 2006 IPCC Guidelines.
Measurement procedures (if any):	1.95 tCO_2/tonne produced methanol
Any comment:	Based on 30 GJ/tonne energy requirement and average of IPCC emissions factors for natural gas and diesel oil

For the appropriation b between the different end products produced by the plant three different criteria were adopted:

- **Mass balance:** Emissions are appropriate according to real yields and mass balance (% weight) in each step...
- **Energy content:** According to the European Union Directive Where a fuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products (co-products), greenhouse gas emissions shall be divided between the fuel or its intermediate product and the co-products in proportion to their energy content (determined by lower heating value in the case of co-products other than electricity). ". Annex V – Point 17.
- . **Market price:** According to EB 50 – the executive board of the Clean Development Mechanism, for assigning of co-products. This methodology is being used for projects that generate certified emission green bonus.

.

Liquid effluents:

The emissions were estimated according to Methodology according to chapter 5 of the IPCC 2006 guide taking in consideration the literature review on soybean seeds transforming plants.

Step 1: Calculate the amount of residual water related to the oil production.

Step 2: Calculate the degradable material (Equation 6.6)

Step 3: Calculate the total emissions from the final liquid (Equation 6.4).

Emission factors

A continuación se detallan los factores de emisión utilizados en los cálculos de emisiones de gases de efecto invernadero:

Energy content:

A continuación se detallan los contenidos energéticos utilizados tanto para los cambios de unidades como para la apropiación de emisiones entre co-productos.

Productio	**Mj/kg**	**Source**
Soybean grain	20,45	Análisis de Ciclo de vida (ACV) de la produccion de biodiesel (B100) en Argentina - Ing. Amb. Luis Panicheli - Tabla 1 - Poder Calorífico Superior - Página 28
Soybean flour	17,00	Analisis de Ciclo de vida (ACV) de la produccion de biodiesel (B100) en Argentina - Ing. Amb. Luis Panicheli -

		Punto 4.3.5 Pagina 40
Soybean peel	15,07	Balances Energéticos de la Producción Argentina de biodiesel con datos locales de la etapa industrial, I Huerga; J.A.Hilbert;L.Donato - INTA - IIR-BC-INF-03-09 - Cuadro 1
Soybean oil	32,20	Analisis de Ciclo de vida (ACV) de la produccion de biodiesel (B100) en Argentina - Ing. Amb. Luis Panicheli - Tabla 14 - Poder Calorífico Inferior - Página 37
Biodiesel	37,00	Directiva Europea de Biocombustibles - EU 2009/28/CE - Poder Calorífico Inferior - Anexo III - Valores por Default
Diesel	43,00	Directiva Europea de Biocombustibles - EU 2009/28/CE - Poder Calorífico Inferior - Anexo III - Valores por Default

Defect values for input Nitrogen to the soils from crop residues:

For estimating N_2O level 1 included in table 11.2 - Volume 4 - Chapter 11 - Page 19 - IPCC 2006 were employed. For sunflower and sorghum the general grain data was used

Direct/indirect sources factores of N_2O emissions:

For estimating N_2O default coefficients included in tables 11.1 (Páge 12) & 11.3 (Page 26) Volume 4 - Chapter 11 - IPCC 2006. Were used

Factor	Description	Unit	Defect value	Range of uncertainty
EF_1	Para aportes de N de fertilizantes minerales, abonos orgánicos y residuos agrícolas, y N mineralizado de suelos minerales a causa de pérdida de carbono del suelo	kg N2O–N / kg N	0,01	0,003 - 0,03
$Frac_{GASF}$	Volatilización de fertilizante sintético	(kg NH3–N + NOx–N) / (kg N aplicado)	0,10	0,03 - 0,3
EF_4	Factor de Volatilización y re-deposición de N	Kg. N2O/ NH3-N+Nox-N volatilizado)	0,01	0,002 - 0,05
$Frac_{Lixiviación-H}$	Fracción pérdidas de N por lixiviación y escurrimiento	kg N Lixiviado / kg N aplicado	0,30	0,1 - 0,8
EF_5	Factor de lixiviación y escurrimiento	kg. N2O-N/Kg. N lixiviación/escurrimiento	0,0075	0,0005 - 0,025

Energy emission factors

Local emission factors were used according to the national Argentine inventory to the United Nations convention for climate change:

			Gas-Oil	Gasoline	Lubricants	G.L.P.	Natural gasl	Wood	Electric energy	Fuel-Oil
	Description	**Units**	**Lts**	**Lts**	**Lts**	**Kg**	**M^3**	**Kg**	**KwH**	**Kg**
PCI	Poder Calorífico Inferior	Kcal/unidad	8.619	7.607	8.497	10.960	8.300	2.300		9.800
D	Densidad	Kgs/unidad	0,8450	0,7350	0,8850	0,5370	0,7190			0,9450
Frac Ox	Fracción de Carbono Oxidado	%	0,990	0,990	0,990	0,990	0,995	0,870		0,990
C_C	Contenido de Carbono	TC/TJ	20,28	18,90	20,00	17,20	15,31	29,90		21,25
FE_{CO2} Unidad	Factor de emisión de CO_2	$KgsCO_2$/Unidad	2,66	2,19	2,58	2,87	1,94	0,92	0,351	3,17
FE_{N20}	Factor de emisión de N_2O	$KgsN_2O$/TJ	2,0	1,00	1,0	0,6	0,525	4,00		0,3
FE_{CH4}	Factor de emisión de CH_4	$KgsCH_4$/TJ	11,00	20,00	0,60	1,10	3,125	30,00		2,08

FE_{CO2eq} Unidad	Factor de emisión de CO_{2eq}	$KgsCO_{2eq}$ /Unidad	2,69	2,21	2,59	2,87	1,95	0,94	0,351	3,17

Data acquisition:

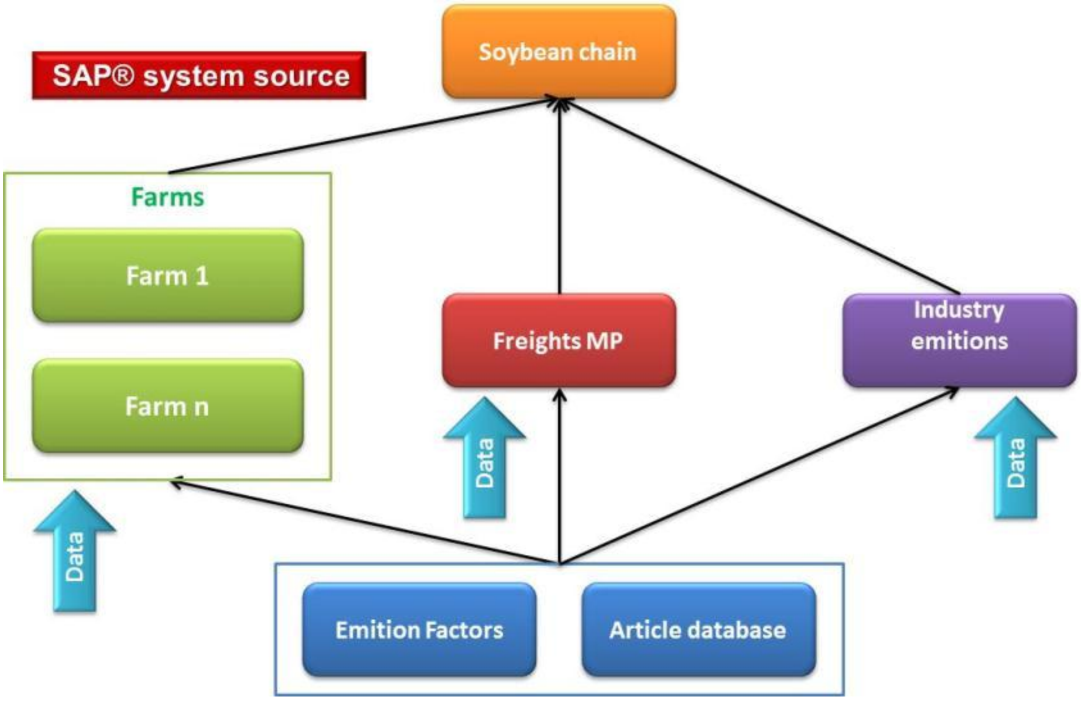
All the data is introduced from the general accounting system of the company per activity and are based in the control of tercerized activities.

All movements of feedstock's and input materials were extracted for the PROFIT® system of the company. Those are the numbers for paying all services acquisitions etc. The information is auditable according to the freight declarations "carta de porte"

The rest of the information was obtained from the SAP® system of the company. Thissystem covers the whole chain from the production of seeds at field or plot level to the industrialization and final output of the different products.

- **Emission calculator**

A complete calculator was developed on spreadshees with the following logic and links in order to manage the information from the different parts of the company.:



Final results;

Emission per ton (KgsCO2eq/Tn Biodiesel)		x Mass balance	x Energy content	x Market price	
e_{ec}	emissions from the extraction or cultivation of ra	150	243	381	Mean from own farms including transport and industry efficiency - EU 2009/28/CE. Includes input production.
e_p	emissions from processing (industry)	420	467	536	Includes production nd transport of input materials.
e_{td}	emissions from transport and distribution	141	141	141	Freight by truck to export port in San Lorenzo and ship to Rotterdam
E_B	**Emissions from production and use of biodiesel (Kgs CO2eq/TN)**	**711**	**851**	**1.059**	

Emissions per ton (gCO2eq/Mj)		x Mass balance	x Energy content	x Market price	European Directive - EU 2009/28/CE Typical values	Default values	
e_{ec}	Production of feedstock	4	7	10	19	19	Drective values: Anexx V - Article D
e_p	Industry	11	13	14	18	26	Drective values: Anexx V - Article D
e_{td}	Transport and distribution	4	4	4	13	13	Drective values: Anexx V - Article D
E_B	**Emissions from production and use of biodiesel (g CO2eq/Mj)**	**19**	**23**	**29**	**50**	**58**	
E_F	Emissions	83,8	83,8	83,8	83,8	83,8	European Directive - Anexx V - Art. 19
RED	**Reduction =$(E_F-E_B)/E_F$**	**77%**	**73%**	**66%**	**40%**	**31%**	

Farm emissions

Emissions x Tn Soja (Kgs CO_{2eq}/TN)	Crops residues	77
	Fertilizers	4
	Fuel and lubricants	27
	Fertilizer production	3
	Fuel & lubricants production	3
	Indirect costs of farms	7
	Total x Ton	**120**

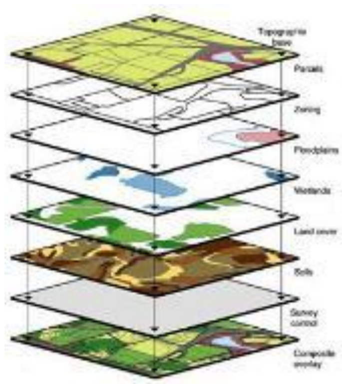
Industrial emissions

Summary emissions per ton of biodiesel			
Storage	26	26	26
Preparation/extraction	76	123	193
Pretreatment	17	17	17
Transesterification	301	301	301
Total (KgsCO2eq/Tn)	**420**	**467**	**536**

3.11 Biodiversity territorial planning and potential areas

As mentioned in Article 17(3) of the Renewable Energy Directive (RED, 2009/28/EC), biomass shall not be obtained from land with high biodiversity value such as primary forests, protected areas (PA) and other biodiversity-relevant areas as well as highly bio diverse grassland.

INTA has been working in the creation of a national system to define the potential areas for different crops including soybeans. To produce the Digital Atlas of Bioenergy Crops the methodology combined the use of an economic, ecological and social criteria with modern techniques used in the construction of a geographic information system (GIS). After a selection of the principal crops with potential to be grown at a high level,
The maximum expansion of them considering the bioclimatic requirements was constructed over the Argentine territory.



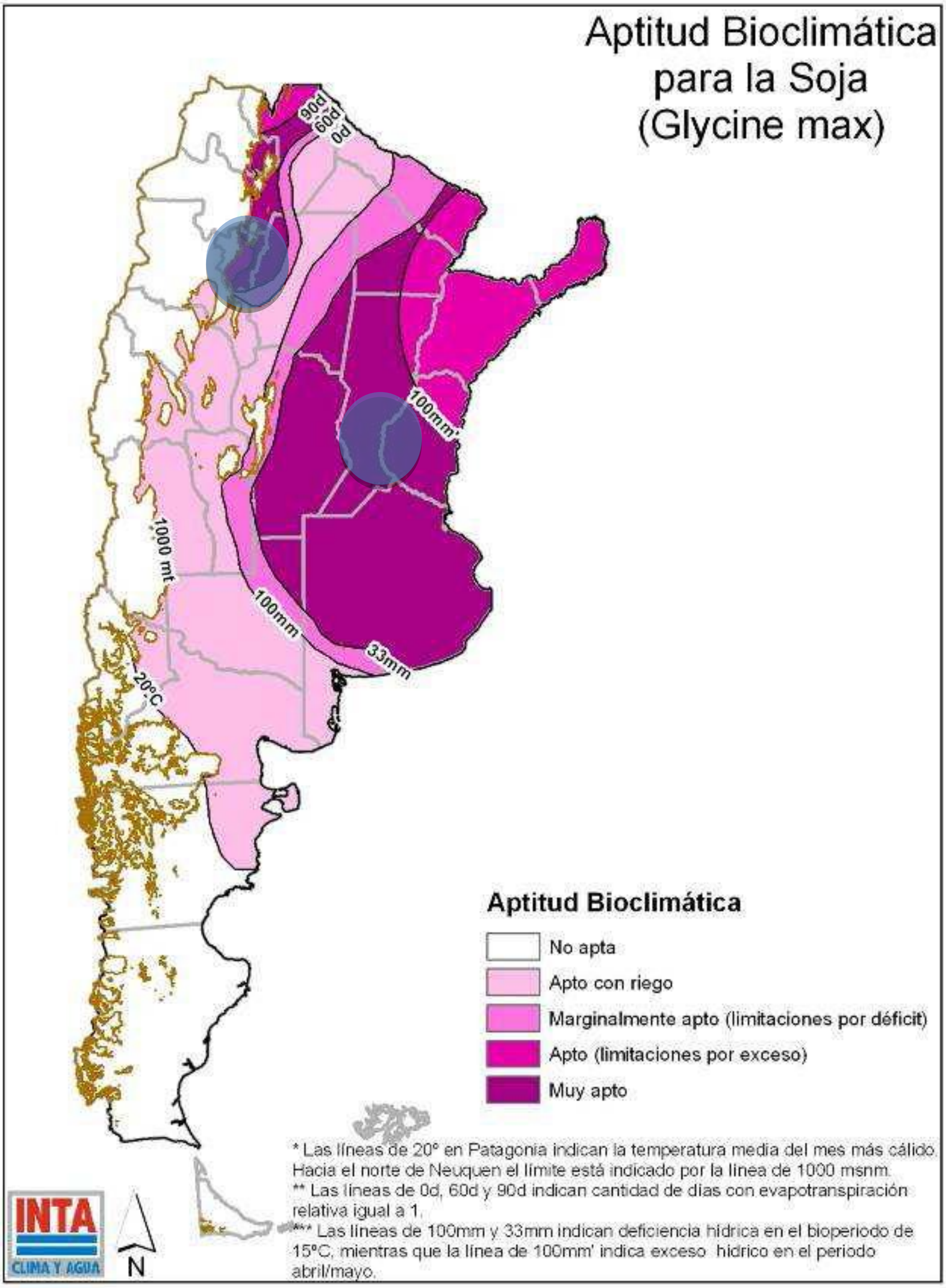
The different climatic requirements were identified including frost resistance according to the international and national literature. Using the national meteorology databases 1971-2000, the boundaries over the territory were defined classifying the regions into four categories according crop aptitude to different weather characteristics: high, medium, low and marginal aptitude. In this work the assistance of the University of BuenosAires Agronomy Faculty was required under the coordination of Ing. G. Murphy.
The resulting maps were integrated into the GIS as a layer withassociated information. Soybean as a food crop with by-product use for energy was studied all over the national territory.

In a second stage the soil characteristics and requirements wereused to generate zones with different aptitude for the crop using the digital soil map of INTA in a scale of 1:500.000.Adjustments of these maps were carried over using satelliteimages in each region. The final consistency was done overLANDSAT images (1986-2007). For obtaining potential according to the eight soil capacity classes of the US soilconservation system were employed. Four categories wereselected as potential criteria.
In order to integrate the different layers raster format wasemployed and the ARCGIS Spatial Analyst tool was used. Anew layer of integration was developed and a multi-criteriaapproach was used defining 4 levels of aptitude.To avoid a possible expansion over land with native forest (arecently approved national law fixed severe restrictions to theiruse), protected areas (according SIFAP and WDPA databases),indigenous communities, or other restricted lands the coversincluding that information were integrated in a layer andincluded in the GIS .
In order to prepare the socioeconomic analysis, processingplants, roads, railways and hydrologic net were also added tothe GIS. Each layer was loaded with its correspondingassociate database.

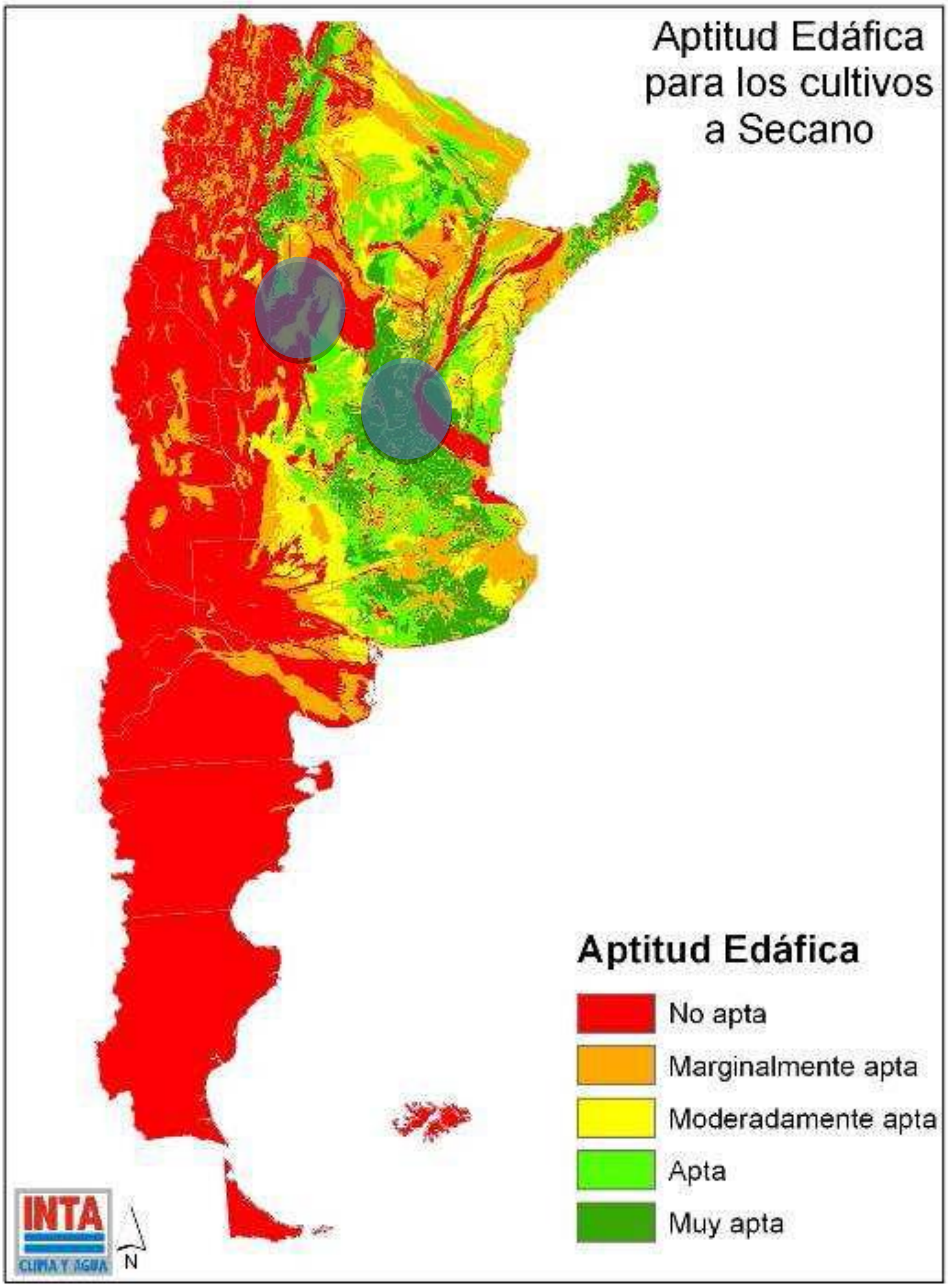
With ARCCATALOG tool a GEODATABASE was created toenable overall analysis.

In a second stage of the INTA Program the residues generatedby the soybean transformation were calculatedand added to the GIS as a geospacialized information in orderto obtain their potential use in electrical energy generation.Heterogeneous and fragmentized information was gathered andincluded in the GIS to can estimate the biomass balance in ourterritory using WISDOM-FAO methodology.

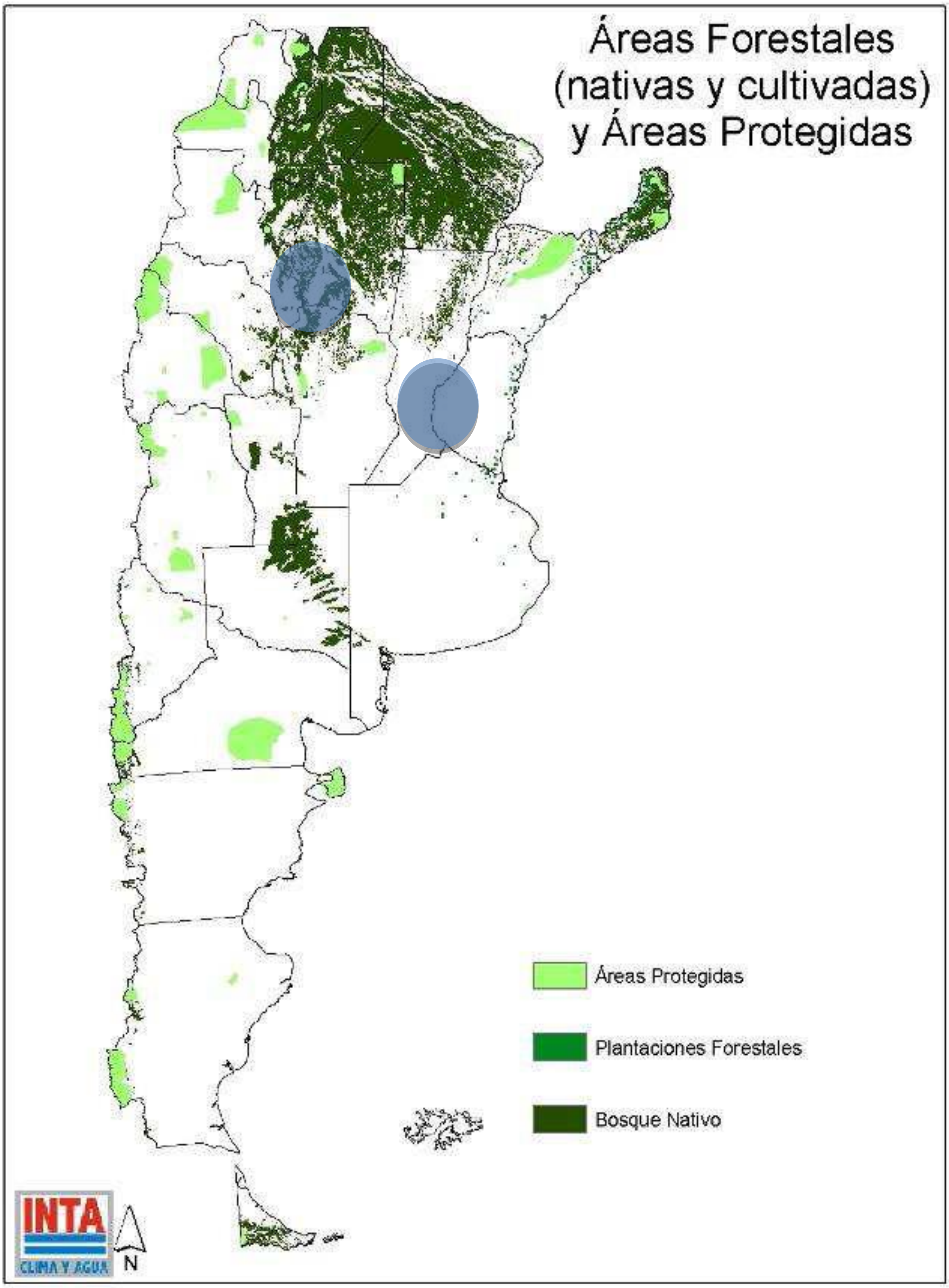
Soybeans between sixteen crops have been analyzed for biofuel productionpurpose at a national level obtaining the final maps anddatabases.As an example in this presentation soybean bioclimatic outputmap, soil criteria map and the interaction outputfor bioclimatic and soil consideration layers (agro ecological
Map) for the same crop are presented. Soybean represents the main feedstock for biodiesel production inArgentina. The restricted areas for agricultures are summarized in the mapand extracted from the potential lands.The final map shows the areas were the expansion is ecological,economic a socially sustainable fixing categories in order to their aptitude.



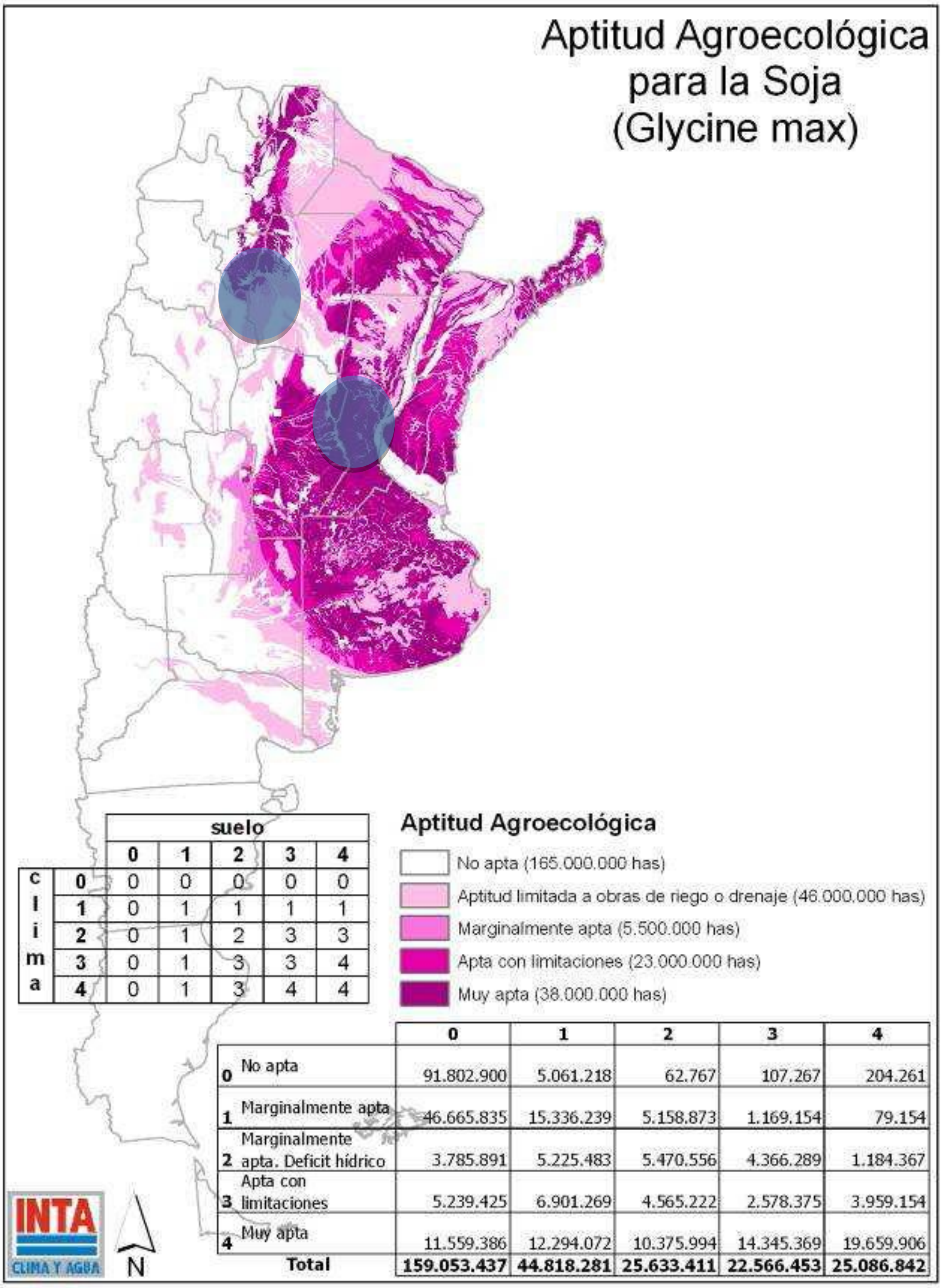
Bioclimatic aptitude of soybean in the whole territory



Soil aptitude for soybean



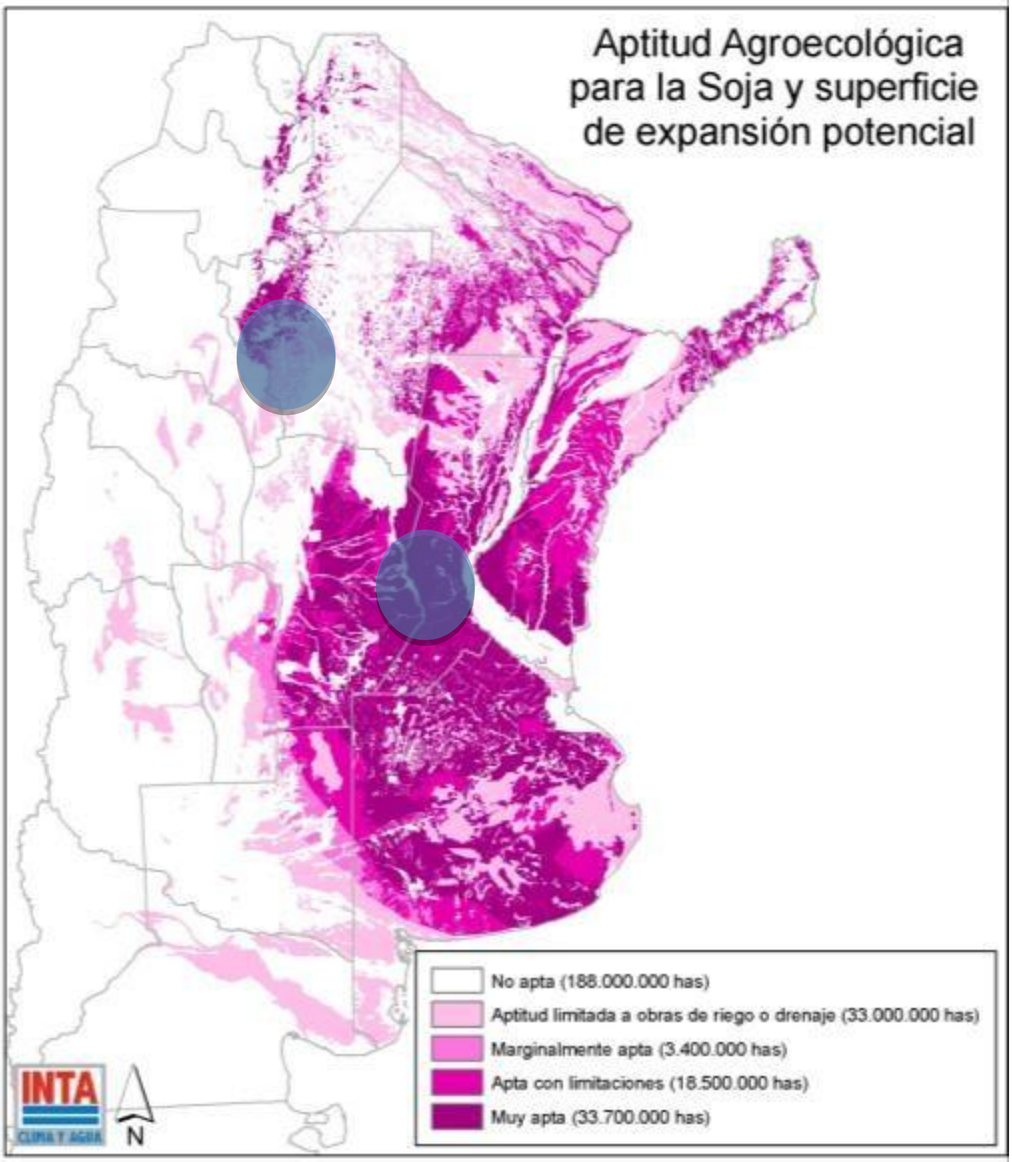
Protected areas adding native forest + forest plantations + protected areas + national reserve areas and national parks



clima \ suelo	0	1	2	3	4
0	0	0	0	0	0
1	0	1	1	1	1
2	0	1	2	3	3
3	0	1	3	3	4
4	0	1	3	4	4

	0	1	2	3	4
0 No apta	91.802.900	5.061.218	62.767	107.267	204.261
1 Marginalmente apta	46.665.835	15.336.239	5.158.873	1.169.154	79.154
2 Marginalmente apta. Deficit hídrico	3.785.891	5.225.483	5.470.556	4.366.289	1.184.367
3 Apta con limitaciones	5.239.425	6.901.269	4.565.222	2.578.375	3.959.154
4 Muy apta	11.559.386	12.294.072	10.375.994	14.345.369	19.659.906
Total	**159.053.437**	**44.818.281**	**25.633.411**	**22.566.453**	**25.086.842**

Potential areas according to bioclimatic and soil demands



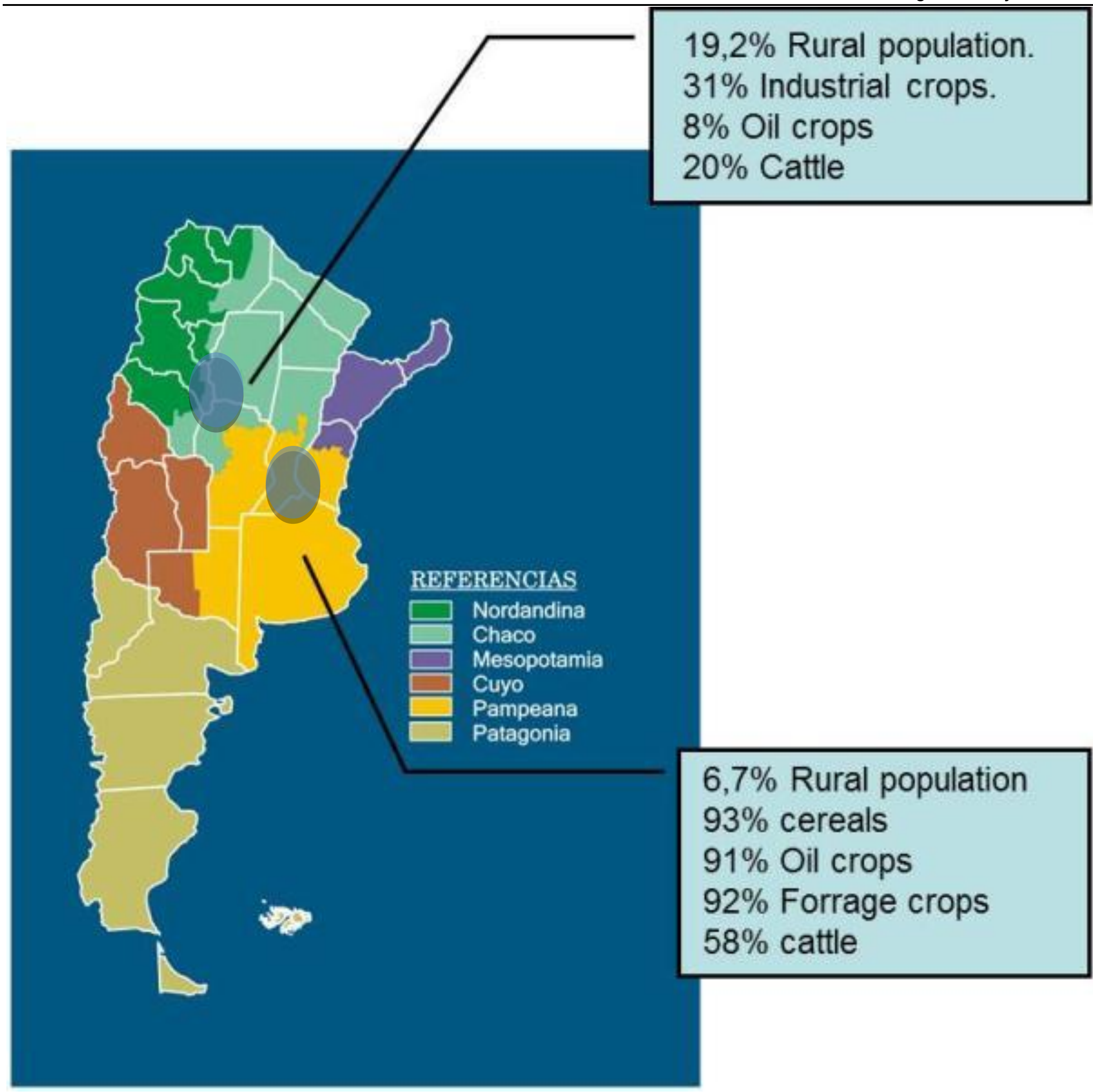
Potential expansion with all the restrictions added

Biodiversity and Protected Areas-- Argentina

EarthTrends Country Profiles

	Argentina	South America	World
Total Land Area (000 ha)	278,040	1,785,515	13,328,979
Protected Areas			
Extent of Protected Areas by IUCN Category (000 ha), 2003:			
Nature Reserves, Wilderness Areas, and National Parks (categories I and II)	3,893	66,424	438,448
Natural Monuments, Species Management Areas, and Protected Landscapes and Seascapes (categories III, IV, and V)	2,019	39,637	326,503
Areas Managed for Sustainable Use and Unclassified Areas (category VI and "other")	11,524	269,145	692,723
Total Area Protected (all categories)	17,435	375,207	1,457,674
Marine and Littoral Protected Areas (a)	782	21,008	417,970
Protected Areas as a Percent of Total Land Area, 2003 (b)	6.3%	21.1%	10.8%
Number of Protected Areas, 2003	299	2,586	98,400
Number of Areas >100,000 ha, 2003	29	465	2,091
Number of Areas > 1 million ha, 2003	7	86	243
Wetlands of International Importance (Ramsar Sites), 2002:			
Number of Sites	11	61	1,179
Total Area (000 ha)	2,670	23,360	102,283
Biosphere Reserves, 2002			
Number of Sites	10	39	408
Total Area (000 ha)	2,848	163,832	439,000
Number and Status of Species			
Higher Plants			
Total known species (number), 1992-2002	9,372	X	X
Number of threatened species, 2002	42	X	5,714
Mammals			
Total known species (number), 1992-2002	320	X	X
Number of threatened species, 2002	34	X	1,137
Breeding Birds			
Total known species (number), 1992-2002	362	X	X
Number of threatened species, 2002	39	X	1,192

View more Country Profiles on-line at http://earthtrends.wri.org



Ecoregions into wich Argentina is divided according to INTA Ecoregion National program

This program carries along the whole territory of Argentina different active projects that generate information, tools and methodologies to address territorial planning and impact measurement

INTA Territorial planning integrated project

Specific projects:

1: Environmental, productive and socioeconomic SIG

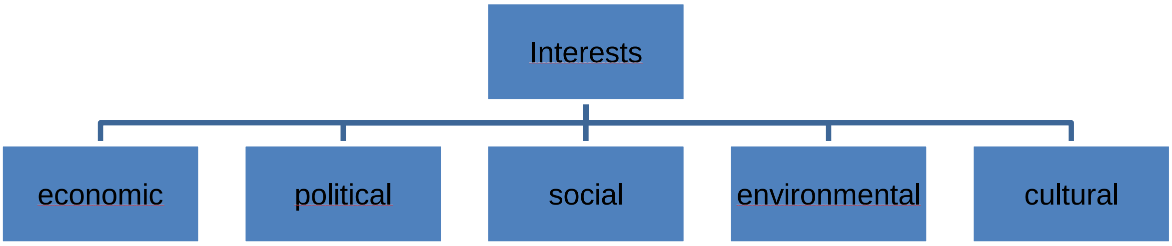
2: Remotesensing studies on land use and coverage

3: Environmental impacts over ecosystems according to field management

4: Value of environmental services according to the vulnerability of ecosystems

5: Development of strategies and tools for territorial planning.

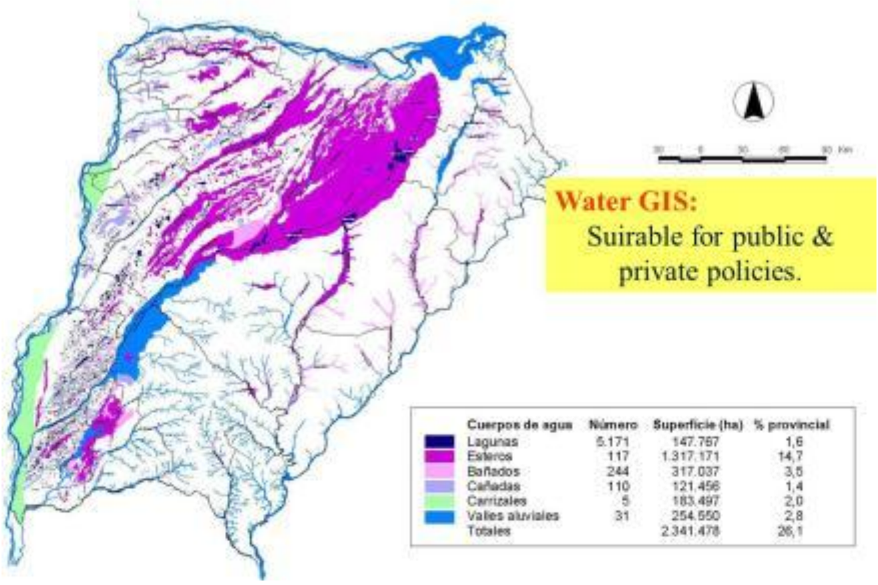
6: Development of quality and health indicators for different Eco regions.



A recent study of soybean expansion by INTA analyses the different factors that are producing the expansion of the crop in different regions. One of the main reasons relies on the very efficient technological package (seeds + planting + agrochemicals) with a direct cost according to EEA INTA Marcos Juárez[4] (main Santa Fe + Cordoba) of 140 dollars per hectare, soybeans planted after wheat 101 dollars. The main indicator a farmer looks at is the rent ability of the crop estimated in the last crop season in 508 dollar per hectare for a yield of 3, 6 tons/ha and 368 for a "second soybean crop" after wheat with a yield of 2, 6 tons/ha to which we have to ad in the same year an income of 125 dollars given by a wheat with a 2, 7 T/ha yield.

3.12 Water resources and water quality

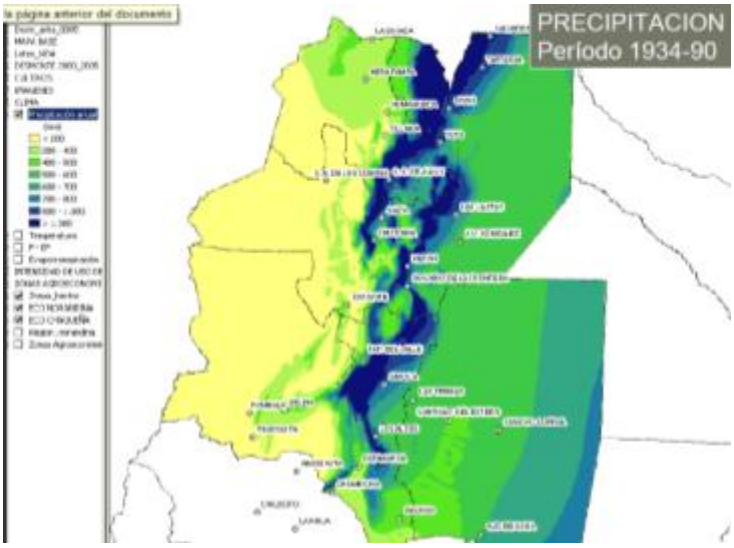
Water resource management is critical depending on the province. There are some provinces were wetlands and water sources conservation is critical as the province on Corrientes places between the two main rivers of Argentina (Parana and Uruguay) and with extensive wetland conservation areal



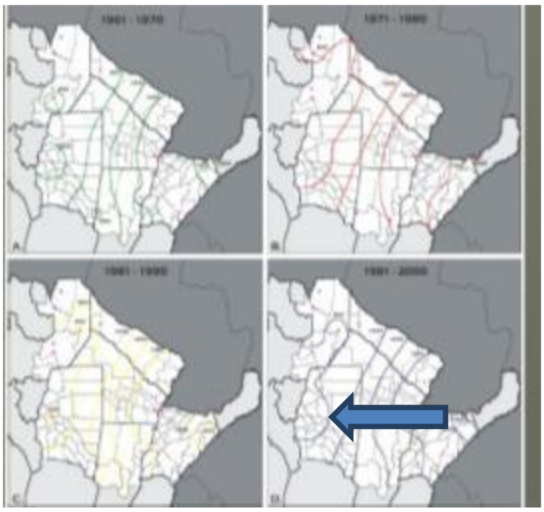
[4]

In other areas there is a severe concern on water availability, underwater management for crop irrigation and surface water use.

The two case studies are places in these types of regions, although extensive crop irrigation is very limited.



In the last 40 years there has been a shift in water rainfall availability increasing the suitable crop areas from the east to the west were the most arid areas of the country are places beside the Andean chain of mountains.

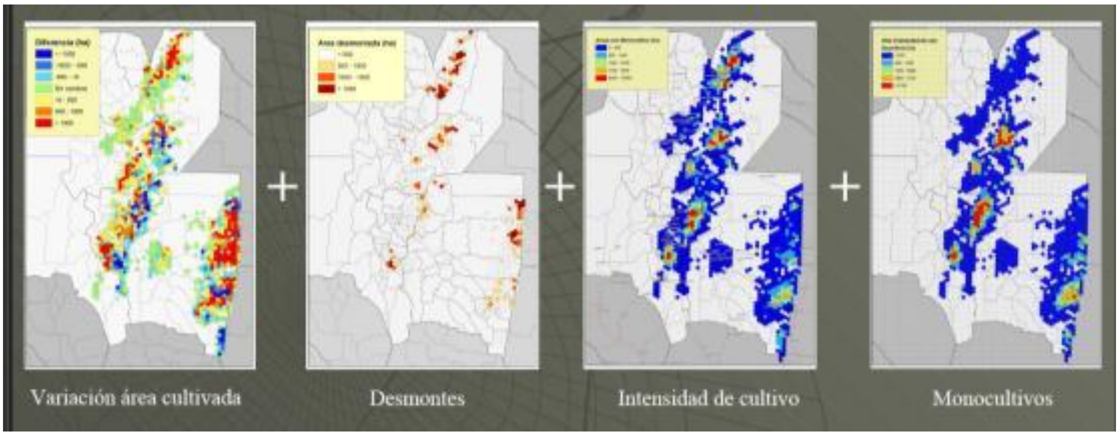


Regarding the water efficiency of the crop soybean could be catalogued as a medium plant.

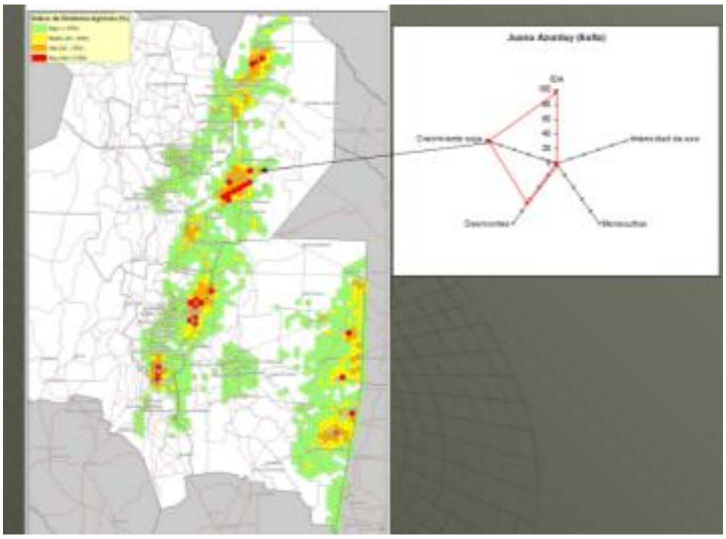
Product	Water consumption (mm year^{-1})		Rain wáter efficiency use (%)	
	M	S.D.	Mean	S.D:
Wheat	186,06	83,09	20,41	9,81
Corn	543,86	207,36	54,69	20,33
Sunflower	221,88	108,21	25,56	12,14
Soybean	343,53	99,92	34,92	10,54

The North West part of the country were case study II is located is the area were most intensive studies are carried over in order to monitor the development and expansion of agriculture and cattle in the area.

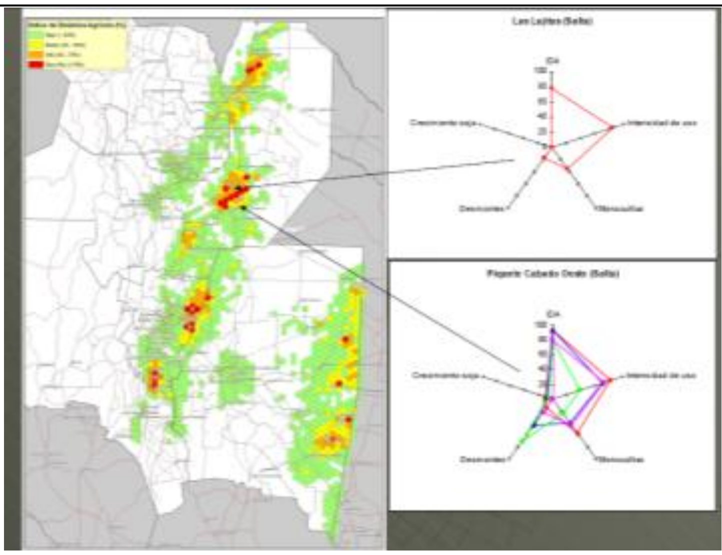
INTA has a specific group of GIS experts relating all the information though an agricultural dynamic index that covers variability in cultivated area + deforestation + crop intensification + monoculture use...



For each area of this territory under surveillance complex indicators are calculated and followed



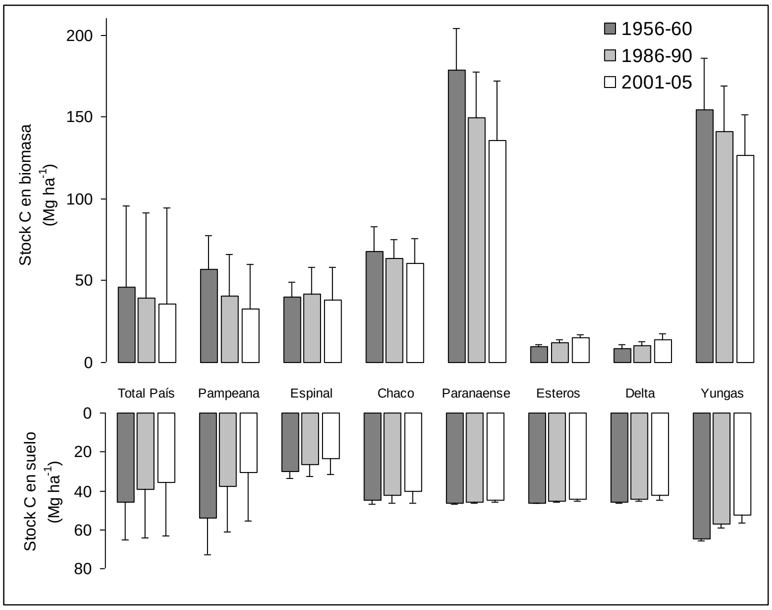
This areas are the ones from where the soybeans seeds are grown from Viluco Plant.



Soil

The literature and studies over soils in Argentina is very big. Since the early fifties the soil has been studied and a complete map of soils is available. From that base a classification of soil aptitude has been developed. More recently there are risk GIS on different nutrients, water and wing erosion.

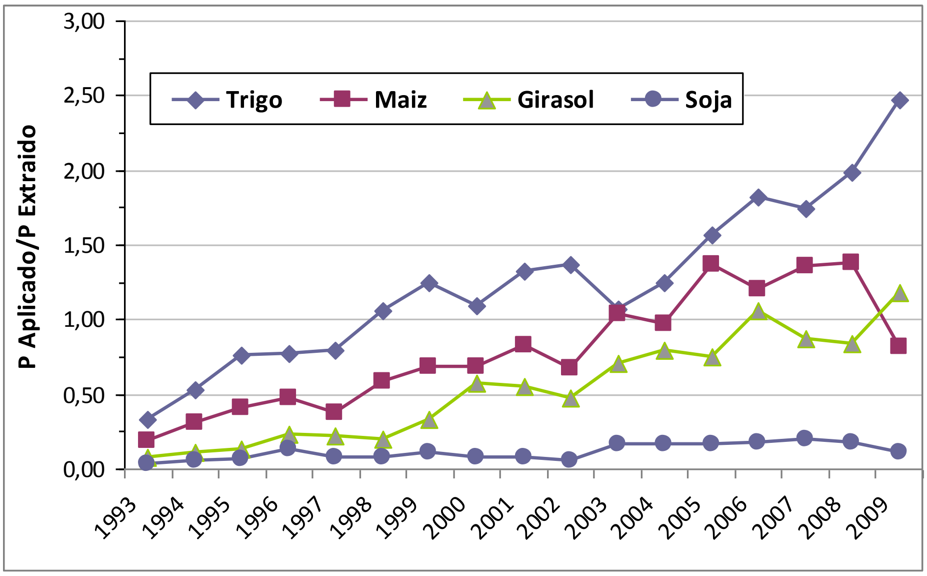
Carbon stoks were studied by INTA for several regions relating the amount of carbon retained in forest and native pastures and the soil.



Carbon stocks for different regions of the country and periods

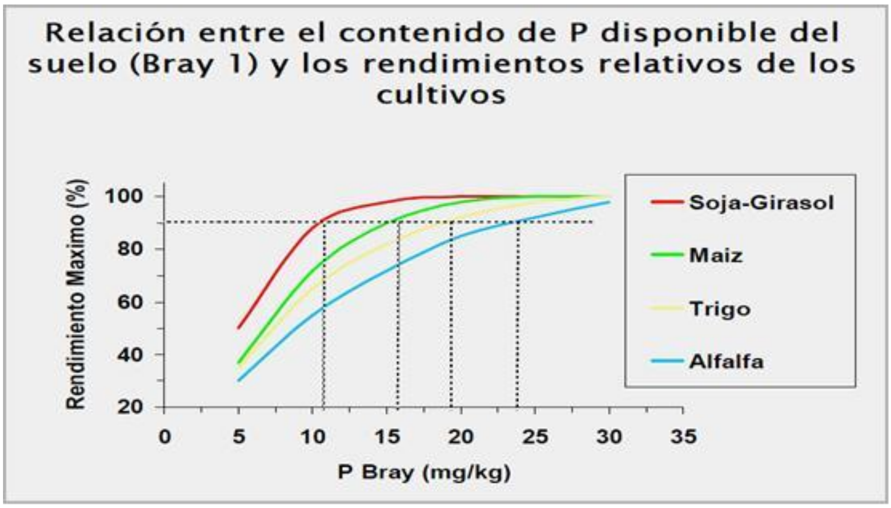
No till is not sufficient if no good crop rotation is implemented.In soybean monoculture the net incorporation of carbon is rather low 2,8 tn ha^{-1}. Studies developed in the central productive area (Andriulo e Irizar, 2010; Irizar, 2010) after 17 years of studies demonstrated that no till alone was not sufficient and original values of 38/39 tn ha-1 in A horizon (Soil organic carbon = 1,54%), diminished to 33/34 tn ha-1 (SOC = 1,34%) (Andriulo e Irizar 2010; Irizar 2010). For the semiarid region (case study II) Hapludol éntic soil after 7 years with a crop rotation between 10 crops and no tillage soil organic matter was maintained in the first 18 cm of soil (45.6 tn ha $^{-1}$) under conventional tillage the loss was 6,7 tn ha^{-1} (Ormeño y Quiroga, 2001). The stubborn from soybean is scarce and with a high nitrogen/carbon ratio this causes a rapid degradation. Crop rotation with high carbon content residue is needed together with no tillage practices.

The increase in crop production has not been followed at the same rate by nutrient application to the soils generating negative balances lowering natural fertility of soils.During the last years an important increase in fertilizer application has occurred



Relation between applied and extracted phosphorus in soils for wheat – corn – sunflower and soybeans (part of soybean needs are given by wheat application in the same year) (IPNI, 2010).

During 2009/10 the relation between application/extraction from the principal crops were 30 %, 39%, 1% y 29% for N, P, K y S respectively.Soybean presents a peculiar nutritional behavior. The requirements per grain ton are higher 80 kg de N, 8 kg de P y 7 kg de S (García, 2000) corn and wheat have 20-30 kg N, 4-5 kg P & 4-4,5 kg de S. Exports fractions are higher. Soybean plant is resistant to mineral shortages and it does not show an increase in yields till soil values are very low this is clearly shown in phosphorus answer(García et al., 2005).



Soybean corn wheat and && yields answer to different phosphorus levels in soils

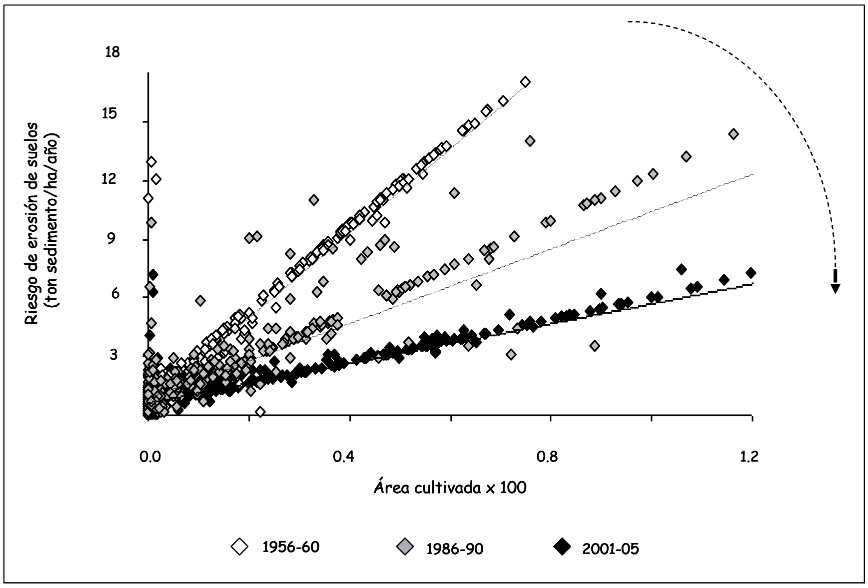
Nitrogen high requirements are covered by nitrogen fixation from the air at root levelBiological Nitrogen Fixation (BNF). Total contributions ranging from 30 to 70 % have been detected according to soils nitrogen content and agro climaticconditions (Salvagiotti et al., 2008, González, 1996).

Although (BNF) is very important the general nitrogen balance is negative. This can be improved through BNF efficiency and nitrogen application to other crops in the rotation.(Cordone y Martínez, 2004).

Soil compaction has been detected in certain areas and can be minimized using traffic control over the fields and presition agriculture techniques.

Soil contamination through agrochemicals have been decreasing by the extensive use of low toxic new products that replace hazardous ones. There are extensive studies on glyphosate in soils, water and seeds. The results indicate that good practices of application must be followed in order to minimize contamination risks. Recent studies show an important decrease in toxicity and agrochemicals use.

In relation to soil erosion index the risk of soil erosion has decreased in the last 20 years. Through the agroecoindex INTA is monitoring the risk in each period.(Viglizzo et al., 2010)



The slope of the lines are lower indicating a lower risk of soil loss in the last period compared with early days were ploughs were extensively used.

4 Evaluation of the measurable units and indicators

4.1 Relevance of impacts

An important issue commonly described relates the production to social aspects and development in different countries and areas. These impacts are farther large than the local changes in employment and other social indicators. In the soybean case in Argentina the soybean complex delivers such huge amount of resources to the government that its real impact on society is very difficult to measure. According to the last table the Public Sector will be receiving more than 10 billion dollars from the soy sector in terms of export tax rate collection or more than 15 million tons of products.

The estimated USD collected by export taxes represents near 4% of the GDP of Argentina. This is by no means a small number given that for example Argentina's spending in Education totals 4% of the GDP; Health spending is near 5% of the GDP, housing spending is near 0.5% of the GDP and Social Security near 9%.

The latest figures give a comparative dimension of the impact of soybean chain in the country we could choose one of them in order to measure and attribute the effects of the whole change for example Argentina's large and widely spread public education that covers the whole country.

This percentage represents also the magnitude of the soy complex for Argentina's fiscal stability and the indirect social impact of this activity as a whole...

In terms of total tax collection the soy complex transfers near 30% of the taxes collected using export taxes. This states the importance of the sector in terms of the country finances given that those dollars are later bought by the Central Bank and used to keep the exchange rate fixed at the value determined by the monetary authority.

The export tax also contributes to maintain low internal prices for certain food goods with a significant impact in food security for the low income people of the country that depend on welfare.

4.2 Interlink between socioeconomic and environmental impacts

In this case as in others it is impossible to find a separate impact caused by the biofuel as a product. Impacts will be related with the different crops and cattle on the environment of different provinces.

We can say that socioeconomic policies have great impact over farming production in the country. As an example the policy that artificially maintained low cattle meat prices down in the internal market caused an enormous decrease in the activity since it could not compete with agriculture. In less than 10 years this together with a severe draught caused a decrease of over 6 million heads.

The export tax over the crops also produce important consequences over farm production since it constrains the agricultural frontier expansion lowering the end price of grains.

4.2.1 Positive correlations between socioeconomic and environmental impacts

Improvement in income and development situation has favourable impacts in environmental behaviour of populations. Regarding the different chain actors an improvement in the overall benefit derived from the export and use of a more elaborated product brings positive environmental impacts since more hard regulations have space to be implemented, there are more controls and studies.

In the case of the biofuel chain in Argentina every new factory has to comply with very hard environmental and laboral security assessment studies. Laws and rules become more strict year by year.

All this is measurable through the documents and established procedures implemented by federal and local authorities.

4.2.2 Negative correlations between socioeconomic and environmental impacts

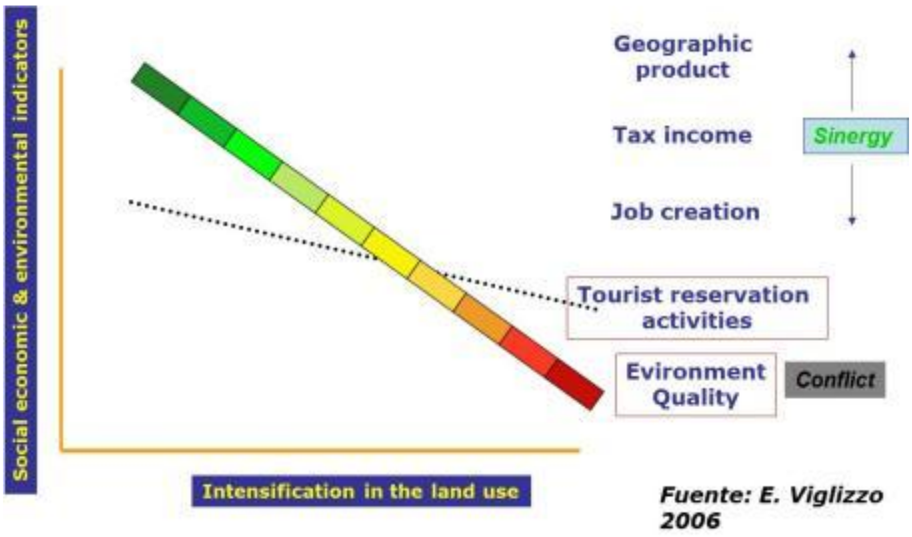
Improvement in the living level and income of the populatios brings and increase in general consumption movement, tourism etc. If this is not properly addressed it may bring an increasing pressure over the environment. Although this is true Argentine society is still far away from the mean environmental pressure of northern hemisphere societies. This is measurable.

4.3 Determination of thresholds

We suggest in this case to comply with the international and national laws regarding laboral conditions.

4.4 Impact mitigation options

The development and intensification of land use in every country is a very controversial subject since there are positive and negative consequences



In a federal country like Argentina we also have federal, provincial and municipal legislation and interest in place. Laboral and social issues are mostly under international or federal legislation and there are no big differences between regions.

Natural resources in the other hand like soil, water and air are in the provincial authority and although federal laws can establish a baseline the specific application must be fulfilled by the provinces.

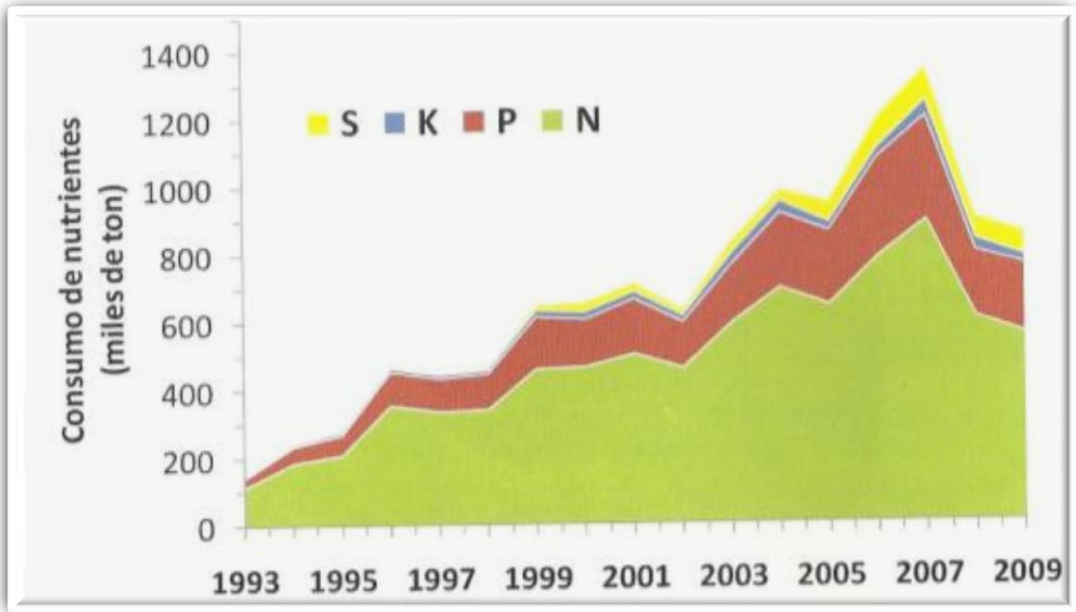
The no till cconceived as a technique, is basically the practice to work the land without plowing it.

The negative impacts of intensive farming has been diminished by no till a production system based on the absence of tillage and the presence of a permanent soil cover (crops or crop residues). Based on a collection of Good Agricultural Practices, this system allows producing without degrading the soil, while improving its physical, chemical and biological conditions. Also, it allows using soil water more efficiently – a natural resource that is commonly a limiting factor in dry land crops production. Therefore, No Till achieves high productive levels that are stable in the long term and in harmony with environment.

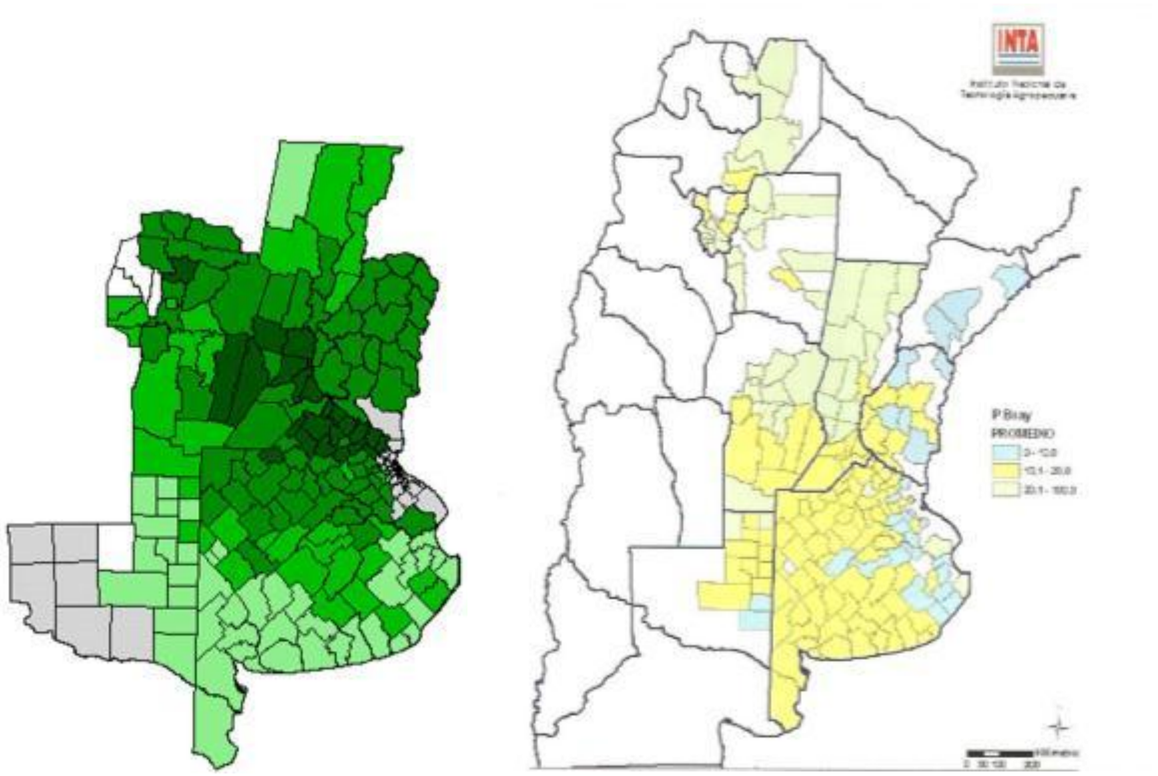
There is an increasing concern regarding a reduction in crop rotation in many areas and the negative balance of the main plant nutrients. The strategy followed by the governmental and private sectors is finding the way to improve the economics of alternative crops mainly corn or other C4 plant that provide large amounts of plants residues. This situation is also more critical y North West region were high temperatures provide the environmental conditions for rapid organic matter mineralization.

From the private and governmental sectors there are several studies regarding nutrient balances in the principal regions. On the last 10 years there has been an important increase in fertilizers use but equilibrium stage has not been reached yet

Although soybean has the capability of fixing nitrogen from the air there are still negative figures for nitrogen and phosphorus balance. No decreasing yield has been detected so far. There is a need to promote nutrient replacement through active polices and new technologies as precision agriculture.



Principal nutrient application to Argentine soils



Nitrogen balance Phosphorus content in the ppal soils

4.5 Impact and biomass certification

Both case studies are receiving material from different areas that are undergoing certification schemes.

Case study I CSCS (Carbio) certification scheme

Although the certification scheme presented by CARBIO to the European Union is still under study, the companies between which the case studies are included began using the system in order to be prepared.

Even though EU-RED requires no conversion of certain areas – such as high biodiversity areas, high carbon stocks and high conservation value areas, among others- after January 1st, 2008 to produced certified biofuels feedstock, CSCS has a much more stringent requirement related to land conversion than what EU demand: no conversion whatsoever of non-agricultural area into crop land, after January 2008, is accepted. If a particular area had agriculture production on it before this date, it is considered a “Go” Area. Au contraire, any area that was not agricultural before January 2008 is considered a “No go” area.

Evidence of compliance with the aforementioned land related criteria will be verified using maps showing the Approved “Go” Areas. These maps are based on aerial pictures, satellite images, soil charts, land register databases and site surveys. On-field checks will be performed to verify the accuracy of these maps. SIFAP, HCV Network, and other sources of information, such as the Convention on Biological Diversity, will be used to define the Approved “Go” Areas. Maps identify minimum administrative regions, such as districts, which are equivalent to an EU - NUT 3 level of identification. Only areas that fulfil RED and CSCS requirements on land related criteria will be defined as Approved “Go” Areas.

Maps are developed by INTA (the National Agricultural Technology Institute). The classification of land uses is based on images of the American Landsat 5 satellite captured with the Thematic Mapper sensor. The spectral resolution of this satellite includes 6 bands covering a range of the electromagnetic spectrum from 0.45 (blue) to 2.35 µm (medium infrared) in a 30m (pixel) spatial resolution, and a 120m thermal-band spatial resolution.

This type of satellite enables the approach of regional studies in territories of great extension, and is particularly effective in the classification of vegetation and cultivation covers of areas above 5 has. In the case of regions where mini-fields prevail, the information will require to be complemented with higher-resolution images (Ikonos satellite or similar) (Carballo, 2010).

A satellite image becomes an element impossible to alter both in capture date and data. The different scenes that cover the whole area of the Earth are identified in the files with a Path-Row (identification of the scanning line and capture order), coded before launching each satellite.

For each satellite scene, the classification considers the crops present throughout an agricultural season (selected for presenting low or zero cloud cover within the set timeframe –before January 2008), as well as the grazing lands implanted or intervened with extensive or intensive livestock activity, following the methodology developed in the INTA within the Project of Forecast of Grains and Oilseeds Harvests in the Pampa Region (*“Proyecto de Prevision de Cosechas de Cereales y Oleaginosas en la Region Pampeana”)* developed in the frame of the INTA-JNG-INDEC-SAGPYA agreement in the 1991-1995 period, and later on used in the Technology Transfer Area (*Area de Transferencia Tecnologica*) of the INTA Institute of Climate and Water (*Instituto de Clima* *y Agua)* for the surveillance of crops in Argentina and in countries of the Mercosur related to the Specific Project on External Agriculture ("*Proyecto Especifico sobre Agricultura Externa"*) (2005-2009).

For the classification of each scene (path-row) and date, Landsat^{TM} images will be composed in three bands of the electromagnetic spectrum 3, 4 and 5 (red, near-infrared, and medium-infrared) which, through experience in agricultural covers, have proven to render the most information and allow working with unsupervised classifications with the highest degree of accuracy (indispensable when classifying images from the past, lacking ground survey).

Band 3 captures the spectral responses of the various covers to the red portion of sunlight received and enables the recognition of the content of chloroplasts of the different vegetal covers. The near-infrared band (4) permits the interpretation of the sanitary conditions of the plant, and that of medium infrared (5), an assessment of the differences of the different covers concerning humidity-content, which, in the case of plants, is determined by their cellular structure. These three factors generate a certain spectral signature for each cover, which will vary throughout its phenologic cycle and will be possible to detect through a multi-spectral and multi-temporal classification.

The images will be geo-referenced to the UTM projection[5], band 21, taking as a basis for this geo-referencing the images available in the Earth Science Data Interface (ESDI) of the Global Land Cover Facility, which show great geospatial precision. The base images may be downloaded from the webpage: http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp

The method of "the closest neighbour" will be used to perform the process of geo-referencing, as it is the only one that preserves the original values (ND) of the images to be used in the classification. The ERDAS IMAGINE 8.4 software will be used for the classification. The classification will be made through the unsupervised method, using the ERDAS program ISODATA algorithm. The "Isolda Clustering" method uses the minimum spectral distance formula to form clusters. The method starts with an arbitrary average cluster or with the average of a set of existing spectral signatures. Every time the process of "cluster" formation is repeated, the average is modified. The new average is used in the following interaction, repeating the procedure until reaching the number of requested interactions (6 or more) with a certain convergence threshold.

The system begins the classification on a scene on one of the dates, generating the number of pre-determined classes, depending on the diversity observed in the image (20 to 30 classes). The original classification generates a file of statistics through which the curves corresponding to the spectral response of each of the classes may be drawn.Each class is assigned to a certain cover present in the classified scene, showing "pure" classes (where all the pixels have been correctly assigned to one category), and others which present pixels corresponding to more than one land cover. The classes which present confusion are reassigned to the corresponding category through the utilization of other dates and a model to structure through the ERDAS program "Modeller" module.

Through this model, other dates and bands deemed indispensable for assigning the pixels to the various categories of land use in the best possible way are integrated to the original classification through a "conditional" function which allows pixel reassignment. The process to carry out this reassignment consists of applying a series of conditions according to reflectance values in the different electromagnetic spectrum bands which characterize a certain cover (assignment through thresholds of spectral response). The digital value in just one of the bands of any of the additional images used for the classification may be enough for the pixels which had been wrongly assigned within a class to be reassigned to the correct one.

These conditions are decided based on the contrast between a crop´s response to the sunlight received at a certain phonological stage of its cycle (which is caught by the

[5]Universal Transverse Mercator geographic coordinate system.

capture instruments placed in the satellites) and the rest of the covers, which may be observed in frequency histograms. Thus, for instance, if a pixel that should belong to the “Soybean” class has been wrongly assigned within a different class, when showing a digital value determined in one or more bands of one or more dates, it is reassigned to the “Soybean” class. The opposite case may be solved following the same way: a pixel wrongly assigned to the “Soybean” class may be eliminated. Through the same methodology, band quotients or other combinations, which improve separation, may be analysed.

Once the final classification is obtained and if counting with ground survey information, the results may be assessed using a confusion matrix[6]. The classified image will be incorporated into the GIS to be related and intersected with the administrative division layer being considered (department, cuartel, etc.) and thus enabling the generation of statistics on the areas of different land uses at the level of each administrative unit (Carballo, 2010).

During onsite inspections, publications from the local ministries and departments for agriculture can be used to check if the information provided in the maps is valid. Criteria such as the total agricultural production in the area, soil type, climate, ecosystems, natural vegetation, and agricultural operations must be consistent with the information provided.

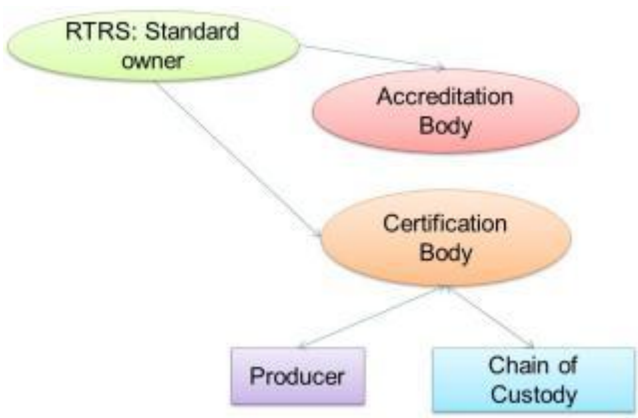
Case Study II

Several fields mainly owned by the company have concluded the RTRS procedure in order to be certified.

The system consists of 5 Principles:

1. ***Legal compliance & good business practice***
2. ***Responsible labor conditions***
3. ***Responsible community relations***
4. ***Environmental responsibility***
5. ***Good agriculture practices***

- Each principle consists of criteria and each criteria of auditable indicators
- Progressive entry level for farmers with immediate, short term and medium term indicators



The recent press release from Läntmannen (Sweden) of a purchase of 30.000 RTRS credits is an example of the direct trade variant where Läntmannen first agreed on a price

[6]Confusion matrix is a numerical matrix that relates field data (taken in surveillance transects) with data from the classification, determining the margin of error contained.

and quantity with the seller. Companies that possess credits as a result of their RTRS certification are Viluco S.A., Los Grobo, AGD, Adecoagro all from Argentina,

Agricultura certificada AAPRESID

Certified Agriculture is a quality management system for the productive processes under No Tillage. It has been designed to improve the business management and to optimize the resources-use efficiency. As a result, we obtain greater productivity within an environmentally friendly and energetically sustainable context. It constitutes a key step for the institutional life of Aapresid. It is supported by a 20-year experience in No Till practice –a productive system based on the absence of soil tillage, on crop rotation and the coverage of the soil surface with crop residues. This procedure allows achieving a rational, sustainable and even reparative use of the agro-ecosystem basic resources like soil, water, air and biodiversity. The implementation of AC requires the fulfilment of a set of Good Agricultural Practices (GAP´s). It also needs the registry of the agronomic management and the measurement of soil chemical and physical indicators for subsequent audits and the productive process certification.http://www.ac.org.ar/listado.asp?col=194

This certification process is more related to the whole farming business rather than specific crop,it is the production alternative that better combines the interests – many times confronted – of reaching a production:

- Economically viable for farmers.
- Environmentally sustainable.
- Socially accepted.
- Energetically efficient.

The certification process consists in the following basic steps

Documenting

The farmer analyses and describes the processes comprised in his productive activity.

Measuring and Registering

The farmer should establish, implement and keep systematic records that allow tracking the management plans of AC.

Auditing and Certifying

The certifying entity must obtain evidences and evaluate the accomplishment of the management plans and requirements of the AC Protocol so as to issue the Certificate.

It is based in following six basic principles in farming procedures.

No Soil Disturbance / Presence of Soil Residue Cover

A practice that consists in the absence of continuous soil tillage, and the presence of a permanent soil cover (crops or residues). It contributes to:

- Minimize soil erosion;
- Reduce the use of fuel;
- Lower carbon emissions;
- Improve water quality;
- Increase soil biological activity;
- Increase soil fertility;
- Improve productivity and yield stability; and
- Lower production costs.

Crop Rotation

It means the alternation of different crops in time and space. This practice has advantages from the agronomic standpoint.

- It has an inhibitory effect on pathogens;
- It uses nutrients in a balanced way; and
- It improves the soil physical, chemical and biological conditions.

It has an inhibitory effect on pathogens; It uses nutrients in a balanced way; and It improves the soil physical, chemical and biological conditions.

Integrated Pest Management (IPM)

It aims to optimize the control of weeds, diseases, insects and other pests, reducing the sanitary problems through different methods considering economic, social and environmental factors. It requires a deep knowledge of the pest biology as well as of the environment. The concept of “eliminating” a pest has been changed for that of “maintaining it below the economic damaging threshold The IPM implies a lower environmental impact and a more efficient business management.

Efficient and Responsible Agrochemical Management

It is necessary to achieve a highly efficient application of phyto-sanitary products in all the treatments applied according to responsible agronomic decisions. This means:

- To choose the product with less toxicity and/or higher selectivity, which only controls the “target pest” without affecting the others;
- To consider the minimum time needed between the product application and harvest;
- To store and transport the products in a safe way;
- To care for workers’ health; and
- To manage sewage waters and containers in the right way.

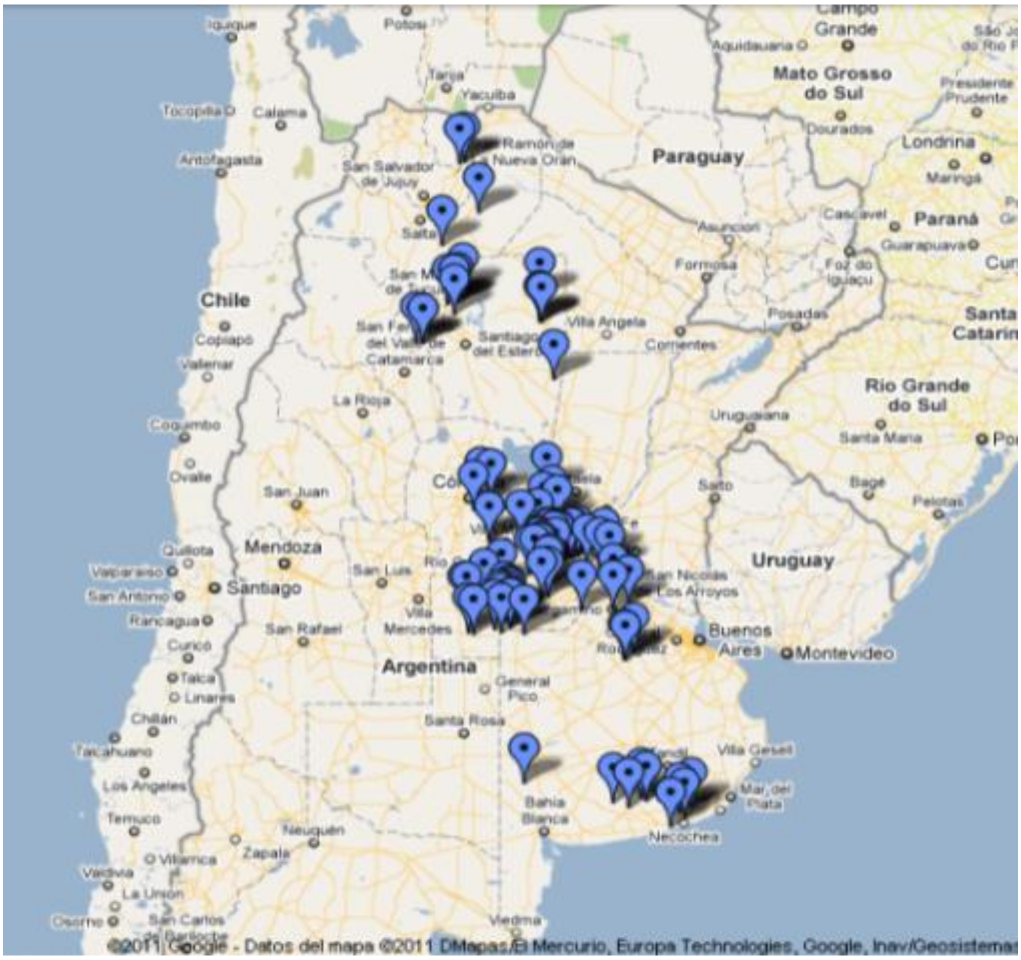
Strategic Crop Nutrition

Adopting a rational fertilization strategy in every production unit, which not only considers the amount of nutrients to apply, but also their efficient use by crops, constitutes a challenge that will have to be fulfilled to achieve an environmentally sustainable production. The soil chemical health should be maintained or recovered. The soil nutrient balance is a good method to evaluate it, considering production strategy in a comprehensive way. As a consequence, it is key essential to conduct soil testing.

Stockbreeding Information Management

All stockbreeding activities developed in the farm will have to fulfill some minimum traceability requirements according to the National Service of Animal Sanity (Servicio Nacional de Sanidad Animal, SENASA).The pastures and crops produced in the farm will have to comply with all the GAP´s, registries and indicators defined under the AC Protocol. (1 to 5).

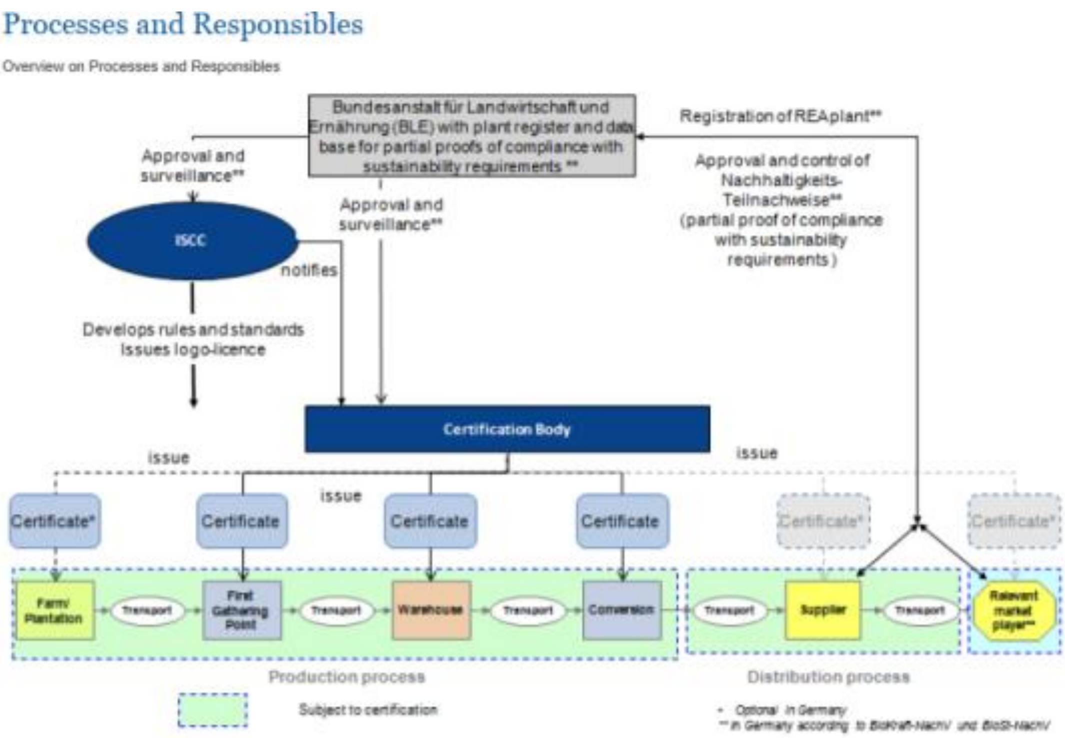
At the present date there are more than 100.000 hectares under this certification process



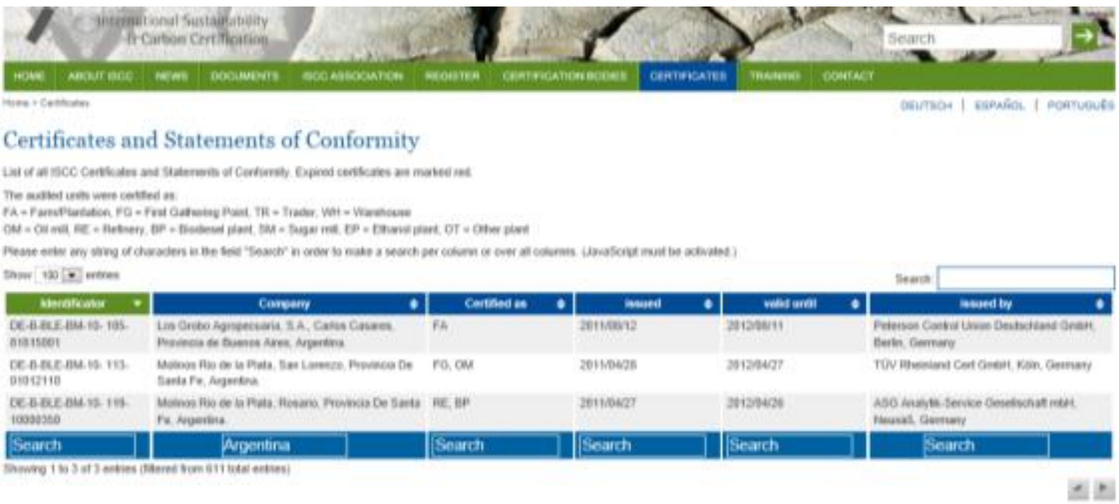
ISCC Certification Scheme

This standard for sustainable production comprises six principles with their respective criteria and does not only aim at the prevention of ecological shortcomings but also at the safekeeping of adequate working conditions and the protection of health of the employees on farms. The criteria are defined as “major musts” and “minor musts”. For a successful audit, all major musts have to be complied with. At the same time, 60% of the minor musts have to be fulfilled.

As needed, a National or Regional Initiative (National or Regional Technical Working Group) can adapt the international ISCC standards to local conditions by the means of a specification of the standard. Therefore the working groups shall consider the regulations in the documents ISCC 102 National and Regional Initiatives



Several very big companies from the farming and industrial sector have received the certification, one of them is one of the main oil provider of Case I study http://www.iscc-system.org/certificates/index_eng.html



5 Conclusion

- ✓ Soybean production is immersed within a complex agricultural production system that cannot be analyzed in an isolated approach. A number of political and market factors both nationally and internationally explains its development and growth throughout the globe. The analysis of those factors is essential to understand the biodiesel industry development and constrains.
- ✓ In Argentina's case the evolution of the agricultural system with soybean production, as perhaps the most important asset over the last few years, is characterized by a continuous technological improvement.
- ✓ This evolvement has allowed a substantial development of the whole agricultural system and has set the base that needs to be maintained in order to fulfill the growing requirements environmental and socially wise that societies demand.
- ✓ In the social and environmental aspects the institutional aspect is crucial from the government and private side. Argentina has developed a very important and sophisticated network of institutions related to agriculture and the agribusiness as a whole. A growth of the influence of several organizations has been significant Just to name the most important ones: INTA, AACREA, PROSOJA and AAPRESID mainly focused on the primary production; INTI,ACSOJA, MAIZAR, ASAGA, CARBIO & ABH more orientated to the agroindustry and agribusiness.
- ✓ An enormous evolution regarding sustainable development awareness is in place in the whole agricultural system with special emphasis in soybean production. This materializes in the whole research made by the mentioned organizations.
- ✓ Sustainability criteria indicators and certification schemes are well known by the principal actors on the soybean transformation chain and also by the public sector.
- ✓ Sustainability certification has a large impact on possible future demand and export marketsto which most of the agricultural and agro-industrial products go.
- ✓ There are very good information resources (SIG, remote sensing, field scouting, efficiency reports etc.). These are well known and increasingly being used by the different sectors.
- ✓ There is a very active role of the federal and provincial governments on land planning and developments to which sustainability criteria are incorporated and including social, economic and environmental aspects.
- ✓ Technological evolution has allowed unquestionable improvements in the preservation of the environment. Just to name a few:
    - o Reduction of agrochemicals toxicity
    - o Application technologies (Good agricultural practices)
    - o Direct seeding technology
    - o Precision agriculture
    - o Yield improvements that reducepressure on land use.
- ✓ Main concerns in the agricultural sector are related to suitable crop rotation and fossil resourcesfootprint.
- ✓ Regulatory improvements have allowed better control and development of land use. In Argentina's case the Law of minimum budget is an example towards that direction.
- ✓ Very high export tax over all crops has acted as a regulatory measure to decrease the expansion rate of agriculture.
- ✓ There is a good knowledge on different procedures to calculate greenhouse emissions following international or national criteria. A complete analysis has already been made on biofuel production from feedstock produced in different agro-ecological areas of the country.
- ✓ Social aspects are also increasingly consideredfrom the public side (municipal, provincial and federal governments) and the private sector through new trends in enterprise management as fair trade social enterprise responsibility and certification schemes. The development of this trend has been institutionalizedthrough the Social responsibility institute with specific tools to

address this important issue http://www.iarse.org/new_site/site/index.php?put=indicadores.

- ✓ The 10 billion dollars collected by export taxes from soy products represents near 4% of the GDP of Argentina (biodiesel reperents 350 million in export taxes). This is by no means a small number given that for example Argentina's spending in Education totals 4% of the GDP; Health spending is near 5% of the GDP, housing spending is near 0.5% of the GDP and Social Security near 9%. The social and development consequences of the production and transformation chain are very significative for the country.
- ✓ The bioenergy sector in Argentina is mainly governed and depends on the food chain prices and conditions since they are using a sub product of the grain transformation.

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