

Biofuels: Environmental benefits or trade-offs?

The South-North perspective on biofuel business, trade and environment

A case study from Argentina on soy biodiesel

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Abstract

The thesis describes the global development of biofuel trade from a South-North perspective, with a particular focus on the view from the global South on the case of soybean bio-diesel from Argentina. The overall question of the thesis focuses on the balance between benefits and trade-offs of biofuels from an environmental perspective, it also considers economic and social dimensions.

One of the main reasons that biofuels are being promoted are environmental benefits as reduced carbon emissions in the transport sector and as such presents an alternative to mitigate global warming and climate change.

Due to politically set biofuel targets and increasing oil prices, global biofuel production and trade is expected to increase rather significantly in the future. However, the carbon neutrality of biofuels can be questioned and the thesis illustrates several crucial issues concerning how “green” the development of large scale biofuel production is.

Main findings are that biofuels will probably further advance the agricultural frontier and increase the pressure on land in Argentina, a country with already high rates of deforestation. It is questionable whether soybean diesel could contribute to reduced greenhouse gases in Argentina. The lock-in effects of soybeans, the weak political-institutional culture impeding sustainability strategies, the strong external demand for soybean products, the biofuel tax incentive pushing investments in biofuels; are some of the push factors that are likely to further exacerbate environmental trade-offs such as an advancement of the agricultural frontier, reduce carbon sinks and cause an increased loss of biodiversity.

Executive Summary

An increased use of biofuels is expected in the future. This is mainly driven by political goals to reduce carbon emissions and business interests for a new global market. Due to the secure demand, compulsory blending requirements and the increasing oil prices, global trade in biofuels is estimated to increase significantly the next coming years.

One of the main arguments for promoting biofuels have been how “green” they are. Having the potential to reduce the levels of carbon dioxide, being carbon-neutral, improving the GHG balance for the transport sector. Some biofuels, depending on a number of factors have the potential to do all this, during certain circumstances. As biofuels are most often described in terms of benefits or trade-offs, the underlying question of the thesis is “what are the expected environmental benefits or trade-offs of biofuels?”

Having a global scope, as the energy demand is greatest from the North and the best conditions for production is in the South, the thesis is framed in a North-South perspective following the equation of demand and supply. The scope is following the future trade patterns between North and South, with the emphasis on the view from the global South, represented by a case study on biodiesel from Argentina. A nation believed to become one of the biggest biofuel exporters to Europe.

The first part of the thesis is giving a holistic frame of the biofuel industry, current and future biofuel trade and markets and describing main political and business reasons for promoting biofuels. Second part is looking into the view from the South, a closer look at the biofuel development and potential social and environmental consequences in Argentina.

The best conditions for producing the most energy efficient feedstocks, oil palm for biodiesel and sugar cane for bioethanol, are in Southern countries with tropical and sub-tropical climates. Therefore, large-scale production and export is expected to take place in the South.

Southern countries have completely different competitive advantages than the North. There is more land available for growing crops, more suitable soils, longer growing seasons and lower labour costs. Thus, it is a more cost-efficient and energy efficient approach to produce biofuels in the South.

Biofuels could become very important and increase trade significantly for countries in the South, as it means an opportunity to export a value-added product increasingly in demand. Estimations are that sugar cane production could respond to 10% of the gasoline use globally. While the main export markets are in the North, where OECD countries use 49 million barrels of oil every day, Northern countries do not have the land availability to meet the energy needs, nor does it have Southern factors as favourable climate or soil conditions or the lower production costs of the South. Hence, the biofuel trade is expected to follow a South-North/North-South trade equation.

In the first part of the thesis, the focus is on issues regarding biofuel business and the expected increase in biofuel trade worldwide. In the second part, the agricultural production of soybeans in Argentina is described and subsequent issues regarding deforestation, balance of nutrients, lack of sufficient land use laws and the increased pressure on land is described and discussed.

The development of the biofuel industry is happening in a fast rate on a global scale and consequently will have a global effect. The potential implications of a global development of biofuels; the economic, social and environmental impacts this could have worldwide is poorly understood. As always with new technologies, there is a risk for unexpected negative impacts.

From an *economic perspective*, the politically set targets for blending requirements are guaranteeing a demand for business, that in addition to governmental subsidies make it an interesting business opportunity.

The biofuel industry is characterized by an inflow of large investments from several sectors, such as energy, agriculture and financial sectors. There are also several market actors benefiting from an increase of production as seed companies, engineering and equipment companies, the biotechnology industry, gasoline blenders, farmers, agricultural equipment industries, suppliers of agricultural input products as fertilizers and logistics suppliers. Governments and international monetary institutions and regional development banks also invest money to support the biofuel industry in order to sustain its economic viability.

The agribusiness is one of the main investors in biofuels. There is a possibility of increased profitability not only by producing and selling biofuels, but also considering the global commodity boom that this new source of demand will generate for agribusiness.

As feedstock costs is one of the main production cost, many agrofuel companies control both the production and supply of the feedstocks.

There is a trend towards building entire chains of agrofuel networks that integrate the whole production process from seeds to shipping.

Another strategy for keeping down production costs is relocating to countries where production costs are lower.

The investments flows into biofuel industries are having a restructuring effect on agribusiness. There are patterns of global financial flows that is reorganising and strengthening transnational structures, there seems to be a trend of connecting the landowning elites of the South with the most powerful companies in the North.

Considering *social aspects*, the effect that biofuels will have on related markets is a subject of debate worldwide, i.e the food vs fuel debate. There are concerns that an increased production in biofuels, using food crops for energy purposes can increase commodity prices of food and have an impact on the access and availability of food for poorer parts of populations.

It is believed that prices will increase both for energy crops and for traditional crops, (FAO) as demand for energy prices increases and traditional plants are displaced and less produced (Villalonga, Greenpeace Argentina, 2007).

ECLAC/FAO predicts that in the short term a dramatic increase in global biofuel production will have quite a significant impact on the agricultural sector. The results are likely to be changes in demand, exports, land availability for energy and non-energy crops, and an increase of crop prices that will most certainly have a negative impact on the food access for the poorest part of populations.

For countries that are net importers of food higher commodity prices are of concern, especially for the poor in urban populations. Moreover, it is likely to be a shift of incomes and

costs between farmers. While there will be those farmers favoured by the increased biofuel feedstock prices and having a larger income, for others it will imply higher costs and lower incomes for those producers that use the same feedstock for animal feed (OECD/FAO, 2007).

A positive social benefit that biofuels potentially could generate is rural development but for this to occur tailored governmental strategies and policies are required. There also have to be specific conditions as rural areas that are distant from the centre, in order to have a multiplier effect on the economy in the area. It would take investments from the government or another source and one would have to target small-scale farmers and create a secure demand for them from government or processing companies (Dufey, 2007).

One of the main reasons to why biodiesel is being promoted worldwide is because of its ***environmental qualities***. Having the potential to reduce GHG emissions in comparison to regular fuel. As this is one of the main reasons, or from an environmental perspective la raison d'être of biodiesel, it is essential to ensure that biodiesel is a better alternative compared to diesel in terms of environmental impacts.

The results for GHG emissions' balance in comparison to regular diesel fuel are interesting considering the environmental impacts generated by the production throughout its life cycle in comparison with conventional diesel. In addition, the overall effect the production has on the ecosystem, the expansion of the agricultural frontier and deforestation.

Generally, the South is often characterised by less environmental awareness than the North, there is also in the South where most biodiversity exist and the most fragile eco-systems. There are often less land mangament and lack of law enforcement and in some cases significant corruption. These are all indications on weak governance from the state.

Argentina as a country has a combination of weak governance and a large-scale agricultural production with environmental consequences as soil degradation, an expanding agricultural frontier into grasslands and forest, a soy expansion deplacing cattle and other cultivations. Agricultural production of soy biodiesel is generating substantial environmental effects both directly and indirectly.

Though, there is a lack of comprehensive studies analysing the interrelated effects between the massive soyexpansion and its social and environmental effects, which is especially essential now with the biofuel industry probably expanding soy cropping even more.

Biofuel is primarily viewed as a value added product in Argentina and there is no sustainability policies or indexes in place.

The great difference in tax for exports of vegetable oil and biodiesel, 24% respectively 5% and a rebate of 2.5% for biodiesel, is a strong incentive driving vegetable oil producers and new investors into the export market. Though volumes are still very small by the end of 2010 production volumes are estimated to 2 billion liters.

There are a number of factors that make the internal market less interesting, such as regulations, not competitive biodiesel prices compared to conventional fuels, there are also large investments into export market and a strong demand from foreign markets.

As biodiesel presents a new profitable product it will most probably have the effect of a shift between markets, considering all the favourable conditions pushing towards exports of

biodiesel. Some exporters might leave vegetable oil markets for biodiesel markets and new or current producers of vegetable oil will fill that gap. There is also the possibility of current oil producers maintaining their export markets and expanding their production.

Anyhow, the effect will be the same. There will most probably be a change in the markets and to fill the demands for the two markets based on the same raw material-there will be an increasing pressure on the land, both in terms of area and intensity, i.e productivity.

Previous years with soy cultivation, there has been a linear correlation between higher foodstuff prices and an expansion of the agricultural frontier. The tendency one primarily have seen the last 10 years is the expansion of soy for various reasons, the main reasons being the low costs of production, low risk and high profits. Soy is the main reason for an increase of the land area, an expansion of the agricultural frontier into areas with more fragile soils in the Northern parts of the country. New businesses as biodiesel with soybean as the basis for production-will probably mean a continuation of the previous tendencies.

This is largely due to new forms of organization, larger units of production, an evolution of competitiveness as part of the increasing globalisation of agricultural markets. Economies of scale and new technology as no-tillage management and increased use of fertilizers have had the effect of cropping on soils that were not possible earlier. With the new technology, one does not have to take into account factors as soil suitability or sustainability. This has generated patterns of an intensification of agricultural production with less rotation and intensive cultivation of soy in the Pampas during the last decade.

The massive expansion of soy has displaced other cultivations and cattle breeding. Which has led to higher commodity prices for basic food products as potatoes, lettuce, peanuts and meat. For example, one can see in the micro-economy of Argentina, a strong increase of vegetable prices. There are less potatoes, batata and onions, since soy areas are expanding and displacing other cultivations (Villalonga, Greenpeace, Argentina, 2007).

From a climate perspective, when considering solutions to emitting less greenhouse gases, it does not seem reasonable to cultivate more soy, as soy itself is indirectly a source of greenhouse gases through the cutting of forest. Deforestation and nitrogen emissions from agriculture represent 18% and 14% of greenhouse gases globally. Sowing soy is reasonable from a business perspective, but not to mitigate climate change.

Soy is the main motive to deforestation, leading to a subsequent destruction of ecosystems and its biodiversity. An activity that seems rather uncontrolled due to weak laws and law enforcement in the Northern parts of Argentina. Deforestation of one hectare of native forests means that one would have to produce soy during 197 years to compensate these emissions according to calculations from Greenpeace Argentina.

While soy is generating deforestation, soy biofuel has very low chances of making any contribution in environmental terms or climatically. Greenpeace is calling it “a reverse CDM mechanism” to symbolise the production of clean energy which emits a lot in the production country and is exported to countries where it will be burned as a cleaner fuel. All the emissions of the agricultural production stay in the country.

Soybeans are used as the main feedstock for biodiesel production as it is readily available. It is available in large quantities, there is a knowledge and production structure built on soy cropping and a lot of invested capital. It is also in itself a very valuable commodity. So, it is convenient

to use soy beans as a feedstock, more than being a suitable feedstock for biodiesel production. This is a clear result of the lock-in effects that soy generates.

This is especially evident when considering the relative low oil content in soybeans compared to other plants with higher oil content as oil palm or even sunflower: Soy beans are on the low end of the efficiency scale. Therefore it does not seem to be the most suitable feedstock for biodiesel production when considering large-scale exports, as it will demand more land than other crops. In Argentina this is specially out of concern, as the most fertile soils in central areas of Argentina is already used and the Northern areas are close to the tropic of Capricorn and are less suitable for intensive cultivation of soybeans.

The most oil producing plant is palm oil, which yields 5550 l/ha, in comparison to soybean that yields only 420 l/ha. This is a difference of magnitude, oil palm yields about 13 times more than soybeans. Yields are estimated in liter per hectare which makes it easy to compare with how much it would be in biodiesel. As 1 liter of oil gives about 1 liter of biodiesel one can conclude that there is a great difference in the amount of land needed for different cultivations (Asal and Marcus, 2005).

If one would use another raw material than soybeans, e.g. sunflower which yields 890 l/ha, there is a difference in land areas. To achieve the mandatory blending requirements of 5% for 2010 with biodiesel one would need to produce 700 000 000 liters of biodiesel. If one produce this out of soybeans this will be 1.3 million hectares, in comparison with soyflower it will be 1 million hectares.

One has to remember that to accomplish the goal of 5% for 2010 close to 9% of the land area sown (taking the 9% of the 16 millions of hectares). This number will be 15% for 2023. This indicates the difficulty that Argentina might have for producing significant volumes of biodiesel without expanding the land areas, when expansion is not something positive. While this is only the calculations for the internal market, the external demand for biofuels is infinite. Europe is expected to import 50% of its consumption of biofuels. In comparison to China the demand for biofuels from Europe is rather low.

While soy causes these environmental problems, the environmental balance soy has is very bad, because its benefits as a biofuel would be rather low in comparison to the environmental trade-offs it causes. One can never regenerate the ecosystem services.

In this sense, the North-South trade, the often referred to win-win, from an environmental perspective becomes more like the export of environmental externalities, greenhouse gases and other environmental and sustainability problems generated in the South, to export cleaner fuels to the North.

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1 Introduction

The world stands in front of a great challenge, the seemingly impossible equation between reducing the impact of global warming and at the same time managing a growing global energy demand. Alternatives to fossil energy as biofuels have been put forward as a means to reduce carbon emissions and reduce global warming, through substituting fossil fuels in the transport sector and thus, mitigate the impact of greenhouse gases.

The Stern report and the Intergovernmental Panel of Climate Change (IPCC) have confirmed that the increase of greenhouse gas emissions is with a 90% certainty caused by anthropogenic activities. Reducing global carbon emissions have become a main priority among the world's governments, thus the creation of the Kyoto Protocol.

According to estimations energy consumption is believed to increase as much as 30% by 2020. This is explained by factors as a growing world population, strong economic growth in developing countries as China and India which will increase energy consumption, further accelerated by urbanization and industrialization (IADB/Greenoutlook, 2007).

Only some time ago, in 2007, the Chinese economy exceeded the United States and became the largest emitter of greenhouse gasses. This is years earlier than previously thought. It is another reminder of the continuous increasing pressure on the Earth's eco-system, of the consequences of the combination between demographic and economic growth.

The fact that energy demand is expected to increase rather significantly and fossil fuel prices are rising and supply limited, has the effect of pressuring countries to search for alternative energy sources. As the dependency of fossil fuels for national economies, in a future energy insecurity world, could lead to severe disruptions and wreck economies over a night (Mathews, 2007).

Security of supply and energy independence is important push factors in the search of alternative sources of energy. Other important drivers in the search for alternative sources of energy are the environmental concerns posed by global warming and subsequent climate change.

One measure to reduce carbon emissions is in the transport sector. The transport sector is believed to be responsible for 20% of global gas emissions in 2001 and its share will further grow as it is expected to consume 55% more energy by 2030. The transport sector accounted for the fastest Greenhouse gas (GHG) increase in Western countries as US, Japan and the EU. Therefore, it is essential to provide cleaner alternatives, non-fossil fuel sources of energy, as biofuels (IADB/Greenoutlook, 2007).

Biofuels have become viewed as a serious alternative to oil for transport and also to alternative technology such as hydrogen, as it is easily adaptable to existing distribution infrastructure, flexi-fuel technology are becoming increasingly available, and not withstanding, the most efficient producers as Brazil have prices competing with the oil industry (Dufey, 2006).

The current biofuel options, the first generation of biofuels, bioethanol and biodiesel, are agricultural products processed into liquid fuels. The first generation of biofuels are said to have a time span of ten years, before technology of second-generation biofuels become commercially available (Dufey, 2006).

Up to date international trade in biofuels is still in its infancy. Though, an increased volume of international trade in biofuels is expected to follow, as political set targets for blending requirements are prevalent among many of the world's countries, creating a secure demand in the domestic market. For those countries, not able to for fill blending targets with own production, imports will be necessary, creating export possibilities for the most efficient producers.

Europe is expected to become a "major global sink for biofuels" and therefore is likely to have an impact on the growing biofuel industries in the South (Verdonk, 2007). Though, the demand from Europe will be relatively low if one compares with the large-scale imports, which will probably be the case of China and India. Europe's biofuel import is in this sense comparative small. The market will be global.

The European demand is expected to be met by countries in the South, as they have comparative advantages considering factors as land availability, right climate and soil conditions, longer growing seasons and lower cost of production. The most efficient producers will most probably be Southern countries, as the most energy efficient feedstocks, sugar cane and oil palm trees, are located in tropical and sub-tropical countries (IPC, 2006).

In Latin America, the Brazilian success story has generated great interest over the continent. Several countries have introduced tax incentives and regulatory frameworks, as mandatory blending requirements, in order to attract foreign investment and stimulate an expansion of the industry (IADB, 2006).

Argentina is one of the countries with a national strategy directed towards large-scale biofuel export to Europe and US. Argentina is predicted to become one of the world's leading biofuel producers. Being one of the major producing oil-plant nations, a large-scale exporter of products made from soy cultivations; both the raw material for conversion to biodiesel and the export markets are established.

So far so good.

2 Problem Definition

At the international Biofuel Conference at the European Commission in Brussels in July 2007, the EU Trade Commissioner Peter Mandelson declared that the EU biofuel policy should be based on global environmental concerns. That the greenest fuels should be prioritised whether it was EU produced or imported. Mandelson argued: “Biofuel policy is not ultimately an industrial policy or an agricultural policy-it is an environmental policy, driven by the greenest outcomes.”

Mandelson further continued: “Europeans won’t pay a premium for biofuels if the ethanol in the car is produced unsustainably...or if it comes at the expense of the rainforests. We can’t allow the switch to biofuels to become an environmentally unsustainable stampede in the developing world.”

Mandelson is right about having these concerns. Cause although “green and environmentally friendly may seem synonymous with biofuels,” (Berkeley, 2006) this is not always the case. As the production of biofuels are well context specific and results varies significantly in environmental performance from case to case.

Currently there is no systematic measurement in place to monitor the environmental performance of biofuels, so there is no way to know which are the “greenest” biofuels. Therefore consumers have no information on which one of the fuels is the “greener” fuel. Nor is there any incentive for the producers to produce them. If one created regulatory instruments that could govern the biofuel industry, it could generate innovation and more environmental friendly biofuels. Without any incentive or regulations of the industry there is a risk that it develops in a way that will create significant environmental impacts (Berkeley, 2006).

The point is that all biofuels mean trade-offs among positive and negative environmental effects (Berkeley, 2006). On the one hand, biofuels have the ability to reduce pollution, but they can also exacerbate a range of other environmental problems if not developed carefully (WorldWatch Institute, 2006).

There are a number of factors that are cause for concern.

As the carbon released when burning biofuels is absorbed by the feedstock, biofuels are often regarded as carbon-neutral. However, there is still no scientific consensus that this really is the case, as the results of Life-Cycle studies vary significantly depending on the type of plant, where it is grown, how it is grown, the amount of fossil fuels used in agricultural production and in conversion stage (Boswell, 2007).

The worst case scenario is when biofuels are produced from low yielding crops, with a high input of fossil fuels, on a previous grassland or forest, as in this case it could cause as much greenhouse gases or more than petrol fuels (Worldwatch, 2006).

Moreover, agricultural production is a typical case of a non-end source and greenhouse gas emissions occur during feedstock production and conversion by the use of fossil fuels and also somewhat through the emission of nitrous oxide in agriculture. What is critical is that “some of the greenhouse gas producing processes are poorly understood, and some agricultural emissions are not controllable” (Berkeley, 2006).

There is also the risk that an increased demand for biofuels could push the agricultural frontier further towards tropical forest areas, which are important carbon sinks and deforestation would result in large greenhouse gas emissions (Biofuelwatch, 2007).

As it is more efficient producing biofuels in the South, considering a better climate and lower costs, biofuel production will be established in developing countries in the Southern hemisphere. Countries with more land, longer growing seasons, lower costs of production. These are also the countries with tropical forests at risk and with less law enforcement. A case in point is the case of Malaysia where the national large-scale investments have had considerable social and environmental impacts.

The development of biofuel industries is also global. Countries in Asia, Africa and Latin America are planning to develop biofuel industries. Brazil and Argentina will use GM (genetically modified) soy to produce biodiesel. The EU has an aim of using 5.75% of biofuels by 2020. In sum, it is a large-scale development of biofuel industries worldwide and it is developing without any substantial environmental or scientific studies on its overall global effect from an economic, social or environmental perspective (Boswell, 2007).

There is also the business dimension; the biofuel industry is accelerated by a large wave of investments from companies such as Archer Daniel Midland, Cargill, Daimler Chrysler, Dupont and Shell. Followed by major investors in biofuels as Richard Branson, Bill Gates, Vinod Kholsa and Goldman Sachs. Within the auto industry, Ford, General Motors, and Volkswagen, are launching plans for increasing productions with flexi-fuel vehicles that can use a variety of blends of ethanol and gasoline.

Further, the time factor, the first generation of biofuels have a time span of 10 years before second generation becomes available and competitive. One has to move in fast to be a part of this market. This has an accelerating effect.

International biofuel trade have been described as a win-win opportunity for developing and developed countries alike, as increased international trade in biofuels would bring “sustainable benefits” for both parties. Simply, it would help Kyoto signatories to reduce greenhouse gas emissions and give developing countries comparative advantages in a new booming market. In sum, GHG savings for the North, and economic gains for the South.

The development of the biofuel industry is happening in a fast rate on a global scale and consequently will have a global effect. The potential implications of a global development of biofuels; the economic, social and environmental impacts this could have worldwide is poorly understood. As always with new technologies, there is a risk for unexpected negative impacts.

Perhaps it is developed too fast without knowledge on its fully life cycle impact. As Boswell claims, there is an increased risk for this to occur when “the intrinsic benefits of the technology are exaggerated for political or commercial reasons” (Boswell, 2007).

The main risk is that if biofuels are developed too fast without scientific scrutiny and consensus on the potential effects, there is a risk that the main reason for promoting the biofuels-to ameliorate the global climate-will not be achieved if there is an expansion of energy crops into forest areas or if cultivation is very input-intensive, as the two processes generate carbon emissions (Dufey, 2007).

This study is looking at the development of the biofuel industry from a geographical perspective of North-South. Following the geographical asymmetry between demand and supply in the biofuel case.

Generally, the South is often characterised by less environmental awareness than the North, there is also in the South where most biodiversity exist, the most fragile eco-systems. Where there are less land mangament law, lack of law enforcement and in the some cases even corruption. Governance is often weaker in the South.

By taking Argentina as a case study, the thought is to convey a holistic picture of a country in the South that is in the beginning of starting to export biofuels internationally, mainly to Europe and US, though Asian markets are also interesting.

Argentina has been chosen to represent one view from the South, as it is one of the leading agricultural producers in the world. It is one of the world's largest vegetable oil producers, having vast land areas for agricultural production and an impressive crushing capacity of 150,000 ton per day. A vegetable industry mainly based on production of soybeans and its derivatives.

3 Research Framework

3.1 Objectives and Research questions

The main objective of the thesis is:

To give a *comprehensive study* of some of *the most important trade and environment related aspects* considering the development of the global biofuel industry. To present indications and critical aspects from a social, but mainly environmental perspective. To highlight the importance of national or international governance systems of biofuels.

The overarching research questions analysed in the study is following:

- *Why is soy the first and seemingly only alternative for large-scale production of biofuels in Argentina?*
- *What are the drivers behind Argentina's biofuel strategy?*

Biodiesel export is a great opportunity for agricultural producers as it is a value-added product and a chance to diversify agricultural markets. In the Argentinean context most biodiesel will be made on the basis of soybeans. As the cultivation of soy have had quite a few negative consequences for the environment until now, further questions arise.

- *What could be the expected outcome of Argentina's biofuel strategy from an environmental perspective, trade-offs or benefits?*

3.2 Data sources

The gathering of data have consisted in finding information from multiple sources and with the use of triangulation as one of the prime research methods, verifying first source information with second sources of data-all from a number of different sources.

Other techniques used are structured and unstructured interviews.

Interviews and discussions have been carried out with a number of persons on different positions with expertise regarding trade or environmental aspects of biofuels. The intention was having a wide fact base and a number of different stakeholders with competing interests and perspectives in order to better perform a triangulation of statements with conflicting ideas.

In all I have interviewed thirteen persons from a wide range of institutions, representing research institutes, academia, the private sector, governmental organisations, international governmental organisations and non-governmental organizations.

3.3 Analytical approaches

3.3.1 A case-study approach

The thought is to substantiate a trade and environment oriented thesis with a case study from Argentina. To portraying a holistic view, filled with details. In order to create a holistic picture, a context to be emphasised with details a case-study approach has been chosen as the most suitable. A case study approach is useful to “investigate a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, 1993).

3.4 Scope

The scope is partly “global,” in the sense that biofuels-the main theme in the thesis- is a global solution to a global climate problem and the biofuel industry is being developed worldwide. The thesis has an overarching global frame due to factors as the globalization of trade and markets and the interdependence between nations for solving environmental problems that reaches across national borders.

A main focus is on the geographical perspective of North-South. Given the geographical asymmetry between demand and supply in biofuel trade. There is an emphasis on the trade relations between Europe and Argentina, as the EU will be one of the main importers of biofuels and a big export market for Argentina. The trade part is over viewing biofuel trends and is thought to illustrate the current trade status and challenges related to large-scale biofuel trade.

The scope is also limited to liquid biofuels that is first generation of biofuels, bioethanol and biodiesel; there is a more specific focus on biodiesel made on the basis of soybeans.

A particular focus is on the case of soybean cultivation in Argentina. To provide an account of environmental concerns of the development of the biodiesel industry in Argentina, by focusing on agricultural production and the sustainability and environmental concerns it generates.

3.5 Limitations

Information availability is one limitation for the thesis. There is a CDM (Clean Development Mechanism) project on soy biodiesel at the Environmental Department, which could have been used to find out more about the sustainability issues with soy biodiesel. However, the document is confidential, as it was carried out by a consultant and therefore not accessible.

It had also been interesting to know what kind of sustainability indicators that the Designated National Authority (DNA) works with in Argentina, as it would give an idea of the concept of sustainability on a national level. However, there are no such sustainable indicators for CDM projects, as one would have thought, as several CDM projects have been approved by the DNA. The projects have been approved without any established indicators, but one is working with some kind of sustainability criteria and is currently developing indicators.

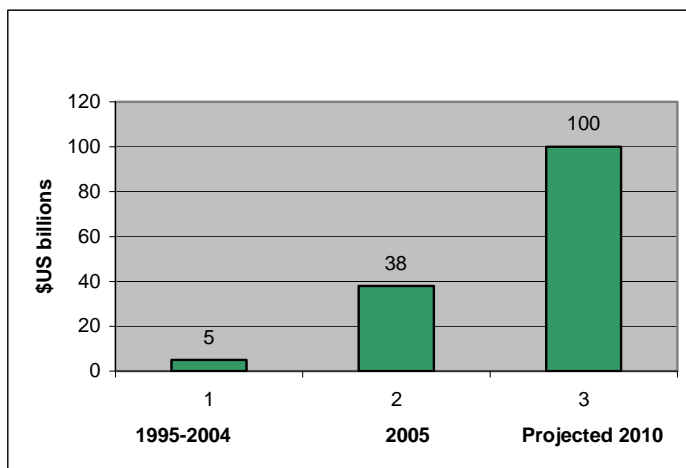
4 Background

4.1 The biofuel industry

Around the world governments are re-examining their energy alternatives in search for cleaner fuel alternatives and technologies. Peaking oil prices, the expected depletion of fossil fuels, concerns for global warming and subsequent climate change are some of the main reasons that explains the growing global biofuel industry.

A clear indication of the interest in cleaner energy is proved by the amount of investments generated. United States are estimated to invest US\$100 billion in clean energy by 2010, which is to be compared with previous years, like in 2005 when this figure was US\$38 billion or even ten years earlier when the same figure was around US\$5 billion. Another major influential power, China, seems to follow in the same direction, as it has announced that it will invest US\$187 billion in clean energy by 2020 (IAB, 2007).

Table 1-1 Global Renewable Energy Investment



Source: IADB, 2007, p. 1

Biofuels have become an integral part of this shifting investment environment and are increasingly becoming an important element of it, driven by the growing number of governments worldwide that require blending targets and by the estimated future investments in renewable energies, as indicated in table 1-1 above (IADB, 2007).

During the last five years, biofuels have become viewed as a serious alternative to oil for transport and also to alternative technology such as hydrogen, as it is easily adaptable to existing distribution infrastructure, flexi-fuel technology are becoming increasingly available, and not withstanding, the most efficient producers have prices competing with the oil industry as the case of Brazil (Dufey, 2006).

Both bioethanol and biodiesel can be used in conventional engines. Though an engine modification is required for pure bioethanol and biodiesel, but mixes of gasoline and diesel work up to 5 and 10%, B5 and B10 respectively (ESMAP, 2005).

First generation of biofuels, bioethanol and biodiesel are both produced worldwide, though more bioethanol than biodiesel is produced. Bioethanol is mostly produced and consumed in the Americas, while the EU is the world-leading producer of biodiesel, and consumes most of it domestically. However, compared to bioethanol, total biodiesel production remains small. EU is currently the world leader of biodiesel production but will be challenged by countries in the Americas, Africa and Asia in the near future (Dufey, 2006).

4.2 Different types of biofuels

Biofuels exist in liquid form as bioethanol or biodiesel or in gas form as biogas. What they have in common is that they are all made of biological/agricultural sources.

The current biofuel options, the first generation of biofuels, bioethanol and biodiesel, are agricultural products processed into liquid fuels.

For bioethanol production it is common to use feedstocks as sugar plants and cereal crops and through the process of fermentation obtain bioethanol. Feedstocks currently used are sugar cane, corn, beet, cassava, wheat and sorghum. Second generation of bioethanol will be produced mainly from sources of lignocelluloses, which are tree plants and energy grasses.

The raw material used for production of biodiesel is plants and crops containing oil to a lesser or greater extent, as for example rapeseed, sunflower, soy, palm, coconut or jatropha. It is also possible to make biodiesel from already used cooking oil, or from animal fats and tallow.

The second generation of biodiesel is made through the Fischer-Tropsch process, which is a gasification process, from wood and straws to fuel (Dufey, 2006).

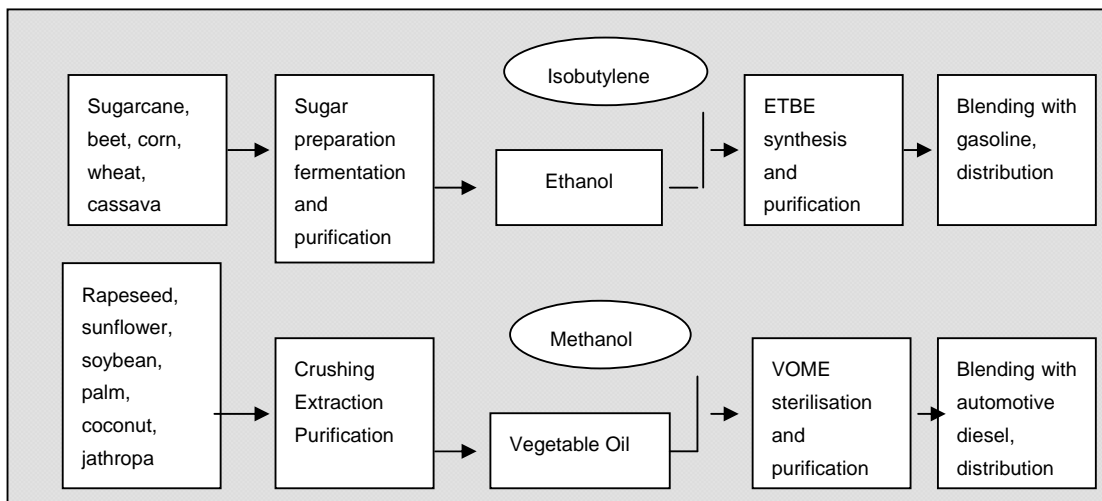


Figure 1-1 Biofuel manufacturing processes, bioethanol and biodiesel

Source: Dufey, 2006, p.3

The first generation of biofuels are said to have a time span of ten years, before technology of second generation biofuels become commercially available. Second generation biofuels are expected to have a better energy balance, more energy efficient and will require less land (Dufey, 2006).

The issue with second generation biofuels is the expensive and extensive process it takes to break down cellulose, hemi-cellulose and lignin-which make up the woody parts of the tree feedstocks. This technology is costly and takes time to develop and it is estimated that prices will be at commercial levels within ten years.

The on-going research and technology development of second-generation biofuels, is putting a time frame on the current biofuel options. It is difficult to predict how the second generation will affect the market for the current options of biofuels. It is also a matter of speculation of whether bioethanol or biodiesel will dominate the markets in the future.

In an interview with Annie Dufey, International Institute for Environment and Development, (IIED), bioethanol was said to become the main biofuel in future markets. As the economic costs for producing second generation biofuels is dropping faster than for biodiesel and thus the technological development goes faster. Therefore it will obtain a larger share of the market, especially with second generation of biofuels.

Professor John A. Mathews, Macquarie University, Sydney, the writer of the Biopact, is of the opposite opinion. Mathews said that thanks to the efficiency of the diesel engine biodiesel is expected to become the mayor fuel and overtake ethanol. Already now there are lots of engines running on biodiesel as ships, buses and trucks. The combustion engine has blocked other inventions for hundreds of years, but that could be over now.

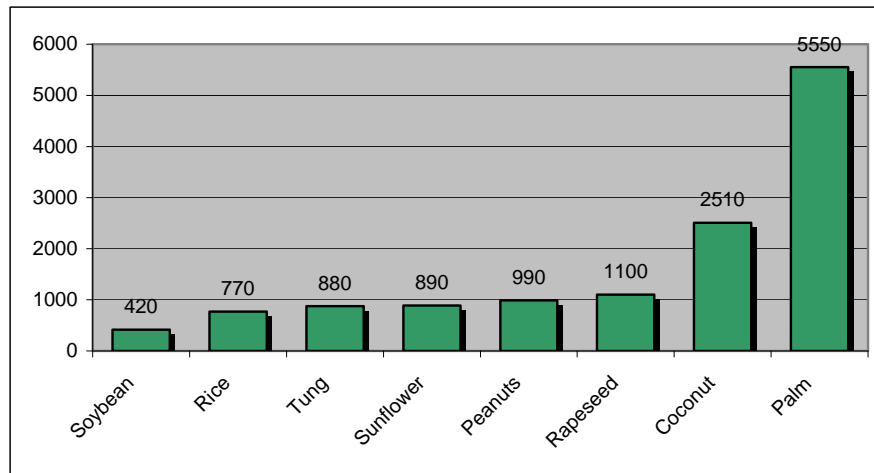
4.3 Feedstocks for biodiesel

The raw material used for production of biodiesel is mainly vegetable oils. Vegetable oils are said to be excellent biodiesel feedstocks. In Latin America there are mainly three vegetable oils that are out of interest for biofuel production, soy oil, palm oil and sunflower oil other oils as rapeseed, olive oil and castor oil are currently produced in too small volumes to be interesting for the biodiesel market (IADB, 2006).

There is quite a great difference in oil yields of the different plants. The most oil producing plant is palm oil, which yields 5550 l/ha, in comparison to soybean that yields only 420 l/ha. As one can see in the table below, soy oil is at the low end of the efficiency scale of oil content. Oil palm is the largest existing source of vegetable oil and yields about 13 times more than soy beans.

The variations between oil yields depends on the content of oil that a plant generates and not by how great volumes one can generate per hectare. It is estimated that 1 liter of oil generates about 1 liter of biodiesel (Asal and Marcus, 2006).

Table 1-2. Oil (or biodiesel) yield per unit cultivated area.



Source: INTA, in Asal and Marcus p.56, 2006.

When comparing the yields in terms of seeds between soy and sunflower in Argentina, soy generates more, about 2200kg/ha compared with 1700 kg/ha for sunflower. However, sunflower, as shown in the table, generates almost the double amount of yield in litre per hectare.

This is due to the difference of oil content in the plants. The oil content for soy is estimated to be 18% of the plant, whereas the sunflower seed's oil content is between 30-40%.

The choice of which oil to use for biodiesel production is primarily determined by the climate and cropping conditions of the region in question. Which feedstock to use for biofuel production is mainly a function of the prevailing agricultural production of a country and its vegetable oil industry, as it already exists an established production chain, infrastructure and markets for vegetable oil production.

4.3.1 Soybeans

Soybeans are originally from Southeast Asia, but most production takes part in the Americas, up to 90% is mainly produced in US, Brazil and Argentina, which are the three world leading soy producers and exporters to global markets.

Soybeans are grown for its oil and protein and have become a global commodity the last decades used in many different industries. The main part of the crop is used to extract vegetable oil and the rest is used for animal feed. A smaller part of the production is whole soybeans consumed by people. Globally, 87% of the total soybean production is crushed and 13% is used by the food industry directly as whole beans. The crushed soybeans on average gives 79% soy meal and 18% soy oil (WWF, 2003).

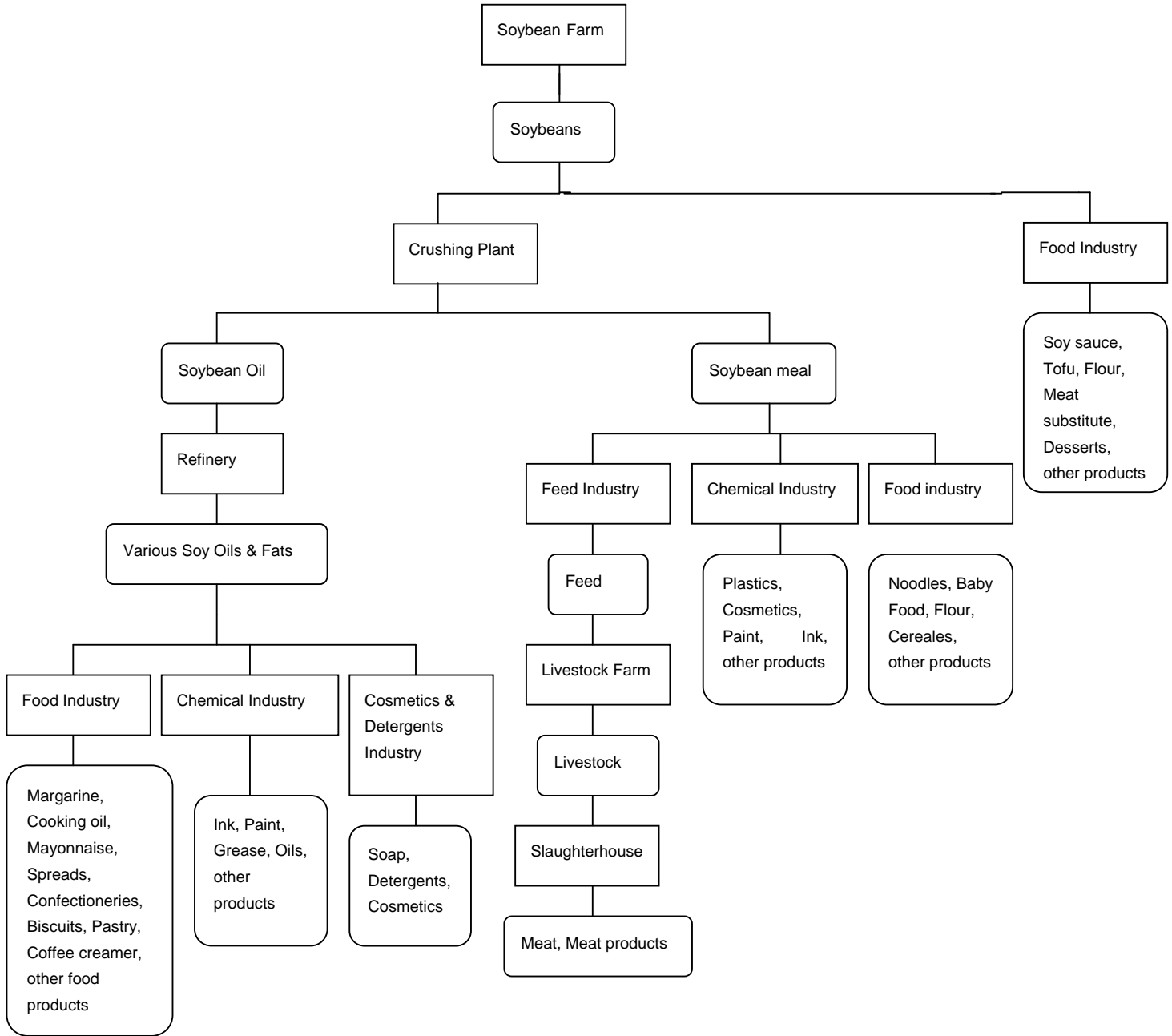


Figure 1-2 The soybean production chain

Source: WWF, 2003, p.3

Soy is used in several different industries worldwide. In the food industry soybeans are used to make soy sauce, tofu and other kinds of meat substitutes. Soy oil is mostly used as table oil, but also as an ingredient in mayonnaise, margarine, pastries and snacks.

The feed industry uses soy meal together with other meals to produce feed for the livestock industry. As it is rich in proteins and low in raw cellulose one uses it especially for single stomached animals as pigs and poultry.

Soy is also connected to the cosmetic industry, as it is used in the preparation of cosmetics, detergents and soap. It is likewise used in the chemical industry when preparing products like paint, lacquer, soy diesel and soy ink (WWF, 2003).

4.4 Biofuel production

Biofuels are produced in two phases. First there is the cultivation of feedstocks by conventional agricultural production. Second, after having the raw material, it is converted to biofuel in a bioraffinery.

The conversion of vegetable oils into biodiesel is produced through two steps. First oil extraction when the oil seed is crushed and then a chemical solvent is used, as for example, hexane to extract the oil. The second step is a chemical process that occurs when vegetable oil reacts with an alcohol, the process generates biodiesel and glycerine as a bi-product.

In the specific case of soy oil production, the soybeans are cracked, checked for moisture content, made into flakes and then the solvent extraction with hexane. The resulting oil product is refined, blended depending on what kind of application and in some cases hydrogenated. What remains after the process, the larger part of the production, the crushed soybeans are sold as animal feed (IADB, 2006).

4.5 Biofuel markets¹

In 2006 it was estimated that global biofuel production was more than 35 billion litres, which is a relatively small number if one compares with the 1, 200 billion litres of gasoline produced yearly worldwide.

The dominating part of the biofuel production is bioethanol, which was about 33 million liters of bioethanol in 2004. The production numbers for biodiesel is only one-tenth of ethanol production as can be seen from the figure on next side

¹ The information for the initial part of this section is from IIED, Dufey, A. (2006). *"Biofuels production, trade and sustainable development: emerging issues."*

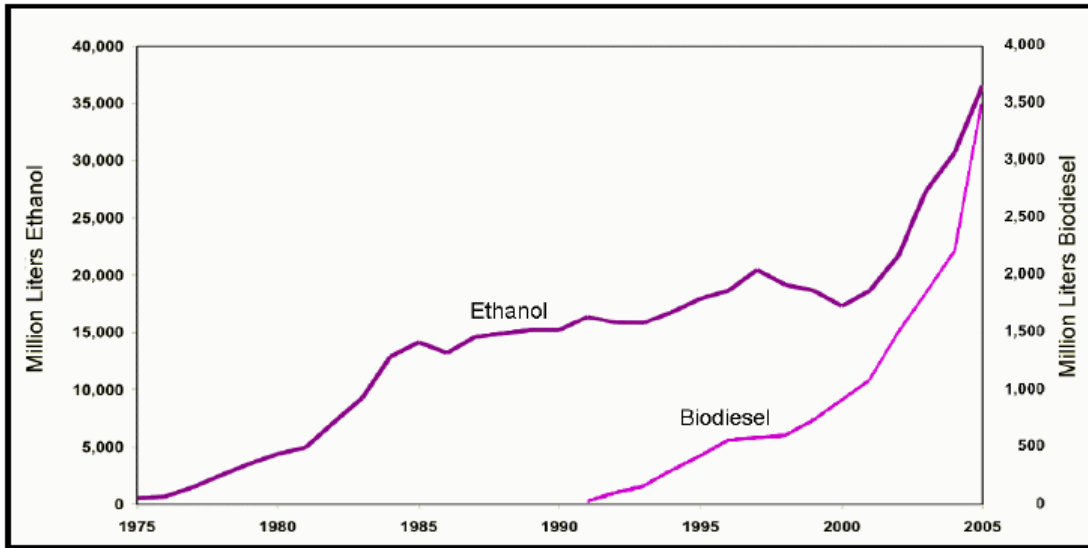


Figure 1-3 Biofuel production growth

Source: LADB, 2006, p.1

The main part of the biofuels produced was bioethanol from sugar cane from Brazil, having 38% of world production. Brazil started producing bioethanol in the 1970's when the oil prices peaked and has become the most successful production country of biofuels. Thirty years of experience and research, added to natural conditions and low labour costs have made Brazil the most efficient biofuel producer in the world. Most of its production is used on domestic markets, 40% of national gasoline consumption comes from bioethanol. Exports have increased recently, but are still quite limited and are estimated to be less than 10% of domestic production.

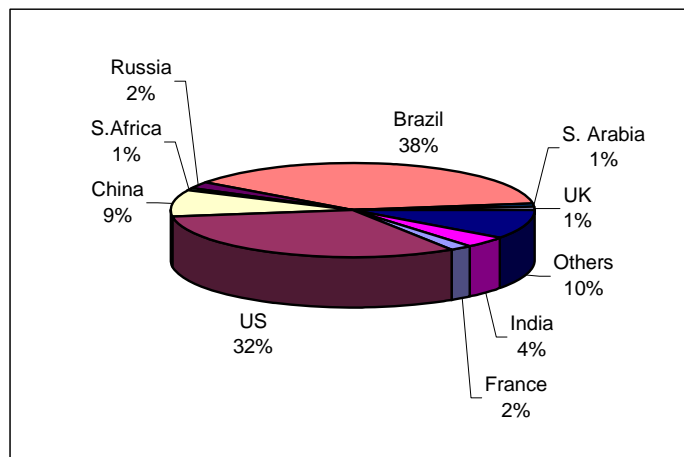


Figure 1-4 Top 10 bioethanol producers 2004

Source: F.O Licht, cited in Dufey, 2006, p.6

Bioethanol production has so far mainly been dominated by Brazil and US, the second biggest producer and consumer of bioethanols. In 2004 US part of the global bioethanol production was 32%. In fact, one started producing biofuels in the United States in the seventies as well, bioethanol from corn. But it is only in more recent years that one has started to use it more frequently.

With the Brazilian case as a role model, many other countries worldwide are focusing on bioethanol production. The EU accounts for 10% of the ethanol produced worldwide in 2004, with France and Spain in the lead. In Asia, China, India and Thailand are all looking into different strategies for enhancing bioethanol production from different feedstocks as corn, cassava, rice and sugar.

In North America Canada is having plans on achieving 1.4 billions litres by 2010.

In South America Colombia produce 1,050 million litres per day. Also in Africa, sugar producers as South Africa, Kenya, Malawi, Zimbabwe and Ghana are looking into possibilities for large-scale bioethanol production.

Compared to the amounts of bioethanol being produced worldwide the share of biodiesel remains relatively small. Biodiesel production took off in the beginning of the 1990's and has increased yearly since then. Biodiesel production hit a record in 2003 when it reached 1.8 billion litres.

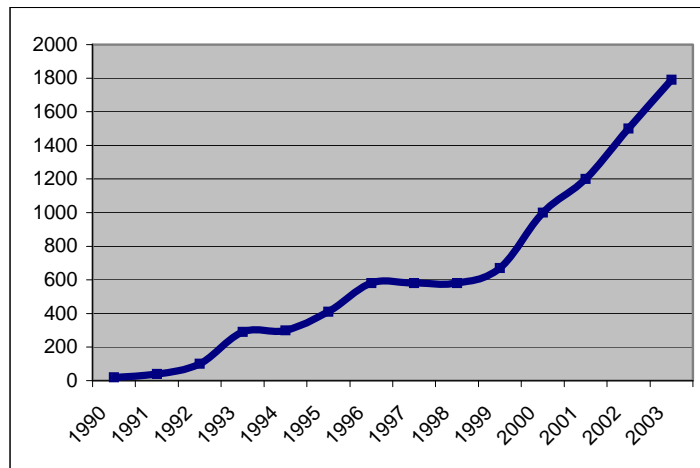


Figure 1-5 Global biodiesel production in million litres 1990-2003

Source: F.O. Licht, in Dufey, p.7, 2006

EU is so far the main producer of biodiesel, producing 95% of all production worldwide. The production began in the 1980's as a strategy to maintain development in rural areas and to meet increasing energy demand. Since the 1980's production has somewhat fluctuated but has been on the increase since 2002 by 80% yearly. Most of the biodiesel made in the EU is from rapeseed oil. The consumption of biofuels in the EU is estimated to be around 1.4% of EU fuel consumption and the leading member states in biofuel production are mainly Germany with half of the production followed by France and Italy.

Table 1-3 World biodiesel production 2005

Country	Production, million litres
Germany	1,886
France	556
Italy	447
United States	280
Czech Republic	150
Poland	113
Austria	96
Slovakia	88
Spain	82
Denmark	80
United	58
Slovenia	9
Lithuania	8
Estonia	8
Latvia	6
Total	3,867

Source: LADB, 2006, p.12

The EU may presently be the leader in biodiesel production, but there are a number of countries that have started or will start producing biodiesel. The US is producing biodiesel out of soybeans and it has been calculated that in a best-case scenario biodiesel could represent 25% of US diesel needs. Brazil has decided on progressive blending requirements of 2% by 2007, 5% by 2013 and 20% by 2020. There are many more countries in the Americas, Asia and Africa that are looking into possibilities for biodiesel; Colombia, Argentina, India, Thailand, Malaysia, Indonesia, Ghana, Burkina Faso and Malawi, to name but a few-are countries embarking on biofuel production. See appendix for more extensive information on biofuel production worldwide.

4.6 Future markets for biofuels

Production of biofuels has increased substantially the last ten years, while there are also more countries worldwide using biofuels in large volumes. Future prediction for the biofuel market is positive considering that all sorts of countries around the world have plans on implementing biofuel blending directives in order to promote an increased use of biofuels. According to the IEA world biofuel production will quadruple to more than 120 000 million liters by 2020, which would correspond to 6% of world transport fuels. Later reports from the IEA have increased the figures, making it 10% of transport fuels by 2025.

Forecasts are that Brazil will continue its leading position of bioethanol production and exports. While a large part of the production will still go to the domestic market, exports are projected to increase exponentially.

US are expected to continuously be a large importer of bioethanol. The demand will be satisfied with both national production and imports from Brazil and other countries from the Caribbean and Latin America. Sugar producing countries as Indonesia and South Africa are also forecasted to become exporters.

Table 1-4 World biodiesel production, 2004 and 2010

Country	2004 (Thousand Mt)	2010 (Thousand Mt)	Var. 2004-2010 (%)	Participation by 2010 (%)
EU	1,400	6,000	329	77
US	125	750	500	10
Brazil	25	750	2900	10
Other	50	250	400	3
Total	1,600	7,750	384	10

Source: Early J, Early T. and Straub M. 2005, in Dufey, 2006, p.16

For the EU in order to for fill the European Directive 2003/30/EC that has a target of 5.75% of biofuel blends within the transport sector by 2010. This is calculated to be 18.6 million tonnes of oil-the corresponding amount is demanded in biofuels. In order to achieve the politically set target, EU is expected to import up to 50% of biofuels externally. Some countries are already preparing to meet the increasing demand, as Malaysia and Indonesia that have expanded the palm oil plantations substantially. Brazil is expected to export biodiesel on the basis of soy as well as Argentina.

Asian countries like Japan, Korea and Taiwan with little land areas available for production are expected to become good import markets.

4.7 International biofuel trade

There are currently low volumes of international trade in biofuels, most of the current biofuel production is being produced and consumed in domestic markets. Though, considering the politically set targets worldwide for blending requierments for biofuels, the great interest in biofuel from the private sector and increasing oil prices, trade in biofuels is likely to increase (IPC, 2006).

Estimations are that biofuel production will quadruple the next coming twenty years, as mentioned, indications are that this could be as much as 10% of global motor oil (Dufey, 2006). As countries will not be able to supply the internal demand with domestic production, trade is expected to increase significantly.

4.7.1 North-South

The energy demand is greatest from the North where the OECD countries consume 49 million oil barrels a day. While the demand from the Northern countries is rising, they do not have the land availability to meet the energy needs. Europe as mentioned would need an estimation of 19 million toe-which would mean 17 million hectares of agricultural land, that is 16% of arable land in the EU (Faaij and Foerester).

It is not only the land availability that speaks against any large-scale production of biofuels in the North; it is also factors as energetics, climate conditions and high costs.

The best conditions for producing the most energy efficient feedstocks, oil palm for biodiesel and sugar cane for bioethanol, are in Southern countries with tropical and sub-tropical climates. In the South there is more land available, more suitable soils, longer growing seasons and lower labour costs. Thus, it is a more cost-efficient and energy efficient approach to produce biofuels in the South.

The geographical asymmetry between demand and supply, North and South, has so far been insignificant as there are presently low volumes of international trade.

An estimation is that sugar cane production could respond to 10% of the gasoline use globally, which means a possibility for Southern countries to become producers and exporters of a value added product much in demand (Worldwatch, 2006).

Currently, there are a number of obstacles on an international level that impede any greater volume of biofuel trade, those generated within the international trading system itself due to a lack of clear classification by the WTO and in addition to that those posed by national protective measures, such as tariffs, tariffs escalation, quotas, technical, environmental and social standards (Dufey, 2006).

4.7.2 WTO standards and biofuels

There is no uniform classification of biofuels within the WTO (World Trade Organization) as yet. According to the International Food and Agricultural Trade Policy Council the topic has not been properly addressed and their discussion paper² is one of the first to address the issue in detail. The paper is presenting a number of challenges for the international trade system on how to accommodate biofuels within existing trade rules or creating new ones.

Generally, energy trade has not been much of a focus within the WTO. One of the reasons is that some of the main exporting countries for oil, as for example Saudi Arabia, have not been WTO members. There are also certain exceptions in the General Agreement on Tariffs and Trade (GATT), which is the main agreement of the WTO for trade in goods, which have left energy policies outside the discipline.

Currently ethanol is classified as an agricultural product, whereas biodiesel is classified as an industrial product. The difference is very important because the rules of the trading system related to market access and subsidises generally treat agricultural products differently from industrial products.

² For more details on the subject, the discussion paper titled "WTO Disciplines & Biofuels: Opportunities & Constraints in the Creation of a Global Market" written in 2006 by the International Food and Agricultural Trade Policy Council addresses in a most detailed and comprehensive manner how current rules of the WTO could be applied to biofuels.

One of the questions debated is how one should classify biofuels-if they should be classified as agricultural, industrial or environmental goods.

So far one has based the classification of how the substances are conceived and not as fuels, with biodiesel being an exception having its proper HS (Harmonized System) classification. In contrast, bioethanol is classified by its chemical composition as undenatured (220710) and denatured (220720) alcohol in the Harmonized System, and there is nothing distinguishing fuel ethanol from ethanol for other uses.

This poses mainly two problems-it is difficult to have any proper statistics over biofuel trade and it might make it more difficult to liberalise tariffs for biofuels. Countries might be ready to liberalize tariffs for ethanol for fuel use, due to environmental or energy security reasons, but are perhaps not willing to reduce any tariffs on other ethanol products as it might generate competition with domestic products.

The inconsistency of classification for bioethanol also causes issues of an inconsistent application of WTO rules. The European Union of Ethanol Producers, brought up the case of bioethanol entering Sweden from Brazil under another classification than denatured alcohol, but under HS 3824.90.99, which has a much lower duty rate. Though, the argument for import was based on the degree of denaturing which is supposedly much higher than normally for HS 220720.

In addition to these classification issues, there is an additional complication for classification, as there is also the possibility of having biofuels classified as environmental goods. Which would make biofuels subject to special negotiations to reduce tariffs barriers according to paragraph 31 (iii) of the Doha Ministerial Declaration. A paragraph that calls for “the reduction or, as appropriate, elimination of tariffs and non-tariff barriers to environmental goods and services”. Talks about the application of this paragraph, which criteria that would be developed to include an environmental good had not come very far way when the Doha Round was suspended. Brazil and India wanted negotiations on Environmental Services and Goods (ESG) on biofuels, so did the European Community (EC).

Renewable energy technology has been discussed as having the potential to be classified as environmental goods. There are three kinds of possible environmental goods that have been discussed. Low carbon-fuels, the category of ethanol or biodiesel, renewable technologies as solar cells or wind turbines, or energy efficient environmentally preferable products (EPPS), as for example more efficient refrigerators (Sell, 2007).

The definition for ESG has to be agreed upon by all WTO members, some agree to that environmental good include renewable energy products as biofuels, if all agree is still a matter of negotiation. It has also to do with the environmental performance of biofuels considering the outcomes of life cycle analyses.

In unilateral and bilateral agreements there is a tendency of including biofuels in preferential treatments on the basis of environmental grounds, as for example in the Cotoneau Agreement and in the EU's preferences Everything But Arms (Harvard, 2007).

From a policy point of view, in order to provide incentives for promoting technologies to emit less or no greenhouse gases, it is important that there is a distinction between goods. The ESG paragraph provides such an incentive as with lower tariffs one would reduce costs and subsequently trade would increase. It would give producers an economic incentive to produce more Environmental Services and Goods (Sell, 2007).

4.7.3 Sustainability standards for biofuels

Besides the unclear classifications of biofuels within the WTO, there is another main issue for biofuel production and trade, sustainable indexes.

Southern countries have a comparative advantage in biofuel production and it is from the South one is expected to outsource the main part of biofuels for substituting fossil fuels in the transport sector in the North. Concerns for the social and environmental impacts a rapid increase of feedstock production can have in these countries have been raised. In order to address these issues sustainability indexes are being developed.

A case in point is the intensive and large-scale palm oil-production in Malaysia, which has exerted pressure on natural resources and local communities. Malaysia and Indonesia have plans on large-scale exports of biodiesel to meet the demand of the Northern markets. In Malaysia biodiesel production have had quite significant adverse social and environmental effects. Tropical forests have been cut down to accommodate large mono-crop plantations and subsequently reduced the sustainable village livelihoods (Verdonk et al, 2007).

Holland, one of the main importers of palm oil from Malaysia in Europe, recognized the issues in Malaysia and the Dutch government established the Cramer Commission, in order to develop sustainability criteria for bio-energy production, which have now become an integral part of the Dutch criteria for renewable energy policies (Verdonk et al, 2007).

There are a number of national initiatives developing biofuel indexes or certifications. In Europe there is Holland, Belgium and the United Kingdom that are working with criteria related to biofuel production.

From a European perspective a main part of the discussion of biofuels is related to how one can increase biofuel use without causing any adverse social or environmental impacts in Southern countries or growing economies.

The concern from Europe relates to the fact that Europe is likely to become “a major global sink for biofuels” and as such could have a significant impact on the development of markets elsewhere. However, in comparison with the demand from China and India, European demand remains relatively small (Foerester and Faaij).

Many different actors, researchers, EU trade ministers; governments in Europe are of the opinion that a global governance system for the production and trade of bioenergy is needed. It is generally agreed upon that the challenge for the international society consists in the creation of a sustainable global biofuel market, with incentives to promote sustainable development and trade of biofuels, but also with mechanisms that sanction. Ideally, a global governance system that could minimize possible negative impacts and maximize sustainable benefits (Verdonk et al, 2007 and Dufey, 2006).

However, there are several problems related to the development of indexes. There is the issue of how WTO rules work with PPMs (Process and Production Methods).

Moreover, there are concerns that sustainable indexes could become trade barriers, used as a pretext for trade protectionism. That would deny Southern countries access to export markets. One would also have to see to that it does not become another tariff barrier; in order to prevent that one would have to provide technical assistance. Another problem would be that of small farmers not being able to obtain certification. Considering the proliferation of

indexes, there are also concerns regarding the capacity of being able to create one single certification system (Harvard, 2007)

5 Reasons to promote international trade of biofuels

There are a number of reasons for promoting global biofuel trade and there are interests and enthusiasm from all corners of the world. Biofuels are portrayed as a good solution for many different causes. On a local level there is the generation of rural development, on a national it can be a source of increased energy security and enhanced energy diversification and on a global level it has the potential to reduce greenhouse gases. According to Dufey, IIED, here are some of the main drivers:

5.1.1 Energy diversification

One of the main reasons for investing in biofuel for oil importing countries is energy diversification. By increasing production or import of biofuels, one would increase energy security. This is an interesting strategy for many countries considering the fluctuating oil prices and oil cartel structures.

5.1.2 Improved trade balance

An alternative energy source as biofuels that can be produced domestically offers the opportunity of reducing dependence on imports of energy sources. In the case of Brazil, it has been estimated that one saved US\$43.5 billion between 1976-2000 when replacing gasoline by bioethanol.

5.1.3 Product diversification and value added

As biofuels are made of agricultural products, biofuels will contribute to an increasing demand for agricultural commodities and probably having the effect of reducing surpluses of agricultural products. Biofuels also creates possibilities as a diversification of the agricultural market and the opportunity of a value-added product.

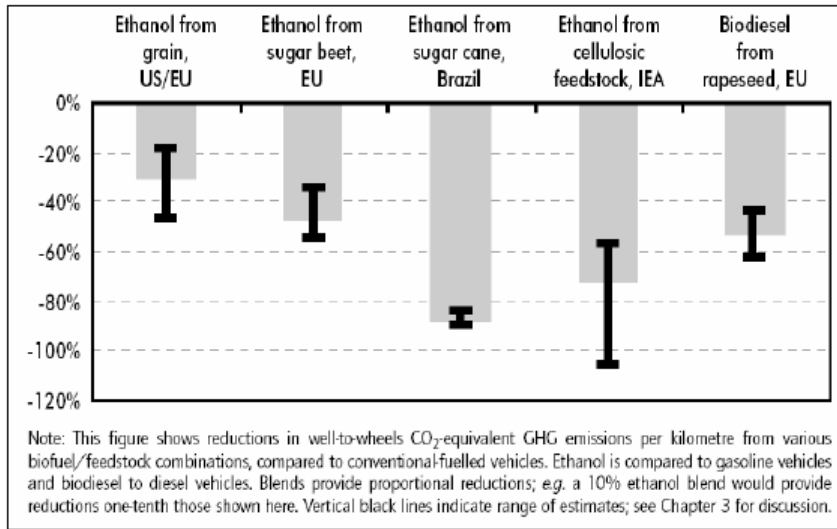
5.1.4 Rural development

Establishing bio energy programmes in rural areas have the potential to generate development if small-scale farmers are targeted and secured market access and buyers by the government or processing companies would generate a regular income. This could further generate investments and broaden the scope of business activities. In Brazil there are examples of programmes with castor oil producers that gave a real push to local economies. Current figures are that more than 30 000 small-scale farming units are producing raw material for biofuel production in the northeast of Brazil. One has also combined the fuel and food cultivation by using intercropping techniques, which have increased the food production as well (ECLAC/ FAO)

5.1.5 Greenhouse gas emissions

One of the main reasons for promoting the production of biofuels is due to the supposed reduction of greenhouses gases. The theory is that as energy crops absorbs CO₂ when growing, thus the CO₂ emissions released during biofuel combustion are not causing new emissions as the whole process is part of the carbon cycle (IEA, 2004).

Table 1-5 Range of estimated GHG reductions from biofuels



Source: IEA, 2004, p.13

Though, there are quite significant variations on GHG reductions, studies shows a number of different results, from negative to more than 100%. It is all depends on feedstock, agricultural production, and conversion technology.

5.1.6 Air emissions

Generally air emissions of key toxic substances are lower from biodiesel compared to conventional diesel over the life cycle.

BIOETHANOL (E85)	BIODIESEL (B20&B100)	FISCHER-TROPSCH
15% reductions in ozone forming volatile organic compounds.	10% (B20) and 50% (B100) reductions in carbon monoxide emissions.	Nitrogen oxide reductions due to higher cetane number and even further reductions with the addition of catalysts.
40% reductions in carbon monoxide.	15% (B20) and 70% (B100) reductions in particulate emissions.	Little or no particulate emissions due to low sulphur and aromatic content.
20% reductions in particulate emissions.	10% (B20) and 40% (B100) reductions in total hydrocarbon emissions.	Expected reductions in hydrocarbon and carbon monoxide emissions.
10% reductions in nitrogen oxide emissions.	20% (B20) and 100% (B100) reductions in sulphate emissions.	
80% reductions in sulphate emissions.	2% (B20) and 9% (B100) increases in nitrogen oxide emissions.	
Lower reactivity of hydrocarbon emissions.	No change in methane emissions (either B20 or B100).	
Higher ethanol and acetaldehyde emissions.		

Table 1-6 Typical biofuel emissions compared to standard fuels

Source: EPA, in Dufey, 2006, p. 2004, p.43.

5.1.7 Energy balance

LCA studies are used as an indication of the energy needed to produce 1 unit of biodiesel, whether it takes more or less energy to produce it than the energy that is generated (Dufey, 2006).

When estimating the energy balance one have to consider the total fuel cycle of the production, from the feedstock production to final consumption, the “well-to-wheel approach” approach. There is quite a difference in results depending on where the biofuels are produced; in which country or region, what feedstock used, what agricultural methods and what kind of conversion technology.

Results may also differ as different methodologies are used when calculating the energy balance, for example depending on the assumptions made for the co-products.

In Brazil for example, for bioethanol, energy balance is in a range between 3.7-10.2. That is an average of 8.3 units. It gives 8 times more energy than the 1 unit it takes to produce. In the United States, bioethanol for corn gives two energy units for 1 unit of input.

Studies from the EU on biodiesel made on rapeseed gives an energy balance between 0.33 and 0.82 units.

The differences in energy balances depend on differences in the production process. As Brazil has good soil fertility-no extra inputs as fertilizers are needed, nor does it take much irrigation as the rainfall is good. In sugar cane production one also uses the bagasse-what is left of the crushed cane to generate energy to the production. So, the energy demand of fossil fuels is none.

In the States the use of fertilizers and pesticides is much higher and the corn processing takes extra fossil fuels.

6 Biofuel business and investors

There are a number of actors interested in promoting biofuels, according to McKinsely Quarterly only the actors involved in the value chain are:

Asset owners-such as agribusinesses, petrol industries, chemical industries, plant operators and farmers, market actors are investing in biofuel industries.

Product and service providers-as seed companies, engineering and equipment companies, the biotechnology industry, are all industries working towards mainstreaming their process and creating new technologies for the biofuel industry.

Market participants-as gasoline blenders, farmers, agricultural equipment industries, suppliers of agricultural input products as fertilizers and logistics suppliers-market segments that will benefit of an increased growth in the biofuel industry (McKinsey Quarterly, 2007).

The biofuel industry is accelerated by a large wave of investments from different business sectors. Some of the main investments come from multinational agricultural commodity companies as Archer Daniels Midland (ADM), Noble and Cargill, who are making rather substantial investments into agrofuels. As well as companies that have an interest in sugar trade, palm oil and forestry.

From the energy sector large corporations as British Petroleum and Mitusi are investing in biofuels. There are also the investments from oil companies that have direct relations to the national governmental agendas as Petrobrás in Brazil and Petrochina or Philippine National Oil Company.

The most substantial investments in agrofuels are believed to come from the financial sector, some of the main sources of globalised capital as banks, such as Barclays, Morgan Stanley and Goldman Sachs are investing in biofuel industries.

Investments into biofuel industries are also coming from some of the wealthiest individuals in the world, billionaires George Soros, Vinod Khosla and Bill Gates. Richard Branson is the owner of Virgin Group and also the owner of Virgin Fuels. They all have large investment into agrofuels.

Governments and international monetary institutions as the World Bank and regional development banks also invest money by giving support to the biofuel industry through subsidies, less taxes, carbon-trading schemes and soft loans-to sustain the economic viability of biofuels.

The investments flows into biofuel industries are having a restructuring effect on agribusiness. There are patterns of global financial flows that is reorganising and strengthening transnational structures, connecting the landowning elites of the South “with the most powerful corporations of the North”. It seems as biofuel industries are “being managed by transnational corporations and absorbed into their profit strategies and expansion plans” (GRAIN, 2007).

Table 1-7 Some transnational corporations investing in agrofuels.

Agribusiness	ADM, Cargill, China National Cereals, Oils and Foodstuffs Import & Export Corporation, Noble Group, Dupont, Syngenta, ConAgra, Bunge, Itochu, Marubeni, Louis Dreyfus
Sugar	British Sugar, Tate & Lyle, Tereos, Sucden, Cosan, AlcoGroup, EDF & Man, Bajaj Hindusthan, Royal Nedalco
Palm oil	IOI, Peter Cremer, Wilmar
Forestry	Weyerhaeuser, Tembec
Oil companies	British Petroleum, Eni, Shell, Mitsui, Mitsubishi, Repsol, Chevron, Titan, Lukoil, Petrobrás, Total, PetroChina, Bharat Petroleum, PT Medco, Gulf Oil
Finance	Rabobank, Barclays, Société Générale, Morgan Stanley, Kleiner Perkins Caufield & Byers, Goldman Sachs, Carlyle Group, Kohsia Ventures, George Soros

Source: Grain, 2007, p.11

The politically set targets for blending requirements are guaranteeing a demand for business, that in addition to governmental subsidies make it an interesting business opportunity.

The most crucial factor is the price for feedstocks. It is the main production cost and is estimated to be around 60% McKinsley. The feedstock price “can make or break an agrofuel production” (GRAIN, 2007).

Prices for the biofuel industry is competing with other markets, in particular the food market, as one is using the same crops and lands. When the use of biofuels will increase, feedstock prices will also increase and have an impact on supplies. High feedstock prices are risky for any business. Therefore there are many options to lower production costs.

In order to ensure low costs many agrofuel companies are controlling both the production and supply of the feedstocks. There is a trend towards building entire chains of agrofuel networks that integrate the whole production process from seeds to shipping.

Another strategy for keeping down production costs is relocating to cheaper countries. Brazil for example is moving some production to neighbouring country Paraguay, as production costs are lower there. Another example of this is an American company, the Maple corporation that is establishing sugar cultivations and plants in Peru, as the country have low production costs and preferable access of export to US.

BP and ConocoPhillips negotiated with big meat industries in order for them to supply animal fats to be used in the production of biodiesel.

There is an interest from the biofuel industry to lower costs and to improve the energy efficiency of biofuels; therefore biotechnology is likely to play an important role for the

industry. Genetic modification or improvement is interesting for the reasons that it can increase yields and reduce the agricultural inputs to less. Concerns are that crop production for biofuels will increase the application of GMOs (GRAIN, 2007).

Chinese and South Korean companies are investing in large productions of cassava in Africa.

Table 1-8 Corporate control of key agrofuel feedstocks

Maize merchants (US)	Cargill, ADM	Top 3 control over 80% of US maize exports
Maize seeds (US)	Monosanto, DuPont, Syngenta	Monosanto controls 41% of global market
Sugar trade (Brazil)	Cargill, Louis Dreyfus, Cosan/Tereos/Sucden	Cargill is the largest shipper of raw sugar from Brazil
Palm oil trade (Global)	Wilmar, IOI, Synergy Drive, Cargill	60% of palm oil area in Malaysia is owned by corporations, only 9% is owned by individual landowners
Soy trade (Global)	Bunge, ADM, Cargill, Dreyfus	3 companies control 80% of European crushing: 5 companies control 60% of Brazilian production
Soy seeds (Global)	Monosanto, DuPont	Monosanto controls 25% of global market

Source: Grain, 2007, p.12

7 Argentina: A case-study of soybean cultivation for biodiesel

Having a background about some of the issues with sustainability, certification and trade related rules; this section will describe the main characteristics from one of the expected large-scale exporters of biodiesel-Argentina.

A number of factors give Argentina clear competitive advantages in biofuel production. The vast land areas dedicated to production of oil-bearing plants, providing the raw material for big scale biodiesel production. Moreover, Argentina has one of the worlds most developed vegetable oil industries with a crushing capacity of 160 000 tonne per day (Asal et al, 2005). Due to the export directed nature of the agricultural sector, there is also good infrastructure. When considering the factors of the current production structure, it is believed that Argentina could become a main producer and exporter of biodiesel, using soybeans as the prime feedstock (GAIN report, 2007).

For the Argentinean economy biofuels are an interesting option as it could reduce dependence on oil, increase the value of the agricultural sector and exports (US embassy). Biofuel production presents interesting opportunities as a value-added product within an efficient and well-established agricultural sector that is largely directed towards export markets.

There are currently four bio plants that will be producing biodiesel by the end of 2007-early 2008. The plants are joint ventures between local and international enterprises, located in Rosario, the area with most oil crushing plants in the world. The feedstock will mainly be soybean oil and the vegetable oil crushers have very good processing capacity and logistics.

Agricultural commodities as soy oil and soybean meal are taxed with 24,5% when exported. In comparison biodiesel exports are only charged with 5 percent, and after three months of exports there is a 2.5% of rebate. Though, these favourable taxes could be subject to change as biofuel exports increase (GAIN, 2007 and Almeda, 2007).

Currently the diesel prices are subsidised in Argentina and are therefore lower than international prices. The cost of biodiesel is a bit more than US\$ 0.5+/liter. The cost of biodiesel within the internal market is quite high, but on the other hand it is most competitive on the external market (GAIN, 2007).

There are a lot of investments going into export oriented biofuel industries. The internal market is less interesting since it is heavily regulated, for example quotas per company or administered prices to sell the product. Many of the key issues are still waiting to be defined.

In comparison, the export market has fewer regulations and there is a great external demand. There are 20 biodiesel projects that are planned and forecasts predict that if all these start production, production results could reach more than 2 billion liters by 2010.

The blending requirements for biofuels are 5% for ethanol in gasoline and 5% of biodiesel in diesel; this will be mandatory by 2010.

Companies interested in producing biofuels have three alternatives:

1. Produce for internal market-with tax incentives

2. Produce for self-consumption-similar incentives as for alt.1
3. Produce for export market-no tax incentives

7.1 Future feedstock

Argentina will primarily produce biodiesel from soybeans, there are some smaller plants producing biodiesel from sunflower and rapeseed oil. For bioethanol, there are plans of using molasses, sugar cane and corn. Sugar mills are working on using bagasse to be self-sufficient for energy and sell to nearby towns.

There is research and cooperation among a number of entities as universities, governmental institutes and from the private sector working on different projects for using jathropha, algae and castor oil plant.

7.1 Future markets

Europe is a potential market, considering the biofuel targets of the European Union that cannot be met with domestic production. The American market is also interesting, partly because blenders can have some advantages of subsidises in that market. Another possible scenario is using Argentine biodiesel in the States and re-exporting it to Europe.

Bioethanol will be exported to Chile and South-Asian markets.

7.2 Argentinean agriculture

Agriculture has always been an important component in Argentina's economy. The characteristics of the country as having deep soils, temperate climate, favourable levels of precipitation and good accessibility to ports, have given Argentina favourable advantages for agricultural productivity and export possibilities. Thanks to the natural endowments the country has been able to maintain and increase its agricultural productivity, even though state policies have been less favourable and taxed agricultural export commodities quite significantly and made very little investments back to support agricultural producers (Goldsztein, Hilbert 2007 and World Bank, 2006).

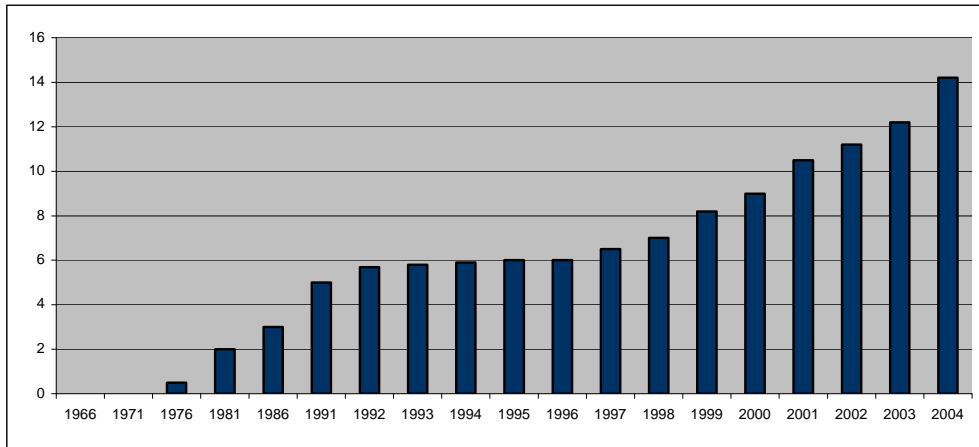
Agriculture has a main role in the national economy of the country. In 2004 the agricultural sector corresponded to 58% of the total goods exports, whereby 39% were primary products and 61% manufactured agricultural commodities. When measuring the economic performance by GDP, the agricultural sector accounted for 9%, and of that 63%, the largest proportion, was by crops and 31% livestock (World Bank, 2006).

The last decades, since the 1980's Argentina has increasingly specialised its production on soybeans. An agricultural product that has become a global demanded commodity, exported mainly from North and South America, from US, Brazil and Argentina to the European market and Asia.

The soybean production in Argentina has increased dramatically the last decade. The main part of it is exported to world markets for animal protein supplement and vegetable oil. It is the increasing demand for meat in Europe that has increased the demand for fodder to the pig and poultry industry. Globalization has had the effect of connecting global markets, making it

possible for agricultural products to be produce at one location and consumed in another place (DARCOF, 2005).

Table 1-9 Soy harvested area Argentina in million of hectares



Source: WWF, 2004, p.14

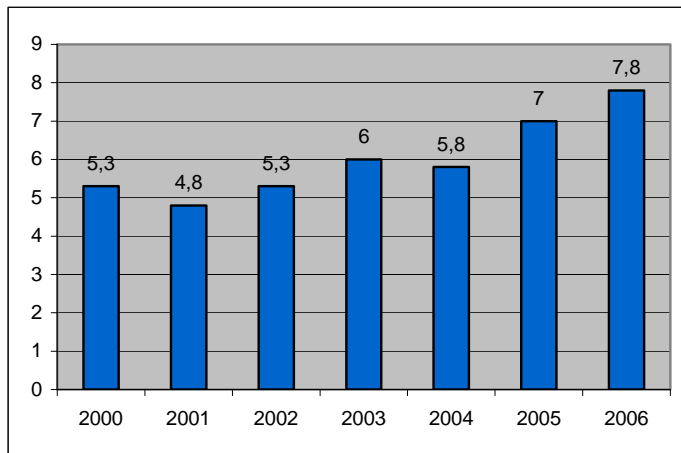
As can be seen from the table below, 90% of the crops from the agricultural production 2006/2007 are soy, corn and wheat. Among the oil bearing plants soy is dominating, when comparing areas sown of soy being 16 million hectares and for sunflower the correspondent number is 2,4 million hectares. Soy will be the future for Argentina, due to a number of reasons, which will be explained within the next pages.

Table 1-9 Agricultural seasons 2006/2007

Grain	Sown area in million of hectares	Production in million of tonnes	Participation %
Soy	16,1	47,6	50%
Corn	3,6	22,0	23
Wheat	5,6	14,6	15%
Sunflower	2,4	3,6	4%
Sorghum	0,7	3,0	3%
Others	3,8	4,2	4%
Country total	32,2	95,0	100%

Source: SAGPyA, 2007, p.1

Table 1-10 Production of vegetable oil in millions of tonnes

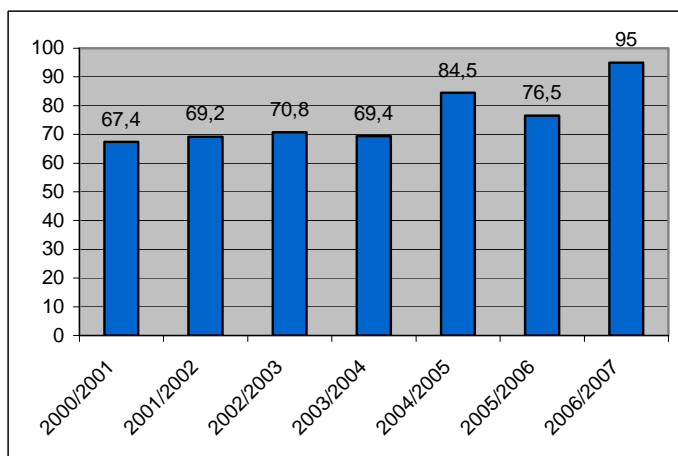


Source: SAGPyA 2007, p.2

The production results for the national oil industry in 2006 was 7,8 million tonnes of vegetable oil. Soy is the main oil bearing plant production as it is 75% of the total production. As can be seen from the table 1-10 the latest agricultural season of 2006/2007 soybeans made up 50% of the total agricultural production. In some areas there is only monocultivation of soy.

One of the main characteristics of the oil industry is its export directed profile as 90% of the production is sold on the world market. Argentina is third world producer of soy oil, but first exporter. It is also 2nd world producer for sunflower oil, but 1st exporter of sunflower oil.

Table 1-11 Grain production in Argentina



Source: Source: SAGPyA, 2007, p.1

The grain production for the agricultural year 2006/2007 reached a historic record of 95 million tonnes.

A characterization of the agricultural system by Asal et al in “Opportunities for and obstacles to sustainable biofuel production in Argentina” tells that it is a:

- Highly specialised system with latest agriculture technology, precision agriculture, no-tillage management and direct sowing
- No-tillage management is practised by 65% of the farmers or more
- Large scale farming with units of 10 000- 20 000 hectares
- Entrepreneurial system-planting pools
- An extensive use of genetically modified organisms (GMOs) 90% and efficient systems of planting, spraying and harvesting
- Highly skilled and educated professionals and farmers
- Intensive use of farm machinery

The agricultural production is a highly-specialised system featured by the latest cutting-edge technology, precision agriculture, the technique of direct sowing, a wide use of genetically modified organisms (GMOs) and efficient systems of planting, spraying and harvesting during the supervision of specialists. Agricultural production is further characterised by an intensive use of farm machinery and a highly skilled staff of professionals and farmers (Asal et al, 2006). The most common method is that the producer manages the farm and professional technical staff assists him (World Bank, 2006).

The agricultural production system in Argentina differs from the European one. As it is characterised by large-scale farming, the main units are of 10 000 to over 20 000 hectares.

A common practice is the use of no-tillage that is used by a majority of farmers, by over 65% or more of them. No-tillage management is when one leaves the soil covered with crop residues on the field. Tillage is used for removing weed; with no-tillage one increases the amount of herbicides and pesticides.

The agricultural production in Argentina has become especially efficient and capital-intensive due to a number of circumstances.

The competition from the West is one of them. Europe and US is characterised by high inputs of capital and energy and state subsidises, all of it resulting in competitive prices on the world market. For producers in Latin America this has had the effect of creating very efficient farming systems in order to stay in the market (Asal, et al 2006). This is partly explaining why Argentina has one of the lowest costs of agricultural production in the world (Hilbert, 2007).

Another factor pushing this development is the governmental taxes on exports that apply to all agricultural products and gives less income for producers (Asal et al, 2006 and Goldsztein, 2007).

There are a number of factors driving the structural formation of agricultural production in Argentina; these are primarily of an economic nature.

7.2.1 Structural change of agricultural production system

During the 1990's agricultural production was organized into new forms of management, into planting pools. This was a development mainly taking place in the Pampas, but was also developed in other areas. According to the World Bank, this "institutional creativity" was driven by the economic profits generated by –soft technology- as Round up Ready (RR)³ soybeans and the economic of size.

Agricultural production in Argentina is a rather capital-intensive business activity and great amount of investments are needed. In the beginning of the 1990's financing of investments within agricultural sector was good since the availability of credit from the National Bank was increased, rates rather low and longer-term credit was offered. However, when credit was reduced, new ways of facilitating finances were created, such as warrant systems, leasing, trust funds and guarantee societies were developed as an option to conventional financing. It became a system of pooling of resources, bringing together the capacities of different owners such as " land, technical and managerial know-how, machinery and inputs " (World Bank, 2006).

The period 1991-2001 was a tough period for many farmers in Argentina. The nineties was a decade when a lot of economic changes took place. The economy went through a phase of liberalization and privatisation. It was also the decade when Mercosur was coming into force. In addition to this, there were great macro-economic imbalances that had consequences as currency overvaluation and credit unavailability. For a majority of farmers their economic circumstances changed significantly (World Bank, 2006).

Favourable conditions in the internal and external markets made agricultural production expand fast through 1998. Restrictions on imports was eliminated, a reduction in import taxes for fertilizers, herbicides, pesticides, machinery and irrigation equipment, fuels on taxes taken away. The effects were an increase in fertilizer use, five times as much as before. The use of herbicides and pesticides increased three times (World Bank, 2006).

The macro economic instability in the end of the nineties led to a recession and great out flows of capital and the economic situation accelerated to a financial crisis. This resulted in a low demand on the domestic market and low gains from export, due to over evaluation of agricultural commodities (World Bank, 2006).

Consequences were that many farmers went into financial difficulties; many sold their business and moved to the cities.

To be a successful farmer one has to be competitive on a globalised agricultural market competing on quality, time and costs from other large scale producers. To achieve this, a strategy is to make a strategic alliance with others in the supply chain, and then one can together identify weakness and strengths and have the ability to enter "differentiated, high value markets" (World Bank, 2006).

³ **Roundup** is the product name of a herbicide produced by the American company Monsanto. Roundup contains the active ingredient glyphosate. Glyphosate is the most used herbicide in the US and claimed to be the most-sold agricultural chemical ever. <http://en.wikipedia.org/wiki/Roundup>. Round Up Ready is genetically modified soy that is resistant to glyphosate.

In order to stay in the market farmers need to become part of “dynamic supply chains that continuously innovate”. Due to the reforms of the 1990’s and the currency devaluation of 2002- there were large investments in export markets. Often in joint cooperation with foreign investors or with domestic investors. Many farmers, who do not have the financial capital or access to credit, cannot make “the investments necessary to upgrade. The number of farms is being reduced over the country as the more successful farmers are buying out those in financial difficulties.

7.3 Results of the new production structure

7.3.1 Increased efficiency

The new contractual agreements, the planting pools, that combines land, machinery and high performance management have had an overall effect of increasing the efficiency of mangament and also has the advantage of risk diversification. The results for 2000-2004, showed an increase for primary agricultural exports by 46% from the Pampas region, which is a significant increase when compared to the rest of the country that grew 29% (World Bank, 2006).

7.3.2 Effect on farm size

The planting pools or with another name the agricultural enterprises (EAPs) are having an effect on the farm sizes. Many farms are being consolidated in order to push costs down. This is facilitated by labour saving techniques as no-tillage mangament and direct sowing.

From being 85 000 in 1988, the number was reduced to 54 000 EAPs in 2002, which is a reduction of more than 40 %. This shows a considerable consolidation of farms (World Bank, 2006).

7.4 Reasons for the soy expansion

Soy plantations have gone from being the size of 5000 hectares in 1942 to expanding over 16 million hectares in 2006/2007.

In the 1980’s the soy expansion reached a point of significant increase. In 1981/1982 the area grown with soy is estimated to 2 040 000 hectares. Again, this was tripled 15 years later, with soy plantations of more than 6 000 000 hectares in year 1996/97. About a decade later, the soy expansion had doubled again, as it in 2002 was expanded over more than 12.000 000 hectares (Alicia da Veiga, 2004).

Table 1-12 The expansion of soy cultivation in Argentina the last 30 years

Year	Sown hectares	Harvested hectares	Production
1971/1972	79,800	68,000	78,000
1981/82	2,040,000	1,985,600	4,150,000
1991/92	5,004,000	4,935,710	11,310,000
2001/02	11,639,240	11,405,247	30 000 000

Source: SAGPyA, in Alicia da Veiga, 2004, p.1

When comparing the increase of soy with the plantations of other crops, between 1977/79 to 1996/1998, soy is estimated to have increased +465%, meanwhile the land areas with other cultivation only increased with 4.3%, this indicates an expansion of soy on the expense of other crops and cattle (Alicia da Veiga, 2004).

There are a number of factors that explain why soy cultivations went from being around 5000 hectares in the 1940's to covering a land area of 16 000 000 hectares in 2006/2007. The hectares of land used for soy cultivations have increased exponentially in Argentina especially the last decades. The reasons to the linear expansion and why soybeans have become the most sown crop are several, such as: Improved climatic conditions, application of new agricultural techniques and biotechnology, its low production cost and a constant high external demand.

7.4.1 Versatile plant

Moreover, soy is a versatile crop that can be grown in a diversity of soils, it easily adapts to a variety of climates. The vast land areas it covers extends to over 50% of the agricultural land areas and soybeans are in many regions the only plantations grown (WWF, 2003).

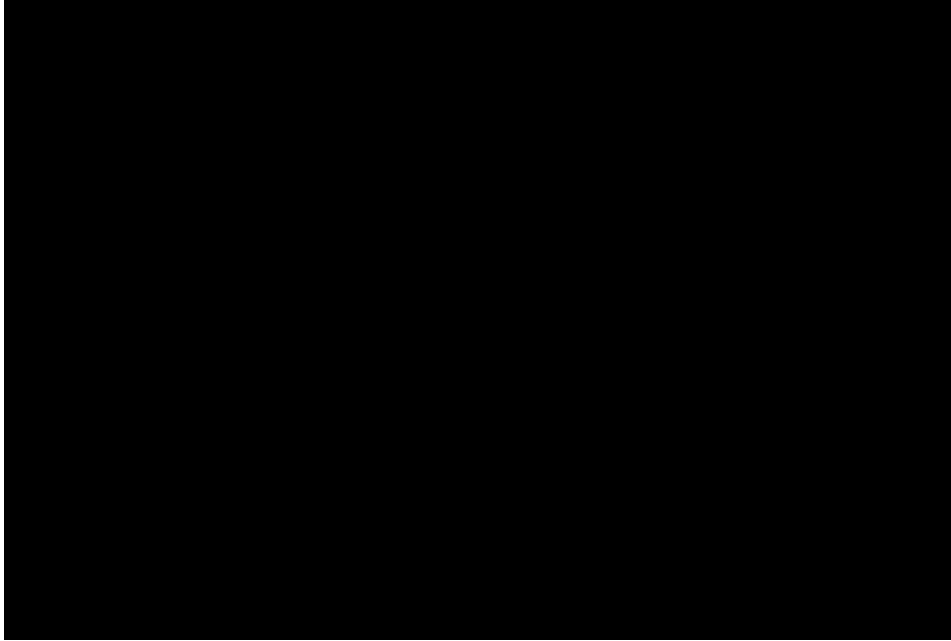
7.4.2 Improved climatic conditions

The last decades Argentina has experienced an increase of precipitations which have allowed the expansion of the agricultural frontier towards zones in the North that were previously considered as marginal areas for agriculture (Hilbert, 2007).

Traditionally the agricultural land has been located in the central areas of Argentina, which have the most fertile soil. Since Argentina started producing soy in the 1970's and until 1998 around 90% of the planted area was in the central areas (WWF, 2003).

Since 1998 soy cultivations have extended towards the Northern part of Argentina into the provinces of Entre Rios, Santiago del Estero, Chaco, Salta and Tucumán (da Veiga, 2004 and WWF, 2003).

Table 1-13 Development of the soy area in hectares in each province during three decades of soy cropping



Source: SAGPyA, in Da Veiga, p.12, 2004.

7.4.3 The use of GMOs

In 1996, Argentina authorised the use of GMOs, a measure that helped reduce the production costs and convert the country into the third world producer of soy, after Brazil and United States.

The Round-up Ready soy is resistant to the herbicide glyphosate and in combination with direct sowing it has improved adaptability to the diverse climates and it is also easier to grow. The genetically modified soy produced by Monsanto was given a gene called RR, which made its genetically structure resistant to glyphosate.

7.4.4 Low production costs

One of the main reasons for the soy expansion is that soy cultivations have two main advantages over other crops. It has lower costs of production and a better yield per hectare than other crops. With the use of the transgenic soy it has been possible to reduce costs, because with the use of only one herbicide the glyphosate, one can eliminate all the threats to the plantation, while previously one had to use much more agrochemicals (Da Veiga, 2004). It is a known truth among farmers that soy is easy to cultivate and give good profit margins, with less investment (Schulmeier, 2007).

For example with soy one can reach profitability with 18 quintals, which is something relatively easy to achieve, while with corn one would need 60 quintals, which is not that easy to obtain.

7.4.5 No-tillage management and GMO soy

The main reason to the exponential increase of the soybean industry in Argentina is due to the combination of two recently introduced technologies-no tillage system and transgenic Roundup Ready (RR) soybeans.

From 1996 to 2004 the land area for soy cropping increased 2.4 times from 6 million hectares to 14.2 million hectares. Out of this 50% was cultivated with soybeans. During 4 years from 1997 to 2001, transgenic RR soybeans went from being applied by only 6% to covering 90% of the fields (DARCOF, 2005).

The factors that facilitated the expansion of soybean areas and the fast establishment of the transgenic crop were the globalization of agricultural products, an open market and also strong campaigns promoting technological change. For many agricultural producers RR-soy was an interesting solution to one of the main problems in farm management, it dealt with weed control. Transgenic soy was an interesting “technical package” which had many advantages. Costs for herbicides went down, with no-tillage management one reduced costs for fuels and as it was easy to apply, it was a very interesting business opportunity.

Between 1996-2004 soybean areas expanded into new areas. In the book by DARCOF it has been estimated that:

1. 25% was from conversion of land growing wheat, corn, sunflowers and sorghum
2. 7% was from conversion of land for crops as cotton, beans and oats
3. 27% came from conversion of former pastures and hay fields
4. 41% came from conversion of wild lands, including forests and savannahs.

As described above the main expansion of soy was into new areas into areas of natural vegetation, an indication of this is for example the fact that 86% of the soyexpansion in Chaco and Santiago del Estero in Northern Argentina were into areas of natural vegetation and 13% was in cropped areas (World Bank, 2006).

7.5 Impacts of soy expansion

7.5.1 Increased herbicide use and resistant weeds

As the areas sown with RR soy have increased and also the practice of no-tillage management and the use of glyphosate herbicide has increased quite significantly. The consequences are that using the same herbicide consistently a number of years in a row results in the generation of genetically resistant weed phenotypes. Predictions are that a continuous application of glyphosate for some time will lead to weeds developing tolerance to the herbicide. According to Knudsen in DARCOF's book, this has already happened in Argentina. Considering the consistent and continuous application of glyphosate in production the evolution of tolerant weed is an inevitable development in Argentina (DARCOF, 2005).

7.5.2 Phosphorous export and depletion of Argentinean soils

The soybean is a very extractive plant of nutrients from the soil. When comparing the amount of extraction of nutrients per tonne in the Pampas region, it extracts the most nitrogen N, phosphorous P, sulphur S, and potassium K, of each tonne of grain that is produced. Until a few years ago one did not recommend fertilizing the soy because it was not needed. By the

end of the 1990's one practically did not use fertilizers, but in 1998 investigators from INTA observed that practice of fertilization in the Pampas had become a common practice.

Currently, land that was usually known to have good nutrient balances are presently deficient in phosphorous. This is a development that is particularly significant in the Pampas, where extraction of phosphorous has been significant the last decade.

The decline in soil fertility and increase of soil erosion were the consequences of the intensified production. The use of fertilizer increased quite substantially during the last ten years. Between 1990-1999 it increased from 0.3 million tons to 2.5 million tons. It seems as the expansion of the soy production during the nineties turned Argentinean culture into a more intensive production system similar to the agricultural practice in the North. Prior to this change, the nutrient balance was somewhat stable and good, as rotation among crops and cattle were practiced consistently.

7.5.3 Displacement of other agricultural products

The other part of the agricultural production, the beef sector has had a period of stagnation. The land productivity for beef in Argentina has been growing slowly the last 50 years compared to neighbouring countries as Chile and Brazil. The theory is that it is not due to lack of management, since a mix of crop and livestock is usual in the Pampas. Rather it seems to be due to the “very high and competing profitability of grains and soybeans”, since the adoption of no-till planting and pooling contracts. Farmers have increasingly concentrated on cropping and therefore converted pastureland to cropping. Another reason is the greater risk related to cattle of diseases as the foot and mouth disease in 2001. Economic conditions as unstable macro economic conditions and high interest rates for the beef sector, which is relying on long-term economic pay-offs (World Bank, 2006).

7.5.4 Increased monocropping and reduced rotation

Changes in technology and farm organization in Pampas the last decade have had an effect on the rotation system and reduced pasture in the system. Pasture was used to regain organic material and soil fertility after the land had been used for intensive cropping. With zero-tillage one rotates soybeans that have little stubble and then one can complement that with crops as wheat and corn that have a lot of stubble. Also, for the reason that their root system help to maintain soil structure. The risks with monocropping are that it generates and increase spread of diseases and can cause land deterioration and environmental deterioration. Depending on how no-tillage is used, it can also be used to contribute to keeping the soils structure intact. Also, the carbon soil loss, is less with no-tillage.

7.5.5 Increased soy cropping in fragile soils

The last decade there is a tendency of soy expanding towards marginal zones of the country where the soil is fragile and more prone to erosion. Soils that are very important to rotate due to its organic material and nutrients (Da Veiga, 2004).

According to a study made by the World Bank, in the 1980's one would consider environmental factors as soil suitability before expanding the cultivation, but now with the new no-tillage technology that can be used on a variety of different soils, soil variables are no longer taken into account. The technology of no-tillage has created the possibility of sowing on hills or on dry or shallow soil (World Bank, 2006).

7.5.6 Deforestation

The Yungas forest is situated in the Northwestern subtropical parts of Argentina, by the border of the Andean mountains. The forest is situated between 400 to 3000 metres above sea and it extends over 5 million hectares and is one of the most diverse ecosystems in the country, has the biological diversity and highest levels of endemism-which is the highest number of unique plants and animals (WWF, 2004).

The Chaco forest has both dry and moist savannah ecosystems and extends over 70 million hectares, which is about 25% of the land surface of Central and Northern Argentina. It has high biological diversity, but less than the Yungas forests. It is a prioritised area for conservation due to its fragile soils and hydrology and its exposure to being converted to agricultural land. Even though there are special protected areas, some of this land has been used for soy cultivation. Governmental statistics show that in the provinces of Chaco and Yungas soy is the most expansive crop (WWF, 2004).

Table 1-14 Area of native forests 1998 and 2002. Rate of deforestation between 1998-2002 in hectares

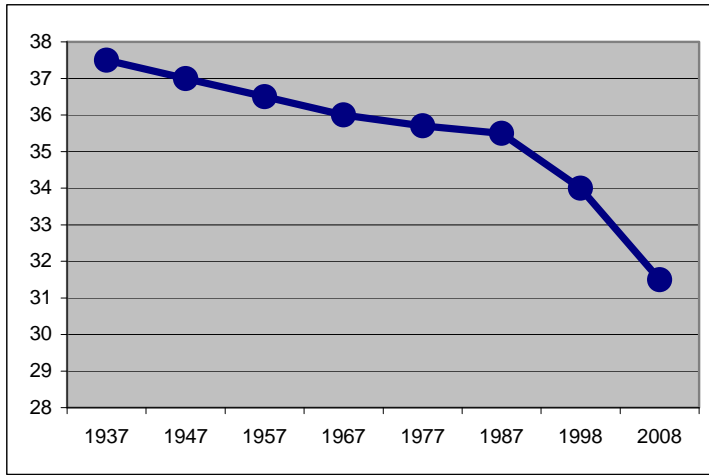
Province	Year 1988	Year 2002	Deforestation 1998-2002
Córdoba	1,207,395	1,042,151	121,107
Chaco	5,101,781	4,939,466	117,974
Formosa	2,591,417	2,314,464	20,112
Jujuy	939,124	953,149	6,174
Salta	7,156,168	6,931,705	194,389
Santiago del Estero	6,911,484	6,193,705	194,389
Tucumán	792,988	797,634	22,171
Total	24,700,357	23,172,405	787,889

Source: SA y DS, 2004, p.7

Yearly around 250 000 hectares of forests are being eliminated. 70% of this deforestation is happening in the Chaco Seco. The other important areas with high levels of deforestation are: Chaco Húmedo, Selva Paranaense and Yungas (Greenpeace, 2006).

The lost of forest between 1937 to 1987 was not a constant progress as one can see in table 1-14, but there were probably decades of more intensive changes as during the period of the 2nd World War. Apart from that, one can notice that starting from the 1980's-1990, there is a push of deforestation, most probably related to globalization and technological change of agriculture as transgenic soy and no-tillage. The transformation of the native forest during this period is the largest transformation of native forests in the history of Argentina (SAyDS, 2004).

Table 1-15 Surface of the natural forest in Argentina in millions of hectares



Source: SA y DS, 2004, p.7

The conversion of natural ecosystems in lands where the cultivation is product of a series of factors social, economical, political, technological and climatical. Out of all these the expansion of soy is mainly caused by the international demand of soybeans according to the Forest Department and Greenpeace Argentina.

8 Analysis-Driving factors at the expense of the environment

8.1 Export driven strategy-tax incentives

Biofuel production on the basis of soybeans, is primarily viewed as a value added product, a commodity which can enhance economic benefits through export. The great difference in tax for exports of vegetable oil and biodiesel, 24% tax on oil exports, but only 5% and a rebate of 2,5% for biodiesel, is a strong incentive driving the vegetable oil producers and new investors in the biofuel market towards export. Though volumes are still very small by the end of 2007 production is estimated to 200 million liters, by 2008 more than 800 million liters and by 2010 if the 20 current projects work as planned-2 billion liters (GAIN, 2007).

8.2 Favourable conditions pushing export

The conditions on the internal market, a market with more regulations and controls than the export market make it a less interesting option for biofuel producers. Also, as the internal market is subsidised with low fuel prices, it is difficult for biodiesel to compete there. On the other hand in the international market Argentinean biodiesel have competitive prices. There are also large investments into the export market and a strong foreign demand. These factors make the internal market less interesting, while at the same time this provides incentives for export.

8.3 Biofuels-a value added product, increased energy security and reducing risks

For the agricultural producer biofuels represent a new value-added product, one more product in the value chain that one can export with more profit (Villalonga, 2007). It is one more product and competence besides current agricultural crop production and cattle breeding. Biofuels is also a strategy to spread risks considering the uncertainty of climate intensive production as agriculture. For the producer energy security could also be a driver as he can replace gasoline with a biodiesel, a sub-product (Giraldine, 2007). Which is important in an Argentina that is recently going through a national energy crisis.

8.4 A shift in the markets-increased pressure on land

As biodiesel presents a new profitable product it will most probably have the effect of a shift between markets, considering all the favourable conditions pushing towards exports of biodiesel. As the basis for biodiesel is vegetable oil, there will probably be a change in the vegetable oil market. It is hard to predict, but one can speculate that some exporters might leave vegetable oil markets for biodiesel markets and new or current producers of oil will fill that gap. There is also the possibility of current oil producers maintaining their export markets and expanding their production. Anyhow, the effect will be the same. There will most probably be a change in the markets and to fill the demands for the two markets based on the same raw material-there will be an increasing pressure on the land, both in terms of area and intensity, i.e productivity.

8.5 Higher commodity prices- expansion of agricultural frontier

Previously there has always been a linear correlation between higher commodity prices and an expansion of the agricultural frontier. The last ten years soy has expanded exponentially for various reasons, the main reasons being the low costs of production, low risk and high profits. Soy is the main reason for an increase of the land area, an expansion of the agricultural frontier into areas with more fragile soils in the Northern parts of the country. One cannot disregard the fact that a new business as biodiesel with soy beans as the basis for production will probably mean a continuation of the previous tendencies.

8.6 Crop rotation-depends on profitability

Concerning the crop rotation, the imbalances of crop rotation mostly depend on the difference in prices for soy and corn production. The prices for corn have increased since the growth of alcohol in the US. The higher corn prices have led to a correction of prices and one can see a beginning of growth of the corn surface. When it is profitable to crop other cultivations than soy-there is a tendency to sow more of these (Hilbert, 2007 and Giraldiva, 2007).

Hilbert expressed a concern for the nutrient balance, that there is a deficiency of nitrogen, phosphor, potassium, and sulphur. That more nutrients are taken from the soil than is being replaced (Hilbert, 2007). Schulmeier complements this view by explaining how the soybean is a highly extractive plant. It extracts a lot of nutrients. In order to give back the soil its balance one would have to add a lot of nutrients, this does not often happen in reality as it would be too unprofitable (Schulmeier, 2007).

8.7 Intensified production-economy of scale and new technology

Factors as new forms of organization, larger units of production, increased competitiveness are all part of an increasing globalization of agricultural markets. The results are patterns of an intensification of agricultural production with less rotation and intensive cultivation of soy in the Pampas during the last decade. Economies of scale and new technology as no-tillage management and increased use of fertilizers have had the effect of cropping on soils that were not possible earlier (World Bank, 2006). With the new technology, one does not have to take into account factors as soil suitability or sustainability.

8.8 Soy displacing other cultivations - increasing commodity prices

The consequence of the massive expansion of soy has meant a displacement of other cultivations and cattle breeding. This has in its turn had an influence on the higher commodity prices for basic food products as potatoes, lettuce, and peanuts and for meat. For example, one can see in the micro-economy of Argentina, a strong increase of vegetable prices. There are less potatoes, batata and onions partly due to the fact that the soy areas are expanding and displacing other cultivations like vegetables (Villalonga, 2007).

8.9 Soy main cause for deforestation

Soy is the main motive for deforestation, a destruction of ecosystems and its biodiversity. The size of the forest of Las Yungas is somewhat small, so the expansion of agricultural land there

means relatively a very large part of the ecosystem (Giraldine, 2007). Chaco seco, is also a very important forest, and one cultivating soy there, such an intensive crop in those fragile soils with a more tropical climate means a greater demand of water, and an increase lost of nutrients.

In temperate zones there is more nutrients in the soil, the rate of decomposition is slower, as there is less rain, less nutrients are washed away. Cultivation in tropical areas is very productive in the first few years, but after a few years there is not much nutrients left in the soils and the eco-system functions poorly and land is often abandoned (Schulmeier, 2007).

8.10 Increased expansion of land

It seems as soybeans are used as the main feedstock for biodiesel production as it is readily available. It is available in large quantities, there is a knowledge and production structure built on soy cropping and a lot of invested capital. It is also in itself a very valuable commodity. Clearly, these are the lock-in effects created by a economical, political and technological system built on production of soybeans. It is convenient to use soy beans as a feedstock, more than it being the most suitable feedstock for biofuel.

Especially when considering the relative low oil content in soybeans compared to other plants with higher oil content as oil palm or even sunflower: Soy beans are on the low end of the efficiency scale. Therefore it does not seem to be the most suitable feedstock for biodiesel production when considering large-scale exports, as it will demand more land than another crop. In Argentina this is specially out of concern, as the most fertile soils in central areas of Argentina is already used and the Northern areas are close to the tropic of Capricorn and are less suitable for intensive cultivations of soybeans.

When looking at the efficiency scale of oil producing plants, the most oil producing plant is palm oil. It yields 5550 l/ha, which is estimated to be about 13 times more than the soy bean, that yields only 420 l/ha. As yields are estimated in liter per one can easily compare how much the volume would be in biodiesel. Considering the fact that 1 liter of oil results in about 1 liter of biodiesel one can conclude that there is a great difference in the amount of land needed for different cultivations (Asal et al, 2005).

Therefore it is interesting considering alternative raw material to biodiesel than using soybeans. Estimations are that if one would use sunflower instead, which yields 890 l/ha, there is a difference in land areas. To achieve the mandatory blending requirements of 5% for 2010 with biodiesel one would need to produce 700 000 liters of biodiesel. If one produce this out of soybeans this will be 1.3 million hectares, in comparison with soyflower it will be 1 million hectares.

To accomplish the mandatory requirements of 5% for 2010, one would need about 9% of the land area sown (taking the 9% of the 16 millions of hectares). That figure will increase to 15% for 2023. These figures indicates the difficulties that Argentina might have for producing significant volumes of biodiesel without expanding the land areas, as expansion is not something desirable. These calculations were only for the internal demand while the external demand for biofuels could be infinite (Greenpeace, 2007). If one takes into account that Europe is expected to import 50% of its consumption of biofuels in the future. However, comparing Europe's demand with China's-it is rather low.

8.11 GHG balance of biofuels

Analysing the environmental aspects of biofuels, it is essential to consider two main environmental impacts of the biofuel industry. First, the very reason to why biodiesel is being promoted worldwide is because of its environmental qualities. The quality of being able to reduce GHG emissions in comparison to regular diesel fuel. This is one of the main reasons, or even from an environmental perspective la raison d'être of biodiesel. Therefore it becomes crucial to ensure that biodiesel actually is a better alternative compared to diesel in terms of environmental impacts. This is why the results for GHG emissions in comparison to regular diesel fuel are most significative. Second, it is likewise important to take into consideration environmental impacts of biodiesel as the externalities generated by the production throughout its life-cycle (Asal et al, 2006). Third, it is also of importance to consider the subsequent consequences from the overall effect of the production, consequences for the ecosystem, the expansion of the agricultural frontier and deforestation.

When one makes a simplified analysis of the emissions of biofuels one considers the CO₂ emitted as zero as it is part of the carbon cycle, and that the plant will capture CO₂, when one burns the biofuels then this returns the CO₂ to the atmosphere, and then this will be captured by other plants. That is, that the net balance will be as there are no emissions. Taking this idea, the difference between burning biofuel and fossil fuels is 3 to 1 approximately. For each ton biodiesel that one burns one avoids the emission of 3 tons of CO₂ (Villalonga, 2007).

But if one makes a LCA one have to consider how much CO₂ that is needed to emit in order to make a litre of gasoline or the equivalent in biodiesel. And there the factors start to play, when one sows one uses certain machinery that uses fossil fuels and emits CO₂, use fertilizers that also emits N₂O, with which emissions appear that make the equation complex (Greenpeace, 2007).

There are important differences between biofuels, depending on a number of factors. Depending on how the plant was cultivated, how much fertilizer used, what kind of conversion technology. The point is, that one cannot generalise or systematize the amount of greenhouse gases generated when producing biofuels. According to the Stern report greenhouse gases from agriculture corresponds to 14% globally, while deforestation accounts for 18% (Biofuelwatch, 2007).

In Argentina, agriculture emits Greenhouse gases through three sources according to the National Inventory of Greenhouse Gases:

1. The emission of CH₄ methane rice production in inundated lands.
2. The burning of agricultural residues generate CH₄, CO, N₂O and NO_x
3. Direct and indirect emissions of N₂O due to synthetic fertilizers, biological fixation of Nitrogen and the covering of fields with agricultural residues

When the inventory was made in 2000, soy had increased from 12 to almost 30 million tonnes. According to the inventory soy is a main source to the nitrogen oxide emissions of the country (Fundacion Bariloche, 2000) and (Greenpeace Argentina, 2007).

Currently, there are many studies in the US and Europe undertaken, see table 15, but biofuel industries are being developed all over the world. In Argentina there are very few studies on the energy balance and GHG emissions of soy biodiesel.

The interviewees were largely unaware of any LCA studies made in an Argentinean context. Osvaldo Giralde, environmental director of the research institute Fundación Barrioloche said during the interview “if one thing is certain in Argentina, it is that there is not one comprehensive study which covers all the related aspects”. The director of Greenpeace Argentina Juan-Carlos Villalonga, also expressed a concern over the fact that there are very few rigorous studies in Argentina and pointed out the necessity of it, considering the great variation of results that one see from LCAs in Europe and US.

With as different results as one have from LCAs in Europe, US, there is no room for simplifications (Villalonga, 2007).

Table 1-16 Fossil fuel energy balances of fossil from different fuels⁴

Biofuel	Energy balance
Ethanol of cellulose	2-36
Biodiesel (palm oil)	~9
Ethanol sugar cane	~8
Biodiesel (used vegetable oil)	5-6
Biodiesel soy	~3
Biodiesel EU rapeseed	~2.5
Ethanol wheat	~2
Ethanol sugarbeet	~2
Ethanol corn	~1,5
Diesel petroleum	0,8-0,9
Nafta petroleum	0,80
Nafta tar	~0,75

Source: Greenpeace Argentina, 2007, p.49

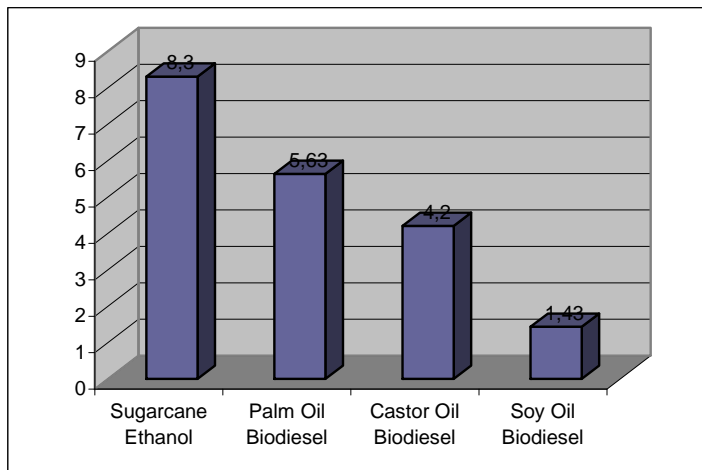
The one accessible LCA study in Argentina on B100 by Luis Panichelli found that for the environmental indicators of non-renewable energy and greenhouse gas potential, the results for soy biodiesel were lower than in the other cases of Brazilian soy, Swiss rapeseed and EU rapeseed. US were the only reference case that had better results. The study concludes that it was not comprehensive and it is necessary to make more studies assessing more environmental indicators as soil erosion, biodiversity losses, emissions to water and soils, calculating systems by-products, etc.

In the case of Argentinean biodiesel, Panichelli’s LCA was based on no-tillage cultivation, which is the most common agricultural method. The fuel consumption is much lower when using no-tillage, as one passes the tractor fewer times over the field. According to Asal et al the difference is rather significant. If one would use conventional tillage the consumption of fuel in Argentina would be 815 000 m³ in comparison with the current fuel consumption of

470 000 m³. Lidia B. Donato, INTA, agricultural engineer, the person responsible for developing methodology for fuel consumption of tractor, the person who made the statistics, further confirmed this in an interview, explaining that the reason for conventional tillage consuming more was the increased number of times one had to pass the tractor, but also that in tillage technology one has to use double-wheeled tractors to pull the extra machines used. This is the main reason to the increased fuel consumption for conventional tillage.

The Argentinean LCA compared the national values with international values from US and Europe; still the feedstocks compared are on the low end of the efficiency scale. It is possible that the results from Argentina concerning soy biodiesel are better in relative terms, but it is important comparing with the most efficient producers and the oil plants that yields the most in order to compare with the best environmental performance. Biodiesel studies from Brazil by Macedo⁵ shows that the best energy balance is from palm oil; in comparison to the worst that is soy oil. The table below shows that the energy unit from soy oil is 1.43, compared to more than 8 and 5 units for sugar cane and palm oil.

Table 1-17 Energy balance of biofuels in Brazil



Source: Macedo et al in Dufey, 2006, p.41

Annie Dufey makes the assumption that due to the great differences in energy balance, the crops on the higher end of the scale will have better opportunities to “become global energy sources.” As the other plants require so much more land in comparisons that these would be out competed compared to those with higher yields from less land. Though, this all depends on how different policy incentives evolve. As Dufey concludes, “however, the existence of policy incentives could mean that the biofuels market develops in favour of those crops that are not necessarily the most energy-efficient biofuel” (Dufey, 2006).

⁵ Macedo I, Lima, Verde M and Azevedo J. 2004, Assessment of greenhouse gas emissions in the production of use of fuel ethanol in Brazil. Government of the State of Sao Paulo and Secretariat of the Environment.

8.11.1 The indirect GHG emission for soy

Greenpeace has made some calculations taking in consideration the thousands of hectares that have been deforested in order to cultivate soy. Soy has indirectly caused quite substantial GHG emissions. To give an idea of the magnitude, the total carbon content per hectare where the agricultural frontier has advanced significantly is in Parque Chaqueño: 110,5 ton/ha, Selva Misionera 229,5 ton/ha, Selva Tucumano Boliviana 184,5 ton/ha (Greenpeace, 2007).

According to the Secretary for Environment and Sustainable Development (SA y DS) 790 000 hectares have been deforested during the period between 1998-2002, which are associated with the agricultural expansion. Yearly this would imply an emission of 54 366 Gg of CO₂ when deforestation is an average of 197 500 hectares, which presents 275,3 ton CO₂/ha (Greenpeace, 2007).

If one produces soy with the objective of producing biodiesel and deforest one hectare of the native Monte of the Chaqueño Park or the Selva Pedemontana de Yungas one will have emitted 275,3 tons of CO₂ which means to balance the emissions of deforestation with savings of emissions of biodiesel one would have to sow soy in this hectare for 197 years (Greenpeace, 2007).

Other significant comparison is that one hectare of forest of Park Chaqueño would absorb annually 1,833 ton CO₂/ha/year, which is that this hectare would absorb more carbon than the reduction would generate of biofuels in this area (Greenpeace, 2007).

Considering that soy is the main motive for deforestation, cutting trees, is removing valuable carbon sinks. Taking that into perspective, soy biofuel has very low chances of making any contribution in environmental terms or climatically (Villalonga, 2007). Greenpeace Argentina has named this a reverse CDM mechanism as it refers to the production of clean energy which emits a lot in the production country and is exported to countries where it will be burned as a cleaner fuel. All the emissions of the agricultural production stay in the country (Villalonga, 2007). To illustrate this, one can also draw a parallel to the oil exporting countries, which have the highest pollution per capita (Giraldin, 2007).

8.12 Argentina-a case of weak governance

8.12.1 No national resource management

There are no strict land use laws on a national level since the change of the Constitution in 1994, and the natural resources now belong to the provinces instead of the national state. The legal framework of the state is a basic framework, which implies no strict laws on natural resources. The national state only provides a basic legislative framework to be followed, while the provinces own the natural resources and can decide to impose more stringent laws (Naveira, 2007).

As Argentina is such a vast country both in latitude and longitude, there is a diversity of natural resources and ecosystems. Considering the variety of natural resources from region to region it made sense letting the provinces control their own lands, as it was not very useful for each province to have the same laws. However, regionally there are very big impacts on the nature and a metamorphosis used is that “the whole country is being liquidated ” (Giraldine, 2007).

8.12.2 Short term strategies-to maximize economic benefits

An indication of the problem with the provinces regulating their own land use laws and that there is no centralised national planning, is the example of the governor from Santiago del Estero, who sold permits for deforestation of 150 000 hectares last year. According to the director of INTA, Hilbert, these are actions taken by politicians to generate more votes and create jobs, political populism (Hilbert, 2007). It seems, as there are no long term plans, instead that there are occasions when politicians take decisions to maximize the economic benefits during the period they are elected for.

8.12.3 No coordinated national cooperation for sustainability

Osvaldo Giraldiva, Fundación Barrioloche is of the opinion that biofuels are a rather new theme and there is no coordinated national political strategy as yet and seems unsure if there will be a coherent one from the state.

This is confirmed by previous studies as by Asal et al, “The regulatory framework for biofuel production is structured through different ministries depending on the aspect involved. It is remarkable that, despite the increasing interest in biodiesel, the issuing of new regulations has suffered from a lack of inter-disciplinary coordination and communication so far” (Asal et al, 2006).

“What is happening is a reaction, of each one of the organizations, governmental or non-governmental that is produced, for each one of them that can have a relation to the theme. The Environmental department, Energy Department and Agricultural department all act in different ways. This is because they have different political responsibilities and stakeholders that they have to cooperate with and get along with” (Giraldiva, 2007).

8.12.4 Internal contradictions of the state

There is a lack of a real sustainable strategy from the State. This year the grain production reached a historic record of 95 million tons, the agricultural sector has as the aim of reaching 100 million metric tons by 2010; soy production is expected to be 45 million metric tonnes out of this. In order to achieve this, one would have to further expand the land areas with soy cropping to 17 million hectares.

While the Agricultural Department is part of realizing these goals, the Department of Native Forests, are generating statistics on deforestation, which is mainly caused by soy expansion.

In the interview with the director of the Department of Native Forests, Jorge Menéndez, Menéndez expressed great concern by the alarming pace of deforestation. While at the interview with Almada and Leones at the Agricultural Department, which is supporting investments in Soy, deforestation seemed to be much less of concern. The position of the government is somewhat contradictory in this respect.

The government seems to have internal contradictions. On the one hand, the Department of Native Forests produce very clear information of deforestation, with the main motive being soy. On the other hand, the Agricultural Department is promoting soy cropping and expansion of agricultural frontiers and expansion of cattle towards the North as well as promoting a biofuel industry, which will probably further increase the expansion of soy areas. As the Greenpeace Director Villalonga said “There is no discussion that there is deforestation, however, one can always have different opinions on how severe this is, being rather severe or an emergency situation for the native forests of Argentina” (Villalonga, 2007).

8.12.5 Political-institutional culture which makes long term planning difficult

The impression given by interviews was that there was a lack of coordination and cooperation among all the different stakeholders interviewed. One of the explanations came from Giralaine, who used a historical perspective to explain the difficulties for communication. “It is a country which since its beginning always have had very antagonistic groups, that always have had difficulties of getting along. Through history there has been very difficult to communicate, to have a dialogue between winners and “losers”. This has lead to a lack of communication between different groups in society. When there is a change of government, the government taking over usually erases the work of the previous one. The consequences are that it generates a very shortsighted perspective that is often for each owns interest and not for the common good. Unfortunately, this is a political context that will not lead to sustainability (Giralaine, 2007).

9 Conclusions

The global development of biofuel production and trade and whether its benefits will exceed its trade-offs or vice versa is subject to much debate. One has to consider that the development of biofuel industries is happening on a global scale. Thus, it will have worldwide repercussions, economic, social and environmental. The Argentinian case of biofuels produced on soybeans presents the difficulties that large-scale production of biofuels could generate.

It is likely that the biofuel trade will be global, considering the asymmetrical geography for demand and supply, the demand created by blending requirements, the interest from the private sector and increasing oil prices. These are some of the main driving factors, with which one can assume that current tendencies to produce and consume in domestic markets will change.

An increase of international trade of biofuels will depend on how the biofuel market evolve considering import tariffs and subsidises which keep prices artificially higher than they are, and is the reason to why there is little trade today. Achieving any changes in the biofuel market will be a challenge considering how it is intertwined with the agricultural market, which is dominated by agricultural subsidies, high import tariffs, export subsidies and preferential arrangements (OECD, 2008).

Estimations on future volumes of international trade in biofuels are therefore uncertain, it depends on whether markets will be more liberalised and whether for example European imports of “greener” biofuels as stated by Mandelson will be favoured.

There are also speculations on whether an increased international biofuel trade could re-ignite the Doha Round or whether increased food prices could mean less subsidises to farmers or if larger multi-national companies would hi-jack the development and maintain subsidises.

When the European Commissioner for Trade, Mr. Peter Mandelson, stated that Europe should be open to imports of cleaner and cheaper fuel from the South, it sounded like a rational approach. It was portrayed as a win-win situation. A dynamic export market for countries in the South and burning of cleaner fuels in the North. Though, as discovered in the thesis, the equation is not that straightforward. Could it even be that biofuels is not one of the solutions to the climate problem, but would it aggravate it further?

Much point towards that biofuels is not the solution, and that it could aggravate climate change further, as well as creating additional problems, much depending on how national and international policies evolve.

Predictions are that the biofuel boom will have repercussions in the global economy, on food, water and land prices. Food prices are expected to rise as much as between 20-50% over the next decade according to FAO.

According to the Economist, food prices have been low for decades, until spring 2007, when the food prices reached a top and increased 75% in real prices since 2005. Explanations are the current agflation, in combination with changes in people’s food habits in emerging economies and as a reaction to the increased biofuel production in Brazil, China, the EU and the US.

The inflation, the increased demand for food products to be used as a source of alternative energy are pushing food prices up, it causes a chain reaction of increased food prices, as demand increases for certain products spread to other non-fuel crops, which are bought by consumers to substitute for the high prices of the basic everyday products.

The changes of food habits in emerging economies can be exemplified by the increased demand of meat among consumers in China. An example is that in 1985 a Chinese consumer ate 20 kg meat, while today the meat consumption has risen to 50kg/person and year. What is crucial is that it takes 8kg of grain to produce one kilo of beef, subsequently the demand for grain increases.

In today's globalised world, cause and consequence becomes visible when one starts examining the global interrelations, as for example the first question I posed during the thesis research:

9.1 Why is soy the first and seemingly only alternative for large-scale production of biofuels in Argentina?

In order to answer that question, one must first understand why soy is the main preference, why are soybeans the raw material for biodiesel when soybeans are at the low end of the efficiency scale? When palm oil yields 13 times more and sunflower 50% more?

Soybeans have since the 1980's become a global commodity and since then Argentina started to increasingly specialise its production on soybeans. The demand for soy products have soared with the increasing demand for meat in Europe, an increased demand for fodder to the pig and poultry industry. An increased external demand, due to factors for example as emerging economies and changed foodhabits.

Besides the great external demand from mainly China and Europe for all soybean related products (see flow chart p.13), there are other explanations to why soy cultivation has more than tripled the last decade and especially in the mid-nineties when it increased 2.4 times from 6 million hectares to 14.2 million hectares in Argentina.

The reasons to the linear expansion and why soybeans have become the most sown crop in Argentina are several, such as:

It is a versatile plant that can grow in a diversity of soils and easily adapts to different climates. Improved climatic conditions, increased rainfalls in the North of Argentina has made it possible to extend the agricultural frontier towards zones in the North that were previously considered as marginal areas for agriculture.

The introduction of GMO soy in 1996 reduced production costs and turned the country into one of the three biggest world producers of soy, next to Brazil and the United States. The combination of GMO soy, the Round-up Ready soy with the genetically resistant structure to glyphosate in combination with no tillage management, has improved soy's adaptability to the diverse climates and also made it easier to grow.

The main reason to the exponential increase of the soybean industry in Argentina seems to be the combination of the two technologies, no-tillage management and transgenic Roundup Ready (RR) soybeans. Transgenic soy was an interesting "technical package" which had many advantages. Costs for herbicides went down, with no-tillage management one reduced costs for fuels and as it was easy to apply, it was a very interesting business opportunity.

Simply, for farmers soy is an ideal crop to grow. It is easy to cultivate and give good profit margins, with less investment. It has lower costs of production and a better yield per hectare than any other crop.

Out of all these explanations the expansion of soy is mainly caused by the international demand of soybeans according to the Forest Department at the Secretary for Environment and Sustainable Development (SAyDS) and Greenpeace Argentina.

This is the background to why soy is the dominating crop and the reasons to why soybeans are used as the main feedstock for biodiesel production-it is readily available. It is available in large quantities, there is a knowledge and production structure built on soy cropping and a lot of invested capital. It is also in itself a very valuable commodity. Obviously, these are the lock-in effects created by an economical, political and technological system built on production of soybeans.

9.2 What are the drivers behind the Argentinean biofuel strategy?

As previously mentioned, one of the strongest drivers is the tax incentive; it drives producers towards international trade and export markets. The great difference in taxes for exports of vegetable oil and biodiesel, 24% tax on oil exports, but only 5% and a rebate of 2,5% for biodiesel, is a strong incentive pushing the vegetable oil producers and new investors into export markets for biofuels.

The tax incentive is a strong push force, added to this is also the fact that the conditions on the internal market are much less favourable for producers, with more regulations and controls, with lower fuel prices-while Argentinean biodiesel prices are competitive in international markets.

Moreover, for the agricultural producer biofuels represent a new interesting product, a value-added product, and one more product in the value chain that is possible to export with more profit. There is also the possibility for the producer to substitute gasoline with biodiesel a sub-product, an important advantage in a country recently shocked by a national energy crisis (Giraldine, 2007).

The great external demand is another driver. An example of this is the future international demand of biofuels from the European Union. EU's aim of achieving 10% of biofuels in the transport sector by 2020, and as 50% of it will need to be imported; this is another great push force for producers and investors. The external demands created by political targets, in combination with the tax incentive, seem to be two main drivers for the rapid establishment and development of biofuel production for international export in Argentina.

9.3 What could be the expected outcome of Argentina's biofuel strategy from an environmental perspective, trade-offs or benefits?

From an environmental perspective the last decade of exponential soy cultivation in Argentina indicates a certain pattern of negative trends.

It was the expansion of the soy production during the nineties that turned Argentinian agriculture into a more intensive production system. This was due to the structural change of the agricultural production system in the 1990's, the planting pools, driven by the economic profits of soft technology as RR soybeans and the economic of size.

The outcome was an increased use of GMOs, from being applied by 6% it covered 90% of the fields. The new technology, the no tillage management, made it possible to crop on a variety of different soils, soil variables were no longer needed to take into account and one could also sow on hills or on dry or shallow soil. There was a massive expansion to unused lands in the North of Argentina, where soils are more fragile and prone to erosion due to the warmer climate close to the tropic of Capricorn.

Prior to this change, the nutrient balance was somewhat stable and good, as rotation among crops and cattle were practiced consistently. Decline in soil fertility and increase of soil erosion were the consequences of the intensified production. The use of fertilizer increased quite substantially during the last ten years.

There was an expansion of land, advancement of agricultural frontier, during the most exponential phase of soy, 1996-2004 soybean areas expanded into new areas with 41% into wild lands, including forests and savannahs. Most remarkable is the soy expansion in Northern Argentina, in the states of Chaco and Santiago del Estero, where there was an 86% increase into areas of natural vegetation and only 13% was in previously cropped areas.

When comparing the diagrams between the progressive expansions of lands for soy cropping it is as a reflection of at the same time the linear negative graphs indicating high rates of deforestation. During the 1980's-1990's there was a strong push of deforestation which is related to economic market forces as globalization and technological changes within the agriculture field, the application of GMO-soy and no-tillage.

According to SAyDS, the transformation of the native forest during this period is the largest transformation of native forests in the history of Argentina. Greenpeace Argentina estimates that areas as big as 40 football fields/an hour are cut down. Yearly this amounts to 250 000 hectares, a number which is expected to be surpassed during 2007.

The point is that in the case of biofuels one cannot only look at singular cases of best performance, as for example sugar cane in Brazil. What is required is a holistic comprehension and illustration of the many interrelated factors at interplay, which the particular case of Argentinean soy biodiesel proves.

According to a report by the OECD it is only sugar-to-ethanol in Brazil and ethanol produced as a by-product of cellulose production as in Sweden and Switzerland or when producing biodiesel from animal fats or used cooking oils that generate a substantial reduction of GHG compared to conventional fossil fuels as gasoline and diesel.

The same report further concludes that when taking into account impacts as acidification, fertilizer use, biodiversity loss and toxicity of agricultural pesticides, "the overall environmental impacts of ethanol and biodiesel can very easily exceed those of petrol and mineral diesel" (OECD, 2007).

The OECD report confirms that one of the most important points to emphasise is that there are very large variations of biofuel performance depending on a number of factors. Depending on how the plant was cultivated, how much fertilizer used, what kind of conversion technology. The point is, that one cannot generalise or systematize the amount of greenhouse gases generated when producing biofuels. According to the Stern report greenhouse gases from agriculture corresponds to 14% globally, while deforestation accounts for 18% (Biofuelwatch, 2007).

There are very few rigorous studies in Argentina on environmental impacts of biofuels. The studies that exist on biofuels mostly from Europe and US show very varying results, with energy balances that range from 2-36. As the director of Greenpeace Argentina expressed:

“With as different results as one have from LCAs in Europe, US, there is no room for simplifications” (Villalonga, 2007).

As soy is the main motive for deforestation, that is removing valuable carbon sinks, it is questionable whether soy biofuel could make any environmental contribution. As Greenpeace Argentina has stated, international export of biofuels based on soybeans are more like a reversed CDM mechanism. As the production of soy biodiesel generate carbon emissions in the production country and cleaner emissions in the user countries.

Considering the thousands of hectares of deforestation for soybean plantations, soy has indirectly caused quite substantial GHG emissions and is likely to continue to do so, considering political and organisational factors as the lack of enforced land use laws, populism and its impulse to maximise economic benefits during a short time period, the lack of coordinated sustainability strategies from the state, subsequently a political-institutional culture that impede long term planning necessary for the environment.

As biodiesel presents a new profitable product it will most probably have the effect of a shift between markets, considering all the favourable conditions pushing towards exports of biodiesel. As the basis for biodiesel is vegetable oil, there will probably be a change in the vegetable oil market. It is hard to predict, but one can speculate that some exporters might leave vegetable oil markets for biodiesel markets and new or current producers of oil will fill that gap. There is also the possibility of current oil producers maintaining their export markets and expanding their production. Anyhow, the effect will be the same. There will most probably be a change in the markets and to fill the demands for the two markets based on the same raw material-there will be an increasing pressure on the land, both in terms of area and intensity, i.e productivity.

Previously there has always been a linear correlation between higher commodity prices and an expansion of the agricultural frontier. The last ten years soy has expanded exponentially for various reasons, the main reasons being the low costs of production, low risk and high profits. Soy is the main reason for an increase of the land area, an expansion of the agricultural frontier into areas with more fragile soils in the Northern parts of the country. One cannot disregard the fact that a new business as biodiesel with soy beans as the basis for production-will probably mean a continuation of the previous tendencies.

To conclude:

It is clear that soy is not the most suitable feedstock for biofuels, but as long as there are no regulatory or market incentives that favour other types of cultivations, the more inefficient feedstocks as soybeans will be used for biodiesel. The main reasons being that it is readily available in large quantities, have good profit marginal due to its relatively lower costs of production and better yield than other crops. Also, the economical, political and technological lock-in effects maintain and push for using soybeans as the rawmaterial in biofuel production.

Depending on how national and international policies evolve, certain crops will be favoured over others. Annie Dufey stated that considering the great differences in energy balance, one could assume that the crops on the higher end of the scale will have better opportunities to “become global energy sources.” Since the other plants require so much more land in

comparisons that these would be out competed compared to those those with higher yields from less land (Dufey, 2006). Depending of different policy incentives, there is a risk that the biofuel market develop in favour of crops that are not the most energy efficient, which is exactly what seem to be happening in the case of biofuel made on soybeans in Argentina.

Another fact that has to be mentioned and cannot be ignored in the context of biofuels, is that currently deforestation and nitrogen emissions from agriculture together account for a third of greenhouse gases globally. Biofuel production often means a rather significant increase of both agricultural discharges and in some cases also deforestation.

The main conclusion of the thesis is the importance of national sustainable indexes for biofuels or an international governance system of biofuels considering the findings from the case study. It is a essential to install governance systems or incentives with the the capacity to minimize trade-offs and maximize benefits.

The question is how this could be done or if it could be done. Due to the institutional-political culture in Argentina the question is if it will ever be any sustainable indexes or any sort of “green-labelling” of biofuels. It is more likely that that kind of incentives will come from abroad, from Europe. As there are already plans in Belgium, Holland, England and Brazil for governance systems of biofuels.

Though, some critical points to make is that the time factor, the time it will take before sustainable indexes are established and implemented, is working against the rush to markets of all the actors involved in the production chain of first generation biofuels.

There is also the risk of a proliferation of the number of indexes with different national initiatives. Even if the sustainability indexes would be implemented from Europe or US, Argentina could always export large scale of biofuels to Asian markets-which might have less environmental considerations.

The findings from the thesis conclude that the biofuel development is rather critical from a social and environmental perspective. There are too many uncertain factors at play and much point towards a low carbon performance in the case of soy bio diesel in Argentina, especially when taking a holistic perspective and considering the expansion of the agricultural frontier at the expense of forests, an important source of carbon sinks.

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Abbreviations

ADM Archer Daniels Midland

BP British Petroleum

CDM Clean Development Mechanism

DARCOF Danish Research Centre for Organic Food and Farming

EAP Agricultural Enterprise

ECLAC The Economic Commission for Latin America and the Caribbean

EPPs Environmentally Preferable Products

ESG Environmental Services and Goods

FAO The Food and Agriculture Organization of the United Nations

GAIN Global Agriculture Information Network

GATT General Agreement on Tariffs and Trade

GHG Greenhouse gases

GMO genetically modified organism

HS Harmonized System

IAD Inter-American Development Bank

IEA International Energy Agency

IIED International Institute for Environment and Development

INTA Instituto Nacional de Tecnología Agropecuaria

IPC International Food and Agricultural Trade Policy Council

IPCC Intergovernmental Panel on Climate Change

LCA Life-cycle Analysis

OECD Organization for Economic Co-Operation and Development

Toe Tons of oil equivalent

SAGPyA Secretaría de Agricultura, Ganadería, Pesca y Alimentos, Argentina

SAyDS Secretaría de Ambiente y Desarrollo Sustentable

UNCTAD United Nations Conference on Trade and Development

WWF World Wide Fund for Nature

WTO World Trade Organization

Appendix

Global biofuel production, Dufey 2006.

Country	BIOETHANOL			BIODIESEL		
	Production (ML)	Typical Use	Feedstock	Production (ML)	Typical use	Feedstock
AMERICAS						
Brazil	15,098	E26	Sugarcane	Still minimal	B2, B5	Soy oil, castor oil, palm oil
US	12,907	E10; some E85, E10	Corn (95%), sorghum;	75 gallons (200) 200 gallons by 2007	Blends <75%	Soy oil
Canada	231	E10	Wheat and straw	10		Straw
Colombia	900 lt/day	E10	Sugarcane		B5	Palm oil
Argentina	42	E5 by 2010			B5 by 2010	Soya oil
Ecuador						Palm oil
Peru		E7.8 by 2010	Sugarcane			
EUROPEAN UNION						
Germany	269		Rye, wheat	1,035	B100; B5	Rapeseed
France	829		Beet and wheat mainly	348		Rapeseed
Italy	151		Wheat	320		Rapeseed
Denmark				70		
Austria				57		
Spain	299		Wheat, barley, wine	13		

Sweden	98	Fuel heating; (E5; E85)	Forestry; Wheat	1,6		
UK	401		Beet	10		Rapeseed
Czech.Rep	47			60		Rapeseed
Poland	201					Rapeseed
ASIA						
China	3,649	E10 but not for most fuel	Corn, cassava, sugarcane, rice sweet potato	68 ML (capacity 2004)		Jatropha and others
India	1,749	E5	Sugarcane		B20 by 2011	Jathropha
Thailand	280	E10	Sugarcane, tapioca/cassava	90 ML (2005), 722 ML by 2010		Palm, peanut, soya, coconut, jatropha
Indonesia	167		Sugarcane			Palm oil
Pakistan	26		Sugarcane			
Philippines	83		Sugarcane			Coconut oil
AFRICA						
South Africa	416		Sugarcane		B1-B3 by 2006	Jatropha
Malawi	6	Encouraging use	Sugarcane			
Ghana	6	Encouraging use	Sugar, corn			
Zimbabwe	6		Sugarcane			
Kenya	3		Sugarcane			
OCEANIA						
Australia	33		Sugarcane		B5	Soyabeans

