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ECONOMICS OF TRANSGENIC SOYABEAN PRODUCTION: IMPLICATIONS FOR EU

Ian McFarlane, Julian Park, Graziano Ceddia, Richard Phipps
School of Agriculture, Policy and Development
University of Reading, UK

Abstract

World oilseed trade consists of many closely substitutable commodities, with canola and cotton seed as possible alternatives to soyabeans for many purposes. Transgenic events in all three crops have been widely adopted, particularly in North and South America, for compelling economic or agronomic reasons. Despite the close attention from organisations concerned about the potential environmental consequences of transgenic crop adoption, no evidence of permanent disruption of ecosystems has been substantiated.

No transgenic canola, cotton or soyabean crops are permitted for commercial cultivation in Europe, and although some transgenic feed resources are permitted for import, importers are at severe risk of shipments being denied entry if the slightest trace of an unauthorised transgenic crop is detected in a non-transgenic shipment. This means that livestock farmers in the EU can be disadvantaged due to restricted access or higher feed costs thus losing a degree of competitive advantage.

In this paper the extent to which transgenic soyabeans have become a major component of livestock nutrition worldwide is examined. The future trends in prices for EU imports of soyabeans and soyabean oil in the light of further transgenic soyabean events now being introduced are assessed, and the effect on import prices of demand for soyabean oil for conversion to biodiesel is discussed.

Keywords: soyabean, biotechnology, transgenic, economic

JEL Classification: Q18, Q56

1 Introduction

World oilseed trade consists of many closely substitutable commodities, with rape-sunflower- and cotton-seed as alternatives to soyabeans. Divergent requirements for protein meal, vegetable oil and oil for biofuel determine the ratio of oilseeds to oilseed products that countries import. Soyabean oil remains the most widely used edible oil in the United States, with consumption exceeding that of all other fats and oils combined. It is a major ingredient in cooking oil, margarine, mayonnaise, salad dressing, and shortening. Lecithin is a natural emulsifier derived from soyabean oil.

Soyabean meal is the dominant protein supplement used in U.S. livestock and poultry feeds. Soya products are also used to make baby food, diet-food products, beer and ale, and noodles. Technical uses include adhesives, cleansing materials, polyesters, and other textiles. In this paper we consider the current and future of economics of transgenic soyabean production, with a particular focus on Europe. The paper reviews the current growth of transgenic soyabean and its use in livestock nutrition. Then the economic implications of restrictions on cultivation of HT soyabean in EU for livestock feed costs are discussed and the sustainability of supply of soya-based livestock feed is considered

2 Transgenic soyabean

The economics of growing transgenic crops has been reviewed elsewhere (James 2009, US Board on Agriculture and Natural Resources 2010) and this has illustrated in particular the economic benefits of transgenic soya (Konduru et al 2008, Bonny 2009).

Herbicide-tolerant (HT) soyabean is often viewed as the most important biotech crop, and in 2009 the crop occupied 69 Mha, compared with 64 Mha of conventional soyabean (James, 2009). In 2005 and 2006, prior to EU entry in 2007, Romania was growing biotech herbicide-tolerant soyabeans on a large scale, about 140 kha compared with 60 kha of conventional crop (Ceddia and Rodriguez 2008); farmers who used HT soyabeans indicated that this crop was the most profitable arable crop grown in Romania, with gains derived from higher yields and improved quality of seed coupled with lower costs of production. Other advantages included:

- increased convenience and management flexibility
- small saving on harvest cost
- significant benefits in the crop rotation pattern.

Profit margins for HT soyabeans in Romania were €100-187/ha (Otiman et al, 2008), while, in the same market year (2006), conventional soyabean growers were losing money. The increase in income was the result of herbicide cost reduction (on average, 1.9 treatments applied to HT soyabeans and 4.3 treatments to the conventional soyabeans) as well as the higher yields (3-3.5t/ha for HT and 2 t/ha for conventional). On accession to the EU in 2007 cultivation of HT soyabean ceased in Romania as the crop is not yet approved for commercial cultivation in EU.

Soyabeans were the largest of EU agricultural imports during the decade from 1999 to 2008, with imports of soya-based feed increasing by 7 Mt, and in soyabean oil the EU went from being a net exporter to a major importer during that period (von Witzke and Noleppa, 2010). EU Member States currently import approximately 40 million tonnes of soya

material. Without the protein offered by soya, Europe would not be able to maintain its current level of livestock productivity. Soyabeans are also used to produce many food additives. The EU is self-sufficient in vegetable oil production, but its protein deficit still makes it the world's largest importer of soyabean meal and second-largest importer of soyabeans.

Gryson et al (2009) note that EC Regulations 1829/2003/CE and 1830/2003/CE have allowed the placing on the European market of transgenic products in food and feed chains, and have defined their rules of traceability and labelling. For some supply chains, such as for derived products that are used in the production of feed, manufacturers have to face both non-transgenic and transgenic production, although there are no labelling requirements for animal products derived from animals fed with genetically modified organisms (GMOs).

There is increasing demand for soyabean oil as biofuel; the EC (2007) conducted an impact assessment of the decision to incorporate a minimum of 10% biofuel by 2020 in total transport fuel use, in particular the location of biofuel industries in Europe or in exporting nations such as Brazil, to determine whether seeds or vegetable oils or biodiesel will be imported, with consequences for by-product markets. . EC (2009) amended the target for biofuels in road transportation by including renewable energy from other sources (such as hydrogen and 'green' electricity) within the 10% target. On the basis of this Al-Riffai et al (2010) estimated that only about one half of the 10% target would be derived from "agricultural" sources. They noted that this may over-estimate the potential of other sources to provide transport fuel at an acceptable cost.

The Commission's biofuel-related impact assessment pointed out the positive impact on livestock production in terms of reduced prices for animal feed, with soyameal prices predicted to fall by 25% by 2020. Banse et al (2007) modelled alternative scenarios taking account of two key factors – the development of the world price of crude oil and the elasticity of substitution between different inputs in biofuel production and in the petroleum industry. They predicted that under high crude oil prices, the subsidy required to meet the EU biofuels would be significantly reduced, and that crop prices that would otherwise fall will increase in response to demand for biofuel.

The environmental consequences for the EU of adoption of the biofuel target for 2020 is being monitored by a JRC task force. In an interim report (Edwards et al 2008), the task force commented that while most types of biofuels can save GHG in the best circumstances, the only major biofuels which are likely to save greenhouse gas (considering indirect effects) are bioethanol from sugar cane from Brazil, compressed biogas and second generation biofuels. For biofuels currently used in EU the overall indirect emissions are potentially much higher than the direct emissions. The magnitude of these indirect effects depends critically on the policy and effectiveness of control in the regions of the world where the extra demand for crops will result in expansion of farmed area.

Hertel et al (2008) estimated the economic impact of by-products of biofuel production, in assessments of the energy balance of biofuels. In particular they found that studies which did not take by-products into account concluded that biofuels had a negative energy balance because they failed to take account of the energy use offset due to by-products. The increased availability of by-products has beneficial side effects; for example Taheripour et

al (2008) found significant differences in feedstock prices when by-products are taken into account, moderating the impact of the biofuel mandate on livestock markets.

According to the EU Joint Research Centre (Stein and Rodriguez, 2009) only one transgenic soyabean event is currently available worldwide, but this number is predicted to increase to 17 by 2015. A Bt soyabean has been reported, with encouraging pest management outcomes during trials (McPherson and MacRae, 2009).

3 Livestock nutrition

Approximately 400 million tonnes of oilseeds were produced in 2009; soyabeans represented 53% of the total, followed by rapeseed, cottonseed, peanut, sunflower seed, palm kernel and copra which contributed 15, 10, 9, 8, 3, and 1% respectively, of the total global production. These figures produced by the American Soybean Association (ASA, 2010) show clearly the overriding importance of the soyabean crop in terms of oilseed production.

There is a complex network of worldwide supply chains for soyabeans and related products, illustrated in Figure 1. Products are consumed in four broad categories, in order of importance:

- livestock feed
- protein for human consumption
- oil for human consumption
- feedstock for biofuel

In each category there is competition for market share from alternative products from various other sources; in every category soyabeans command a major share of the market.

Five countries, the USA, Brazil, Argentina, Paraguay and Canada dominated global soyabean exports of 77 million tonnes in 2009 (ASA, 2010). Of the 44 million ha of soyabeans grown in these three countries, 84% are transgenic, and are responsible for approximately 90% of world exports of soyabeans and soyabean oil. Soybean meal is the product remaining after extracting most of the oil from whole soybeans. The oil may be removed by solvent extraction or by an expeller process in which the beans are heated and squeezed. The protein content of solvent extracted soybean meal is about 48%, and is the preferred protein supplement for livestock production. Approximately 60-70% of soyabean meal is used in poultry and pig rations and 15-20% is used in beef and dairy cow rations. Soyabean meal is nutritionally superior to other oil seeds meals as it has an excellent amino acid profile containing all essential amino acids.

4 Economic dimension

Konduru et al (2008) reviewed the global economic impacts of Roundup Ready (RR) soyabeans, while noting that adoption has been associated with non-pecuniary benefits such as ease of use, decrease in health risk for operators and environmental advantages. In modelling yield trends they assumed that RR and conventional soyabeans have comparable yields. Trigo and Cap (2003) reported cost reductions of about US\$20 per hectare, mainly

because of the reduction in energy costs resulting from more effective weed management techniques. Moreover, the price of glyphosate was less than 30% of its 1993/94 level. At the same time, there was synergy with no-till practices, which facilitated the incorporation of double-cropping soybeans. Konduru et al concluded that the combination of savings in weed control with tillage benefits was worth \$28/ha to Argentine farmers in 2006. Bonny (2009) noted a global reduction in herbicide treatment costs for all soyabean producers after glyphosate patents expired in 2000, whether they used transgenic varieties or not, but herbicide prices has since increased again, notably in 2008.

Europe could be a beneficiary if imports derived from transgenic soyabeans were to be permitted, but although some transgenic soyabean products have been authorised for import, the presence of non-approved GMOs, even in tiny amounts, leads to entire shipments being rejected. Feed industry and grain trade associations suggest that the EU farming sector need to import 6 - 7.5 Mt soybeans in 2010. The associations urge approval of a workable low-level presence of GMOs to allow urgently-needed imports to take place.

EU biodiesel policies have encouraged EU farmers to increase oilseeds area, especially rapeseed. Trade in whole oilseeds, particularly soyabeans, is relatively unrestricted, but oilseed meals are subject to tariffs. Soyabean prices (in Chicago) were relatively stable from 1999 until 2007, apart from a period of shortage in 2003-04, when poor harvests led to simultaneous price rises in wheat and corn as well as soyabeans. The price of soy-based oil is closely correlated with soyabean prices, as illustrated in figure 2. Soya prices also correlate with the price of maize (corn) and to some extent with the price of crude oil (figure 3). Eight EU countries grew conventional soyabean in the years 2003-09, as shown in Table 1.

Table 1 - European soyabeans, by area (Source: Eurostat, 2010)

	x 1000 ha						
	2003	2004	2005	2006	2007	2008	2009
EU (27)	-	-	431	-	-	-	-
Italy	152	150	152	178	130	108	135
Romania	129	121	143	191	133	50	49
France	81	59	57	45	32	22	44
Croatia	50	37	48	63	47	36	43
Hungary	30	27	34	36	33	29	31
Austria	16	18	21	25	20	18	25
Slovakia	11	9	11	12	8	5	10
Czech Republic	8	9	9	10	8	4	6

Of these 8 countries, Brookes (2009) reported selling price in just four countries in 2008/09:

Romania	223	€/t
France	282	
Hungary	290	
Austria	240	

Using these prices coupled with other survey data, Brookes calculated a gross margin after all costs and excluding subsidies of about €60/t in Romania, France and Austria, and about €150/t in Hungary in 2008/09. If the advantage of transgenic soyabeans to farmers in Argentina, estimated by Konduru et al, of US\$28/ha could be achieved in Europe, where yields of conventional soyabeans are in the range 2 to 4 t/ha, then net benefit for farmers in EU may result. In 2005 the 27 countries of the EU grew soyabeans on 431 kha (Eurostat, 2010) the advantage to Europe of achieving improvement worth €20/ha will be €9.7 M in a normal year from crops worth €250/t with average yield of 3t/ha, thus having sales value of €(250 x 3 x 431,000) or about €320 M. This represents an increase in revenue of about 2.3%, but with an improvement in farmers' profit margin of about 10%.

This level of economic incentive may not be sufficient to induce farmers to grow soya in Europe; apart from climatic limits to the growth of soybean in the EU, Southern American crushers provide more competitive soybean processing, while EU crushers have specialised in rapeseed because of the increase in availability (Ceddia and Rodriguez 2008). On this basis it is likely that soyabeans and soya-based feed will continue to be major agricultural imports on the scale reported by von Witzke and Noleppa (2010).

5 Discussion

Soyabeans have many uses, not least as an important and nutritious component of the human diet. It has been noted (FAO 2005) that soya can play a direct role in alleviation of world hunger. The crop is an easy-to-grow rotation crop for the millions of hectares in cereal and root crop production. Farmers need to rotate crops to break disease and pest cycles and to maintain soil fertility, and the rotation crops need to be profitable. There are, in some cases, other options for rotation crops, but soybean can be a good choice especially when other legumes are subject to heavy insect and disease pressures and where there is a clear market link from the grower to the industry. Soybean is one of the few choices where major expansion in production area might be possible because of the crop's demand in the vegetable oil and feed sub-sectors, unlike the market for other legumes with food-only uses.

Economies of scale encourage large-scale cultivation. Newell (2009) presented a case study of the role of large Argentinian agri-business companies that cultivate and export transgenic crops, drawing on interviews with public-sector and private-sector actors in biotechnology in Argentina. Newell noted that large-scale transgenic soyabeans cultivation was established in 1996, and made up almost half of Argentina's agricultural output in 2002-03; 98% of this was exported, in the form of beans, feed meal and edible oil.

The economic viability of soya production is determined by the commercial utilization of both its sub-products, meal and oil, which, respectively, account for about two thirds and one third of the crop's economic value. Soyameal occupies a prominent position among protein feedstuffs used in the production of feed concentrates, while soyabeans oil is the single most important vegetable oil.

High investment costs involved in soyabeans cultivation, storage, crushing and marketing have fostered vertical integration within the sector as well as horizontal operations across commodity sectors and countries. A review of agricultural commodity markets in 2009 (FAO 2009) noted the distortion of otherwise normal market forces that has resulted from government subsidies for biofuel feedstock. Market forces that regulate the complex supply chains in Figure 1 will influence the rate at which transgenic soyabeans may be introduced

for cultivation in EU, if permitted. At that stage, the cost of managing the coexistence of transgenic with conventional crop may constrain the rate of adoption. This constraint is less severe in the case of soyabeans than in the case of maize because, as pointed out in a report from the Plant Research Institute, Wageningen (Bindraban et al, 2009) co-existence in the field is easily achieved, because soya is a self-pollinator, with outcrossing levels on average in the order of 1%. This implies that adventitious transgenic presence due to outcrossing declines to close to zero at 2-5 meters from a transgenic field.

Another form of constraint which may restrict adoption is public concern about land use and biodiversity. In Brazil the Roundtable on Responsible Soy (RTRS, 2010) has been established with the aim of addressing the various environmental, social and economic issues surrounding soyabean production. It has recruited members from across the supply chain including producers, suppliers, buyers and NGO's who are working together to establish an international standard for sustainable soy production; some draft Principles and Criteria have been published, covering legal compliance, labour conditions, community relations and environmental responsibility, together with some general recommendations regarding water conservation and other aspect of agricultural practice. An equivalent forum, with an agenda aligned with the quite different preoccupations of Europeans about biotechnology, may be needed to enable all parties to recognise and share the benefits of transgenic crops.

With the exception of ethanol production from sugar cane in Brazil, production of biofuels is currently not economically viable without subsidies. The USA spent US\$5.8 billion on biofuel subsidies in 2006 while the EU spent US\$4.7 billion. As illustrated in figure 1, the biofuel sector is a relatively minor component in the global supply chains for soya, but EU spending that has the effect of diverting soyabean oil to non-food use will add to the cost pressures on animal feed.

Regarding the growing concern that reliance on glyphosate is leading to emergence of resistant weeds, seed providers are seeking to introduce soyabeans tolerant to alternative herbicides. If EU authorities continue to delay approval of transgenic traits newly introduced for producers of soyabeans elsewhere, EU livestock farmers will continue to be denied access to the most competitively priced feeds on world markets.

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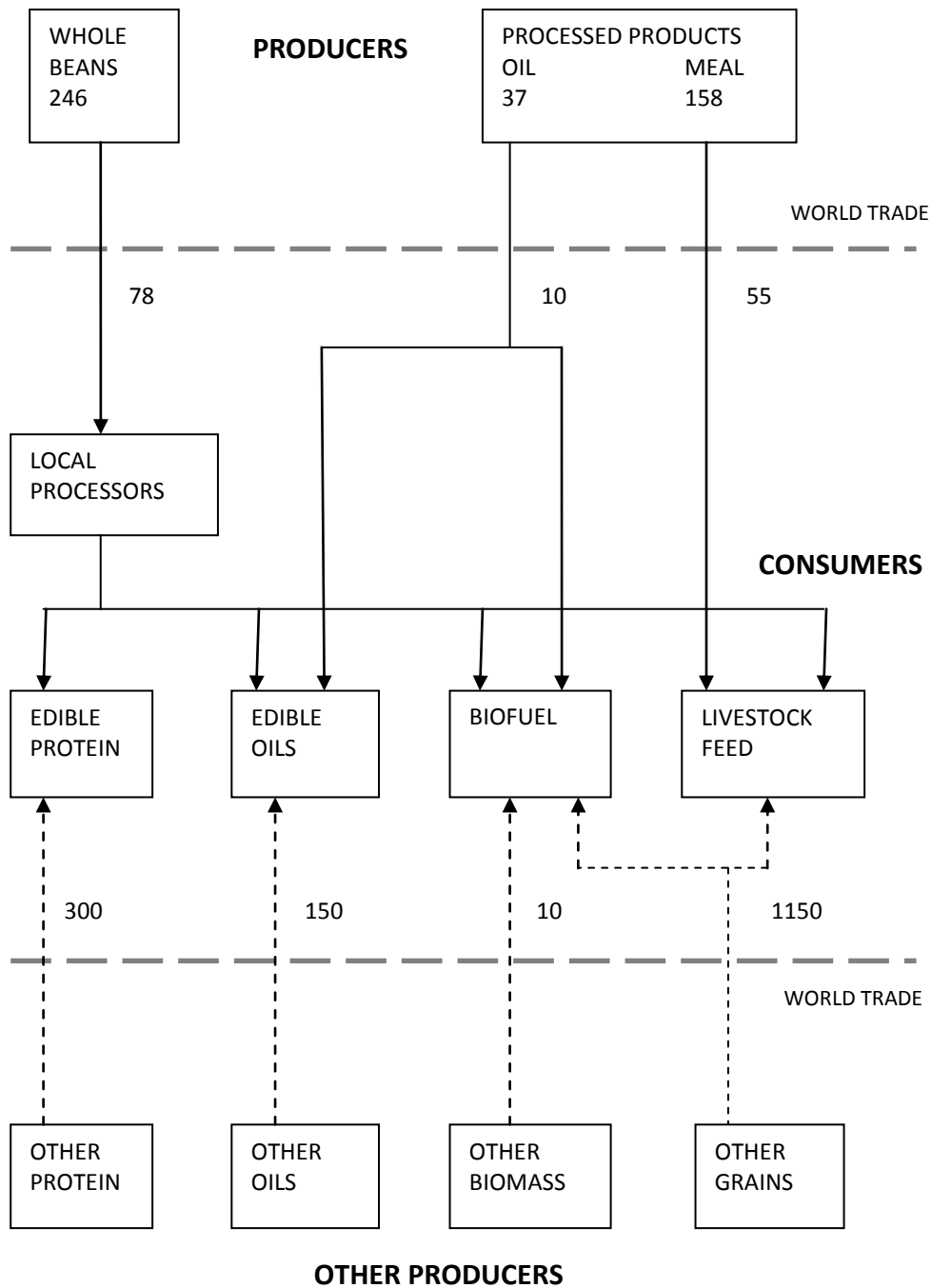
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Figure 1 – Supply chains schematic



Units: Million metric tonnes per year, 2009
 Oilseed data USDA (2009)
 other data FAO (2010), World Energy Council (2007)

Figure 2 – Soyabean and soya oil price trends

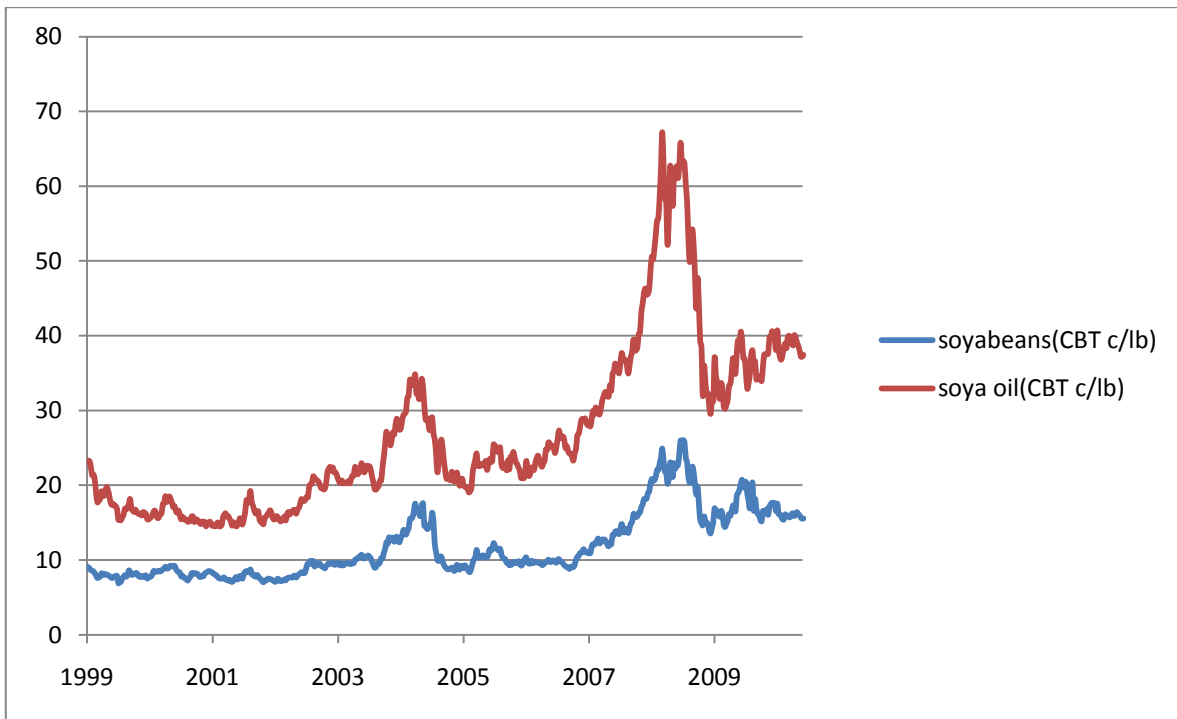


Figure 3 – Soya, maize and crude oil price trends

