Cost-Benefit Analysis of a Traceability and Certification System for Non-Genetically Modified Soybeans: the Experience of Imcopa Co. in Brazil

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Abstract

This paper analyses the economic costs and benefits of a Brazilian soybean crusher as it adapted its production system to sell soybeans and soybean products with non-GM certification. Three fundamental elements were used to guide the analysis: the information asymmetry; the bounded rationality of the actors; and the company's growth. The possibility of selling non-GM soy and soybean products on the international market has provided Imcopa with access to an even broader commercial network of feed and food products. This has given the company a better outlook on why it should diversify its activities and intensify its pace of growth.

1. Introduction

Importação, Exportação e Indústria de Óleos Ltda. (Imcopa) was Brazil's first soybean crusher to implement a soybean traceability and certification system for non genetically-modified (non-GM) soybeans and soybean products, in 1998. As a pioneer, the company has expanded rapidly over the past decade, with invoicing up from US$ 70 million in 1998 to nearly US$ 1.3 billion in 2008. Growth came not only from the emergence of a profitable non-GM food market niche, but also from the identification and exploitation of new production opportunities related to that niche.

This article aims to present a cost-benefit analysis of Imcopa's experience in implementing a traceability and certification system for non-GM soybeans and soybean products. Our analysis is rooted in a theoretical framework that goes beyond a mere economic and financial statement for a single company seeking to optimise its resources in an equilibrium environment. We set out to shed light on a medium-size, family-owned company's decision-making process – in a market dominated by major transnational – regarding investments to create a novel market niche both domestically and for its exports. Our approach discusses four major aspects: the environment of uncertainty in which companies operate; the limited rationality of players in decision making; the asymmetry of information arising from the first two aspects; and the production opportunities identified by the firm based on the entrepreneur's own image of the environment in which he operates.

The dynamic nature of technical progress, along with conditions of competition, make the indicators used in decision making change constantly (particularly costs and benefits), thus limiting the usefulness of static, balance-sheet based approaches for any given decision. That dynamism also involves decisions both on short-term profitability and on long-term growth, meaning that the costs and benefits of a given decision will be assessed with an outlook towards expanding investment horizons in the ontological sense of capital, that is, its mobility. Our analytical framework thus seeks a dynamic analysis between the costs and benefits of a given investment, in which the parameters for decision making evolve along with short-term and structural changes in supply and demand. These changes are caused mainly by the dynamic nature of technology, by a company's learning process, by the discovery of new opportunities for production and by institutional changes regarding the regulation of technology.

The data collected for this study came fundamentally from interviews with Imcopa's Director of Operations in three different periods: first in 2006, as part of a survey done by the Co-Extra Consortium[1]; and then in 2008 and 2009, in order to update and expand the company's experience in a new situation, as the non-GM soybean market has consolidated both domestically and internationally.

The article has four more sections. Section 2 presents a brief theoretical review relating to a firm's investment decisions under conditions of uncertainty and asymmetry of information, in the specific context of the food market. Section 3 describes Imcopa's profile as a producer before and after the implementation of its system for tracing and certifying non-GM soybeans and soybean products. Section 4 briefly characterises the tracing and certification system and then identifies major cost and benefit factors associated with its implementation. Section 5 presents some closing considerations.

2. Information Uncertainty and Asymmetry in the Food Market

The commercial release of GM soybeans in the US and the EU in the late 1990s gave rise to a period of intense controversy on risks inherent to the production and consumption of genetically modified organisms (GMOs). That controversy was enhanced by the spread of Bovine Spongiform Encephalopathy (BSE) in several European countries, which revealed the questionable and unaccountable criteria used by expert committees responsible for analysing, managing and communicating food-related risks (Miller 1999; Millstone and van Zwanenberg 2001).

The rejection of regulatory agencies' risk analyses by consumer and environmental organisations in several European countries led governments to hold back approval of GMOs. EU-wide harmonisation policies adopted from 1992 to 1995 were destabilised by *de facto* moratoria declared by certain governments against the adoption of GMOs in their countries (Morris & Adley, 2000)[2]. Likewise, in Brazil, an attempt by the National Technical Biosafety Commission (CTNBio) to rush through the release of Monsanto's GM soybeans in 1998 was held back by court injunctions obtained by the Brazilian Consumer Defense Institute (IDEC) and Greenpeace Brazil. During the next seven years, as ensuing litigation proceeded through courts, Brazil experienced large-scale debates over the risks and benefits to farmers and consumers of adopting GM soybeans[3].

Resistance against the release of GMOs in several European countries and the 2000 approval of labeling rules for food containing GMOs in the EU were decisive factors in the decision by major supermarket chains and food-industry groups to keep GMOs out of their product lines. Actually, uncertainties arising from controversy over the risks and benefits of producing and consuming GM food reflect a contemporary quandary, most prevalent in developed countries, that goes beyond quantitative food security, to qualitative safety aspects of the food supply. Meanwhile, with the expansion of global trade, particularly within new economic blocs, the harmonisation of plant-health controls has become an enduring and complex problem.

Major retail chains tend to be leading players in the implementation of traceability systems, in order to identify failures in quality control throughout their supply chain as well as to identify responsibilities for any harm caused by shortcomings in their food quality-control systems (Hatanaka, Bain e Bush, 2005). In this context, "third-party certification" (TPC) agents have emerged as important independent players to certify the quality of products offered for sale.

Deaton (2004) states that third-party certifiers provide market signals concerning food quality claims. The strategic role of such signals is to reduce information asymmetry, the importance of which is growing in the perception of societies whose political agenda includes debating the inherent risks of adopting new technologies. According to Loader and Hobbs (1999), the asymmetric distribution of information in the food market gives more information on product quality to sellers than to buyers. This is because food is no longer a commodity whose features can be observed simply by visual inspection. Food products have become a specialty commodity whose quality-related features often can only be perceived when they are consumed. For these two authors, impacts of information asymmetry in the food market can be handled in three, non-mutually exclusive ways. The first solution is to introduce certification and labeling systems to assure product quality and safety firm-by-firm. The second solution is to implement a legal framework to assure labeling and an adequate level of quality control for food. The third solution is to have laws that hold companies accountable for food-safety failures, allowing them to be targeted by civil suits to establish liability and obtain redress. Such measures tend to make companies more concerned about assuring the safety of the food products they market.

These advantages in fact go beyond the distribution and manufacture links in the production chain, to include farmers, final consumers and society at large. Advantages here include: lower production costs and prices for final consumers; higher-quality products and more value added; less chance for fraud by buyers who often make misleading claims about low-quality products; access to new markets; good labour practices including safer working conditions and better wages; enforcement of environmental recovery and preservation standards (Tanner, 2000).

Another important advantage of traceability and certification systems is the chance for agents to identify new production opportunities. The recombination of productive resources required to implement these systems involves the creation of new services, which in turn can allow new market segments or niches to emerge. Along the way, new opportunities identified by agents will provoke a reworking of their own productive resources. The issue of the quality of decisions made by entrepreneurs thus depends on the identification of production opportunities a firm can seize upon, based on the re-organisation of existing resources. A firm's behaviour regarding production opportunities is guided not only by objective facts, but above all by expectations created by entrepreneurs regarding possibilities for growth (Penrose, 2006). In the case at hand, diversification or differentiation of production through traceability and certification systems tends to expand a firm's horizons for growth, while also getting it into new networks of social and economic relations. In this new relational environment, agents' decisions tend to vary based on new elements that influence their own image of the environment and thereby the decision-making process itself (Boulding 1961; Loasby 1976; Callon 1998). To the extent that rationality, or the agents' decision-making process, depends on the environment in which they operate, their positioning along the chain (or multiple chains) of production also tends, in turn, to generate information asymmetries.

3. Overview of Imcopa's Production

Founded in 1967, Imcopa is a medium-sized, family-owned company with approximately 450 employees, located in the State of Paraná, in southern Brazil. The company's soybean crushing capacity is around 2 million tons/year, or 5.5 tons/day, and 98% of its output is exported. It owns three soybean processing facilities, two of them located in soybean production areas and the third about 70 km from the country's main soybean export port (Paranaguá).

The crushing of 2 million tons/year yields approximately 1.5 million tons of soybean meal, with 44-53% protein content. 24% of that output (360,000 tons) is high-protein meal (60-70%). It also produces around 240,000 tons of refined oil, 20,000 tons of lecithin (emulsifier), 230 tons of tocopherol (a precursor to vitamin E), 28,000 tons of molasses extracted from soybean meal and 7,000 tons of ethanol, obtained through fermentation of the molasses (Table 1).

Imcopa estimates total world demand for lecithin at around 50,000 tons/year, meaning its 20,000 tons produced in 2008 accounted for 40% of global consumption. Only 20-22% of the lecithin is sold on the domestic market. Imcopa meets a major share of Nestlé's demand for lecithin, and 100% of Kraft's demand, in addition to sales to other major food companies. As for soybean oil, it was the first company in Brazil to launch non-GM certified oil. Approximately 99% of the oil and 97% of the meal is exported. Imcopa exports to some 250 clients[4] in more than 30 countries[5].

Table 1 – Soybean Products, Imcopa, 2008

Products	Total Annual Production
Processed soybeans	2.0 million tons
Meal	1.5 million tons
High-protein meal	360,000 tons
Refined oil	240,000 tons
Lecithin	20,000 tons
Fatty acid (tocopherol)	230 tons
Molasses	28,000 tons
Alcohol	7,000 tons

Source: Traver (2008)

Imcopa works with about eleven co-operatives, who supply 80% of the soybeans bought by the company. Six co-operatives provide about 70% of the volume used by the company. Imcopa also relates to other partners, including individual farmers and wholesalers who do the segregation of non-GM soybeans. The company's location in Paraná, Brazil's largest soybean producing State with around 20 million tons/year provides Imcopa with logistical advantages such as proximity to production and the presence of adequate infrastructure to move raw material to the processing facilities. It also enjoys easy access to the main export outlet, at the Port of Paranaguá.

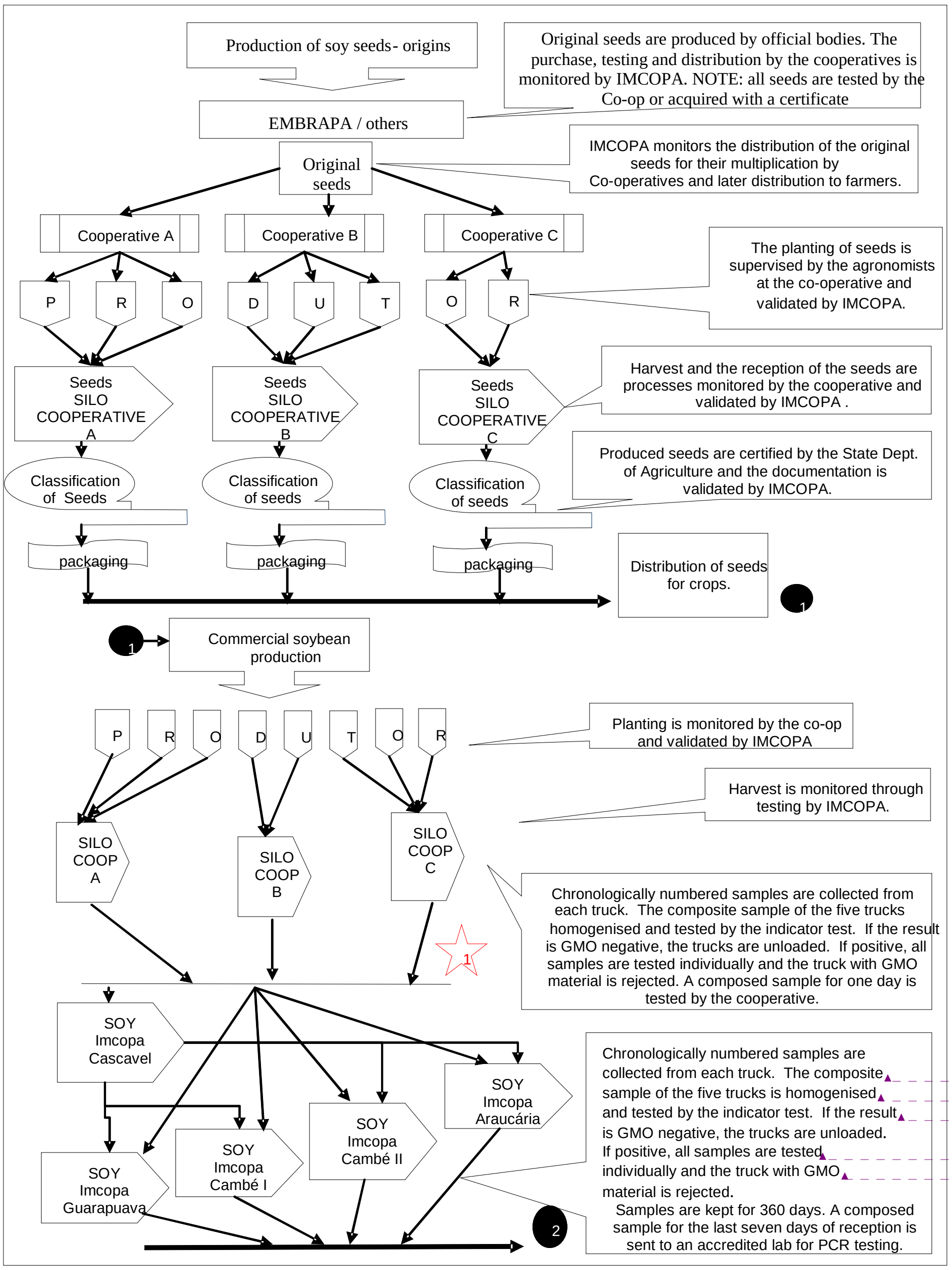
In addition, during the period of most heated debate on advantages and disadvantages of adopting GMOs in Brazil (1998-2005), the State of Paraná strongly resisted the approval of GM crops. This involved the State government's control and enforcement activities to prevent the illegal planting of GM varieties, as well as commercial strategies by several co-operatives seeking to create a market differential by implementing their own systems for non-GM soybean identity preservation and certification6. When the decision was make to implement the traceability system in 1998, Imcopa was well positioned geographically near large supplies of non-GM soybeans, available for virtually no premium at all to local farmers. This gave Imcopa large profits during the initial phase of implementation of the non-GM soybean certification system, as we shall see in the next section.

4. The Traceability and Certification System

Imcopa's traceability and certification system was set up in 1999 by the US company Genetic ID, specialised in GM analysis and detection. That same year, a joint venture between Genetic ID and Law Laboratories – focused on quality control and the legal compliance of food products – gave rise to the Cert ID Ltd. company, specialised in certification and the implementation of non-GM traceability and certification systems, which then began certifying Imcopa's non-GM products.

Imcopa's traceability and certification system is made up of four stages related to the successive activities of soybean production and marketing: i) production and multiplication of seeds; ii) production of grain; iii) industrial processing; and iv) delivery for export. These stages are depicted in Figure 1.

Figure 1 – Flowchart of Imcopa's Traceability and Certification System for Non-GM Soybeans and Products



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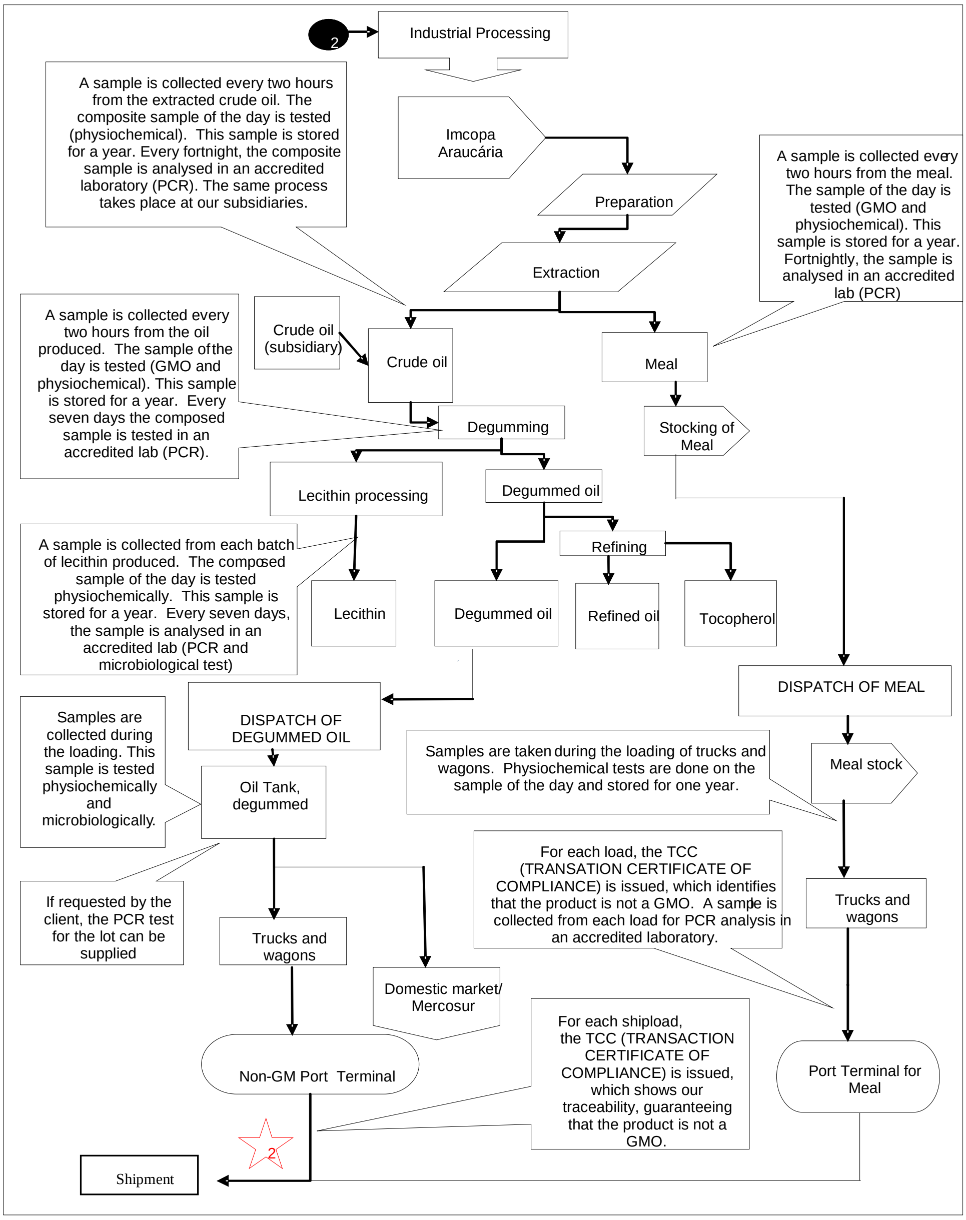

Source: Traver (2005)

Note: ☆ = Critical point in the system.

4.1 Critical Points in the Control System

From the purchase of grain to loading in the port, there are two critical control points to assure the identity preservation of conventional soybeans and products. The first, and most critical of the two, is the reception of grain at the collection and storage facilities in the State's interior region. There are significant risks here because farmers began planting part of their land with GM soybeans after they were legalised in 2005, thus increasing the probability of blending with non-GM grain. For farmers who grow non-GM soybeans, the fact that they are widespread on neighbouring farms tends to increase the risk of blending with conventional soybeans. This is because neighbouring farmers often share combines, which become a vector for the contamination of non-GM grain.

Once the grain has been purchased from farmers, the port terminal is the second critical point. Despite the policy of control over GM soybean shipments adopted by the Paraná State government in the Paranaguá Port, Imcopa does not assume that the port authorities' procedures are reliable enough, due to the huge flows of raw material from various regions of the country. To minimise risks of contamination of its products in the port, Imcopa has an officer of its own at each of the two terminals (Center-South and Cotriguaçu) it uses to store its shipments before loading. Those company employees are hired exclusively to monitor the movement of conveyor belts and the appropriate cleaning of the silos.

4.2 Traceability and Certification Costs

The costs involved in implementing and maintaining traceability break down into four categories: infrastructure investment; personnel training expenses; spending on analyses (GMO tests); and the payment of premiums to farmers for growing non-GM soybeans.

For Imcopa, infrastructure investments were minor, due to the company's choice to work exclusively with non-GM products. It therefore did not have to invest in new silos or manufacturing facilities. Investments were limited to a laboratory equipped with a grain processor to carry out GM identity tests, which cost little and are accounted for as part of the company's general expenses. The second category, for training of personnel, was done by the certifying company. The third category involves operating costs and the purchase of test kits to control identity preservation through the stages of cultivation, transportation, processing and storage. The fourth category has to do with the expansion of the area planted to GMOs in Brazil, particularly in the State of Paraná, following December 2005, when the federal government finally managed to push through a law to impose the commercial release of GM soybeans. Moreover, the Paraná State government's policy of banning the dispatch of GM soybeans through the Port of Paranaguá was overturned by a September 2006 court order, meaning that all the port's berths could now load GM soybeans.

For several years after the system began to operate, therefore, Imcopa only occasionally paid premium prices to rural co-operatives for non-GM soybeans, due to the abundance of raw material available in the State of Paraná[7]. It was only in

2006 that premiums paid to farmers became standard clauses in supply contracts. This also has to do with the fact that soybean crushers are an oligopsony.

In 2005, ten major crushers purchased 70% of Brazil's soybean harvest. Specifically in Paraná, where 23% of the country's soybean crushing facilities are concentrated, Imcopa is the leader in crushing capacity, with 35% of the State's installed capacity (Abiove, 2005). In those circumstances, processing companies – which more than just crushers are often global soybean traders[8] – gain significant bargaining power over co-operatives and individual farmers. This oligopsonic power had allowed those companies to retain the bulk or even the entirety of premiums paid by importers for non-GM products, until the mid-2000s.

In 1999, the total cost of implementing the Imcopa system was around US$ 900,000. Of that, some US$ 650,000 (72% of the total) went to traceability activities. Imcopa paid the equivalent of US$ 250,000 for certification. In that year, Imcopa processed about 250,000 tons of soybeans, which means a cost of US$ 3.60/ton (Traver, 2006).

In 2006, the company crushed about 2.8 million tons of soybeans, and paid US$ 2 million in traceability and certification costs, an average of US$ 0.70/ton of soybeans. Of that total, 75% went to running the traceability system (US$ 1.5 million), while the other 25% covered certification costs. Thus from 1999 to 2006, there was a significant 80% reduction in the unit cost of the company's traceability and certification system. According to Imcopa's director, this cost reduction has to do mainly with gains in scale and with the company's learning curve in running the system. Inclusion of US$ 7/ton in premiums paid to farmers in 2006, however, raised the total unit costs for the system to around US$7.70/ton of processed soybeans (Traver, 2008).

In 2008, total costs for maintaining the system rose to US$ 22/ton, due to two factors: higher costs with traceability and certification (from US$ 0.70/ton to US$ 2/ton) caused by the expansion of GM soybean plantations in the proximities of non-GM areas and by the need for more quality control to dispatch shipments through Paranaguá Port; and, most particularly, the tripling of premiums paid to farmers, from US$ 7/ton to US$ 20/ton. Table 3 describes the evolution of Imcopa's spending on its traceability and certification system, in the three years when data was collected (Traver, 2009).

Table 2 – Imcopa's Traceability and Certification Costs - 1999, 2006 and 2008

Cost item	Implementation (1999)		Maintenance (2006)		Maintenance (2008)	
	Total					
	US$	US$/ton.	US$	US$/ton.	US$	US$/ton.
Traceability	650,000	2.60	1,500,000	0.50	NA	1.70
Certification	250,000	1.00	500,000	0.20	NA	0.30
Total	900,000	3.60	2,000,000	0.70	4,000,000	2.00
Premium[1]	NA	5.00	20,000,00	7.00	40,000,000	20.00
Total + Premium	NA	8.60	22,000,00	7.70	44,000,000	22.00

Source: Traver (2006, 2008).

Note: [1] The value of premiums paid to farmers by Imcopa in 1999 varied depending on the contract negotiated with each co-operative; therefore not everyone received US$ 5/ton. NA = Not Available.

4.3 Benefits of the System

Here we look at three aspects of the benefits of the traceability and certification system: (i) higher turnover for the company, (ii) the profitability accrued from premiums paid by international buyers for the sale of non-GM soybean products and (iii) the diversification of the company's activities as a result of newly identified production opportunities.

4.3.1 Financial Benefits

Premiums paid for non-GM soybean products depend on each year's market conditions. Non-GM lecithin brings in the highest premium, at US$ 1,000/ton in 2006. After falling more than 50% in 2007 and 2008, this premium is expected to return to its 2006 values in 2009. Fatty acid is the product with the most unstable demand. In 2006, it was sold with premiums of up to US$ 4,500/ton, about ten times more than the market value of the non-certified product. At other times, though, this market nearly dries up with almost no consumers, as was the case in 2008 (Traver, 2009). The production of crude and refined soybean oil, meanwhile, provides no benefits at all from the non-GM traceability and certification system, since it is sold at no additional premium (Table 3).

Table 3 – Average Premiums Paid and Received by Imcopa on the sale of Non-GM Soybean Products, 2006/2009

Products	Premiums US$/Ton			
	2006	2007	2008	2009**
Raw soybeans*	7	12	20	NA
Meal	8	14	25	35 - 40
Crude and refined oil	0	0	0	0
Lecithin	1,000	400 - 500	500 - 600	1,000
Fatty acid (tocopherol)	0 – 4,500	NA	NA	NA

Source: Traver (2006 and 2008), Oliveira (2006) and Campos (2006)
* Premiums paid by Imcopa to farmers.
** Forecast.

We can estimate the company's profitability[9] specifically related to its traceability and certification system in 2006 and 2008 in terms of the premiums paid on the sale of meal and lecithin. In 2006, Imcopa sold around 2 million tons of meal, with an average premium of US$ 14/ton. It sold 25,000 tons of lecithin, with a premium of US$ 1,000/ton. This brought in a total annual added value of US$ 53 million for the company, while total costs for certification and traceability were around US$ 2 million. In this sense, the company's profitability concerning the adoption of non-GM controls was around 96%. Even so, additional costs to pay farmers' premiums hiked the system's total operating expenses to US$ 22 million, reducing profitability to the order of 58%. In 2008, increased premiums paid to farmers substantially reduced the company's profitability from 58% to 16% (Table 4).

The largest benefit obtained by Imcopa with its certification program came in its growth, with the company's productive capacity expanding eight times, from 250,000 tons/year in 1998 to 2 million tons/year in 2008. Meanwhile, turnover grew by a factor of 18, from US$ 70 million in 1998 to approximately US$ 1.3 billion in 2008. The most intense period of growth was from 1998 to 2003, when turnover grew 328%. In the following years, turnover continued to grow but at lower rates. From 2003-2005, the company grew 116%, from 2005-2006 another 53% and from 2006-2008 by 30% (Table 4). That rapid rate of growth led Imcopa to become the fifth largest soybean processer in the country, and number one in Paraná.

TABLE 4 – Imcopa's Yearly Turnover and Profitability: 1998/2008.

Years	Turnover	Total Value of Premium Received (Meal + Lecithin)	Total System Cost (Traceability + Certification)		Profitability	
			Without Premium	With Premium	Without Premium	With Premium
1998	US$ 70 million	NA	NA	NA	NA	NA
2003	US$ 300 million	NA	NA	NA	NA	NA
2005	US$ 650 million	NA	NA	NA	NA	NA
2006	US$ 1 billion	US$ 53,0 million	US$ 2 million	US$ 22 million	96%	58%
2008	US$ 1,3 billion	US$ 47,5 million	US$ 4 million	US$ 44 million	92%	16%

Source: Gazeta Mercantil (2005), Gazeta do Povo (2006) and Traver (2006 and 2008).

4.3.2 Production Opportunities

Imcopa's main motivation for implementing the identity preservation system for non-GM soybean products was demand from major food corporations such as Nestlé and Kraft Foods, eager to avoid having their products labeled "GM" in Europe. This situation allowed Imcopa to negotiate a premium price for certified lecithin from non-GM soybeans that was five times the going market price. Imcopa was thus assured not only a rapid return on its investments, but also a high rate of profit as it operated the system we have just described.

Since lecithin is a byproduct of oil production, all stages in the process had to be traced in order to certify each of the products. The company therefore started seeking clients abroad for its non-GM meal and oil. In the late 1990s, although there was significant demand for non-GM products, particularly in Europe, it was hard for Imcopa to find consumers willing to pay premiums for certified non-GM products. This market segment grew slowly. For its soybean meal sales, Imcopa earned virtually no premiums for certifying this product during the first year the traceability system was in operation. In the second year, the company managed to differentiate prices on the export of 60% of the meal it processed. It was only in the third year of operations with the system that Imcopa earned premiums on 100% of its meal production, ranging from US$ 3 to US$ 4/ton.

As it sought out market segments for higher value-added products, however, the company began to identify new production opportunities based on differentiating the protein content of its meal for more specific markets, such as fish food. Soybean meal with 40-50% protein has such a high sugar content that, in water, it tends to ferment and create a toxic environment for fish. Extracting the sugar reduces this effect, in addition to raising the meal's protein content, thus adding value to the product. At the same time, the molasses byproduct obtained by extracting the sugar is a good substrate for producing ethanol. Soybean ethanol obtained from this molasses can be used in pharmaceuticals, beverages and to produce biofuel. The company also uses its soybean molasses as an energy source for its own production lines, thus reducing costs significantly, since energy is the most important cost item in soybean processing (Traver, 2006).

Imcopa's strategy of adding value to its line of products through non-GM certification thus gave rise to new opportunities to differentiate production by increasing the protein content of its soybean meal. As a result, these more high-quality market segments moved the company to implement complementary quality-control programs that in turn demanded new certifications and new adaptations of its production structure. Imcopa has now earned another ten quality certificates[10], which complement a product-quality differentiation strategy in a market traditionally known for the sale of bulk agricultural and industrial commodities.

5. Conclusion

Imcopa adopted quality-control in order to implement its non-GM soybean traceability system, based on a recombination of existing productive resources, and in so doing lowered the costs of both implementing and operating the system. Together with the high premiums it initially earned on non-GM lecithin sales and later on its non-GM soybean meal, with no need to pass part of the profits on to farmers, in the system's early years Imcopa maintained quite a high level of profitability.

Considering this drive for short-term returns on investment, the economic feasibility of maintaining non-GM soybean traceability and certification systems capable of sustaining the coexistence of GM and non-GM crops depends above all on the presence of markets willing to offer a price differential attractive to all players involved in the production chain.

On top of the extraordinary earnings from its certification of non-GM products, this product differentiation based on a recombination of the company's own resources revealed new production opportunities and created previously non-existent market niches for soybean meal. Actually, production opportunities arising from the sale of non-GM soybeans are mainly concentrated in the grain processing stage, as a function of the company's own operational environment. In Imcopa's case, the expansion of its involvement in global food and feed markets allowed it to become part of a much more complex network of commercial and production relations. In this new environment, market niches that emerge for products with higher value added allow a medium-sized, family-owned company like Imcopa to expand its share in a market traditionally known for the sale of commodities and controlled by major transnational corporations.

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[1] Co-Extra (GM and non-GM supply chains: their Co-Existence and Traceability). European FP6 Research Program.
[2] In 2000, the EU required labels for food with over 1% of its content consisting of GMOs (Regulation 49/2000). In April 2004, that limit was lowered to 0.9% (European Union, 2003).
[3] The legal deadlock was removed with the new 2005 Biosafety Law in, which permanently legalised illegal GM soybean crops, which were widespread mainly in Rio Grande do Sul. The illegal spread of GM soybeans in that State was facilitated by its common border with Argentina, where they were widely used and from where

many growers smuggled seeds into Brazil. On this process, see Pelaez and Silva (2009) and Pelaez (2009).

[4] The main client companies are Nestlé, Kraft, Unilever, Porters, Grampian, Amadori, Martini, Danone, Carrefour, Tesco, Asda, Agravis, Ewos, Mitsubishi, Nutreco, Solae, Cargill, Bunge, Barry Callebaut, Fenaco and Degussa.

[5] The main countries are France, Germany, Belgium, Holland, Denmark, Norway, Finland, Sweden, Switzerland, Austria, UK, Scotland, Ireland, Italy, Greece, Japan, Korea, New Zealand, Australia, Argentina, Chile, Uruguay, USA and Canada.

[6] On this process see Pelaez and Albergoni (2004), Brehm and Pelaez (2008) and Nascimento and Pelaez (2008).

[7] From 2004 to 2006, the three rural co-operatives in Paraná that had implemented their own non-GM soybean traceability and certification systems reported paying an average of US$ 4 to US$ 5/ton (Pelaez et al., 2006).

[8] Most notably the multinational traders Cargill, Dreyfuss and Bunge.

[9] Profitability was calculated as – (Total Value of Premium – Total Cost of Traceability and Certification System)/(Total Value of Premium). The Total Value of the Premium was calculated by multiplying the volume of soybean meal and lecithin sold (in tons) by their respective premium values, in dollars.

[10] ISO 9000; ISO 14000; Hazard Analysis and Critical Control Points (HACCP); Good Manufacturing Practices (GMP); GMP-Animal Feed; Kosher Certificate; Halal Certificate; Salmonella-free Program; Special Granulometric Control Program; Agricultural Sustainable Production Certificate (Pro-Terra).