INRA SCIENCES SOCIALES

N° 5-6 – NOVEMBER 2006

RESEARCH IN ECONOMICS AND RURAL SOCIOLOGY

GMO and non-GMO soybean chains: What conditions for a possible coexistence?

The European Union has enforced a regulation with the objective of managing voluntary dissemination of genetically modified organisms (GMO) in the environment. Member States can make possible the coexistence of GMO and non-GMO chains to ensure producers' and consumers' freedom of choice faced with produce that comes or does not come from genetically modified organisms. In the research presented here, we analyze the conditions of such coexistence and the chains' abilities to manage two separate issues, from seed to fork.

To ensure the coexistence of GMO and non-GMO chains and preserve product identity all along the food chains, European and national regulations include several sections:

- Supervision of GMO crops and their spread over the territory
- Compulsory labelling for products, the content of which is higher than the 0.9% (and 0.5% for non-authorized GMO) threshold of "adventitious presence", and a traceability obligation for GMO products toward human food and animal feed, on top of the general obligation of traceability (178/02/EC).
- Systems of public control over the pertinence of information written on products sold and respect for the obligations of documentary traceability with GMO operators, with an obligation imposed on biotechnology firms to provide identification and quantification methods for GMO.

Research conducted within the Co-Extra project[1] focuses on the modalities of this coexistence in various chains and European countries. Here we limit ourselves to presenting the results regarding soybean used for animal feed.

Coexistence systems

Particularly since the ban on animal meat and bowl meal in 2000, soybean has represented the main source of vegetable proteins for cattle. It either comes from national production (in low quantities), or from imports, as seeds and soybean cakes, from Argentina, Brazil and to a lesser degree from the United States. These three countries have adopted transgenic glyphosate (the commercial name being Roundup Ready) resistant soybean crops. This raw material "GMO soybean seed" and all by-products and ingredients resulting from processed seeds are allowed to be imported and traded inside the European Union (EU). Coexistence thus applies to Europe, even though GMO soybean production is not permitted there: around 2/3 of the soybean cakes used for animal feed were GMO-based in 2003.[2] To define the modalities and economic consequences of GMO and non-GMO soybean coexistence, we must successively examine the different chain links, from production areas to consumers (Bourgier et al., 2006).

***As regards soybean production*,** Brazil is the main supplier of non-GMO soybean in France. Regarding contamination risks, the non-GMO soybean crop involves systems, which generate additional costs in relation to GMO soybean production (seed certification, cleaning of crops and transportation equipment, sampling, tests). Up to now, they have remained low: in the case of Brazilian soybean from 0.24 to 0.8 €/ton, that is to say less than 1%.[3] However, if we want to analyse the producers' interest in cultivating non-GMO soybean, it is also necessary to take into account the potential productivity loss linked to the non-adoption of transgenic crops.

***Regarding importation*,** international trade and shipping are provided by a few operators (ADM, Bunge, Cargill, Dreyfus) who have integrated grinding downstream. To meet their clients' demands, particularly European and Japanese clients, these firms have implemented Identity

[1] This research work is part of an integrated project (contract 007 158) financed by the European Commission (Sixth framework programme under the food quality and safety priority). It is under the supervision of Yves Bertheau (INRA). Website: www.coextra.eu

[2] See Agreste (2003) - Surveys on raw materials used in the manufacture of compound food for farm animals 1991 and 2003.

[3] Pelaez, V. et al. - Soja trangenica versus soja convencional : uma analyse comparativa de custos e beneficios. Cadernos de Ciencia & tecnologia, Brasilia, vol.21, n°2, pp 279-309, mayo/ago. 2004.

Preservation (IP) systems with requirements in terms of production, segregation and monitoring throughout the chain (factories and harbours dedicated to non-GMO produce, cleaning of transport means, monitoring at off-loading breaking points, and the use of certification bodies). On this basis, importers provide a segmentation of soybean cakes as regards GMO content of the product and traceability. As regards standard soybean, price differentials depend on the minimum GMO threshold guaranteed and the length of traceability system implemented.

On the level of feed manufacturers*:* three strategies are conceivable: specialization in GMO soybean, specialization in non-GMO soybean or coexistence of both products. Specialization in non-GMO soybean concerns small units (25% of firms in 2003[4]) which cannot use both soybean types for reasons of storage capacity or production channels. For manufacturers processing both types of products (about 60% of firms), coexistence first involves supply inspection operations, then segregation at the factory entrance (unloading pits) and on the production lines. Surveys show that in most cases, no new investments were made in order to manage coexistence, which was most often set up using existing equipment; In general, at the factory entrance, unloading pits are dedicated to non-GMO products, reducing contamination risks but inducing flexibility losses in the operation of equipment. On the production level, the first solution consists in assigning certain industrial areas to non-GMO produces. This helps control contaminations but increases logistics costs and creates threshold effects (non-GMO demand must at least be equal to the dedicated equipment capacity). Other potential solutions are (1) separate production lines, but the purchasing costs of equipment make this solution unrealistic; (2) stopping production lines to guarantee cleaning between free GMO and GMO products, but this solution also proves to be expensive; successive batch production of GMO-free and GMO products, with or without cleaning. Contamination risk is managed by adjusting the equipment used and by the difference in intermediate buffer batches that can bear contamination, between the previous GMO batch and the following non-GMO batch. This solution is most generally adopted.

Additional costs linked to the existence of GMO/non-GMO are very much dependent on the particular situation of each firm. For instance, in a feed processing co-operative plant treating 150,000 tons/year, divided into 42% of non-GMO labelled feed and 58% of labelled feed, additional costs linked to the decision to process both types of products (compared to GMO feed production only) were assessed at about 1€/ton of feed production (among which 60% was attributed to raw material purchase and 40% to coexistence costs, strictly speaking).

On the level of stockbreeders**,** surveys conducted by technical institutes[5] point out that the additional costs are chiefly linked to the cost of non-GMO feed, with coexistence as such generating no strong constraints on the breeding level. At present, given the lack of compulsory labelling for animal by-products sold on the end market, the stockbreeders' decision to order non-GMO feeds mainly depends on the production requirements they are applying. There may be constraints imposed by a public quality label (certain labels or BIO labels), but most often these constraints come from clients, in particular retailers who try to avoid GMO cattle-feed for the reputation of their own brands. As the non-GMO characteristic is one dimension among others in the requirements imposed on these brand suppliers, the potential bonus granted to stockbreeders for such requirements aggregates with the remuneration of all dimensions of these requirements.

A difficult balance to maintain, in the long run?

Up to now, as far as the soybean chain as a whole is concerned, analyses show that coexistence conditions are guaranteed:

- Seeds and soybean cake importers have implemented non-GMO and traceability measures which allow them to offer ranges of products associated to various levels of non-GMO requirements and prices to animal-feed manufacturers.

- Because of uncertainties about the future of non-GMO productions, animal-feed manufacturers have not made any investments to manage segregation. They have mainly modified logistics organization and adopted segregation measures, which generate additional costs linked to the immobilization of existing equipment and to quality controls.

- In France, according to the regulations, since labelling is permitted only on feed and not on the end product, consumer information is supported by private brands (in particular, certain store brands (SB)).

- Additional costs remain moderate. Most of them have been handled by firms and a small part passed on to consumers, with non-GMO characteristics not being used as qualitative differentiation supports, at least in France.

Nevertheless, adaptations carried out by certain firms show strains linked to cost differentials in a competitive sector with low margins. Therefore, even if price differentials in raw material costs may still appear low, some cattle-feed producers who had considered producing only certified non-GMO feeds have modified their production plans to offer less expensive GMO products to their clients. For identical reasons, some retailers who had imposed on breeders higher levels of requirements on imported soybean cakes than those from European regulations (0.5% instead of 0.9%) have revised their requirements in order not to impose more than the statutory constraint of 0.9%.

In fact, today's questions mainly focus on the impacts of GMO crop expansion in Brazil, and their consequences on the availability and production costs of non-GMO soybean. Beyond the effect on prices, and even if the

[4] See Agreste (2003) op. cit.
[5] For instance, the French *Institut de l'élevage* (http ://www.ofival.fr/dei/f715.htm)

threshold enforced is managed by the importers through their range of products, the probability that this threshold is respected decreases with the increase in GMO production areas. In this context, the research carried out in the Co-Extra project has led to identification of certain difficulties for the maintenance of coexistence (Bourgier et al., op. cit.). Put simply, if non-GMO raw-material prices increase (when availability drops), either the firms keep on handling that cost and their profits go down, which might lead to a disengagement from non-GMO chains, or they pass the increase in prices on to consumers and final demand may decrease. In this case, the share attributed to GMO products in their production capacities increases and contamination risks inside factories increase, causing increasing difficulties in maintaining pure products without any further investment.

The maintenance of coexistence, laid down as a principle by the UE, implies avoidance of such dynamics. Several levers can be mobilized in this perspective.[6] We shall explain the arbitrations analyzed in recent economic works, among which the research carried out in the Co-Extra project (see frame).

The labelling issue

All economic works agree on the idea that without labelling pointing out GMO and/or non-GMO characteristics to end consumers, the increase in segregation efforts made in the chains and at the retail level proves to be difficult. Though not implemented yet in France, the extension of labelling regulations to animal products could be envisaged. Some recent analyses show a higher willingness-to-pay by certain consumers for animals fed with non-GMO feed (Noussair et al., 2004; Kontoleon and Yabe, 2006). Nevertheless, as soon as the indication "made from non-GMO feed" is associated with an explicit price differential at the end consumers' level, we may expect a change in demand, with some consumers accepting the price differential and others refusing it. This may lead to a new price / volume balance, about which it is necessary to know whether it helps compensate for the additional costs induced by the level of additional guarantees to be given to consumers (documentary traceability costs, until analytical controls are possible in the case of animal products).

The labelling threshold question

The tolerance threshold of 0.9% adventitious traces, above which labelling is compulsory, results from a compromise between various viewpoints existing at the European level. As far as economics are concerned, it brings into play arbitration between consumers' needs for guarantees and the costs induced by this threshold for segregation and documentary and analytical controls. Furthermore, if we suppose, like Noussair et al. (2004), that consumer acceptability and willingness-to-pay are influenced by that threshold, too low a constraint (i.e. a higher threshold) may deviate some of them from non-GMO products. In these conditions, we show (in Hammoudi et al., 2006) that (i) if the labelling threshold is too low, the non-GMO chain disappears because of direct production and segregation costs; (ii) if the threshold is too high, the fall in demand on the non-GMO market induces a reallocation of industrial capacities in favour of GMO products, which generates a rise in cross contamination risks and imposes additional investments levels which can lead some operators to disengage from the non-GMO chain. Therefore, in this context, we show that the situation in which the market share of the non-GMO product is the biggest is not necessarily that which maximizes the non-contamination probability of non-GMO products released on the end market.

To limit this effect, an area of intervention lies in the differentiation of the tolerance threshold according to the chain level, while at present it homogeneously applies from producers to retailers, without being applied at the level of seeds. From a public point of view, this approach only makes sense if the cuts in the downstream segregation cost linked, for instance, to a more demanding threshold at the level of raw material production, are higher than the additional costs further upstream in the chain. This remains to be demonstrated. However, it is certain that such an approach would modify value-sharing in the chain and would necessarily influence tariff strategies for non-GMO and GMO seeds.

The issue of responsibility and control tools

Regarding the monitoring of compliance with the regulations , public authorities have made the choice of favouring documentary traceability, analytical controls being envisaged at various links of the chains (unloading of raw materials in harbours for instance), or in case of any doubts revealed by documentary controls. As far as liability is concerned, the requirements range from simple recalls to rules imposing the payment of penalties for each infected batch. Some firms carry out self-monitoring, which falls within the scope of commercial relationships between retailers and suppliers. They are carried out in accordance with variable methodologies depending on the case (test frequency, sample size, etc.).

As regards monitoring and liability, the question is to know what types of intervention best favour coexistence. A first point concerns the equilibrium to adopt between public control frequencies and sanction levels in case of contamination. The economic research carried out on this matter seems to indicate that it would be better to impose low sanction levels on the basis of very frequent controls than the opposite (Lapan and Moschini, 2005). A second point concerns the impact of self-monitoring and its possible systematization. In Hammoudi et al. (op. cit.), we show that the obligation to carry out self-monitoring in return for low sanction levels improves coexistence conditions. Subject to a moderate increase in sample costs, an increase in the accuracy of test levels simultaneously increases the share of non-GMO marketed products and the probability of non-contamination of products. However, the integration of these tests into commercial relationships may bring about a modification in the value-sharing between supplier and retailer.

[6] The research for substitutes for soybean in the context of animal feed could be a new matter to discuss. However, this question addresses technology and international-trade dimensions, which go beyond the subject of this analysis.

The research on the soybean chain suggests that, subject to an adaptation of labelling rules, the GMO/non-GMO characteristic may be but an additional vector of market segmentation. Working on this assumption, a potential price differentiation on the end market would make coexistence easier. The problem would be less a matter of maintaining one or the other chain than market-sharing between both types of products. The levers examined above have a direct affect on that distribution.
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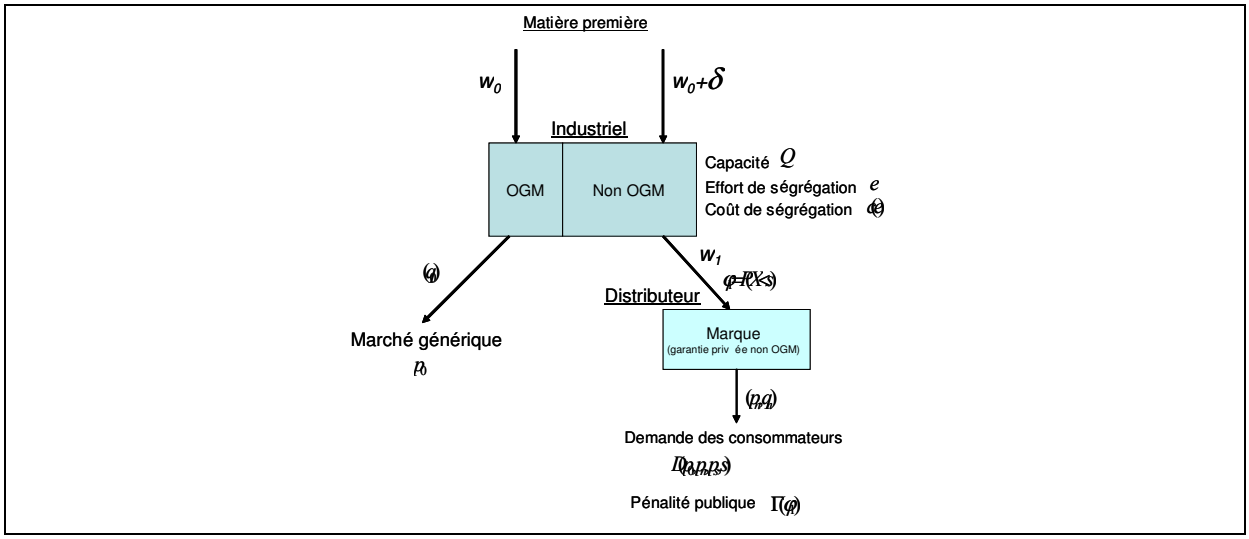
Published by the INRA Social Sciences, Agriculture and Food, Space and Environment
Publishing unit
Editorial Director: Hervé Guyomard – Editor: Didier Aubert (Chief Editor),
Ttranslation and composition: Ariel Gille

Economic modelling of coexistence

Recent economic research was carried out on the impacts of rules and labelling thresholds, as well as on segregation costs and gains (see for instance Bullock and Desquilbet, 2002; Fulton and Giannakas, 2004; Crespi and Marette, 2003; Moschini and Laplan, 2006). The models elaborated in the Co-Extra project continue with this work by studying two approaches: on the one hand, we suppose that consumer demand is influenced by the relative prices of marketed products (non-GMO products (p_0), GMO products (p_n), substitute products (p_s)) and the labelling threshold (s); on the other hand, we consider that cross-contamination risk depends on the segregation effort carried out in firms and that it is higher as the share of production capacity allotted to GMO products increases. On this basis, we analyse the decision of industrial capacities regarding allocation to GMO and non-GMO products (q_0, q_n) according to raw material costs (w_0 the purchasing price of GMO raw material and δ the additional price of non-GMO raw material), segregation efforts (e), and penalties imposed by public authorities (Γ). We deduce the non-contamination probability (φ_1) of the end products, as well as their prices and market share covered by non-GMO product. We also integrate potential tests, at different chain levels and with various detection powers. Therefore, we examine gains and costs associated with the implementation of private self-monitoring in commercial relationships inside the chain.



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ISSN 1778-4379 - N° 5-6 - November 2006