

Case study

Strategies for coexistence of GM and non-GM soy from import to feed processing

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Regulations 1829/2003/CE and 1830/2003/CE have allowed the placing on the European market of GM products in food and feed chains, and have defined their rules of traceability and labeling. For some supply chains, like for soy and its derived products that are used in the production of feed, manufacturers have to face both non-GM and GM production, although there are no labeling requirements for animal products derived from animals fed with GMOs. This study presents the strategies of stakeholders involved in the feed production chain to maintain concurrent production of compound feed with GM and non-GM soy products, by dealing with the coexistence between those two crops. The stakeholders include importers, traders, soy processors, feed processors and retailers. The study shows that many tools are in place to ensure and maintain the current coexistence. However, a profound harmonization of procedures and methods at a European level should be encouraged.

Keywords: GMO / coexistence / segregation / Roundup Ready soybean / carry-over / feed chain / traceability / admixture

INTRODUCTION

The European Union has been legislating on GMOs in order to ensure the protection of human and animal health, and to develop new traceability and labeling rules for safe GMO products in the food and feed chains (Regulation [1829/2003/EC](#) and Regulation [1830/2003/EC](#)). Labeling of food and feed products consisting, containing or produced from authorized GMOs is required, even if the newly introduced DNA or protein can not be detected in the final product. Only in cases where the content on an ingredient basis is below a threshold of 0.9%, provided this presence is adventitious or technically unavoidable, the labeling requirement is not necessary. The interpretation of the terms “technically unavoidable” and “adventitious” is however still under discussion (Waiblinger et al., [2007](#)).

Implementing measures to support the labeling and traceability framework has been done by the stakeholders of all Member States through public and private safety

controls of GM food and feed products. In this new legal framework, the monitoring of the GM crops in the environment is required, and is made possible thanks to the GMO authorization procedure, which obliges the biotechnology companies to provide a description of identification and detection techniques for the authorized trait.

Furthermore, the principle of coexistence has also been introduced into the EU, which means that cropping systems with and without GMOs may be used in parallel (Commission Recommendation [2003/556/EC](#)). It is up to the individual EU member States to decide whether and how to regulate this coexistence. Within this framework, however, the major focus is on the regulation of the cultivation of crops, as coexistence of GM and non-GM crops requires segregation in the field to prevent cross-contamination (Devos et al., [2005](#); Messéan et al., [2006](#)). However, this segregation should be maintained clear to the consumer, and will therefore affect the entire supply chain. In some cases, segregation systems have already been in place at the level of harvest, storage and transport for several years. For instance, this is the case

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for specialty grains such as high-oil corn (Shoemaker et al., 2001).

Globally, soybean production is increasing rapidly, driven mainly by the demand for soybean meal from the animal feed industry, as it is rich in proteins (Van Gelder and Dros, 2002). Since the authorization to import genetically modified soy into the EU in 1996, both GM and non-GM soy have been used in feed products. Soy, as raw material, is mainly imported from third countries: soybeans and soybean meals are shipped from Brazil, Argentina, and to a lesser extent from the United States. Especially in Brazil, the cultivation of GM soy is increasing (James, 2006). In order to meet the needs of the market, traders in Europe have initiated the import of non-GM soy products, especially from Brazil. Consequently, the risk of admixture of non-GM soy with GM products originating from this country rises (Gryson et al., 2007). Therefore, at the different steps of growing, shipping, import and use of soybean products in feed supply chains, measures to maintain the coexistence and the avoidance of admixture need to be taken.

Investigations of the tools and methods to ensure coexistence further in the food and feed chains, at all stages, are few (Gryson et al., 2007; Oehen et al., 2007), but are expected as an outcome of the EU-funded Co-Extra project¹. In the present study, different strategies are discussed which are or could be used by the different stakeholders in the feed chain to enable and ensure the coexistence of GM and non-GM soy.

RESULTS AND DISCUSSION

Overseas transport

The import of non-GM soy ingredients for feed production is done by a small number of stakeholders. In order to meet the requirements of European and some Asian countries (*e.g.* Japan), these stakeholders (importers, traders, processors) have introduced a hard Identity Preserved (IP) program. These stakeholders usually have been assisted by third parties to introduce and validate such a program. By this system, the identity of the soy products is preserved at the different steps of the supply chain, allowing a maximum of 0.1% GMO in the non-GMO product. Segregation and monitoring activities include the use of specialized, dedicated processing companies (*e.g.* for soybean crushing), dedicated harbors, and different cleaning and control activities. This has resulted in many different written procedures for the purchase, sale and the storage of GM and non-GM products.

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Vessel unloading

Once arrived in Europe, goods are unloaded from sea-going vessels with conveyer belts to store and trans-ship them on lighters and trucks. At the time of delivery of a batch of non-GM soy, a specific procedure for the storage and transport is followed. This procedure is checked by an independent accredited inspector, who makes a full report of the procedures, verifies all documents, and takes a sample for GMO analysis. During the entire transportation of ingredients, trucks and other conveyances used to transport non-GM products should be dedicated for that purpose, and inspected and cleaned before loading. Inspection and cleaning records are maintained. To avoid carry-over on the conveyer belt, and to guarantee the segregation of GM and non-GM products, the belts are flushed with non-GM products. The resulting product is stored with a specific label. The use of conveyer belts instead of redblers or elevators reduces the dead time and prevents carry-over. Moreover, these belts allow easy visual inspection. The inspections, together with the rinsing procedure, assure that the admixture of GM and non-GM products is avoided.

Silo storage

The different non-GM feed ingredients are stored in different silos. Every cargo is stored into a different silo. According to the hard IP program standards, all storage facilities and loading and handling equipment needs to be inspected and cleaned before the reception of non-GM products.

Transport

Transport of these products from the importers to their clients (feed manufacturers for instance) is mainly done by lighters and trucks. Similar procedures exist for the charge/discharge of lighters and trucks, taking into account the cleaning of compartments and transportation tools, the conformity of the products and the transfer of traceability documents. All procedures are again checked by an independent inspector.

As a result, different soy products are obtained, with a different GM purity and traceability level. The threshold for GMO presence, together with the rigor of the traceability system, will impart an extra premium for the identity-preserved non-GM products, compared to their GM counterparts.

Traceability

The 1830/2003/EC Regulation requires the labeling and traceability of GMOs from field to end product. The labeling rules are mainly checked at the level of the end product. In every case the labeling system relies on the traceability of the GMO ingredients either to prove that a detectable but lower than 0.9% GMO presence is effectively adventitious or in particular cases where the detection and quantification of the GMO compound in the end product is not possible. This could be due to the low amount of the ingredient, the degree of processing of the ingredient and/or the final product, and the presence of PCR-inhibiting components in the feed product.

The traceability of the imported products is based on the use of traceability certificates (TCC). These certificates contain information related to the transported product, *e.g.* the name of the boat, date of arrival, amount of the product, shipper, point of discharge and buyers. This information allows the traceability down to the silo level in the country of origin. When the importer sells part of this batch to a feed manufacturer, a new traceability certificate is made up, which makes reference to the earlier certificate. The client will receive:

- a delivery note containing the name of the lighter, the loading cell and loading number (necessary to guarantee full traceability);
- a copy of the hard IP program certificate established between the importer and the seller of the batch;
- the invoice containing the name of the product and a copy of the certificate of the importer (allows the buyer to check traceability data without contacting the importer);
- the results of the GMO analysis (if asked for).

Contracting

For European feed manufacturers, the import of trustworthy non-GM soy in the supply chain is of utmost importance. Negligence and the introduction of GM products at the importation level may result in the dispersion of these products throughout the entire chain. To guarantee the continuous import of hard IP non-GM products, the importers and traders are obliged to set up contracts with groups of soybean growers, cooperatives or trading companies. This however is a very difficult situation for importers, traders and feed manufacturers. Two difficulties can be mentioned:

- Estimates have to be made several months in advance on the quantities needed and proportions of GM and non-GM products. However, the demand for non-GM feed products may have changed once the soybean

products are harvested and are ready for export from the American countries.

- Recent changes in stakeholders' strategies point out the difficulties linked to acceptance of high segregation costs in a competitive sector that faces low margins. Some feed manufacturers with an exclusive non-GM commercial strategy have decided to provide GM compound feed in their product line. These products are cheaper for their clients. For the same reasons, some retailers who had contractually asked their suppliers for non-GM feed with a GM threshold below the legal threshold (for example 0.5% instead of 0.9%) have changed their strategy: a non-GM soybean product with a GM content below 0.9% is now accepted. Although this is still below the legal threshold for accidental or technically unavoidable presence, this increases the risk of having an end product containing GM material at a level above the threshold.

Soy processing

The most important soy processing step in terms of compound feed processing is the crushing of soybeans into soybean oil and soybean meal. Usually, the beans are crushed and the oil extracted with hexane. As a result, 74% meal, 20% oil and 6% hulls are produced (with 1 to 2% of loss). The meal is then exported to feed manufacturers. The crude oil is further refined. The system which has been analyzed in this study comprised two separate lines for the crushing of soybeans: one for GM soybean and a separate line for non-GM soybeans. This of course renders the segregation of GM and non-GM easy. The refining of the GM and non-GM oil can be done on the same production line, using an appropriate rinsing of the production line. The resulting rinsing charge should however be considered as GM. Again, the use of very well described and established procedures, which are checked by independent third party control agencies, reduces carry-over to a minimum and guarantees the quality of the delivered product.

Feed manufacturing

At the feed manufacturers' level, there are three ways to organize the segregation of GM and non-GM products: dedicated companies, spatial segregation and temporal segregation. An overview of prerequisites, strengths and weaknesses of these strategies are given in Table 1. The dedication to either GM or non-GM production may be preferred by small companies that are not able to produce both, due to the fact that only one production line is available and due to limited storage capacities. Larger companies with several production sites may also dedicate one

Table 1. Prerequisites, strengths and weaknesses of different strategies to concurrently produce GM and non-GM feed.

Strategy	Prerequisites	Strengths	Weaknesses
Dedicated companies: set aside a factory	<ul style="list-style-type: none"> – A factory can be dedicated to non-GM – High demand for non-GM feed 	<ul style="list-style-type: none"> – Low risk of admixture – Low production costs 	<ul style="list-style-type: none"> – Extra costs for transportation – Decreased non-GM demand leads to under-capacity use – Low flexibility
Spatial segregation: set aside a separate line in a factory	<ul style="list-style-type: none"> – A production line can be dedicated to non-GM – High demand for non-GM feed – The production line is isolated 	<ul style="list-style-type: none"> – Low risk of admixture – Low production costs – No extra transportation costs 	<ul style="list-style-type: none"> – Decreased non-GM demand leads to under-capacity use – Extra costs for storage – Low flexibility
Temporal segregation: rinsing of the production line prior to non-GM production	<ul style="list-style-type: none"> – Separate storage facilities for input 	<ul style="list-style-type: none"> – Adaptation to changing demands possible – No under-capacity use – No extra production line needed 	<ul style="list-style-type: none"> – Rinsing procedures increases costs – Higher risk of admixture – Rigorous planning needed

or several plants to GM or non-GM specifically. Thanks to this, the management of carry-over is reduced to a minimum. However, the geographic location of the plant may introduce logistical costs. Moreover, a changing demand for GM or non-GM feed products may lead to reorganization and to an under-capacity use of one of the production plants. As a result, the feed producer will change its strategy, and at least one processing plant will be used for both the production of GM and non-GM feed to reduce its under-capacity production.

Spatial segregation is done where companies have several production plants or several production lines at one plant. In this case, one plant or one production line can be dedicated to the GM products, which allows the reduction of admixtures. But in many cases, feed manufacturers are obliged to manage the production of GM as well as non-GM at the same production line (temporal specialization). Usually, the current equipment is used and no capital investments are made to manage the coexistence of GM and non-GM products. As a result, flexibility in the production process is lost. To sufficiently segregate both products, admixture needs to be avoided by a rigorous planning of production activities and flushing of the production lines with non-GM products. However, in that case, additional costs arise. The production process may also be stopped to purge the line. However, in that case, additional costs arise from lost efficiency and return. A specific flushing procedure after GM production may be skipped in cases where producers know the level of carry-over in their production lines and the GMO level

of the previous production. However, flushing the production line with a non-GM product may be preferred if the resulting flushed product is labeled and sold as GM. The determination of the volume of feed material needed to flush should nevertheless be done in a company-specific way, and may be expressed in terms of tons or time. This practice is most common for compound feed producers segregating GM and non-GM soy in their production facilities.

Book of charge

In order to produce feed products with GMO levels below 0.9% (under the circumstances considered, this is a technically unavoidable presence), the Belgian feed manufacturers have taken the initiative to introduce a book of charge. Its goal is to describe the methods that should be applied to produce and deliver feed products using non-GM feed ingredients, often referred to as “GMO-controlled” (Gryson et al., 2007). This book was set up in cooperation with scientists, the Belgian Federation of Distribution (FEDIS), the Federal Agency for the Safety of the Food Chain (FAVV-AFSCA), the Federal Administration of Health (FOD Public Health) and the Federation of the Food Industry (FEVIA). An advisory body was also established, with members from different stakeholder groups: distribution, food industry, traders, GMO detection laboratories, dairy industry, agricultural organizations and the government. All producers who work with this book of charge should have in place a well

documented and certified or attested quality system. This quality system should conform with codes for Good Manufacturing Practices (GMP). Generally, the producers should have in place systems to guarantee that before the use of any installation for transport, storage and processing of GMO-controlled products, no GMO material is present. Furthermore, prerequisites have been set up for the acquisition, transportation, reception and storage of feed ingredients and the production, storage and delivery of GMO-controlled feed. These prerequisites involve the full description of actions, sampling methods and frequency, rinsing and cleaning procedures, inspections (internal control, *i.e.* self control, and external control by independent third parties) and GMO analyses. Furthermore, attention should be paid to the management of recuperated and default products and the training of personnel. All these actions should be carefully registered. Certified agencies are involved to control the conformity to this book of charge through audits. Attention is paid to the content and execution of the quality procedures. The inspection agencies are also involved in the sampling for GMO analyses, based on the ISO standard 2859 “Sampling procedures and tables for inspection by attributes”. With respect to the GMO analyses, all results are gathered by the Bemefa federation, enabling monitoring of GMOs at the national level, as discussed in Regulation 1830/2003/EC. Annually, a report is published.

As more than 90% of the feed manufacturers in Belgium are member of the Bemefa federation, a majority of the companies work with this book of charge. This is however not the case for every European country. In France for instance, no specific organization is responsible for a general book of charge for GMO-controlled feed production. Only individual initiatives have been undertaken. This may therefore result in discrepancies between companies of the same and/or different countries, in misunderstandings and in some cases mistrust at the import/export level. National and international (European) harmonization should therefore be very much encouraged. This will strengthen the traceability proposals outlined by the EU through Regulation 1830/2003/EC, increase the reliability of the traceability measures, and thereby consumer confidence in the system.

One of the major points of discussion within the feed industry however remains the fact that animal products from animals fed with GM products are not labeled. Only the feedstuffs are labeled, allowing the farmer to choose between GM and non-GM feed. If the goal of the legislation is also to provide consumers with a real choice between animal products from animals fed with GM and animals fed with non-GM, the labeling of these products should also be regulated. Although the GMO origin of feed cannot be detected in animal products, a labeling system based on the traceability from farm

to fork should allow the labeling of these products. In this way, the extensive measures taken to segregate and allow traceability may be compensated. Despite the fact that in some European countries animal-product labeling is already allowed by the national public authorities, generally speaking, it is not yet possible at the European level. Harmonization would therefore be required.

Costs

This raises the question of how to compensate the segregation costs and efforts made by the compound feed producers if they cannot be translated into a non-GMO related label of the animal products. For retailers, who are the most dominant stakeholders on the market to require non-GM production, non-GM is seen as just another quality request among many others, such as private label specifications, or the origin or organic quality signals. Therefore, no specific price differentiation is made for non-GM suppliers. For these reasons, up to now, costs for that labeling have so far been absorbed by, among others, the feed producing companies, and costs have nearly entirely been transmitted to the consumers. In other words, the non-GM feed characteristic is not used as a specific and independent tool to differentiate end products. A discussion of such a strategy is relevant, especially if the extra costs raised by the segregation measures will increase once the GM pressure at the upstream levels increases. This has already been the case for the Belgian compound feed sector. Due to the increased incidence of GM presence in non-GM products and the increased costs of segregation (particularly because of the increased price premium on non-GM soybean products included in the compound feed), the strategy has recently been changed. The book of charge for the production of GMO controlled compound feed has been discarded and focus is now transferred to the production and inclusion of responsible soy. The Round Table on Responsible Soy (RTRS) is an assembly composed of members from different countries of the world, gathered together according to their role in the soy industry: producers, industry and civil society. The main goal is to establish the basis to develop a standard for the production, trade and processing of responsible soy. This is based on five principles: (1) legal compliance and best business practices, (2) responsible labor conditions, (3) responsible community relations, (4) environmental responsibility and (5) best agricultural practices. This system however does not make distinction between GM and non-GM.

CONCLUSION

The stakeholders in the feed chain have been able to adapt quickly to the introduction of GM materials

in the feed chain. The segregation of GM and non-GM materials has been made possible thanks to a good organization, traceability and management of the flows, without any major investments. These systems can guarantee with great certainty the reliability of their products.

Although the strategies described are dedicated to the segregation and traceability of approved events, the increase in vertical coordination within the supply chains, reinforced by supply contracts, traceability tools and suppliers selection, can also increase the capacity of stakeholders in chains where unapproved events or other contaminants are faced.

Due to increased costs and increased incidence of admixture within the soybean chain and the feed manufacturing industry, the book of charge was laid down. In order to restore the confidence of the feed industry in coexistence measures, several topics need to be handled on a European level in the near future: (1) the negative labeling rules of food products derived from animals fed with (non-GM) feedstuffs, which is applied in some EU countries at this time, should be harmonized within the EU; (2) the asynchronous authorization of GM crops between Europe and US should be dealt with; and (3) some general guidelines for the implementation of a book of charge at European level should be introduced. These measures should increase the competitive position of the sector. This would facilitate trade, increase confidence between stakeholders in the feed chain and increase consumers' confidence. This would especially be the case when the availability of non-GM crops will decrease and the variety of GM events will further increase. However, this evolution is difficult to predict. Although European legislation provides the consumers' choice between GM and non-GM, the availability of the non-GM soy products on one hand depends on production in non-EU countries (Asia, America), and is therefore governed by their national legislation on which the EU has no influence. On the other hand, the authorized GMOs are not a food or feed safety issue. The GM (or non-GM) soy is just a new commodity on the market and production will therefore only depend on the supply and demand of the actual market. Future strategies are therefore difficult to predict.

METHOD

This work is based on interviews and case studies made within the European project Co-Extra. In this study, attention is focused on the coexistence issues for the import into the EU of soybeans and soybean meal and the use thereof for compound feed production. In order to analyze the conditions and consequences of the coexistence of GM and non-GM, the feed supply chain was

considered from the import of soy into the European Union up to the consumer.

For the French soybean chain, 15 enterprises were interviewed, for the Belgian chain, eight companies were interviewed from upstream to downstream level: importers, traders, soy processors, feed manufacturers, retailers and certification bodies. The surveys dealt with: (i) activity description, supply and market strategies, equipment (production lines, storage bins...), and product flow management (logistics and transportation, spatial and temporal specialization of equipment...); (ii) modification of the firms' management (supply chain management, supply contracts and suppliers selection, segregation tools, sampling and testing strategies...) linked to the development of the GM-soy market. Moreover, public officers have been interviewed as well, in order to know the means used to guarantee compliance of the products to the labeling threshold, from the upstream to downstream levels of the supply chains.

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