Cost and benefits for the segregation of GM and non-GM compound feed

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Cost and benefits for the segregation of GM and non-GM compound feed

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Abstract- **Measures are being developed and implemented enabling the co-existence of conventional, genetically modified (GM) and organic cropping systems. In order to segregate GM from conventional crops in the entire supply chain, a food or feed company has to reorganise its production. This may involve the dedication of the production line to non-GM, or production can be organised on the same plant, using spatial or temporal segregation. In practice, only the latter method is used in the feed industry, as no investments in new machinery are necessary in this case. The segregation and identity preservation of GM and non-GM crops has to be well organised. An important tools used to proof the identity of the imported raw materials is the batch or product declaration and in some cases, a supplementary certificate of analysis for the raw materials is provided. In compound feed production, specific procedures to reduce carry-over are introduced and described in a book of charge, such as rinsing of transportation and production line, empty declaration of transport systems or storage bins and specific discharge and production orders. All these measures however imply supplementary costs to the manufacturer. A major additional cost is the price difference between GM and non-GM raw materials. Other extra costs result from losses in flexibility, a devaluation of the rinsing product, analysis and audits. As a result, the cost of a compound feed using non-GM is higher than with GM. Benefits to the segregation measures are an increased gamut of products and an improved organisation and management of the production. Together with an improved traceability system, consumers' confidence is also increased.**

Keywords- **GMO, co-existence, costs, segregation, identity preservation, compound feed**

I. INTRODUCTION

The introduction of EC Regulations 1829/2003 [1] and 1830/2003 [2] for GMOs require the labelling and traceability of GMOs throughout the entire food and feed production chain. Implementing measures to support the labelling 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. At the different steps of growing, shipping, import and use of soybean products in feed supply chains, measures to maintain the segregation and to avoid the contamination of non-GM with GM products need to be taken. The traceability and labelling requirements however impose costs on producers. These costs may vary according to the food product and production system.

Costs due to the identity preserved (IP) production of non-GM products may arise in every step of the production chain, starting at pre-farm level to farm, transport, storage, processing, labelling and distribution of products [3,4]. These costs include costs for cleaning of equipment, costs for drawing up contracts between buyers and sellers, costs for monitoring contract compliance and costs for administration and testing [5].

The magnitude of IP costs depends on the agronomic trait and the precise circumstances of the crop, the range of products derived from it, uses to which they are put, tolerances and specifications set, the sophistication of the distribution system, the volume of material subject to IP, experience of operating IP systems, and whether dedicated plant/machinery and supply lines are used [3,6]. According to Bullock and Desquilbet [7], the major cost in segregation and IP of non-GM soybeans should be attributed to the decreased flexibility.

Extensive research and detailed information regarding these costs is however poor. According to several studies [8-10], an estimated increase of 5 to 25 € per ton due to IP should be taken into account. Alternatively, Smyth & Phillips [6] account for an increase ranging between 15% and 25% above the cost of conventional products for IP systems. According to Brookes [3], empirical evidence relating to soy indicates the additional cost involved is within 10 to 150% of the farm-gate price of soy.

In this study, segregation measures to segregate GM and non-GM at import and feed manufacturing level are presented. Furthermore, an extensive calculation of the surplus cost for the production of compound feed products containing non-GM soybean products is performed. Major cost categories considered are the surplus costs for the soy ingredient, for production and for audit and analysis. As soy is one of the major GM crops, and the co-existence of GM and non-GM soy is present in the compound feed production in Belgium, this study may form an indication of costs when introducing the co-existence of other crops in similar production systems.

II. MATERIALS AND METHODS

To estimate the impact on the end price of animal feed containing hard IP soybean meal, 6 major Belgian animal feed producers were asked to estimate the extra cost for this production, compared to the use of conventional soy. The 6 manufacturers produce about 40% of the Belgian compound feed. A task force of feed manufacturers, scientists and representatives of Bemefa, the Belgian Federation of Compound Feed Manufacturers, has been established. Three task force meetings were followed by written and telephonic contacts.

In Belgium, currently one trader delivers hard-IP non-GM soybean products, based on certificates of analysis and a certified production chain. The system guarantees a GMO absence with a threshold level of 0.1%.

Due to the fact that the different feed manufacturers produce different volumes and the fact that they maintain different proportions of GM and non-GM production on site, minimum, maximum and average costs were estimated or calculated. For the determination of the surplus cost for the soy ingredient (GM vs. non-GM), calculations were made according to a computer program used for the determination of compound feed formulations. The surplus costs for the production of non-GM are estimations proposed by the feed manufacturers. The extra costs for auditing and analysis were based on data from the feed manufacturers.

III. RESULTS AND DISCUSSION

A. Segregation measures

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 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, with an contamination amount of maximum 0.1% GMO in the non-GMO product. Segregation and monitoring activities include the use of specialised, dedicated processing companies (e.g. for soybean crushing), dedicated harbours, 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. Goods are unloaded from sea-going vessels with conveyer belts to store and tranship them on lighters and lorries.

At the time of delivery of a batch 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 reddlers 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 contamination of GM with non-GM products is avoided.

The different non-GM feed ingredients are stored in different silo's. Every cargo is stored into a different silo. According to the hard IP program standards, all storage facilities and loading and handling equipments needs to be inspected and cleaned before the reception of non-GM products. To guarantee the traceability, the buyer receives the name of the vessel at delivery. As the vessel's name is related to a specific silo, not only the segregation but also the traceability is guaranteed. Transport of these products from the importers to their clients is mainly done by lighters and trucks. Similar procedures need to be followed, which are checked by an independent inspector. Similar procedures exist for charge/discharge of lighters and trucks.

As a result, different soy products are obtained, with a different GM purity and traceability level. The threshold for GMO contamination, together with the intensity of the traceability will impart an extra premium for those products, compared to their conventional counterparts.

At the feed manufacturers' level, there are three ways to organise the segregation of GM and non-GM products: dedicated companies, spatial segregation and temporal specialisation. The dedication to either GM or non-GM production may be preferred by small companies which are not able to produce both, due to the fact that only one production line is used and due to poor storage capacities. Larger companies with several production sites may also dedicate one or several plants to GM or non-GM specifically. Thanks to this, the management of cross contamination is reduced to a minimum. However, the geographical orientation of the company may introduce logistical costs. Moreover, a changing demand for GM or non-GM feed products may lead to reorganisation. In the end, the feed producer ends up with a situation where at least one processing plant will be used for both the production of GM and non-GM feed.

Spatial segregation is done where companies have several production lines at one plant. This situation will however necessitate stringent segregation rules and controls. Most feed manufacturers however are obliged to manage the production of GM as well as non-GM at the same plant. Usually, the current equipment is used and no capital investments are made to manage the co-existence of GM and non-GM products. As a result, flexibility in the production process is lost. To sufficiently segregate both products, cross contamination needs to be avoided by a rigorous planning of production activities and flushing of the production lines with non-GM products. The production process may also be stopped to purge the line. However, in that case, additional costs arise from the loss 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, the flushing of the production line with a non-GM product may be preferred if the resulting flushed product is labelled 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.

B. Cost calculation

For the calculation of the total surplus cost for the production of compound feed containing genetically modified soy instead of conventional soy, three cost categories were selected:

1. the surplus cost for the soy ingredient
2. the surplus production cost
3. the surplus costs for audits and analysis

Not included in the extra production costs are the extra energy cost to flush the production lines and the extra cost for transport.

Extra cost soy ingredient: The primary vegetable protein source in animal feed is soybean. The formulation of a compound feed containing soybean meal varies, according to the target animal, its development stage, the price relation to other feed ingredients and the technological performance sought. The exact proportion of each ingredient in a compound feed is calculated through linear programming. For each ingredient, parameters such as nutritional value and price are known. Subsequently, the computer calculates the ideal cost/quality formula (least cost formulation) for a given animal feed.

Three scenario's were chosen to calculate the extra cost for compound feed for laying hens, broilers and pigs, replacing the conventional soybean meal with the more expensive non-GM soybean meal. These scenario's were:

- scenario 1: considering the use of hard-IP with an extra cost of 10€/ton and taking into account that Brazilian soybean is 10€/ton more expensive than Argentinean
- scenario 2: hard-IP extra cost of 10€/ton and Brazilian soybean 20€/ton more expensive than Argentinean
- scenario 3: hard-IP extra cost of 20€/ton and Brazilian soybean 20€/ton more expensive than Argentinean

The results of the calculations, taking into account the differentiation in feed composition depending on the target animal, are represented in Table 1. Results of scenario 3 are more or less 2 times more than of scenario 1. In reality, compound feed manufacturers considered reality to be somewhere between scenario

Table 1. Extra cost for animal feed containing hard-IP non-GM soybean meal instead of conventional soybean meal (€/ton)

Animal	Extra cost Scenario 1	Scenario 2	Scenario 3
Layer hen	1.75	2.51	3.77
Broiler	3.39	4.51	6.88
Pig	1.04	1.7	2.37

1 and 2. Further in this research, scenario 1 is considered as a minimum, scenario 3 as a maximum and scenario 2 as an average extra cost.

Production cost: In Belgium, the production of GM and non-GM feed is generally carried out on the same production line. The extra cost related to the segregation and co-existence of GM and non-GM soy used in feed therefore involves costs related to:

- intake alteration
- flushing of production lines
- installation of extra silo space
- loss in flexibility and profitability

Most feed mills only have one intake point for dry feedingstuff. After the intake point, the feed material is conveyed to a silo. To avoid contamination at this point, an additional intake point for non-GM feed materials could be used. However, in practice, a physical alteration of the intake system, together with a specific planning of the intake order is done. Additionally, in some cases, the dumping pit can be flushed. The extra costs at this stage therefore comprises a loss in flexibility in the intake order, costs for the alteration of the intake system and a surplus cost of non-GM ingredients to flush the intake. As a result, an average surplus costs of 0.19 €/ton is due to the intake of GM and non-GM products using the same dumping pit (Table 2).

Carry-over, measured from the blender onwards, easily attains 5 % of the volume of the feed produced. To avoid carry-over to become too large, several measures have to be taken during the production of animal feeds. The flushing of the production line with non-GM after a GM production results in an extra cost, as the final product cannot be sold as non-GM. The flushing cost can therefore be calculated as:

Flushing cost = Volume (flush batch/day) x
Value loss (batch from non-GM to GM status)

In the production line of compound feed, flushing is necessary at different stages. Flushing will be needed to clean the (hammer) mill and (blender) mixer from potential GM remainders. If at the end of the production chain the animal feed is pelletised, flushing is also needed to clean the entire press line. The energy needed to flush the production lines was not included in the cost calculation. The minimum, maximum and average flushing cost is shown in Table 2. According to the feed producers' estimates, an average cost of 0.90 €/ton should be added to the final cost of the feed product.

Table 2. Extra production cost for non-GM feed (€/ton)

Cost category	Extra cost Minimum	Average	Maximum
Production cost	*0.55*	*2.82*	*8.08*
Alteration at the intake	0.03	0.19	0.60
Costs for flushing	0.19	0.90	2.28
Additional storage	0.14	0.79	2.40
Loss of profitability	0.20	0.94	2.80
Audit and analysis	*0.10*	*0.46*	*1.11*
Audit	0.02	0.12	0.26
Analysis	0.07	0.34	0.85

Unlike some food companies, the amount of different end products produced in a feed mill is enormous. Even small feed mills are known to produce over more than 100 different compound feed types. Mostly, feed is produced and delivered at the same day. In this case the feed is directly loaded on the truck, without intermediate silo storage. However, if end storage is needed, dedicated silos for non-GM compound feed need to be available. The cost for extra intake silos for the non-GM feed materials has been estimated at 0.79 €/ton, with a minimum of 0.14 €/ton and a maximum of 2.4 €/ton (Table 2).

The production of both GM and non-GM compound feed products irrevocably leads to a reduced production flexibility. Also, the number of end products increases, with smaller batches and more interventions of employees. Moreover, the production needs to be interrupted for flushing activities and more samples need to be taken, from raw materials as well as from the finished products. On average, this leads to an extra cost of 0.94 €/ton (Table 2).

In the calculation of the total surplus cost for the production of a GM compound feed, a high variation between companies can be recorded. This mainly depends on the share of non-GM feed in the entire production. Of the six companies questioned, the company with the smallest overall production also has the smallest share of this non-GM production (< 3%) and also the highest costs for non-GM production. A mean total cost of 2.82 €/ton was obtained, with a variation from 0.55 €/ton to 8.08 €/ton (Table 2).

Audits and analysis: Costs for GMO analyses may vary from lab to lab and may depend on the methodology applied (protein versus DNA-based methods). Generally, in Europe, GMO analyses are based on the PCR technique. For the presented calculations, a cost for qualitative PCR analysis was estimated at 205 € per test, for a quantitative GMO analysis 350 € was assumed. This amount should then be converted to the production volume, which depends on the company under investigation. On average, 0.34 €/ton was added to this total cost resulting from GMO analysis.

In 2002, the Belgian book of charge for the production and delivery of GMO controlled (< 0.9%) compound feed products, published by Bemefa, was introduced in the Belgian feed manufacturing industry [11]. The establishment of this book of charge also involves an extra cost for the manufacturers. Moreover, the implementation of this standard is verified by independent certification organisations, amounting an average cost of about 0.12 €/ton for auditing.

Total surplus cost: The extra cost for non-GM raw material, combined with the extra cost for production and costs for audits and GMO analyses, represent the total extra cost for the production of non-GM compound feed containing soybean meal. Although the extra cost depends on the type of compound feed produced, an average extra cost of 6.2 €/ton is caused by the use of non-GM soybean meal instead of GM soy. This amounts for an additional cost of about 2.4% on the total cost of the feed (Table 3).

Table 3. Overall surplus cost for the production of compound feed product containing non-GM soy according to the animal type

	Average extra cost	Cost feed	Average proportion
Layer hen	5.8 €/ton	225 – 275 €/ton	2.3 %
Broiler	7.8 €/ton	310 – 350 €/ton	2.4 %
Pig	5.0 €/ton	190 – 230 €/ton	2.4 %

However, not included into this calculation are the higher insurance fees which might need to be paid, due to the increased risk of compensation for damage in case a non-GM feed is accidentally contaminated with GMOs. Costs for monitoring and possible recalls should also be taken into account, as well as governmental fines for the incorrect labelling. It should therefore be stated clearly that the calculated cost is considered as an absolute minimum cost for non-GM feed production.

A survey, held in April 2005 among 17 major non-GM feed producers in Belgium revealed that about 25% of their production is non-GM, or about 540 000 tons. Taking the results for the extra cost for feed for layer hen, broiler and pig into account, the total extra cost for this volume of non-GM production equals 2.6 million euros. As those 17 companies amount for 44% of the total Belgian production of compound feed and assuming that other Belgian companies have a similar partition of GM/non-GM production, the segregation and co-existence of GM and non-GM soy in the feed industry represents at least 8.6 million euros every year.

Consequently, meat and milk products derived from animals fed with non-GM products, which should not be labelled according to the European legislation, lead to an extra cost for those products. However, until so far, no distinction is made between prices of meat and milk products which are derived from animals fed with GM and with non-GM feed. Only organic meat, which is per definition also not derived from GM, is more expensive than conventional meat products.

C. Benefits

During interviews the companies' mangers as well as experts also pointed out some benefits of qualitative nature, such as a better management, a better control of the GMO issue and a higher consumer trust.

Moreover, on an European level, some initiatives are being undertaken by the feed industry as well in order to guarantee traceability of feed products. European Regulations 852/2004 [12] and 183/2005 [13] states that national or community guides to good hygiene practices should be elaborated. The FEFAC, the European Feed Manufacturers Federation, has therefore implemented this request into the European Feed Manufacturers Guide (EFMC). Its main objective is to ensure the safety of feed through good manufacturing practices during the purchase, handling, storage, processing and distribution of compound feed for food producing animals in accordance with the objectives of the CODEX code of practice on good animal feeding and the requirement laid down in the EU General Food Law. In January 2007 national guides had been set-up for 17 of the 25 EU Member States and Switzerland [14]. It may in this context be assumed that these measures coincide with measures which need to be taken to enable co-existence. This could be seen as a benefit for the feed manufacturers, as some of the discussed additional costs attributed to co-existence correspond to the costs made in the context of good hygienic practices.

The (re-)organisation of the production with a more rigorous planning of activities however also has resulted in reduced risks of mixing of GM and non-GM products, traceability systems and overall management have been improved, and recall of products should be easier. Different contracts which have been set up between sellers and buyers to ensure a non-GM production have also increased the reliability among stakeholders. All the measures taken eventually result in the increased confidence of consumers.

IV. CONCLUSIONS

The stakeholders in the feed chain have been able to adopt quite easily 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 organisation and management of the flows, without any major investments. These systems can guarantee with great certainty the reliability of their products. From the results it can be concluded that the extra costs for non-GM production are substantial in an industry where margins are small. Many compound feed producers state that these costs are not incorporated in the final price of the feed. Animal farmers, producing non-GM fed animals, also assert that retailers, although they demand non-GM, are not willing to pay more for non-GM animal products. It should therefore be questioned who will be willing to pay once the volume of the worldwide non-GM production decreases and therefore the price for non-GM soy will increase. It may be assumed that once consumers will be confronted with a price difference for GM and non-GM products, they will choose for the cheapest alternative. In this way, non-GM production will become a niche market.

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