Study and analysis

Coexistence of GM and non-GM sectors: additional costs

Regulations and consumer pressure demand guarantees regarding the GM or non-GM origin of maize-based foodstuffs. Each link in the chain must ensure the GM and non-GM sectors are properly separated. As part of the POECB[1] programme, ARVALIS - Institut du végétal and AGPM (union of French maize growers) have evaluated the additional costs associated with this organisational requirement. Here is their verdict.

The absence of GM products in a non-GM product is necessary to meet current consumer requirements. But since it is impossible to guarantee the absolute absence of GMOs in a production system, a low level of impurity is tolerated in foodstuffs, i.e. 0.9% of genetically modified material for processing[2] events approved in Europe (Regulations 1829/2003 and 1830/2003).

Those regulations assume that the sectors are physically separated as soon as the first hectares of transgenic maize are being put in the ground. Such requirements incur additional costs at each stage in the maize sector: segregation costs and analytical monitoring costs.

Segregation costs help separate products from both sectors, avoiding the accidental presence of GMOs beyond the level tolerated in non-GM products. They include the cost of measures intended to limit cross-pollination, of using dedicated equipment for each of the products, of investing in new equipment, etc.

Guarantee costs are meant to ensure the purity of a non-GM batch, within statutory limits. They are linked to control tests carried out on product samples, to the establishment of coordination procedures between the different sectors (information system, specifications) and to monitoring activities designed to ensure those procedures are properly implemented.

Cross-pollination

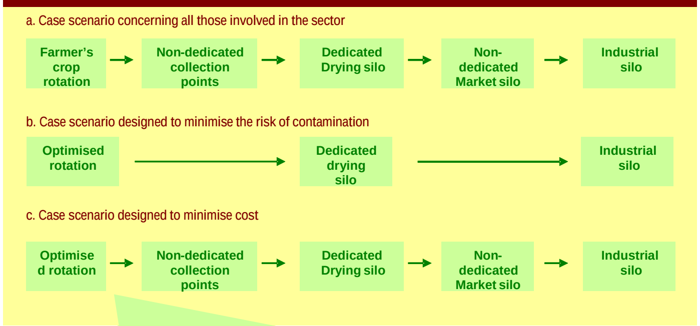
The study of the sectors' critical points helps discern four main sources that explain the accidental presence of GM grains in a non-GM production: seed impurity, cross-pollination, volunteer growth and handling of the product after harvest.

The relative importance of each of those sources depends on the crop and the way the sector is organised. The volunteer growth for instance, which creates major problems in oilseed rape crop management, does not occur in French maize. The case of Spain, where Bt maize has been grown since 1998, shows that coexistence between GM, non-GM and organic crops is not linked to any major economic or commercial problems. With a ceiling of 15,000 ha until 2002, the development of GM maize crops in Spain only really took off in 2003 with 32,000 ha of Bt Maize, which represented 7% of the

Additional costs associated with the coexistence of the GM and non-GM sectors, are incurred by separation and monitoring operations.

At field level, additional costs are mainly associated with equipment cleaning time between GM and non-GM fields.

Organisational scenarios for the sectors *(fig. 1)*



The economic analysis of coexistence helped list preventive and corrective actions at each stage of the sector. Three typical organizational paterns were identified, depending on the objective (real sector conditions, risk minimization or cost minimization).

Estimated additional cost for each main item (tab.1)		
Additional cost item	Equipment	Labour
Cleaning of equipment*	-	0.5 hr* 14€/hr
Monitoring at field level	2.5€/ha	0.25 hr/ha* 14€/hr
Records management		0

**after GM maize harvest*

The additional cost incurred for the control of a non-GM field because of the presence of GM maize nerby is 13€/ha.

If the level of infestation is high (above 0.8 larvae per plant), the financial balance sheet of Bt technology becomes positive

total Spanish maize area. With new varieties listed at the beginning of 2003 having become available for the 2004/2005 cropping season, Bt maize crops reached nearly 60,000 ha in 2004 in Spain, representing 14% of the area used to grow maize. In 2005, 53,000 ha of Bt maize were planted (with an overall reduction of the maize area due to drought). In 2006, the area was estimated at around 60,000 ha. The economic analysis carried out as part of the POECB1 programme aims to supply the Bt maize sector with practical tools to estimate the cost of GM and non-GM maize coexistence within the 0.9% statutory limit. Various possible organisational scenarios of coexistence between the sectors have been studied, based on information available from research programmes and experiments carried out by the waxy maize sectors, for starch and seed maize markets.

Several possible organisational scenarios for the sector

Traditionally, the maize sector includes nine stages: sowing, harvest, transport to collection point, haulage to drying silo, drying, storage, haulage to market silo, storage, use/processing. The economic analysis of coexistence helped list preventative and corrective actions associated with the different critical points that have been identified for each stage. Typical organisational patterns (figure 1) have been defined, to meet realistic sector objectives, as well as risk and cost minimisation objectives.

In the case scenario which seems to best reflect **real practices** (a), coexistence between GM and non-GM production is organised as follows:

• The farmer is free to choose whether he uses Bt technology or not, which means that he decides the crop rotation. The location of GM and non-GM fields is then unpredictable and not optimised.

• Intermediary collection points are not dedicated, which means that they are allowed to receive both types of products simultaneously: GM and non-GM maize, with identified product reception units. Given the current situation and the 0.9% limit imposed for the non-GM sector, this is the most realistic structure, in terms of organisation, for storage facility organisations.

• Market silos are not dedicated, dedicated market silos being absolutely unfeasible in this scenario.

In the scenario aiming to **minimise the risk of admixture** (b), the number of stages is reduced to a minimum, in order to limit the number of times the product is handled, which in turn reduces the risk of admixture. This type of very specific organisation can only work with small volumes. It can be considered as a possibility when contracts are concluded between the farmer, the storage facility organisation and the end processor.

• When this type of organisation involves non-GM maize fields, the fields are chosen for their geographic location, guaranteeing that they are far enough away from the GM source. This assumes a proactive attitude downstream (storage organisation and processor) regarding the choice of rotation.

• The harvested maize is taken directly to a dedicated drying silo. Collection points are eliminated in order to reduce the number of times the product is moved.

• When it comes out of the drying silo, the product is taken directly to the contracting processor's storage site, without going through a market silo.

In a realistic case scenario, the sector's organisation is adjusted to **minimise additional costs** (c). GM and non-GM fields are grouped in such a way as to optimise the way the sector operates. This supposes coordination between storage facility organisations and a very proactive location of fields.

• The various facilities are not dedicated, which means that both types of products can be handled at all sites, cutting down running costs. The fact that the drying silo is not dedicated greatly increases the risk of admixture, resulting in the reclassification of part of the non-GM batches to GM batches. This structure can hardly be envisaged anyway, given the management and organisational problems arising from the succession of batches through the drier.

Estimated financial value of agronomical benefits from Bt maize and maize protected by insecticide *(tab.2)*

	Bt maize	Treated maize
Cost of Bt technology/ha	40.8 €/ha	-
Cost of insecticide treatment	0	31€/ha
Average yield	90 t/ha	
Average price of maize	103 t/ha	
Yield increase compared with untreated non-GM control - if <0.8 larvae/plant - if 0.8 larva/plant < < 2 larvae/plant - if > 2 larvae/plant	1.5% 5.5% 17.3%	1.1% 2.4% 6.6%
Financial balance sheet - if < 0.8 larvae/plant - if 0.8 larva/plant < < 2 larvae/plant - if > 2 larvae/plant-	-2.99€/t 1.13€/t 13.29€/t	0.04€ /t 1.38€/t 5.71€/t

The additional cost of GM maize seed is offset by the absence of insecticide treatment and yield stability in case of pest infestation

Additional collection costs linked to coexistence incurred by three storage facility organisations involved in this study *(tab. 1).*

GM collection	Additional cost per t of collected GMO (€/t)			Additional cost per t of collected maize (€/t)		
	Average	Minimum	Max.	Average	Minimum	Max.
10%	18.26	15.44	21.84	1.82	1.54	2.18

The figures obtained are very close for all three organisations involved in the study, in spite of significantly different infrastructures (area covered), field distribution and strategies. The lowest figures are explained by a denser collection network, with lower additional transfer costs

Estimated additional costs linked to coexistence

Part of the additional costs arising from having to segregate the GM and non-GM sectors, are generated in the field, and directly attributed to farmers. The remaining additional costs are generated by collection and therefore fall to the storage facility organisations' share. Taking into account the reality of cropping conditions within the POECB programme, and in association with partner producers, various additional cost items have been identified at field level (table 1): cleaning of sowing and harvesting equipment, monitoring at field level and records management.

• Cleaning of sowing and harvesting equipment: producers who decide to establish both types of crops on the same farm are responsible for cleaning the equipment. The additional cleaning cost is calculated by estimating the labour cost associated with the additional time spent by the farmer cleaning the equipment between working in a GM crop and a non-GM crop. Good equipment management consists in dealing with all of the non-GM maize first, and finishing with the GM crop, when possible: that way, the drill and harvester need only be cleaned once, at the end of the campaign.

• Monitoring in the field: non-GM maize can be monitored in the field in order to determine whether the harvested crop is within the statutory 0.9% limit. The cost of monitoring in the field depends on the analytical method chosen to detect GMOs (PCR or rapid detection), on the average area of the fields being monitored (estimated at 2 ha in southwestern France, the average area per analysis varies from region to region and can be smaller where non-GM fields form blocks) and includes the cost of analysis as well as the cost of labour to carry it out.

• Records management: this item is considered as void since the traceability demanded by storage facility organisations from producers is already very comprehensive. Therefore, no additional costs are attributed to the document recording and monitoring of the crop.

Those costs must be balanced in the Bt maize field balance sheet. The producer must indeed pay more for the Bt maize seed than he would have for non-GM seed, but he can hope for a financial gain resulting from the absence of chemical treatment and the fact that the yield will remain stable even if the crop is attacked by pests. A Bt maize balance sheet simulation helps build an example which can be used to compare Bt maize and maize treated with one insecticide application (table 2).

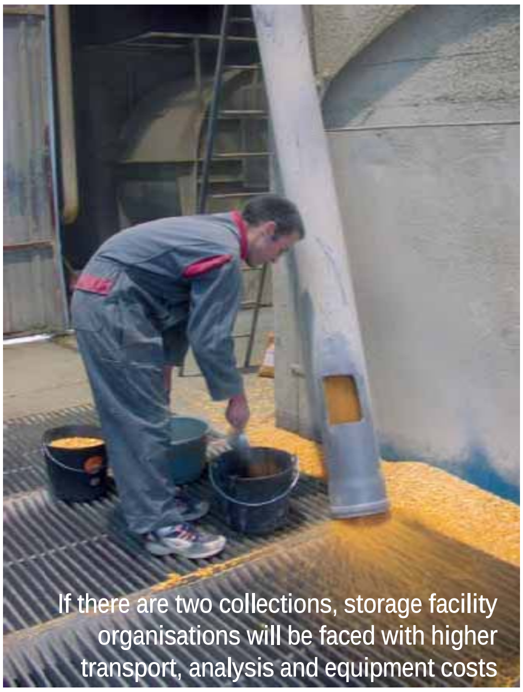
If the level of infestation rises above 0.8 larvae per plant, the financial balance sheet of Bt technology becomes positive, compared with treated and untreated maize. When the level of attack gets above 2 larvae per plant, this advantage reaches 13.29 €/t for untreated maize and 5.71 €/t for treated maize.

With two insecticide treatments, the advantage falls below 2.50 €/t for treated maize. This financial balance sheet does not take into account the environmental balance linked to the application of pesticides in the field, nor the safety quality balance.

One of the hypotheses used to build a concrete coexistence case is based on 10% of the total maize collected (150,000 ha) being GM maize, i.e. 20% of the current area attacked by European corn borers and pink borers (Sesamia nonagrioides), and facing the risk of economic consequences.

The location of GM fields is considered as unpredictable and purely dictated by the farmer's decision to use Bt technology (only events which can currently be used in crops).

The comparison of the different structure scenarios does not take into account the type of organisation involving dedicated silos, which is a technically unrealistic hypothesis.



If there are two collections, storage facility organisations will be faced with higher transport, analysis and equipment costs

In this framework, the different case scenarios proposed by storage facility organisations have been costed. They include all the items listed for each stage of the sector as potential sources of additional time input, investment or running costs.

Additional cost calculations were based on the following elements (table 3):

- Average volume per trailer load delivered by farmers to collection points: 9 tonnes
- Volume per lorry load: 26 tonnes
- Labour hourly rate: 14 €/hour
- Additional acceptance time needed for sampling (when this step needs to be added to the usual acceptance process), chopping, and carrying out the test: 12 mn.

The main additional cost items for storage facility organisations have been identified as:

- Analysis of non-GM maize, using test strips (99.1% purity check). Labour costs are calculated in actual additional time at the acceptance stage. The cost of buying chopping equipment (wet grain chopper) is not included in the additional costs.

- Additional transport (of GM and non-GM maize) to dedicated sites. Storage facility organisations use haulage companies to transport most goods (in terms of collection, 15 to 30% of transport is carried out by internal vehicles).

- Equipment costs (at collection points or driers). On the whole, storage facility organisations are reluctant to invest in new equipment, since the current trend seems to be going towards a reduction in the number of operational collection sites. Therefore, investments tend to be reduced to the strictly necessary minimum.

For the whole maize collection, additional costs associated with organising the coexistence of the GM and non-GM sectors represent around 1.8 €/t. Conversely, when calculated per tonne of GMOs, additional costs represent 18.26 €/t. The same calculation applied to 50% of the GM collection would result in reducing additional costs to 3.6 € per tonne of collected GM maize.

Examples of risks and opportunities relating to the introduction of GM maize *(tab. 4)*

Risks	Opportunities
• Some problems may arise at farm level: flow management for two products, increase in collection time, longer waiting time at loading … • Increased haulage pressure with longer distances and transport time, which are going to lead to an increase in the demand placed on haulage companies (dedicated silos). • Acceptance of GMOs by port silos subject to acceptance of GM products by their markets (destination countries and clients/users). Cleaning of storage facilities in the case of non - dedicated silos.	• In the case of Bt maize, GM production zoning based on pest infestations will make collection management easier. • The sharing of silos between collection organisations sharing the same fields of activity, can help reduce the costs associated with organising sector segregation. This would significantly reduce the transport cost item, by limiting the number of intermediary silos.

Some uncertainties remain

It is still difficult to take into account all of the costs that could arise from coexistence measures. However, those which have been identified are nonetheless real. Other factors can also have an impact: market price and demand will have a very significant bearing on the crop and the way the sectors are organised.

There are still many uncertainties, including regarding the potential price differential between GM and non-GM, acceptance of GMOs depending on the market, or even the potential regionalisation of production (table 4). All those parameters are likely to modify the production costs of a GM sector.

Florence LEPRINCE-BENETRIX
f.benetrix@arvalisinstitutduvegetal.fr
ARVALIS — Institut du végétal
Cédric POEYDOMENGE
cedric.poyedomenge@agpm.com
AGPM
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1.Operational Assessment Programme for Biotechnology-based Crops
2 Processing event: genetic sequence inserted to confer a given property to the plant (for instance, resistance to insects)